Surviving the Storm

Coastal & Offshore Tactics

First Edition

Steve & Linda
DASHEW

B E O W U L F

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Surviving the Storm

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Linda and Steve Dashew

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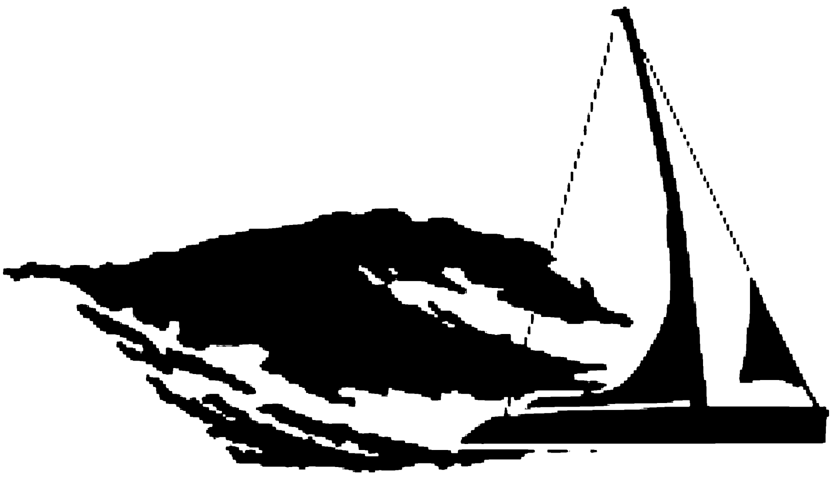

Steve & Linda
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B E O W U L F

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Dashew Offshore Video
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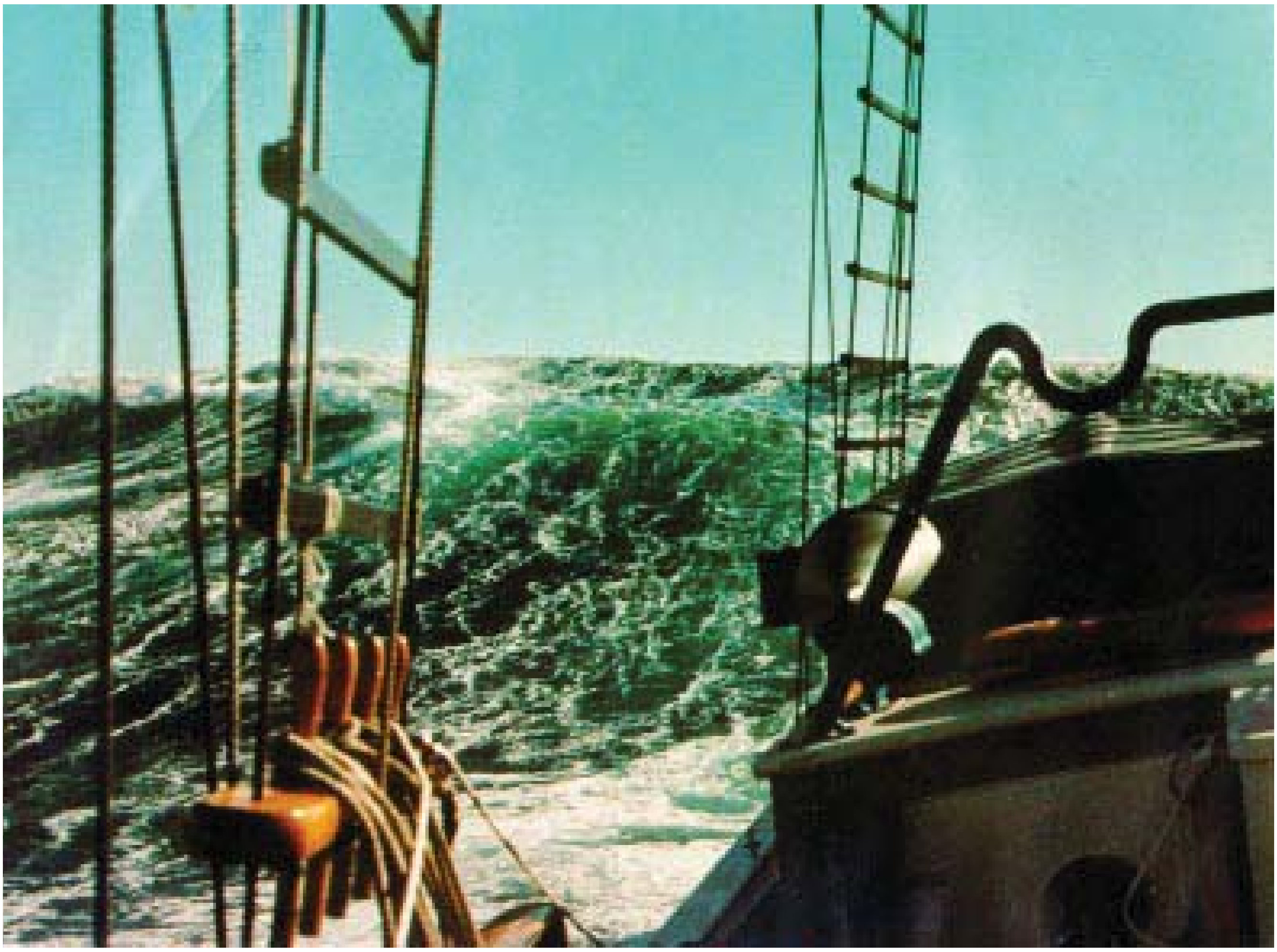


Charles Tobias

"Twenty years from now you will be more disappointed by the things that you didn't do than by the ones you did do...Sail away from the safe harbor. Catch the tradewinds in your sails. Explore. Dream. Discover." *Mark Twain*

Dedication

Throughout the history of seafaring there has been a tradition of helping mariners in distress. From the early coastal dwellers who took huge risks trying to rescue stranded sailors, to the pilots of modern search-and-rescue aircraft, when another's life is in danger, certain people are always willing to risk their own to try to help.

Today's heroes fly helicopters and fixed-wing aircraft in extremely dangerous conditions, venture out in small motor boats in horrendous seas, and put large ships at risk in storm-force winds.

It is not unusual for the rescuers to face more risk than those who think they need to be helped.

To these courageous men and women we dedicate this book.

USCG

Table of Contents

PREPARATION.....105

Richard Bennett

INTRODUCTION

For many years our discussions with new cruising acquaintances have followed a predictable pattern—we've been asked about severe weather and the tactics we use to deal with it. When we reply that we've rarely seen any dangerous weather—less than three days' worth in well over 200,000 miles of sailing—our friends are amazed. Sure, we've been in lots of gales and storms, but they haven't been dangerous. Rather, they've been more in the category of something to be endured.

What is surprising, and so unneccessary, is that the thought of *any* sort of storm often triggers fear. This is primarily due to lack of knowledge. As a result, decisions are often made in a vacuum during the process of preparing the boat, acquiring skills, and thinking about tactics. The goal of this book is to help you change that process.

In spite of the fact that heavy weather is so rare, its possibility has been central to our own cruising philosophy, as well as the design approach we've utilized in our yacht construction business. For years we've been conducting interviews with sailors around the world, both professional and amateur, to find out what has worked for them in heavy weather, and, sometimes more importantly, what mistakes were made in the worst conditions.

We will be using this database, stretching back almost a quarter of a century, to provide you with an understanding of the processes for dealing with survival storms. We'll cover every aspect of the topic, from choosing the right boat (or evaluating the one you have) to getting yourself and your crew up to speed by *practicing* various tactics in moderate gales.

We do this from the perspective of the most severe conditions because, by preparing for the worst, the occasional gale can then be looked upon as an opportunity to learn.

In almost all heavy weather situations, a modern vessel handled with a modest degree of skill is able to take an astonishing amount of punishment from the sea. But key ingredients for success are a well-prepared crew and proper maintenance.

No two storms are ever the same, and different boats react in unique ways to the variables of wind and waves. No single cookbook formula offers the best solution all of the time for all boats in all conditions. However, by understanding the full range of heavy weather tactics, you will then be in a position to judge the best approach for the conditions you are presently encountering.

As conditions deteriorate, different tactics will be required. What may be the right approach for certain boats in a gale—heaving to on a particular tack, for example—may be dangerous for others when the seas begin to break.

However, there are universal lessons to be learned from the heavy weather experiences of others—even when a specific boat's characteristics do not exactly match those of your own. This is why we've included stories of so many different types of boats using similar tactics.

There are many schools of thought on how vessel size relates to heavy weather. We can tell you with a high degree of certainty that a properly designed, well prepared small boat will do better in serious weather than a poorly designed, improperly set up large vessel.

Many small yachts have done amazingly well in some very difficult conditions. But, all things being equal, the bigger the vessel, the better the chance it will have.

Storms at Sea

We categorize heavy weather into three types. First are those situations that may be uncomfortable and hard on vessel or crew, but are not dangerous. Normal gales fall into this category, as well as open-ocean storm-force winds where current or bottom shoaling do not cause waves to break. In these types of blows the vessel will typically look after itself without a great deal of assistance from its crew. A serious mistake might result in a torn sail or some broken gear, but will not compromise the vessel's security or the crew's well being.

Cross references:

All of the material in our *Mariner's Weather Handbook* and much of *Offshore Cruising Encyclopedia* bears on the subject of heavy weather—either avoiding or preparing for it. We have tried to make the job of cross referencing to these books easier by including page numbers for appropriate sections.

The second category is where conditions are more challenging, but still not dangerous as long as the crew exercises a reasonable degree of prudence and good seamanship. If major mistakes are made, this type of scenario has the potential to do damage to vessel and/or crew.

The third situation, the survival storm, is extremely rare. Here we are dealing with a sea state that requires utmost vigilance on the part of the crew. In this case, a breakdown in any of the important systems on board can result in severe problems.

You will find that a disproportionately large percentage of the book contains stories of such catastrophic storms. We wish to emphasize again that this type of weather is, overall, an extremely rare occurrence. We place so much focus on these stories because of the excellent lessons they teach. It is worth repeating that if you are prepared for survival weather, the rest of your cruising will be a piece of cake.

But a weak link in the vessel's systems can become the catalyst for a series of events resulting in disaster. A problem which is merely an annoyance in a gale can become a life-or-death issue in storm-force winds with breaking seas.

Heavy-Weather Games

Since all mariners strive to avoid direct experience with heavy weather, how is it possible to practice what to do? The approach we suggest is to learn how to handle your boat in a stiff breeze. This way you will be better prepared if caught in a real blow. Seek out the *opportunity* to learn in gale-force winds.

For truly severe weather we have to rely on the experiences of others. In this context, you may find it helpful to employ a technique of vicarious seamanship.

Try to imagine yourself aboard your own vessel, caught in the situation about which you are reading. What sail would you be carrying, what would be the best tactics, and what would you do if you lost some vital piece of gear? How fast could you jury-rig something else to get going again, and what would you use to do this?

By thinking through potential problems in advance in the same way that military planners play war games, you can gain a leg up on the sea.

Stock Newport

The top photo is taken at the beginning of a minor gale, gusting into the mid-30-knot range. This is the most common form of heavy weather. These situations provide excellent learning opportunities—preparation in case you are caught in something more serious later on in your cruising.

The photo below represents the extreme end of the weather spectrum, 70 knots, gusting higher. Yet with a moderate degree of seamanship, thorough preparation, and a small dose of luck, these conditions can be dealt with. The bottom photo does not begin to do justice to the sea state.

Royal New Zealand Navy

Illustrations

Throughout the book you will find many photos of boats in heavy weather as well as images of waves. When looking at these, bear in mind that the camera tends to flatten waves, making them appear smaller than what you actually see while standing on deck.

To bridge this gap we have used the computer to create wave images in many of the illustrations. The majority of these images have been modified to give a feel for what you would see if you were experiencing the blow firsthand.

Reinforced tradewinds (above), from the vantage point of the cockpit of our 50-foot (15.2m) Intermezzo, en route between Bora Bora in the Society Islands and Suveroff Atoll in the Cooks. It is blowing a steady 45 to 50. The seas are running 15 to 30 feet (4.6 to 9.1m) and only occasionally breaking. Weather like this provides excellent training and a chance to experiment.

Interview Format

You will find many detailed interviews in this book. Rather than let our writing style interfere with the voice of the person speaking, we have tried to keep the interviews in their original form as much as possible. To differentiate, we use a different type of font (shown below) when others are speaking.

`When you see the text switch to this font, it is a signal that someone other than ourselves is speaking.`

Keys to Success in Heavy Weather

Success in heavy weather is the result of many interrelated factors starting with vessel and personal preparation. When both you and your vessel are prepared, total energy can be focused on dealing with sea and wind, rather than trying to fix things that have gone wrong due to maintenance failures.

This includes husbanding your energy so that when the storm reaches its peak, you are in good shape mentally and physically.

Awareness of the weather is another key element. You need to know where the low center is located, and in what direction it and its attached fronts are moving. This helps you to choose the best tactic; whether running, beating, or heaving to; in addition to the ideal course of action for avoiding the worst conditions.

Using the proper heavy weather tactics is the final piece in the heavy weather puzzle. This means being continually alert to what is going on around you. Changes in wind direction and strength may signal the need for a change in boatspeed or direction—or even a totally different approach to the storm.

Photo above: Steve Dashew at the helm of the 62-foot (18.9m) Intermezzo II at the end of a severe Cape Hatteras storm. Intermezzo II has rounded Diamond Shoals Light and is now in "smooth" water in the lee of Diamond Shoals, well outside of the Gulf Stream.

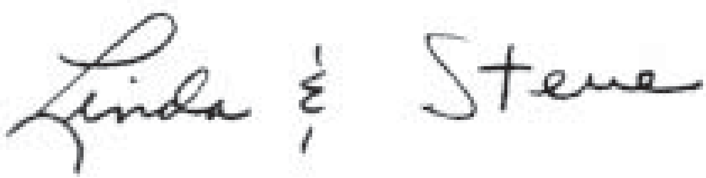
While this list may seem like a tall order at first reading, we can assure you that most of it is pretty basic. And as a bonus, the skills you learn for dealing with heavy weather will pay big dividends in all your voyaging. Your passages will be faster, more comfortable, and that nagging "what if" fear will be gone from the back of your mind.

Perspective

We, as well as most of the professionals interviewed in this book, have spent a lifetime at sea. The accumulated total ocean miles of our contributors is in the millions. Yet most can only relate a day or two (if that) of truly dangerous weather. If you spend a moderate amount of time preparing yourself and your boat, the odds of incurring a major problem are small. Concern about heavy weather is certainly no reason to put off the ocean passage about which you've been dreaming!

We want to close with a request to keep the photos and stories that you'll find here in perspective. We are showing you conditions rarely encountered, so that you can learn second-hand what the options are for dealing with extreme situations.

We wish you fair winds and calm seas.



Acknowledgments

This book is very much a cooperative effort and without the help of literally hundreds of people around the world, it never would have happened. We've been interviewing people since 1979 about their heavy-weather experiences, some of whom would just as soon forget the past and get on with the future. To all of you, we say thank you for putting up with us.

There are also many people in specialized fields who have been helpful. In the area of weather forecasting, at the Australian Bureau of Meteorology, we thank Claire Richards, Peter Boemo, Mike Wilmott and David Turner. At the New Zealand Met Service, we're grateful to Bob McDavitt and Paul Mallinson. Roger Badham in Australia has also been very helpful.

In the US at the Marine Prediction Center we received outstanding help and assistance in both weather and wave issues from Dave Feit and his crew. In particular, Senior Forecasters Lee Chesneau, Scott Prosise, and Joe Sienkiewitz went out of their way to assist us, as did Hendrik Tolman. These gentlemen also took the time to read specific parts of the manuscript and give us helpful comments.

Oceanography is a difficult subject, and we've been chatting with academics in this field from around the world. In particular we'd like to thank the following for giving us some insights: Professor Frank Shillington at the University of Cape Town, Dr. David Burch, Dr. Meric Srkosz at Southampton University, Professor Ron Flick at Scripps School of Oceanography, Professor Hans Graber at the University of Miami and Professor W. Kendall Melville at the Scripps Institute of Oceanography.

In the process of researching the incidents off New Zealand in November of 1998, Phillipa Warwick in Auckland gave us invaluable service. In addition, we'd like to thank Reg Ellwood for discussing the helicopter rescue techniques.

Trying to illustrate a book like this is perhaps the hardest part of the project. We are particularly appreciative for the efforts of Steve Davis, who did all the illustrations you will find herein, as well as for putting up with our incessant phone calls, and working long hours to get the job done on time.

In addition, Rob Johnson at *Sail*, Elaine Bunting at *Yachting World*, Herb McCormick at *Cruising World*, Bill Parlatore at *Passage Maker*, Will Hamm, and Larry Porter have helped us find photographs and other data.

As for the photographs themselves, we'd like to thank: Richard and Alice Bennett, PPL, Stock Newport, Rick Tomlinson, Kim Taylor, Dag Pike, Lindsey Turvey, and Patrick Roach—all of whom put up with our many requests for data and took time to search their libraries. In addition, to the many amateurs who contributed their images, we say thanks.

There were a number of marine industry members who answered our questions and gave us leads on additional information. Amongst these are Mike Cahill, Chris Flavell, Richard Switlik, Don Jordan, Victor Shane, and many others whom space limitations prevent us from mentioning.

At the Seattle Sailing Foundation, Fred Hayes, Mark Pederson, and Doug Freyer have been most generous in sharing their research data. At the University of Wisconsin Space Science and Engineering Center, Bob Fox, Dee Wade, and Jerry Robaidek assisted us in obtaining historic satellite images.

On the production end we'd like to thank Doug Lochner at HLI for handling computer questions, designing the layout and cover, and being a general sounding board. Christina Penn at Dragonfly Film & Video helped us in the process of transferring John Guzzwell's 16mm file to digital files.

Gaelen Phyfe lent a hand with copy editing while Liz Sullivan and Lynne Dieres provided many hours of assistance on the production end.

Putting together a book like this requires periodic reality checks on the direction we are heading. Dan Spurr at *Practical Sailor*, George Day at *Bluewater Sailing*, Kent Williams at the Armchair Sailor in Seattle, Oscar Linde at Robert Hale, and Chuck Hawley and Keith Lamarr at West Marine all were kind enough to respond to our many questions. In addition, Chuck Hawley shared his resources with us, many of which turned out to be invaluable.

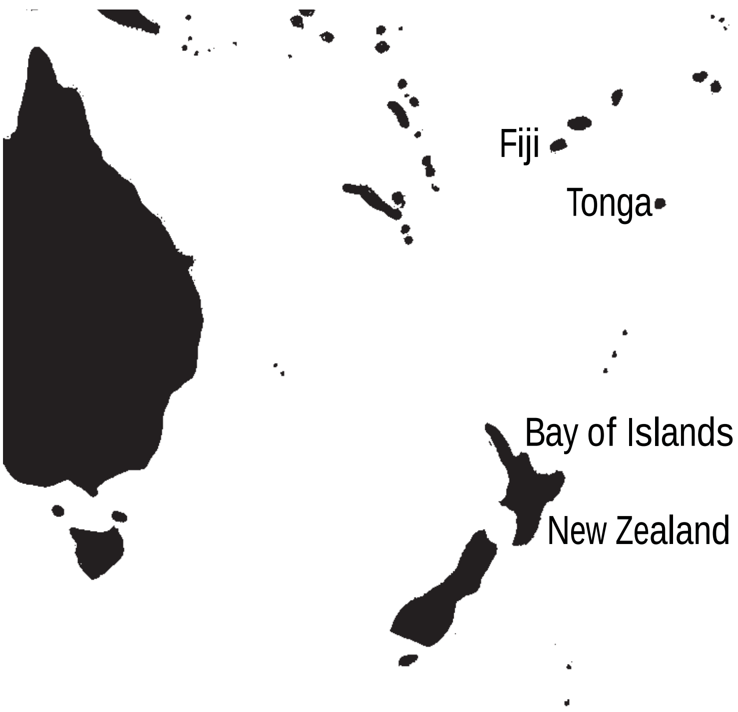
John Rousmaniere has been kind enough to kick around many of the concepts in the book in addition to having many valuable suggestions on layout and illustrations. We've also had many long discussions on the topics surround heavy weather with Ralph Naranjo. Both Ralph and John also contributed chapters to the book.

Richard Findlay and Dave Wyman have taken the time to read rough drafts of the book and give us their comments, both sets of which contributed to clarifying many of the topics we were trying to present.

In the process of looking into search and rescue, we received much invaluable cooperation from the US Coast Guard. In particular, we'd like to thank Commander Dan Abel, Captain Mike Holmes, Robert Patton, Chief Scott Dyer, Captain Larry Holt, Captain Bob Durphy, Chief John Moss and Chief Bruce Pimental.

A number of our contemporaries in the field of yacht design were patient enough to discuss their philosophy of heavy weather and related design factors. Included were Angelo Lavaranos, Erik LeRouge, Steve Seaton, Chuck Neville, and Gino Morrelli.

As with all of our projects this one is very much a family effort. Elyse Dashew has handled all of the production issues necessary to get it into print, working many long nights in the process, while Sarah Dashew has helped us out on the editing front when not touring with her band.



TASMAN TEST BED

Almost every sailor who dreams of sailing to the South Pacific also thinks about visiting New Zealand. It is a lovely country, populated by some of the friendliest people on earth, with wonderful cruising areas and the best marine infrastructure in the world.

The only problem is that to get to New Zealand, regardless of where you are traveling from, you must cross one of the most difficult bodies of water on the planet—the Tasman Sea.

Whether you are leaving from Tonga, Fiji, New Caledonia or Australia, you contend with an 1,100- to 1,200-mile passage, with no completely secure anchorages en route.

In addition, if you are heading south from the tropics you and the weather are on a collision course, because the prevailing systems work their way in from the southwest, coming around the Australian bight and heading northeast up the Tasman Sea. Moreover, these voyages are typically made in the spring or fall (returning to the tropics). Hundreds of boats make this passage every year without incident. We have made the passage to or from New Zealand five times, with the odd gale along the way, but nothing out of the ordinary. Occasionally, however, weather problems occur, just as they do in other parts of the world.

Most of the boats that make this passage have already crossed several large bodies of water before they enter the Tasman Sea. Many have sailed all the way from Europe, or the Atlantic or Pacific coasts of North America. The odds are high that they have seen a minor gale or two along the way, but because heavy weather is a relatively rare phenomenon, most will have limited experience with truly severe weather.

This experience base can lead to false assumptions about what is important in the way of maintenance, vessel preparation and crew skills.

In the early summer of 1994, for instance, an entire fleet of boats took a real pasting in the Queen's Birthday storm, which is discussed later on, starting on page **575**. (The meteorology of this event is covered in detail in *Mariner's Weather Handbook* starting on page **229**.) Many of the problems that occurred could have been avoided by better tactics and/or vessel and crew preparation.

Kim Taylor

EQUINOCTIAL GALE SEASONS

In good weather, the entrance to the Bay of Islands, New Zealand, is an easy approach. It is deep, there are few off-lying dangers, and the navigational markers are reliable. However, if it is blowing and the Bay is a lee shore, you're in for a hazardous landfall—especially if this is your first visit. In deteriorating conditions, it can be difficult to decide whether to stand off until the weather improves or try for shelter.

Early November in the Southern Hemisphere is late spring. Spring and fall represent the times of the year when the greatest temperature differentials exist between the poles and the tropics. As a result, the greatest possibility of severe weather exists if these air masses of differing temperature meet.

When you are sitting in the tropics thinking about heading to the cooler climate for the summer, you have two issues to consider. The first is the risk of an early season hurricane or cyclone, which will tend to push you towards a higher latitude. On the other hand, the earlier you leave the tropics, the greater the chance of encountering a vigorous gale or storm.

If you wait until later in the year, this risk is reduced as the higher latitude air masses warm with the sun's approach; but the potential for a hurricane or cyclone increases.

There is no cookbook formula for making this decision. The best approach is to watch the weather patterns and see how things develop. Generally speaking, the conditions that lead to early hurricane formation can be readily observed, so it is best to wait as long as possible.

During the Southern Hemisphere late spring of 1998, a somewhat unusual series of weather factors conspired to make the trip to New Zealand more difficult than usual. What follows are stories of a group of boats that made the passage. Most of the crews would have preferred to be somewhere else, but made the passage as expeditiously as possible, without incident. A few made mistakes—some serious. From all of them we can learn something, and their lessons will give more meaning to the rest of this book.

Henry Swayze

Caledonia reaching in Fiji showing off her new blade jib.

CALEDONIA

We first met Josh Porter and his partner Nelia Swayze while anchored at Cook's Bay on Moorea in French Polynesia. Josh had a familiar look about him as he motored alongside in his dinghy, and it wasn't long before we realized he was the nephew of an old friend and sailing buddy, Larry Porter.

Josh was raised on the water and has raced or cruised just about his entire life. He purchased *Caledonia*, a Cal 40, in 1995 in the Pacific Northwest and has been cruising full time ever since.

Nelia's grandmother passed away while they were in Fiji and she wanted to make a trip home to pay her last respects. Josh had the option of picking up crew or making the passage to New Zealand single-handed, something he'd been thinking about for awhile. So he chose to make the passage on his own, leaving from Fiji on November 5; his is the first of the boats in the group, with which we are about to head south.

The story continues with an excerpt from Josh's log:

Nov. 5 Depart North Astrolabe Reef, Fiji at 1830. Local Wind: SE to E 15-20. Slight sea. Pos:@2231hrs 18.53S 178.39E, Course:150M, Speed: 8kns BRG to NZ: 179m Range: 1003nm. Full working sails, 100 percent jib.

High pressure moving off Australian coast, a good number of yachts depart, hoping enough lead time to ride down the western side of the approaching low.

Nov. 6 Early, Wind gusting 15-20 knots, still SE'ly, great sailing on rhumbline, seas get bumpy around sunrise then settle into 10-15 knot E'lys. Pos @ 2139hrs 21.10S 178.03E C:178m Spd:6-7kn R:862miles BRG:179

Nov. 7 Pos @0300hrs 21.26S177.47E Tired, watching a dark front approach, I heave to for a nap and to wait for light and front passage. SSE'ly winds at noon. Ocean is a bit disturbed, wind fills back in SE 15-20 at 2109

Nov.8 Good-looking morning, calmer seas, 2-3 meter swell, close-hauled in SE'ly 15-20. Pos@1546hrs 23.51S, 174.51E C:215m Spd:5-6 BRG:168 Bumpy close-hauled sailing, getting pushed west off of my line to New Zealand!

Nov.9 Sailed @1537hrs 24.49S 172.59E Hove to with triple reef main only, 25-30SE'ly and blowing. 1620 hrs. on the move again with double-reefed main and storm jib. Stormy and rough, pounding. The double-reef seems to drive the boat better.

The Cal 40 was a breakthrough design in the late 1960s. Powerful and fast, especially off the wind, it has since become a favorite of cruisers. *Caledonia* is 40 feet (12.2m) overall, 31 feet (9.5m) on the water, with an 11-foot (3.4m) long beam, and 16,000-pound (6256kg) displacement. She draws an even 6 feet (1.8m).

Rig Options

I have three choices of headsail on this close-hauled windy passage: 100 percent lapper, reefed lapper 75 percent, and storm jib and three reefs in mainsail. The 100 percent jib is cut out of a 160 percent heavy genoa (has less than ideal shape).

My headsails are hank-on, and need to be dropped to change. I head nearly downwind—broadreach for any sail change, as this gives me a stable dry platform to work, but this downtime adds up to losing hard-earned miles on this windward passage.

Henry Swayze

Heaving To

I heave to by dropping the headsail and, depending on windspeed, leaving the double- or triple-reefed main prevented out to leeward 35-40 degrees from the center-line. *Caledonia* slows right down to about 1-2 knots, within 30 degrees of the wind, jogging closer and away depending on wind and swell. Breaking seas tend to head the boat up slightly as she rides over.

Aside from two accidental tacks (which in heavier conditions could have been gnarly) she does just fine moving along slowly.

I loosely lash or leave the tiller alone, and she finds her own way. Late at night heaving to allows for a good nap if conditions are changeable and I am exhausted, and, of course, when the going gets too rough. This is a good way to park. The boat doesn't seem to lose much to leeward over periods of days in strong gales.

Nov. 10 Pos@1523hrs 26.15S 171.42E. C:170-200, sometimes 160! Spd:6-8, Brg:152. Range Opua, New Zealand: 547 nautical miles. Wind backing to the east some but strong 25-30 knots.

Hitting the Wall

Last night and tonight I have begun to hit the wall. At night when I am tired, the wind rises and the pounding seems dangerous to my lonely ears, pounding hard with third reef in main and storm jib—finally I give in and heave to in the wee hours and sleep.

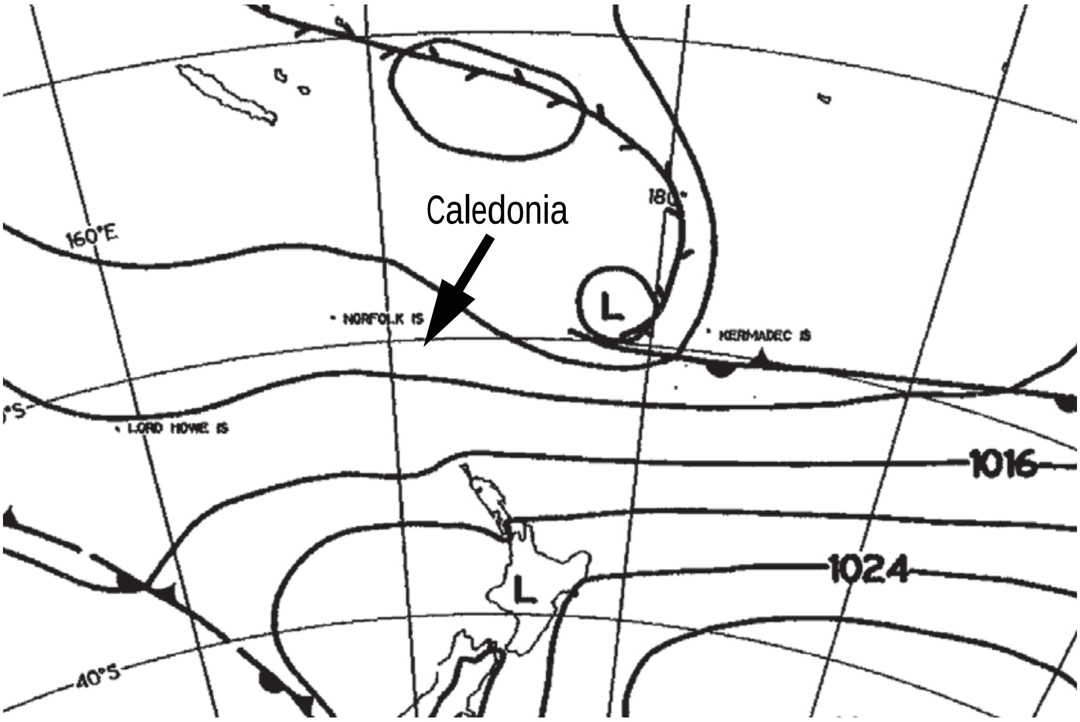
Nov. 11-12 These 48 hours see changeable conditions, POS@ 2011hrs 28.27S 171E. On the 11th I am on starboard tack, heading about 80 degrees magnetic, but the wind keeps shifting and after endless sail changes I heave to at 0100 hours and don't get moving again till 0700 hours.

The 12th is much the same; a few hours jogging to the east. The wind is variable, but doesn't allow me to make up any easting. I have been pushed nearly west of New Zealand and the wind is now coming directly from my port of entry.

Nov.13 The door closes hard again. Seas building up 10-13 feet (3-4m) short and steep. SE gale filling. The high pressure has stalled over NZ, and penetrating it will be difficult.

The weatherfax chills me to my bones and leaves me shaking. A low has developed on the other side of the dateline and will squash the gradients even more, eventually rolling over me as well.

From this fax of the morning of the 13th, it's easy to see where Caledonia's breeze is coming from. With the counterclockwise circulation around the high, she'll have steady southwest quadrant winds. The only relief will be a front, or when there's a dip or curve in the isobars.



I am really frustrated with my sails; my jibs are baggy and blown out. I crave a flat 50-60 percent tri-radial headsail to lift me through these sharp seas without slapping me down.

Nov. 14-18 The Big Heave To, POS 31S 171E. For four days this is my vicinity in the wind-blown Tasman. Winds are SSE, 35-45. The top of the high is feeding an area of strong gales that stretch east of New Zealand nearly to Australia; and, of course, the high is stationary like some huge spider web, catching sailors with buzzing lows arcing down from New Caledonia and Minerva Reef, on the counterclockwise flow of the high.

The stalled high and low spin like meshed gears, nailing me with strong gales and whipping the Tasman day after day. Currents off North Cape, New Zealand flow east against this extended gale. The seas build a bit higher to 9 1/2 feet (2.9m), sending breaking combers along the decks.

The steep seas, combined with the wind and my baggy sails, mean that the stress of beating and carrying on is too great. I am landing flat and pounding even in my parked mode.

(I try all sorts of combinations).With the wind steadily above 40 I'm amazed that even triple-reefed main and storm jib feel too fast and furious. I am learning that a 40-plus-knot gale can mean a lot of different things depending on sea state. The frequency of the 12- to 15-foot (4 to 5m) seas and the flat forefoot of the Cal 40 make beating a shattering experience. Again and again, I try to set out when just sitting becomes tedious, but the shocking slams and pounds get the better of me and I am forced to heave to again.

It's difficult to know how hard to push; I don't want to break anything and on my southerly tack I am closing with the fearful Cape Reinga, so I stay put. I don't want to end up west of North Cape, where I would have to battle back around to the east—close to land, shoals and ships.

While hove to, gut-burning dread is my worst enemy, and the weatherfax fuels the fire. How big will the seas get with more than 40 knots of wind for 40 hours and 1,000 miles of fetch? The answer: Not as big as I think. A steady state is reached in my patch of the ocean that does not exceed 16-foot (5m) seas, with frothy but manageable breakers.

My tolerance for bone-jarring smashes rises steadily throughout the passage. Earplugs help. The sea can always be relied on to clearly communicate the appropriate tactic: heave to!

The weatherfaxes are at times terrifying. At one point, I hoist the headsail and start racing north to sail up around the low and get east. But I am quickly humbled by how fast the weather moves around me. My log is mainly a scribbled list of positions. In the deteriorating conditions I sleep little, eat little, and try to stay warm.

Nov. 19-20 The wave height has dropped, and I find that leaving my triple-reefed main prevented and eased (as when we hove to) I can beat with the storm jib.

The frequency and steepness of the sea is everything; the wind might blow 30, 40 or 50, but it is the sea state that either allows me to nobly knife between the hills or throws up and kicks us in the guts. (I think that the countercurrent against this gale is playing a part in my difficulties.)

Depowering with the tiny triple-reefed main and storm jib is a breakthrough. Suddenly, I am moving forward. I tack toward the east and then come back about on a northeasterly shift. Finally I make it into Bay of Islands, New Zealand.

Postscript

For me, this was an epic adventure, my first single-handed passage, and it challenged me emotionally and physically well beyond any expectation.

I felt at times incredibly far away from everything I knew and loved, pictures of family on the bulkheads took on nearly luminescent quality, and at other times I felt amazingly content and peaceful bobbing over the windswept waves, a pristine prairie, whose soaring mollyhawks I could watch forever.

Josh Porter:

"The major change aboard *Caledonia* following this passage, is the purchase of two blade jibs, one tri-radial at 90 percent, with a wind range to nearly 30 knots and a 60 percent number-4 blade bi-radial with a high cut clew for 25-45 knots.

"As I prepare to sail back north to Fiji I am ecstatic about how these sails have performed in coastal trials.

"I firmly believe that working- and storm-sails need to not only be strong, but also be efficient stable lifting shapes which will pull you up and forward over waves rather than drag and slam the boat over."

Wings is a Serendipity 42, designed by Doug Petersen to the International Offshore Rule in the early 1980s. She is of solid fiberglass construction, built in C-Flex, with a balsa cored deck. At 42.5 feet (13m) long overall, with a beam of 13 feet (4m) and a draft of 8 feet (2.4m), she displaces a svelte 9 tons.

Fred Rosswold

Wings

Two days after the departure of *Caledonia*, Fred Rosswold and his partner, Judy Jensen, were ready to leave Fiji aboard *Wings*.

Fred and Judy have been sailing together since they met on the docks at the Port Angeles Marina in Washington state in 1985. They purchased *Wings* in 1986 and after ten years of local racing and living aboard, cut the dock lines to go cruising in 1996.

Fred picks up the narrative from here:

When *Wings* set sail from Fiji on a sunny Saturday in November,1998, bound for New Zealand to escape the South Pacific cyclone season, we had no expectation of a rough crossing. Perhaps we had become complacent after 2 1/2 years of uneventful passages, for as we prepared for our departure, we were more worried about having too little wind than too much.

On November 6, the weather picture looked benign. A new high was forming west of New Zealand and we felt that it could dominate the weather for the next 5-10 days. There were no lows or budding cyclones anywhere on the map. Several vessels left port over the course of the next two days. We left on Saturday the 7th, just ahead of our good friends Bob Ely and Carol Noel on the Westsail 43, *Elyxir*. It was sunny and the winds were light from the east.

Fleet Departure

In other ports more yachts were preparing to depart for New Zealand. On November 6, the Morgan Out Island 33 *Never Monday* left Tongatapu with John Ferguson, his wife Diana Ruff, and crew Gary Mull on board. Buddy and Ruth Ellison (from whom we'll hear more in the next section) were also in Tongatapu on their Hans

Christian 48, *Annapurna*, but they had ordered a five-day weather assessment from Bob McDavitt at New Zealand's Met Service and were reviewing it, along with weatherfaxes and local forecasts before setting sail. On November 8, McDavitt told them that he thought the next five days looked pretty good. He did mention, however, that the computer model predicted the formation of a low at 28 S and 175 E on or around November 12 or 13. With the option to stop at Minerva Reef if things got bad, they set sail. At least 18 yachts left Tonga within a day of *Annapurna's* departure.

A similar scenario was taking place in Noumea, New Caledonia. By November 9, there was a fleet of nearly 25 yachts bound for New Zealand.

No matter where they departed from, or when, everyone had easy sailing for the first days. On *Wings*, we participated in an SSB radio net with the seven other yachts coming from Fiji. Everyone continued to experience mild easterly winds and the big decision on this crossing was whether or not to sail to a waypoint off to the west or stay on the rhumbline to Cape Brett. We didn't know where the winds would come from later in the crossing, but so far, it looked all easterly. We decided to stay east as long as we could. Some boats had headed west for a point north of New Zealand's North Cape. By noon on November 10, we had knocked off 342 miles and had 711 miles to go. The only problem we had on *Wings* was the failure of our autopilot. The drive unit had failed electrically and was not repairable. We had no spare. From that point on, *Wings* would be dependent on the windvane or hand-steering.

The fleet from Tonga, including *Annapurna* and *Max Grody II*, were also enjoying good conditions. *Never Monday* stopped at North Minerva to have a look around. McDavitt's prediction of a low however, weighed heavily on the minds of many skippers, and the fleet discussed it on the radio net. Twelve to fifteen more yachts made the decision to stop at Minerva. *Esprit II* and *Our Pleasure*, a Force 50, bypassed Minerva and carried on toward New Zealand.

One of the problems with radio "nets" and comparing tactics is that the herd instinct frequently takes over.

It is best to listen, discuss, absorb the data, and then make your own decision based on local weather conditions, crew and boat capabilities, and what you expect to happen.

Going with the herd has the illusion of group security, but in reality this is rarely the case.

Minerva Reefer's Yacht Club

The yachts that had anchored at Minerva formed a North Minerva Reefer's Yacht Club and enjoyed the diving and socializing that occurs when cruisers are together in a nice anchorage. Even though there is no land above water at North Minerva, inside the reef was calm and the holding was good. There was no sign of bad weather at Minerva Reef. *Never Monday* and *Blue Jay* pulled out on the 11th.

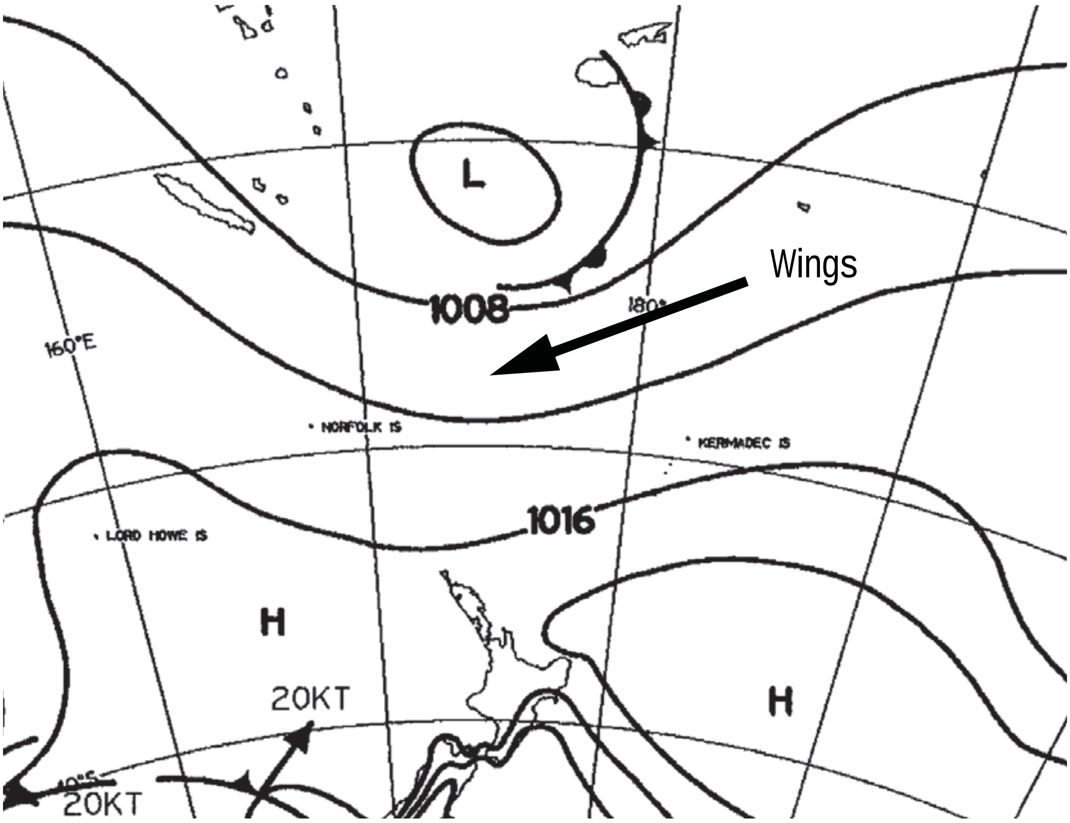
By 1600 November 11, we had 28 knots of true wind and were sailing with a double-reefed main. The waves were getting bigger. We wondered where this wind was coming from, since the weatherfax showed nothing.

A Stitch in Time

At 1730 we noticed a small tear on the leech of *Wing's* main near the third reef point. It seemed to be growing. We decided that we'd try to fix the sail before dark. We dropped it into the cockpit, and with the engine on in forward, we frantically hand-sewed a patch on the sail, re-hoisting just as the last light faded. By midnight, however, the wind had gone down to 24 knots and on Thursday it continued to ease. We thought the worst was over.

It hadn't even begun.

On November 12,the Tonga fleet heard predictions of a low forming south of their course to New Zealand. *Never Monday* and *Blue Jay* picked up this report. *Blue Jay* turned around and sailed 140 miles back to Minerva. John on *Never Monday* remembers, "When we got the first forecast for the low, it was forecast to form east of us and then move southeast. With that forecast, we felt we were well west of the forming low." They



From Wing's position (heavy arrow) this is a worrisome fax. That low shown north of them right now looks innocuous enough, but it will probably track to the south or southeast, and deepen as it is combines with colder, drier air from the higher latitudes. In addition, there's a ridge of high pressure to their south, which may block the low's progress, causing a compression zone. In this situation there are four choices. Moving to the west is the safest choice as it gets you away from the compression zone and the track of the low. However, it also takes you to leeward of your destination in New Zealand—meaning a long beat back. The second choice is to head back north, until you see what develops. The third is to heave to and wait and see what happens. The fourth, which Wings adopted, is to go as fast as possible towards New Zealand and hope you beat the potential blow. This choice only makes sense if you have a fast boat and are comfortable with its capabilities and those of yourself and your crew.

"Well off to the west, a front had formed and as early as November 11 the wind had come up for the Fiji fleet. On *Wings* we heard the boats ahead talk of gusty southerly winds. *Caledonia*, *First Light*, a J-44, and *Scoots*, an Able Apogee 50, had southerly winds and were headed west of south. Two other vessels, *Pelagic II* and *Aka* had already tacked back to the east. Everyone was anxious about their westerly drift and was hoping for easterly winds to help make the course to New Zealand. *Wings* and *Elyxir* had now shifted to smaller sails, were sailing close-hauled in 18 to 20 knots of wind, and were barely holding course. Still, we were making good time and having a good sail. The wind continued to build."

had moderate northwest winds and they were sailing close-hauled. They continued on.

At 1515 local time on November 12, the Met Service broadcast the South Pacific Surface Analysis weatherfax which showed a low between Fiji and New Zealand. It hadn't been there on Wednesday. It was only 1002mb, not very deep, but it was at 21S and 175E, north of the fleet at sea and west of the Minerva Reef.

Back at the Yacht Club

Inside the reef at Minerva, the wind had also swung around to the northwest and it began to build. Late that day and early on the 13th, the boats anchored in Minerva recorded up to 50 knots of wind. By now, even though the anchorage was getting dicey and some boats were dragging anchor, they felt that their decision to come into Minerva had been vindicated. The seas outside the reef were huge.

Squash Zone Potential

It was clear to many cruisers, when they looked at the fax, that there was the potential for a squash zone between the low to the north and the high to the south.

The next weatherfax showed the low right on top of John and Diana on *Never Monday*. The wind had come in from the southeast, was building rapidly, and the seas were getting bigger. By nightfall they had 50 knots of wind and big waves. The low was reported to be moving south at 15 knots. They decided to set their 15-foot (4.6m) Para-Tech sea anchor and let the low and potential squash zone move past them. The sea anchor set flawlessly, according to John, and they settled down to wait out the weather.

On *Wings*, we knew that a low to the north of us could mean pretty severe conditions. We knew about the squash zone and we remembered the stories of the Queen's Birthday storm in 1994. Even though this was spring, rather than fall, the November 12 weather map was eerily reminiscent of the 1994 storm. In fact, it seemed like our worst nightmare coming true. We couldn't believe that there was a low to the north of us. It was sobering and scary. At the time, we only had 20 knots of wind but we were concerned enough that we responded to the weather situation by preparing the boat for storm conditions. We opened the log book to the heavy weather checklist and started through it, securing items and clearing the decks.

Low Pressure Deepens

The night of November 12 was a rough one. The wind built, and by noon on the 13th we had more than 30 knots of wind, still building rapidly. The low pressure system was deepening. Although we were sailing fast and holding our course, the boat was pounding badly every minute or so as it dropped off waves. We also noticed that the windvane frame was twisting when it tried to wrench *Wings* back onto course in the big waves. We put in the third reef and watched the situation nervously. Our speed remained well over 6 knots, but the ride was getting bumpy.

There is always a trade-off between boatspeed—getting there as quickly as possible—and breaking the boat, causing it to take a lot longer. At some point, it begins to make sense to slow down, assuming the risks from being at sea longer are less than those of damaging the boat.

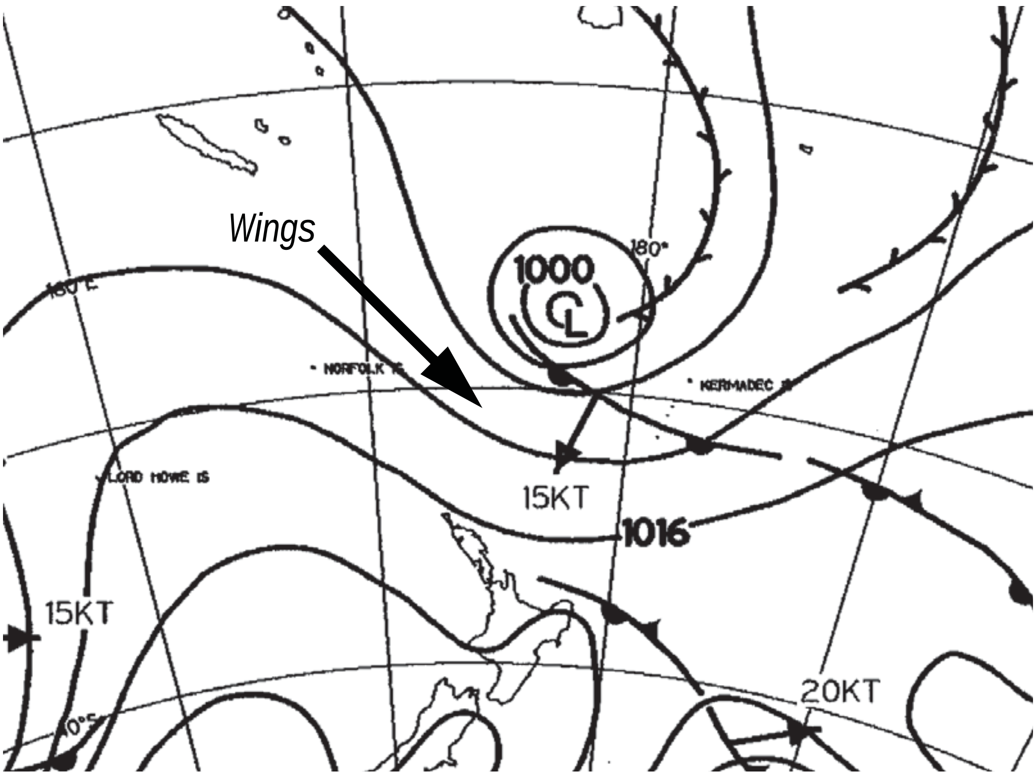
In many cases, however, crews slow down prematurely rather than pressing on, due to discomfort. This is not always the safest course. The boat must be able to make it to the next anchorage in one piece, and for this you need to know what she will take.

By 1300, November 13, the wind was in the forties and the waves were huge. On *Wings* the pounding and the twisting action on the windvane continued to concern us. Our three-spreader rig was particularly vulnerable. We'd noticed earlier that the running backstays were fraying just above the fitting at the lower end. Knowing that in these seas, a broken runner would probably mean a broken rig, we had sistered short pieces of 1/4-inch (6.3mm) stainless wire across the weak spot with U-bolts. It didn't look pretty but it gave us more confidence in the runners and, in the end, it proved to be enough. We'd blown up one of the blocks for the windvane steering lines which we'd replaced. Other small items had also broken.

Slowing Down

We worried about continuing at 7 knots. It was fast and we were on course, but we didn't want to break the boat. We made the decision to slow down. The first thing we tried was to heave to. With the jib backwinded, the main sheeted hard, and the helm lashed down, our forward progress was stopped and we found that being hove to was just like they say: quiet and smooth, while we drifted slowly downwind.

We realized, however, that if we stayed hove to for 48 hours we'd be 50 miles farther away from our destination; what we really wanted was to get into port. Confident that heaving to was an option we got underway again. This time we dropped the jib and sailed with only a triple-reefed main using the engine to keep us moving slowly to weather. Our speed was about 3.5 knots and we were holding course. The ride was 100 percent better, the pounding was less frequent and less severe, and the windvane was no longer twisting. We'd found the combination we needed.



Mid-day on the 13th—Wings (heavy arrow) is entering a compression zone according to this fax. The clockwise rotation of the low and the counter-clockwise rotation of the high reinforce each other in compressing the isobars. The small arrow pointing to 15KT indicates the forecast speed and direction at which the low center will move.

Fred Rosswold

"This photo was taken on November 14 at approximately 32-10 S and 174-18 E. The wind had been in the high 20s to mid 30s for most of the preceding 72 hours.This was prior to the worst weather we had, when the amount of spray flying was still low enough to permit having a camera on deck. "

Aboard *Never Monday*

Meanwhile, *Never Monday* was riding on her parachute anchor in 50 plus knots of wind. The waves were big, breaking, and coming from several directions. The breaking waves kept hitting them from the sides, first one then the other, slamming everyone and everything against bulkheads and jerking severely. They said it was very unpleasant. At 0330 on November 14, a large wave hit on the starboard side and knocked the yacht completely over. Everything that had been on the starboard side was on the floor, including the crew. The chain portion of the sea anchor had been attached to a large cleat on the bow. This cleat broke and the crew heard the chain running out. John ran on deck and found the

"Even with hatches closed and the boat generally well sealed, drops and trickles got in. Over a period of time the drops and trickles accumulated until the inside of the boat was quite wet. The leak at the mast partners was one of the worst. A steady stream of water came down the mast and found its way into our shallow bilge. We pumped each watch just to keep the water from sloshing up onto the cabin sole. Drips from the overhead soaked our sea berths, making our off-watch periods miserable. Judy changed the bedding on the starboard bunk but it was wet again within a few hours. I taped plastic-wrap sheets below the drips to route the water away from the places we wanted to sit or sleep, and away from the chart table. We placed a large piece of clear vinyl over the chart to keep it from dissolving."

sea anchor held on by the chafing gear at the next section of rode, the nylon anchor line. The chafing gear had torn and become tangled in the remaining part of the broken cleat. He secured it as well as he could and started the engine, intending to motor toward the sea anchor and retrieve the chain part of the rode. He found that the steering was jammed.

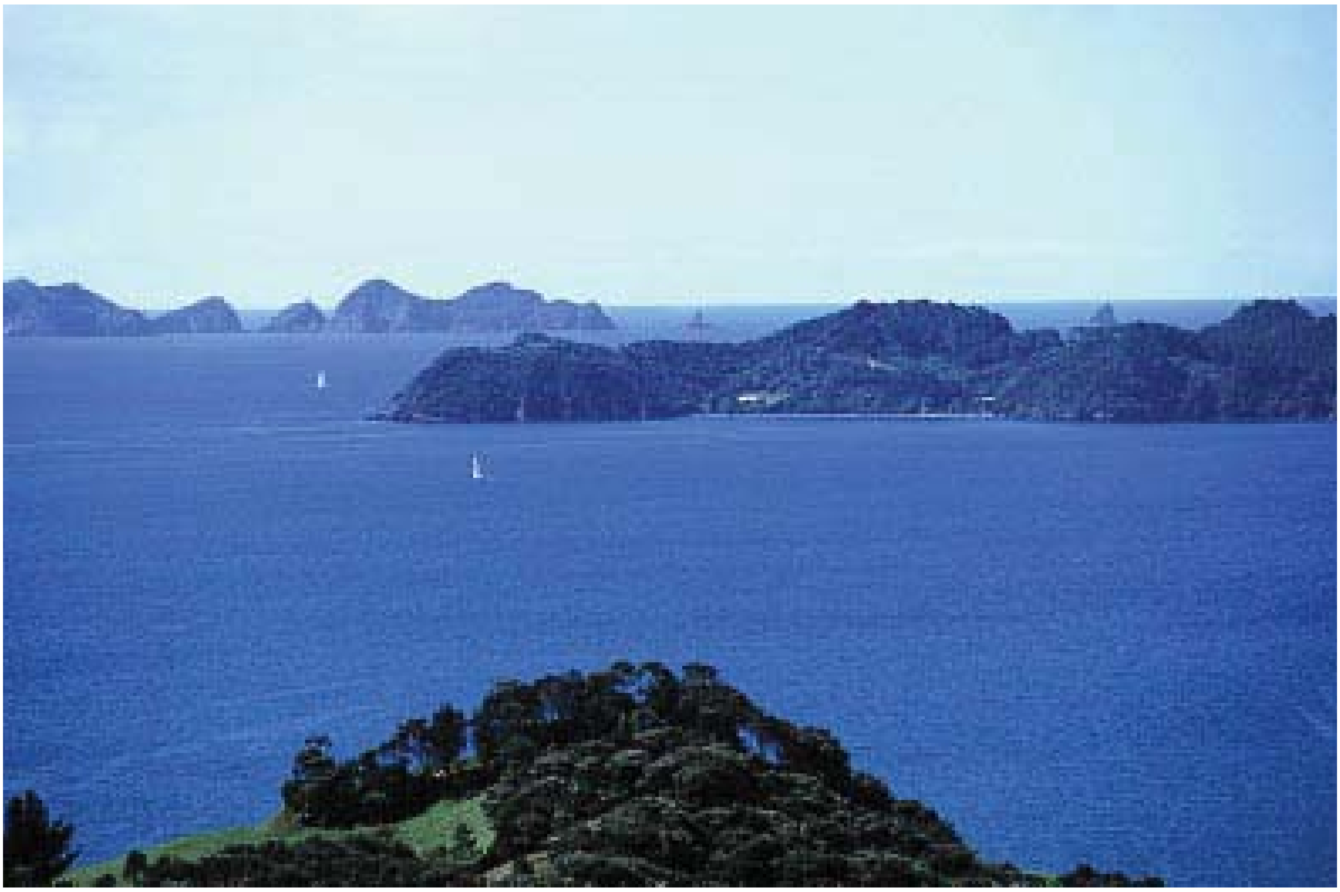
Looking below, John discovered that the 3/4-inch (19mm) stainless rod connecting the hydraulic cylinder to the rudder was bent at a 60-degree angle. They had an emergency tiller, but the bent rod had to be removed. John sawed it off and installed the emergency tiller. In the meantime, the rode was holding and they felt it might be okay to stay put. They added more anti-chafing gear. For three days they continued to ride on the sea anchor and John checked for chafe every 4-6 hours. Waves continued to ravage the boat. The dodger and bimini were destroyed. Two dorade cowls were broken and, unable to locate the caps for the dorades, they cut up a cushion and jammed the foam into the holes to keep the water out. They kept hoping the low pressure system would move on but each day when they talked to Des on Russell Radio he told them that they could expect at least another day of the same terrible conditions. This repeated bad news was demoralizing.

Motorsailing Aboard *Wings*

On *Wings* we continued to motorsail with a triple-reefed main for 2 1/2 days. The wind stayed consistently over 40 knots and out of the southeast. The windvane helped us maintain our desired heading of 165 degrees magnetic by tracking every lift, and we watched our position relative to the rhumbline on the GPS plotter screen. But the going, even at our reduced speed, continued to be difficult. We landed hard about once a minute and clipped the tops off of waves, keeping the deck covered with water much of the time.

On deck it was violent. Spray and wave tops were being blown back over the deck at the speed of the apparent wind, nearly 50 knots. We had heard that *First Light's* dodger had been partially carried away and were listening to the SSB when Jill reported further damage to their canvas. Her voice was urgent when she spoke, "Just a minute, the rest of the dodger has gone, I've got to go on deck and help Andy get it down." The heavy water hitting ours was stretching the canvas and it was getting loose, but luckily it held.

In the end, we felt that we made out pretty good. By 1900 November 15, we were 33 miles out and had reached the point that we felt we could head off a little towards Opua. We turned west and eased the sheets. By 1930, we had turned off the engine. *Wings* was up to 7 knots reaching with a triple-reefed main and no jib. The ride was fast and the angle to the waves was much smoother.



Stock Newport

Annapurna

While *Wings* was starting towards New Zealand from Fiji, Ruth and Buddy Ellison were planning to depart the following day from Tonga, 450 miles to the east.

The following comments were sent to us via e-mail from Ruth and Buddy.

Conditions Along the Way

We left Nuku'alofa on November 8. Winds were light out of the NW, 10-15 knots. Sea state 4 feet(1.2m), generally a nice day, 10 percent cloud cover. Winds out of the NW indicated to us a low pressure system to the west.

Nov. 9 was pretty much the same, with winds a little lighter. Arrived Minerva Reef on Nov. 10.

We stayed in Minerva Reef for five days. Winds were still out of NW, 15-20 knots, cloud cover 15-20 percent. While in the reef, on the 13th we caught the northern side of the first low, gusts up to 50 knots and wind out of the north, 100 percent cloud cover, heavy rain.

We left the reef on Nov. 15 with good conditions, winds out of NW, 15-20 knots, 10-15 percent cloud cover, sea state 6-8 feet (2-3m). Position 23 38S, 178 57W. Barometer 1006, starting to drop.

Nov. 16, 1003 barometer, 26 03S, 179 36E, winds 20-25 knots out of the NW, 15-25 percent cloud cover, seas same.

Nov. 17, 28 31S, 178 10E, barometer 1001, winds clocking around to the SE, 25-30 knots, 40 percent cloud cover, seas 8-12 feet (3-4m).

Nov. 18, 30 54S, 176 38E, barometer 998, winds ESE, 25-35

We were going to show you a photo of Annapurna, but it got lost in the mail, so we thought we'd substitute this photo of the Bay of Islands on a lovely day. It really is one of the great cruising spots on the planet—and worth the effort of sailing there.

Annapurna is a Hans Christian 48 (14.6m). She has a beam of 14.5 feet (4.4m) and a draft of 6.6 feet (2m). In cruising trim, she displaces 24 tons. Ruth and Buddy have been sailing her since 1994, and at this point in their cruising had followed the typical "milk run" from Mexico through Polynesia.

knots, 50 percent cloud cover, seas 10-15 feet (3-5m).

Nov. 19, 33 35S, 175 29E, barometer 998, winds ESE, 30 knots, 50 percent cloud cover, seas 15 feet (5m).

Arrived early a.m. on Nov. 20. Conditions were fair, but you could tell the weather was building, 20 knots out of the SE, 50 percent cloud cover. Weather worsened during the day, second low arriving at Northland in the afternoon with 40 knot winds.

Passage Tactics

When you look at the conditions that Ruth and Buddy sailed in, compared to some of the other stories in this section, you could say they were lucky. On the other hand, we've always believed that luck is 90 percent preparation and hard work.

They watched their weather, picked what looked like a good window to move, and then worked hard to keep *Annapurna* heading as quickly and directly as possible towards New Zealand:

From Tonga to Minerva Reef, 90 percent jib, staysail, full main. From Minerva to Opua, double reefed main, 90 jib, staysail. We reefed the headsail or reefed the staysail as dictated by wind strengths. From Tonga to Minerva winds were out of WNW so we sailed on a broad- to beam reach. From Minerva to Opua, first 1 1/2 days we broad- and beam reached, with winds out of WNW, then winds clocked around to the SE, sailing at a 55-60 degree angle. So we were making between 6 1/2 to 9 1/2 knots; *Annapurna*, very happy, charged along. We would have thoroughly enjoyed the trip, if people weren't getting their asses kicked below us. Our first thoughts were to make a lot of westing but when we learned that everyone had to beat very closely from Fiji—some boats even had to tack into the teeth of the low to make more easting—so we decided to change our tactics and do a rhumbline to Opua.

Doing the trip in two legs—stopping in Minerva—was a big plus, mainly because the best you can get out of Met Service is a five-day forecast and the trip takes seven to nine days.

Lessons Learned

It is always interesting to hear what someone has learned after a passage like this. The Ellison's comments follow:

We learned that every year and every passage can be different; you have to assess each situation as it comes and not rely wholly on past experiences. In the last two years people who have sailed from the tropics to New Zealand sailed west of the rhumbline and for them it was the right decision, but obviously not the right one in 1998. We were thankful that we followed our instincts when the lows started coming down from the tropics, and rhumblined to Opua. It saved a lot of beating. All of the cruising books, such as Jimmy Cornell, state that mid to late November is the optimum time to do this passage, and before November there is a chance of hitting late-winter storms. 1998 was the exact opposite. People we know, who made the crossing in October, motored more than half of the trip. (So go figure!)

Avoid the bad weather if you can, even turning around and going

The Ellisons:

"We think you can compare bluewater passagemaking with shooting dice in Vegas. Sooner or later you're going to get some bad weather. If you don't bet too much—which in our analogy means you have a good and well-prepared boat—you won't lose much. But if you bet a lot, go offshore unprepared—you stand to lose a lot.

"Some people will point out that there are all kinds of small and not-very-well-prepared boats that have done long passages all over the world for years without any problem. We just don't agree with an outlook that relies so much on good luck with the weather. On the other hand, folks with even the best boats and the best equipment can't get lulled into a false sense of security.

"Since *Annapurna* does well in 25 to 35 knots of wind things worked out great. During the passage, our boat seemed to be saying to us, "Yeah, this is what I was built for." And, in truth, it was a great ride. The only reasons we didn't enjoy it was because there was still a possibility we could get whacked; and because of all the bad news we heard when we checked in with the SSB net each day."

right back to where you came from if need be. Dave and Mary Berg, who were the delivery skippers on *Destiny*, did just that and fared well. If possible, stay away from known bad weather areas, thereby cutting down your odds of getting into trouble.

If faced with having to make a passage across a dicey area, pay for professional weather forecasting such as that offered by Bob McDavitt's Met Service. We bought a total of three reports from McDavitt, and we broadcast them over the SSB. Everyone was glad to have them, and some chipped in money to either us or directly to Bob—who refused it. One cruiser even brought him some wine when he got to Auckland. We feel that McDavitt's forecast helped us get to Opua in one piece.

Do what the weather professionals tell you to do. After all, that's what you pay them for. These forecasts are quite different from the weather forecasts on the six o'clock news, which are mainly generalities. When you pay a weather service, they do in-depth research for the time and area in which you need to travel. You get much better results than through the weatherfaxes that are available to cruisers several times a day from either a dedicated weatherfax or computer fax.

McDavitt recommended that we quickly make our way to Minerva Reef which is 250 miles along the way from Nuku'alofa, Tonga, to New Zealand and wait there for the first low to pass. Once that low passed, we were advised to go like hell for New Zealand. This is exactly what we did.

We figured we had to average at least 6 knots to get to Opua by Friday morning, because McDavitt said the next low was expected to come through Friday afternoon. Thanks to steady 25 to 35 knot winds, we went like a bat-out-of-hell, completing the 800-mile passage in four days and 20 hours—an average of just under seven knots. There was so much wind that we only motored for about eight minutes! As predicted, the second low came through on Friday afternoon. We and most of the boats in our group had made port by then.

We think there's probably a big difference between being aboard a 48-foot (14.6m) boat that weighs 50,000 pounds (22,680kg), such as ours, and being in one that's half that size. In our opinion, in heavy weather—of which we sure had our share last year—there is nothing like having a big, heavy, long-waterline boat. (The truth is, we do pretty well in light air too.)

Tactics are tough because of the variables. What you read in books can only open your eyes to the problems you might encounter. Every boat and every crew is different. Some boats, for example, do just fine heaving to; some don't. Some ride to anchor well, others don't.

Our only tactical advice is to sail very conservatively. Pull down the light-air sails well before the shit hits the fan. We left Minerva Reef double-reefed with both our headsails up—and still averaged nearly 7 knots for the whole trip. We used one headsail or the other depending on the wind conditions. Most of the time we had wind that was 55 to 65 degrees apparent, with maybe 36 hours of wind on the quarter. You don't need big sails to go fast in strong winds.

When Ruth and Buddy say "do what the professionals tell you," there needs to be a caveat.

- ❑ Following an outside pro's advice is fine, as long as the conditions he or she has analyzed for your area actually exist—and you need to check this carefully.
- ❑ If your conditions are different, you need to make the pro aware of what is going on and see if the advice is still valid.
- ❑ If you cannot get in contact to discuss this, it is our feeling that you are better off making your own decision, based on what you can see going on around you.

The Ellisons advise:

"If you're in a safe area, anchored, and lows are moving all around you, stay put. Only go when the odds are overwhelmingly in your favor of making the next passage in decent weather. The run from Fiji/Tonga to New Zealand is still a crapshoot—even with good odds. All the weather pros, including Met Service, reported there would be strong easterlies until the second low hit northern New Zealand on Friday afternoon, November 20—after which all bets were off."

Bucephalus

Bucephalus is a Deerfoot 2-62, 62 feet (19m) on deck, 14 feet 6 inches (4.4m) on the beam, with a waterline of 57 feet (17.5m) and a draft of 6 feet (1.8m). She is of fiberglass and balsa core construction, with a cruising displacement of 50,000 pounds (22,700kg).

Ian is a 37 year-old Scot, who's been aboard *Bucephalus* for the past five years. He's logged over 100,000 sea miles over the years and holds a British 3,000-ton Master Class Four certification.

The lessons learned from the sea are usually the ones we remember best, and it is the professional sailors who have learned the most lessons from Poseidon.

So when we got a call with a technical question from Ian McIntosh, the skipper aboard one of our yacht designs, we realized we had a goldmine of information on this passage to New Zealand we've been discussing.

Ian picks up the story from this point onwards:

Bucephalus left the inner harbor of Nuku'alofa at around 1300 on Tuesday, November 17. We motored about a mile across to a sheltered anchorage on the other side of the harbor, where we dropped the hook and spent a few hours squaring things away.

I was expecting some bad weather for the latter portion of the trip, so wanted to get everything snugged down as tight as possible.

Preparing to Go to Sea

I keep a comprehensive checklist on how to stow *Bucephalus* for heavy weather and we went through that, moving all the weight out of the ends of the yacht, down low into the center of the saloon. A heavy-duty leecloth made out of reinforced Textoline runs the length of the saloon and encloses everything below and around the dining table. The sofa on the starboard side also gets used for storm sails to keep them accessible.

Anything we might need from below the floorboards comes out and we leave a passage to the cabin forward. The deck hatches get storm covers installed, jackstays are run out the length of the deck and the dinghy is secured using turnbuckles and padeyes. The steering console is dismounted and lashed down inside the dinghy, steering cables in place. Anchor and chain stay in place, but are lashed down. Rags around the hawsepipe, spray the windlass with Boeshield and then use a whole roll of Saran Wrap on it. A storm cover then encloses the windlass.

The steering quadrant is checked and the kedge anchor we had out gets stowed along with the rode and fenders. We double-check all leads, running rigging etc. Hank on a 10-ounce staysail and lash it to the lifeline. In short, everything that can move on deck and below gets secured. I think it is important to set off stowed for the worst, both for psychological and practical reasons.

There are four of us on board, all guys, all fit, all midthirties and all experienced skippers. I flew in two New Zealanders, Max and Geordie from Auckland—hired guns from a crew agency called 37S and we picked up Soane in Vav'au, where he works as a skipper for the Moorings. This might seem like over-kill, especially considering that I often single-hand the boat or have one [usually inexperienced] crewmember on board. However, I felt that this particular trip was worth taking the extra precautions.

The Rumor Mill

The atmosphere among the cruisers waiting to make the trip South from Tonga to New Zealand is tense. The rumor mill is working overtime and every piece of weather information is picked up, extrapolated on and then passed around like gospel truth. I can already see some people suffering from "analysis paralysis." Sea anchors are coming out on deck to be aired and rigged for the first time, books such as *Rescue in the Pacific*, *Storm Tactics* and *Drag Device Database* are making the rounds. One woman has already decided to fly south, arranging to meet her partner once the dreaded passage is over.

The words "weather window" are repeated around the fleet until they have become a mantra. I even hear myself say them a couple of times, which makes me laugh. The simple fact is that on this particular passage, at this time of year with the daily averages that most cruisers are capable of maintaining, there is no such thing as a weather window. In my opinion, the best you can hope for is that you get mostly fair weather and that when the shit hits the fan your crew and vessel are adequately prepared for it.

Options at 200 Miles per Day

For *Bucephalus*, however, the options are greater. We can maintain 200-mile days quite comfortably, giving us the ability to make this passage in just over 5 days. I call up my secret weapon—Bob Rice. I don't get to speak to the man himself—he's probably on a cel phone to Richard Branson somewhere off around the world in a balloon. However I talk with Sara and she reckons that with our speed, a departure on the 17th/18th would be a fairly good bet.

The forecast calls for light northwesterly winds gradually increasing to northwest 30-35 knots on Saturday. Five days of northwesterly when I'm heading southwest sounds good to me. I'm willing to take the blow on the last day, as the seas won't have too much time to build. More importantly, I know what my boat and her crew are capable of.

This knowledge is crucial—it gives a sense of preparedness and confidence. I grab a taxi and scramble to finish the clearance procedures before heading back to *Bucephalus*. We have been ready to go for the past 24 hours. It's just a case of slipping the docklines and hauling in the kedge anchor.

We have a Mini-M Satellite system on board that gives us voice fax/data capabilities. On trips like this one I set up a sched with Bob Rice's Weather Window (BRWW), calling in daily with my position and conditions. I give them a couple of hours to collate data and then call them back for the scoop. Incredible—from an office somewhere in Massachusetts they can tell me exactly

Ian explains his watch system:

"I set up the watch system with the three guys doing three on and six off, myself doing nothing but the cooking, which causes a few raised eyebrows and slave jokes. My reasoning is twofold, in that I know my galley better than anyone else, having been on the yacht for over 5 years.

"I hate to see inefficient use of time and space and I figure I can get a hot meal out on time in difficult conditions better than anyone else, period. I also want to keep myself out of the watch rotation, so that I can design my day around weather forecasts and radio scheds. I take care of all the navigation and call the shots on deck whilst keeping myself rested and able to step in should the shit hit the fan and the regular watch be unable to cope alone.

"My standing orders specify that I am to be called any time the watchman is unsure about anything (even if he's unsure about being unsure). I see too many skippers load themselves to the point where they are just too tired to make clear decisions. I've done it myself and gotten away with it—I am determined that this would not be the case on this passage."

what to expect in the next 24 hours. Other vessels are not blessed with the sort of budget that allows this and must rely on more traditional sources of weather info.

Russell Radio operating on 4445 and 12353 gives a good picture on what to expect on approach to New Zealand. Despite his years, Des puts a lot of time and energy into this service. To sign on to the radio sched list is free. The station operates on a donation basis. If you are going to use him, then donate something—it's only fair.

Taupo Radio gives voice broadcasts on 8297 and 12356. Standard stuff. Bob McDavitt forecast the weather right on the money a week earlier with a subtropical cyclone popping up right where his computer model said it would. This caused much of the fleet to divert to Minerva. Richard and Gabrielle on *Katriona M* decided to run for it. They had a wild ride downhill with storm canvas for several days in 40 knots plus from the southeast.

Passaging Logic

So, by 1600 we are ready to set off. This gives us just enough time to get clear of the entrance to Nuku'alofa and settled in to things before it gets dark. We motorsail through the night on autopilot, maintaining a steady 8 1/2 knots. I am determined to maintain 200-mile days. To this end I have an extra 100 gallons of fuel in a flexible Nauta Bag low down in the lazaret. I pump directly from this. I am prepared to motor the whole way if necessary.

"This is not a pleasure trip—this is business. The less time you spend out there, the less chance of getting caught by a system."

This is not a pleasure trip—this is business. The less time you spend out there, the less chance of getting caught by a system.

In the morning we have breeze from the northwest at 8 knots. I shut down the engine and chuck up full main, staysail and number-2 yankee, steering for 60/70 degrees apparent. With her big sloop rig, *Bucephalus* loves this and we are soon doing windspeed. The Kiwis are busy fighting over who gets to helm her and my Tongan mate is trolling for dinner. I leave them to it and tune in to the SSB to see how my fellow cruisers are faring.

Two informal nets have sprung up. Southbound 98 run by Peter on *Max Grody II* started up a couple of weeks earlier, with the departure of around 15 yachts from Tonga and Fiji. I am at the head of our little fleet and call back to say that everything's just great out here. Light northwesterly as forecast, good sailing, good fishing. The rest of them are finishing up preparation and will head out on Thursday.

Tropical Depression to the North

Wednesday the 19th is another good day for us—again we make 200 miles no problem. We are all settled into the routine. I call in to BRWW and it's all looking fine until Sara stops mid-sentence, "Hang on, there's something just coming in."

It's not good. A tropical depression has formed to the north and west of us and is heading southeast across our track. We confirm a more frequent sched and I call it in to Russell Radio. They have no sign of anything in the coordinates I was given. I switch on WWVH and at three minutes past the hour I get a confirmation—same coordinates, same track as Sara had just given me. Des has it also by that evening.

I alter course more to the west than south now, hoping to use the system to my advantage. The plan is to head over the top of it and follow it down as it tracks south. This almost works perfectly.

Thursday the 20th and the winds are picking up now, 15 knots or so from the northwest. Great sailing conditions for us. We make yet another 200-mile day. The system is still moving southeast. I still hope to make it around the top.

Friday the 21st and the winds are out of the west-northwest now and up to 18 to 20 knots. Our apparent is up also—it's time to reef. I furl away some of the headsail, keep the staysail and put two reefs in the main. I have to remember that the rig is bigger than the one that was originally designed for this yacht. We are carrying a lot of sail and it's easy to overpower her. My mindset is such that if I even start to ask myself "Do we need a reef?", I do it and I put two reefs in rather than just one—you can always take one out later on. The boat feels much happier, the autopilot isn't working as hard and we lose less than half a knot, still keeping up our 200-mile daily average—all reasons why two reefs are better than one.

Saturday the 22nd and I call up BRWW to find that the system has stalled some and we are getting closer than I had originally planned. The trailing edge of a front will pass over us in the next 24 hours. She signs off with "I'm glad it's you out there and not me"—not exactly the words of comfort that you want to hear from your weather guru.

Notice how Ian uses alternate sources of weather data, in this case Bob Rice's Weather Window, Russell Radio, and WWVH.

This way he has several different forecasts from which to choose, and can make an informed decision on that which best suits the conditions he has at the moment.

Note also the time lag between BRWW, WWVH and Russell Radio.

Getting Ready for a Blow

Now I come into the watch system, changing to two-man watches. If it gets nasty we are going to have to hand-steer, as the autopilot doesn't have that all-important ability to anticipate large waves on the beam and quarter. We check all the deck gear again and I furl away the headsail completely, lashing off the tack so that the sail can't unfurl should the reefline chafe through.

A heavy-duty preventer holds the main all the way out, and the clew is lashed to the boom in case that reefline chafes through (it does later the next day).

The wind is now more west than west-northwest and has gone up to the 25- to 28-knot range. Seas are starting to build. It's not yet what I would call nasty, but it's in the mail, that's for sure. The sky has gone a luminous yellow-gray color. I tell the two Kiwis to stop catching fish and start getting serious.

0300 and we get nailed. (Why does it always happen at 0300?) The boat lifts off a wave and gets airborne. I am off watch, but wide awake anyway and brace myself for impact. Everything that was carefully stowed on the starboard side gets airborne and lands up on the leeward side. I remind myself to fit netting on the bookcases the next time. It's not the angle of heel that gets you—it's the impact on landing. I hit the spreader lights and know instantly that the rig is still intact—good! I get up on deck to find the helmsman grinning sheepishly. I take the helm for a couple minutes to get a feel for what's going on. We alter course a little to get the seas off the beam and we carry on until it gets light. I look at the barometer and it doesn't look pretty—this is the front for sure. Ah well, at least it's been another 200-mile day.

Long-term reefing considerations:

- ❑ Tie cringles loosely so sail chafe is not an issue.
- ❑ Put an extra lashing through the reefing clew.
- ❑ Ease off the clue pennant so the lashing around the boom takes the load.
- ❑ Be sure that the load on the tack pennant is forward as well as down, so slides or batten hardware are not subject to tension loads.

Seascape from Hell

Morning on the 22nd comes and it's the seascape from hell. Big rolling waves come marching in, one after the other. Fifteen-foot (4.6m) breakers. Wind is a steady 30-35 knots with gusts over 40. Occasionally the stern is lifted by a larger-than-normal wave and the helmsman has to scramble to keep her in the correct attitude. There's a lot of anticipation involved. It's an upper-body workout and at this point I'm really glad that it's not just me and my girlfriend. The barometer has risen, however, so things are only going to get better.

"Everyone is wearing Ocean Mustos and suspenders and is clipped on. The helmsman is double-clipped on, to separate strong points. I run up the engine to temperature and ensure that the oil level is topped off. There's something very reassuring about knowing your engine is ready to go. I cook up some food to eat later and I chew a couple of non-drowsy Dramamine even though the last time I got sick at sea I was eight years old. I go through the heavy-weather checklist again and try to cover all the bases."

I call back my position and conditions to the others. *Glory Days* seems to be getting something of a pasting, however the rest are too far back for the worst of it to affect them. I'm glad—I wouldn't want to be out here in anything other than a Deerfoot.

Sara has good and bad news for us in that the system is continuing to track southeast—the steadily dropping winds and improving sea conditions bear that out. However we are slowly but surely being headed. Wind is now south of west and it continues to back throughout the day until it is dead out of the southwest. By late afternoon we are 120 miles out and barely making East Cape. Seas are down to 6 to 8 feet (1.8 to 2.4m) and winds are 18-22 knots. I have a quick conference with my crew—none of whom seem keen on staying out here any longer. Soane has already sworn that he is sticking to the confines of Vav'au for the remainder of his sailing days.

A decision is made to drop the staysail, bring the main in tight and motorsail at seven to eight knots for Cape Brett. We Bang!Bang!Bang! our way towards the coast, with the winds and seas dropping constantly and every mile bringing us closer to the lee of North Island. Come daylight and we are entering the Bay of Islands in nothing more than a Force Three. We clear in at Opua and then head across the bay to Russell where we drop anchor. The rest of the day is spent squaring things away. That night we go on a guided tour of the seedier pubs of Russell, courtesy of my crewmembers—one of whom happens to be a local boy.

The next day I miss the radio sched for fairly obvious reasons. I check in a day after that to see how *Bossa Nova*, *Shakti* and *Hio Avae* are doing.

Thane is now net control for our little fleet, which is scattered over a wide area. *Glory Days* has gotten in to Whangarei safely.

Bossa Nova gets in next and we listen in as the drama outside starts to unfold. Another tropical depression has formed—much stronger than the one we have just been through. It is heading straight for the last remaining yachts in our fleet. Russell Radio has stepped up the frequency of check-ins and Des sounds very worried. This is a big one.

It is now blowing a steady 40 knots in Russell, with gusts over 50. Offshore it must be much worse.

Shakti is 44 feet 7 inches (13.7m) long, 39 feet (12m) at the waterline, with a beam of 13 feet (4m) and draft of 6 feet 6 inches (2m). As cruising boats go, she's relatively quick.

SHAKTI

Thane and Corinne Roberts have been cruising aboard *Shakti*, a Norseman 447, since March of 1997. Prior to taking up the cruising lifestyle, Thane had raced, taught small boat and sailboard handling, and done a variety of short cruises and charters. Their departure from Tonga took place two days after that of *Bucephalus*.

Thane picks up the story from here:

After completing our errands in Nuku'alofa, we left the security of the boat basin and headed out to a small offshore island to make our final preparations. I wanted to clean the hull and check the propeller, which would have been a disagreeable task in the confines of the small harbor, where waste was pumped directly overboard.

On the 18th, the same day we departed to the outlying island, four other yachts left directly for New Zealand: *Glory Days*, *Max*, *Sweet Prophecy*, and *Bandit*. Our small group of laggards, which would leave one day later, consisted of *Bossa Nova*, *Hio Avae*, *Sara*, *Freya*, *Vanessa*, and *Shakti*.

While we were checking our systems, securing all loose items on deck, and bracing ourselves mentally for what was to come, David from *Bossa Nova* went back into town to receive the latest weather prognosis from our "weather guru" Bob McDavitt. The basic problem, of course, is that the passage lasts at least two to three days longer than his five-day forecast, so the uncertainty lies just when one is approaching New Zealand's rocky coast and is most likely to encounter a dangerous storm.

David returned with the message that Bob thought we might have a "reasonable" trip: Not too comforting to me, but David was convinced it was the perfect moment—he may have decided that prior to receiving the report. While I did not agree that it was

Five-day forecasts:

- ❑ These can be quite reliable in some cases, but often anything beyond 24 to 48 hours is going to be a wild guess.
- ❑ One of the questions to ask the forecaster is about the quality of the data in the forecast periods beyond the next day or so.
- ❑ Most forecasts will give you a heads-up on how the computer models are shaping up and the reliability of their data.

the "perfect moment"—reasonable would be more accurate—we would be leaving on my birthday, which I thought might be auspicious. After reviewing the weather maps, I still had two concerns: 1) that we would encounter headwinds two-thirds of the way through our voyage, and 2) that a dangerous low might develop as we approached the coast of New Zealand.

Departure from Tonga

Later that afternoon, our small flotilla threaded its way through the reefs to the west; there we broke free of the islands of Tongatapu and headed out into the open sea. The sky was overcast with a few small squalls as we cleared the pass through the barrier reef in the fading light of day.

It was not long thereafter that *Hio Avae*, the "chick boat," encountered problems. Kristin's previous female crew had been replaced by her ex-boyfriend—neither of whom had a lot of sailing experience to supplement their youthful exuberance. They had just exited the pass when they stopped. A quick trip into the water revealed that their propeller had fallen off...whoops. We were about to turn around and tow them back, when a local hotel offered their launch.

Upon hearing that they were safely on their way back inside the protection of the reef, we continued sailing. It was a big disappointment for them and ourselves to have lost one of our fleet. They would now be forced to make the trip alone.

First Three Days at Sea

"At this point, we were sailing with a full main and 130 percent genoa and moving along at 4 to 5 knots. When the boatspeed dropped too low, I turned on the engine. At the end of this period, the winds started to move aft, and I was able to sail at six to seven knots under a 1,500-square foot gennaker. The seas were flat, and the larger sail area made a huge difference in boat speed, enabling us to pass *Freya* and move up on the boats ahead of us. In retrospect, I think that these first days making good time with the cruising spinnaker may have cut one day off of our trip."

The first three days of the trip, through the 21st, were some of the best sailing we had encountered. The seas were oily calm with a gentle breeze that was just sufficient to fill our spinnaker and carry us along at a comfortable speed. At night, our wake bounced small beads of light across the smooth sea surface, which reflected the billions of stars in the sky above. The weather was still tropical and the t-shirt worn to protect from the sun during the day was sufficient to keep us warm all night during our watches.

The winds were light and variable from the west. We held as high a course as possible, but were just able to lay Minerva. Since we did not see any surprises on the weatherfaxes as we approached Minerva Reef, we decided to forego the stop and head on a more favorable course directly for New Zealand.

This tactic, along with many other small, seemingly insignificant decisions, were to combine to greatly affect our different fates in the coming days. In hindsight, the realization of the delicate balance, in which our destiny had hung, suspended, was quite unnerving when viewed from the standpoint of a random universe. However, I believe in fate, so I saw these small events as less portentous since the outcome was secure—some combination of circumstances would always conspire to produce the same result.

I sailed hoping that our destiny was in the hands of a benevolent God, or at least some protective force—guardian angels or the spirit of a lost father—which would protect us. Together, I and my divine navigator(s) set the course which *Shakti* followed south.

With three days of perfect sailing conditions, we were being lulled into imagining that our entire voyage would take place in these benign conditions. The boats were starting to spread out across the flat seas. Everyone was paying careful attention to the weather and trying to best position themselves for what would come in the future. It was as if we were pieces on a large game board. Time would tell who would win or lose from their strategy, each trying to anticipate from which direction the winds would fill. What we didn't realize was how high the stakes would be.

The wind died somewhat on the 22nd, but we were still able to carry the gennaker because of our course change, and continued to make good time. The winds were variable, and we had to motor occasionally.

We had planned to ride the back of a low southwards, staying just out of its clutches. Two of the boats that left the day before we did, *Glory Days* and *Max*, were already being affected by the edge of the storm and reported that conditions aboard were like living inside a ping pong ball.

"One night I was awakened by a strange clicking sound. I raced on deck to discover that Corinne was using a winch to adjust the headsail. I was in shock. It was the first time she had taken it upon herself to see if she could put *Shakti*'s sails back in balance with the variable winds. This was just one of several instances in which Corinne started to take more responsibility for seamanship aboard. Her timing was good since we would need all our resources for what lay ahead."

Cold Front

On the 23rd, we sailed through a cold front and the winds increased as the temperature dropped. We were catching the low and the winds were rising. Unfortunately, they were mostly on the nose. At this point, we were sailing with a full genoa and a single-reefed main.

Our boatspeed was about 5 to 6 knots. Our course was just to the east of the rhumbline, but we were sailing high and trying to make as much westing as possible, as we headed south.

As the winds continued to move southerly on the 24th, I decided to roll the genoa and motorsail using an extremely flat staysail and double-reefed mainsail. With this configuration, I can sail between 25 and 35 degrees of the apparent wind direction. I was able to stay close to my rhumbline over the next two days. This was the second tactic that shaved valuable hours off the trip time.

Eventually, on the 25th, our seventh day out, the winds swung around to the north and we were able to sail on a reaching course under main and genoa at 5 to 6 knots in 10 to 15 knots of wind—I am not sure why our boatspeed wasn't higher in these conditions.

Although the ride wasn't as comfortable, our daily runs increased from 125 miles per day to just over 150 miles per day. The phosphorescence that we had seen in our wake was now on the deck, which was constantly awash as we cut through the building seas. We had been trying to make westing as we ventured south to set up for the westerly winds we were anticipating. When the wind finally did shift, however, it went only as far as the southwest, forcing us to sail directly into the wind and waves to keep our proper course. Motorsailing enabled us to keep up our boatspeed and stay closer to our desired course, but it was a bumpy ride for the next two days.

On the 26th, the wind shifted to the northeast and started to build. The new low crossing the Tasman was moving much faster than anticipated.

When the wind was on the beam, I carried the staysail, a mostly-rolled genoa, and a double-reefed main. In the rising winds, I was able to control speed by rolling the genoa in and out, depending on the wind strength.

A smaller headsail would have been preferable for better sail shape, but what I was using seemed to balance the helm and keep the boat moving. We would carry this sail plan all the way into Opua, motoring on occasion to maintain an average speed of close to 8 knots.

We were now aware of the strong front on our tail and were careful not to let our boatspeed drop below 7 knots. By monitoring the weatherfaxes and updates from Des, we realized that the front scheduled to arrive on Saturday was now forecast to arrive Friday. Having learned this 24 hours in advance, we were able to pull out the stops and make all way possible in order to beat the system.

Landfall on a Lee Shore

While I was sure that we would arrive safely on Friday the 27th, I kept the boat moving quickly throughout the night in the hope that we could make landfall before darkness. Friday morning everything changed. The cold front had accelerated and an expanding high pressure system to the east was going to create a squash zone just off the coast. Fifty-knot winds with "very rough seas" were forecast to develop by Friday afternoon or evening.

This would be directly in our path and coincide with our arrival. The winds would be from behind us, which was good, but would force us onto a lee shore, which was bad. It was a cruel joke to be so close—already patting ourselves on the back—and at the last minute be reminded that we weren't the ones running the show. I did what any normal, reasonable skipper would do in a similar situation. I panicked.

Our navigation had to be perfect. We would have no second chance to return offshore against the strong winds if we missed our landfall. We also had to arrive as early in the day as possible to escape the worst of the storm and arrive in daylight.

The wind and seas were already building and I could see a wall of dark clouds on the horizon, bearing down on us from behind. I was preparing the boat for storm conditions, but was hesitant to reduce sail prematurely since we needed every bit of speed. Each half knot would move up our arrival by one hour. If our speed dropped below 7 knots, we put on the motor.

From the moment of the fateful forecast, I did not have a minute of repose until our arrival. Although I had only slept a few hours the previous night, I was running on adrenaline. I staved off fatigue, and to a certain extent panic, by constantly trimming sails and checking my navigation while I looked over my shoulder at the approaching wall of blackness. Corinne slept. By noon it appeared that we would make it. With only twenty miles to go, the wind was still below 35 knots and the seas below 10 feet (3m). We were surfing down the swells at an average speed of 8 knots.

I had picked up the bay on radar and calculated that we would be in the lee of Cape Brett in three hours, within late afternoon. The feeling of relief at our own good fortune would soon be replaced by concern for those who were still in the clutches of the impending storm: *Sweet Prophecy*, *Bandit*, *Freya*, *Salacia* and, possibly, *Sara*.

Two hours later, the vague outline of the headland at Cape Brent could be seen through the mist and rain. I am still amazed every time we arrive exactly at our intended destination after traveling over 1,000 miles and passing many days at sea—eight, in this case. During the next hour the rough, sculpted form of the cape slowly came into focus and we were soon looking through the large hole at its base as we sped by on our way into the bay.

We finished our check-in and left the dock to motor back to Russell where *Bossa Nova* and *Bucephalus* were anchored. We just had time to drop our hook before night fell and the wind started howling. Since it had been calm inside the bay while it was blowing 35 knots outside, I couldn't imagine what the conditions were like offshore now, where four boats were still trying to make landfall as the wind gusted to over 40 knots in our protected bay.

Despite the wind and rain, we found our way ashore and joined our friends for a celebration dinner at one of the town's better restaurants. All of us were dressed in our foul-weather gear and must have looked like a wayward Everest expedition as we entered the posh establishment and started to disrobe, creating a small inland lake. Everyone was friendly, however, and we received a warm welcome for a well-deserved meal.

It was not long before the adrenaline rush of our safe arrival began to wear off and our heads started to wobble as if held by only a thread to our fatigued bodies. We arrived back on board and fell into a deep sleep to the sound of the wind whistling through the rigging.

We heard later that *Sweet Prophecy* and *Bandit* arrived at 0100 later that night. Before they reached the bay, they were experiencing winds up to 60 knots and seas at 15 to 20 feet (4.6 to 6.1m), building rapidly. They entered the bay without charts and with only minimal visibility in the driving rain. They were extremely fortunate to be able to find their way to a protected anchorage in the darkness. At least three more boats still remained unaccounted for: *Freya*, *Salacia* and possibly *Sara*.

Weather Logic

Thane spends more time than most studying local conditions and various weatherfax reports. He is not shy about consulting outside experts, as you have seen.

We asked Thane to outline in more detail his weather logic for this passage:

Our timing for the passage to New Zealand was based on the concept that it is best to wait for the end of the winter storms but not so long as to risk encountering an early-season cyclone.

Conventional wisdom holds that the window opens in early November, although some believe that leaving later is better than earlier. I wanted to leave as late as possible.

To get a reading on the timing of the cyclones last year, I monitored the sea surface temperatures from the AXM/AXI fax

Understanding the 500mb level fax charts is the very best thing you can learn to do to avoid heavy weather.

Surface depressions are the result of a venting process, which takes place in the upper atmosphere. If there's no venting going on, you are not going to have depressions.

The signs to watch for at the 500mb level are well understood, and easily learned. For more information, see *Mariner's Weather Handbook* starting on page 128.

stations in Australia and plotted them against the normal temperatures shown in the Pilot Charts for the same time of year.

Based on what I could see, the warm water required for the creation of cyclones was following a more or less normal pattern. I guessed that it would be unlikely to encounter a cyclone prior to the beginning of December.

The other consideration was the winter storm activity and position of the Tropical Convergence Zone. There appeared to be a lot of activity in the early part of November with several lows crossing our intended course. We hoped that things would settle down a bit more if we sat tight and waited—which they did to a certain extent.

Towards the middle of the month, a large high moved across New Zealand and the isobars started to spread out. The track of the highs and lows seemed to be moving south. The only potential problems seemed to be a couple of lows forming in the Tropical Convergence Zone which was now around 25S. I watched these, but since I didn't see any indication of them being fed from above on the 500mb maps I doubted that any of them would deepen significantly...and they didn't.

There was a second high over southern Australia at this time, that I hoped would move across and be sitting above New Zealand when we arrived around one week later. The easterly waves seemed to have a period of about one week to ten days.

The fact that most boats had already headed south to avoid any early cyclone played on my insecurities and prompted me to head south at the first opportunity, rather than waiting for the weather to settle any further.

Since I wasn't convinced that my simplistic water temperature analysis would provide an accurate prognosis on the lateness of the season, I decided to "be on the safe side" and leave earlier than I might have otherwise. It still did not appear to me that the weather had settled by mid-November, when we decided to leave Tonga. The boats that left just after us experienced gale conditions, but those who left in the beginning of December had a good trip with consistent winds from 12 to 20 knots.

A week later the conditions worsened once more for the last group to leave Tonga.

Professional Forecasts

In addition to my own amateur efforts, I obtained copies of two reports generated by Bob Rice for *Bucephalus*. I also went halves on a Bob McDavitt five-day forecast. Both weather consultants talked about the low that was forecast to move over the North Island. It was predicted to occur prior to our arrival and Bob pointed out that it may actually help our passage with northerly winds.

I did not see anything on their extended forecast to contradict my own expectations for the conditions we were likely to encounter. It seemed like riding on the back of the low might be a good strategy to pick up some westerly winds, if we arrived just after it had safely passed. At the time, I did not think that the low would move so slowly over new Zealand.

I was concerned that we might encounter headwinds if we arrived too soon after its passage before the high filled in.

My other worry was the southerly position of the Tropical Convergence, which might spawn a new low that would cross our path before we could reach New Zealand. I had hoped that with the recent passage of the first low, the second, if it came, would be some distance behind.

On November 18, the first of our group of boats left. It appeared that the boats that had left a day earlier benefited from stronger winds for most of the passage, since they were closer to the low, which had by this time almost stalled over New Zealand.

The bad news was that they eventually caught up with it, and for a short while were sailing in gale-force winds (40 knots) and seas (20 feet/6m).

Our plan was to leave a day later, November 19, and head towards Minerva Reef. Bob McDavitt was supposed to be supplying us with another forecast prior to our arrival at Minerva, which would help us decide whether or not we would stop to wait for the weather to clear or continue on. I chose a course for Minerva Reef that was west of the rhumbline, since I expected southwesterly winds to fill in as we approached New Zealand.

The only other strategic decision was following the common knowledge to keep moving as fast as possible. I did not want to spend any more time exposed to the weather than necessary.

I had filled my tanks prior to leaving, and intended to motor if my speed fell below 5 knots. (In fact, it was usually more like 3 to 4 knots before I used my motor.) It was important to monitor my fuel consumption since my tanks only hold 100 gallons (plus 18 on deck). I would be able to motor for no more than half of the total distance. Since I expected the latter part of the trip to be in the high, I decided that I would try to save as much fuel as possible for the second part of the trip, when I might have less wind.

"Catching up with the low" could have been foretold by watching the weatherfax charts. The stalled, and expanding, high pressure system was bound to slow down and then stop the southeasterly progress of the low.

In Retrospect

Anyone completing a passage where there is some degree of weather exposure is going to learn from the experience. It is even better when we can learn from what others have been through.

Thane has given the subject of crossing tactics a lot of thought, as you can see by the preceding comments. His suggestions for others are worth noting:

I think it is a good idea to watch the weather in advance of any passage and try to establish the pattern (the period of the easterly waves for this part of the world). When the weather seems settled and predictable is usually the best time to leave. I think I may have left too early for my crossing to New Zealand, since the weather was still establishing itself and the low was moving too slowly across the North Island.

Keep the boat moving and sail the shortest course. Unless there is a good reason to do otherwise, sailing close to the rhumbline is usually the most prudent course of action in unsettled conditions. (Several boats who tried to anticipate the wind shifts found themselves on the wrong side and spent many uncomfortable days beating to weather or hove to.)

Try to give yourself an alternative plan (escape route).

"While every sailor should be self-sufficient, traveling in a fleet and sharing information can be a valuable resource. We created a 'net' that met twice a day and shared weather as well as other pertinent information (navigational hazards, and the like). The weather experienced by the boats directly ahead is usually the best indication of the conditions you are likely to encounter. "

"Sail fast. Carry the proper sails. Knowing your boat and how to make it perform well in a variety of conditions is invaluable for shorter, safer, and more comfortable passages. In retrospect, I think that sailing with a 100 percent to 110 blade on long passages would have given me better sail shape and flexibility in my sail plan.

"Keep abreast of the weather from as wide a variety of sources as possible. Don't rely on any single source but your own interpretation based on the actual conditions you are encountering. Shoreside forecasting is rarely more accurate than on-site reports.

"Plan on having sufficient fuel and a properly serviced engine should the need arise to motor. Knowing the best sail plan for motorsailing can add boatspeed and comfort during the times when it may be necessary to use the engine, especially in headwinds.

"Don't be afraid to alter or reverse your course if the weather ahead doesn't look favorable."

Although we didn't need to take advantage of the stop at Minerva, several boats in the group ahead of us did so and saved themselves a lot of grief. It was a good tactic to pass close to the reef in the event that we needed to stop. Next time I will have e-mail on board so I can pick up McDavitt's weather forecast en route.

Another example of vessels needing to change their itinerary were the boats headed to Auckland who had to divert to Opua on the night of the storm. Since they didn't plan on going to Opua, they didn't have the proper charts on board. We carried charts and waypoints for all ports on the east coast of the North Island as well as Minerva Reef and the Kermadec Islands route.

Freya relied on the forecasted conditions (40 knots with 15 foot seas) when deciding to heave to in the approaching low. In fact the conditions were much worse—not that they could have known.

To my knowledge, New Zealand weather has limited coverage above 25 degrees South, which is in the jurisdiction of Fiji. Their weatherfaxes do not indicate this and even show isobars, which would lead one to believe that their analysis is complete to the edge of the chart at 10 degrees South.

Inmarsat C provides both Fiji and New Zealand weather which, taken together, offer a more complete forecast on board. I would write the Fiji and actual weather on the Met Service weatherfaxes to supplement my other prognostic tools. Sometimes I would write down my own forecast to check it against what actually occurred later.

On the other hand, it is always best to make your own decisions based on your own vessel and its capabilities. Some of the smaller boats ran into bad weather when they tried to fit through a weather window from which only the larger boats were in a position to benefit.

Avoid the crowd mentality. I fell prey to this one when I left Tonga earlier than I wanted so that I could sail with my friends.

Prepare your boat properly for sea. As much as possible, clear the decks and have everything well battened down, both above and below decks. It is too late to start taking the necessary steps when bad weather hits. Think of your boat as a potential submarine and prepare accordingly. In the future, I would be more prudent about what was carried on deck, the securing of the hatches, and other vulnerable areas. I installed storm windows on my hull ports when I reached New Zealand.

Watch the highs as well as the lows. The problems that our fleet encountered when approaching New Zealand were as much from the expanding high (that had already passed through) as the approaching low. Stay clear of the "squash zone": the area between two systems where the isobars tend to compress, creating strong winds and seas. Since the danger zone can be relatively narrow, around 100 miles in some cases, it can sometimes be avoided if one is sailing defensively.

When the Situation Deteriorates

It is rare that amateur mariners face life-threatening circumstances, and rarer still that the sea exacts its ultimate toll. Yet serious difficulties do occur, and, on rare occasions, lives are lost.

We include the next four stories because there are lessons to be learned from each—lessons, which, if taken to heart, can prevent similar occurrences.

We are indebted to Fred Rosswold and Thane Roberts who shared what they learned, along with New Zealand Yachting Safety Officer, Jim Lott, who was kind enough to allow us to reprint from his official incident reports.

Woody Goose

On the night of November 17th, *Woody Goose*, a beautiful 53-foot (16.2m) wooden ketch from Britain, with Roger and Anita Dean aboard, was overdue in the Bay of Islands.

Roger and Anita had been dealing with steering linkage problems all the way down from Fiji. The result of a previous grounding, the steering system would hold in light airs, but would fail when it blew. As a result, Roger was forced to try to effect repairs under extremely difficult conditions as they closed with the coast of New Zealand.

Without an SSB radio, and because of several other problems, they had been buddy boating with another yacht. During the early days of the storm, the two boats lost touch with each other and *Woody Goose* did not come up on the VHF radio. Their friends looked for four hours but never again saw *Woody Goose*.

The Deans were having problems keeping their diesel engine going, possibly the result of bad fuel or clogged filters, so they were unable to motor to maintain speed in the lighter conditions.

The autopilot was not functional and, as a result, when they were able to steer the boat, it was by hand. The following comes from the official New Zealand Maritime Safety report:

At about 0830 hours NZDT on 5 November, 1998, the yacht *Woody Goose* left Suva, Fiji on passage to Opua. Another yacht, *Aka*, left with her on this passage.

On 5 November, the two yachts passed to the east of North Astrolabe Island and set a rhumbline course of 194 degrees (T) for a waypoint at 35 degrees 12.0S 173 degrees 52.0E in the approaches to the Bay of Islands.

On 6 November, the yacht was steering a course of about 160 degrees (M).

On 7 November, the wind veered from north of east to southeast. *Woody Goose* was keeping to the plotted track with *Aka* remaining within sight of her masthead light.

On 8 November there was an increase in adverse wind strength resulting in *Woody Goose* being set about 70 miles to the west of the plotted track. *Aka*, which could sail closer to the wind, adjusted her course in order to remain with *Woody Goose*.

Small maintenance problems tend to multiply in adverse weather. Consider the chain of events unfolding:

- ❑ Intermittent steering failure.
- ❑ Autopilot inoperable.
- ❑ VHF radio not working.
- ❑ SSB radio non- functional.
- ❑ Masthead light failure.
- ❑ Fuel supply contamination caused engine difficulties.

Problems Begin

During the morning of 9 November, *Woody Goose* suffered a total loss of steering. *Aka*, which was close by, came over to assist. Over a period of about five hours, temporary repairs were conducted to the steering gear in order to enable the yacht to continue on passage. A GPS fix taken at 1215 hours showed that *Woody Goose* was about 110 miles to the west of her plotted track. About two hours after completing the temporary repairs, the wind increased further to about 35-40 knots from the southeast. The skipper of *Woody Goose* and his wife were alternating watches approximately every 3-4 hours.

At about 1900 hours on 10 November, *Woody Goose* was about 95 miles to the west of the plotted track. The skipper was unable to transmit on his VHF but was able to acknowledge messages from *Aka* by clicks.

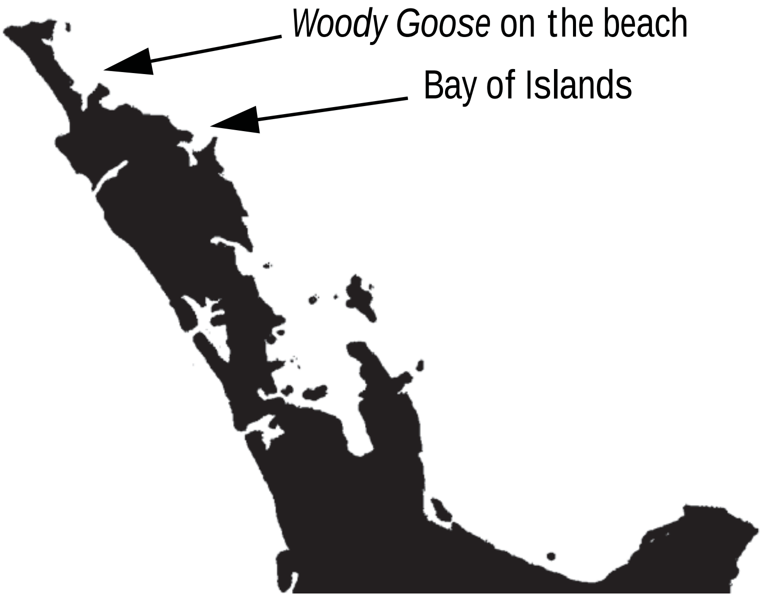
By about 0900 hours on 11 November, the set of the yacht to the west of the plotted track was reduced to about 75 miles. This was mainly as a result of using the main engine, enabling the skipper to steer closer to the wind.

The masthead light on *Woody Goose* failed when he switched it on at dusk. The skipper was unable to replace the light because of the weather conditions. Initially, *Aka* was able to keep *Woody Goose* in sight from the other lights which she exhibited. However, *Aka* subsequently lost sight of the yacht and despite several attempts to relocate her was unable to do so. The skipper of *Aka* kept calling on the VHF but received no response. Afterwards, *Aka* resumed her course and continued on passage to Opua where she arrived safely on 14 November.

By the morning of 12 November, the set of the yacht to the west of the plotted track had been reduced to about 30 miles as a result of running the main engine throughout and being able to steer closer to the wind. However, by about 1900 hours on 13 November, this had increased to about 40 miles following problems to the fuel supply of the main engine. The problems with the fuel supply continued until the vessel grounded on 17 November.

Navigational Difficulties

The two GPS units started to malfunction on 12 November. The handheld GPS did not function at all and the main GPS failed to continually update the yacht's position. The skipper changed the batteries on the main GPS and was able to get a further position at 1900 hours on 13 November before it malfunctioned again. At 1900 hours, the yacht was about 40 miles to the west of the plotted track. The course to make good on the waypoint off Opua that the skipper had programmed into the GPS was 170 degrees true and the distance to run was about 100 miles. At this time the skipper was having difficulty in keeping the yacht on a course of 160 degrees (M) due to the wind direction and the



inability to use the main engine continually because of the fuel supply problems.

At or about this time, the automatic steering system failed.

The skipper's recollection of the sequence of events after 13 November is unclear as he was very tired from attending to the continuing problems with the fuel supply and steering gear system. Further, the weather remained bad up to and including the grounding of the vessel on 17 November.

The skipper states that during the afternoon of 16 November he fixed the yacht's position from the GPS. The coordinates of this were 35 degrees 12S 173 degrees 52E. The skipper states he plotted the position on a large-scale chart of the New Zealand coast, which included Cape Brett and North Cape. During 16 November, he remembers observing land, which included "sand dunes, rolling hills, green fields and some buildings." He was tacking into and away from the shore and keeping about 3 miles off. He was unsure of his position until he got the fix from the GPS. After obtaining this fix, the skipper thought they were "looking good for Opua."

Anchoring Off a Lee Shore

At one stage—the skipper cannot recall when—he let go his two main anchors, so that he could attend to repairs of the fuel supply system and steering gear. Later, however, when he tried to weigh the anchors, he found that they were stuck fast. In attempting to free the anchors, the anchor rope of one anchor parted and the swivel shackle on the other snapped with the result that both anchors were lost.

During the early hours of 17 November, the skipper decided to rest for an hour as he was very tired. He let go the remaining anchor, which was attached to about 200 feet (60m) of chain. At this time, the skipper thought, from observing his radar and the GPS, that he was about 4 miles north of Opua. He left instructions with his wife to call him in an

Navigation has gotten quite a bit simpler with the advent of GPS. Yet mistakes still occur with plotting, mis-reading coordinates when tired, and cutting obstructions too close.

The best way we know around this is to make an hourly plot of your position on the chart. Once you get in the habit of doing this, a mistake in the GPS or an incorrectly-noted GPS coordinate will show up immediately on your paper chart as an incongruity.

Another good practice is to always back up one position with another. If you've got GPS, back it up with the depth finder, radar, another GPS, or bearings on a known object on the shore.

John Neal

This is the saddest sight—a beautiful vessel stranded, never to sail again. Usually when this happens the crew walks ashore, shaken, but alive. In this case, a safety harness failure probably lead to the demise of one of the crew.

In the days of commercial sail, lee shores were avoided at all costs—they were responsible for the majority of all maritime losses. Today, with better navigation gear and more weatherly vessels, we've all grown a bit lax in our fear of what lies to leeward.

Had *Woody Goose* headed offshore, even under reduced sail so Roger could gain a bit of rest before tackling his maintenance problems, none of this would have happened.

hour. He showed her the radar and said that if the land got any closer, she was to wake him immediately. Before retiring, the skipper repaired the steering system again so that it could be used quickly in the event of an emergency.

The last thing the skipper recalls was when his wife called him about two hours later. The skipper was told that the yacht had "moved off the line, that the anchor wasn't holding and that the yacht was no longer head to wind."

Upon being informed of the situation, the skipper immediately checked the radar and noticed the nearest land was about 2 miles distant. The yacht was beam-on to the seas and swell and rolling very heavily. The skipper tried unsuccessfully to start the main engine. He started the generator in order to charge the batteries. The skipper commenced weighing the anchor but before he was able to complete this task he heard the sound of breaking surf and left the anchor. The skipper's wife told him not to panic and in response the skipper states, "I gave her a roasting for letting me oversleep."

The skipper raised the mainsail which filled immediately. He turned the wheel but found the yacht wasn't answering to the helm. After lowering the sail, the skipper entered the lazaret in order to repair the steering system. In the meantime, the skipper's wife put on a safety harness. The skipper was still in the lazaret when he felt the vessel ground. Almost immediately afterwards, the yacht was struck by three "huge waves." The skipper heard his wife cry out, "like a muffled scream." After exiting the lazaret, the skipper went to the saloon to try to find her. He then noticed that the safety harness worn by his wife was empty and still clipped onto the port side of the yacht.

The skipper threw a Dan buoy and an inflatable dinghy over the side. He grabbed hold of the Aldis lamp and started scanning the water. He also set off a number of flares to illuminate the sea surface. The skipper sent a Mayday message on the VHF but received no response.

The skipper left the yacht, which was lying over on its starboard side, and stumbled through the heavy surf to the shore. It was getting light as he walked along the beach. Subsequently, the skipper found the Dan buoy and the inflatable dinghy. Afterwards, he met a Mr. Everitt, who alerted the local police. The body of the skipper's wife was eventually found about 2,600 feet (800m) north of the yacht.

The skipper was told his yacht had grounded in Exhibition Bay, in a position about 60 miles northwest of where he thought the yacht was situated.

Key Conditions

The skipper had extensive sailing experience. He purchased the yacht in 1994. His wife was diagnosed with Multiple Sclerosis and they decided to sail around the world. The skipper's wife had very limited knowledge of navigation.

Before the yacht's arrival in Fiji, it grounded on a reef in the approach to Suva. According to the skipper, this was because of an inaccurate French chart which he had obtained from a yachtsman in Tonga. As a result of the grounding, a new rudder had to be manufactured in Fiji and the propeller shaft repaired.

There was also some damage to the hull, which the skipper proposed to attend to after arriving in New Zealand. Both GPS units sustained salt water damage during the three days the yacht was aground in Fiji. These were serviced in Suva and according to the skipper were tested and found to be working satisfactorily before leaving for New Zealand.

The radio was damaged beyond repair while the yacht was aground. The skipper purchased a new radio in Suva which was supposedly designed for use on board yachts. However, he was never able to receive any weather forecasts with this radio and consequently was reliant on *Aka* for all weather information. After losing contact with *Aka*, the Skipper did not receive any weather reports. *Aka* was equipped with an SSB radio.

The conundrum faced by the crew of *Woody Goose* in Fiji was a difficult one.

A short passage to the south lay a wonderful network of efficient and highly skilled repair facilties.

To get there they needed to take some chances with the weather.

If they decided to do a major overhaul in Fiji, they would be stuck there during cyclone season—also taking chances with the weather.

You could argue that this entire unfortunate scenario began because of a problem encountered with the Fijian reefs. We are not privy to those details. But the best policy is to avoid new ports of call, especially those with reefs, until there is good visibility with which to confirm our position, and the location of any reefs or coral heads.

Opinions and Recommendations of NZ Safety Authorities:

- ❑ In the space of several days preceding this tragic accident, a number of gear and navigational equipment failures occurred which, when combined as a whole, would have taxed even the most competent skipper to the extreme. In this case the owner of *Aka* describes the skipper as meticulous and a person who did everything well but who was overcome by a combination of circumstances.
- ❑ The skipper's reliance on his GPS, when both visual and radar information should have warned him that he was not in the approaches to Opua, highlights the importance of not using GPS as the sole means of navigating a vessel. A prudent mariner should always confirm position fixes from a GPS by any other means available.
- ❑ The grounding of the yacht in Suva would most probably have resulted in stresses and strains to both the hull and external fittings of the yacht, including the coupling between the rudder and rudder control box. These would have been exacerbated in the heavy weather, which the yacht encountered en route to New Zealand.

The skipper was able to receive messages on the VHF but could not transmit. Before leaving Suva, the VHF was working satisfactorily.

The problem with the steering gear was due to the stainless steel bolts/pins in the rudder control box shearing. Two holes were drilled through the collar and shaft of the rudder stock and new bolts/pins inserted as a temporary measure. However, these kept failing and had to be replaced at frequent intervals with spare bolt/pins which were given to the skipper by the owner of *Aka* who assisted him in conducting the repairs.

The problem with the supply of fuel oil was due to the sedimentation in the service tank, which clogged the fuel oil filters. The fuel oil remaining on board was tested after the grounding and found to be bunker fuel oil. The skipper had been told it was marine diesel oil when he filled his tanks in the Galapagos Islands.

In order to overcome the problem of the clogged filters, the skipper was eventually able to rig a direct feed line from portable fuel containers to the main engine fuel pump.There were adequate reserves of fuel on board to run the main engine for several days.

The two anchors that the skipper lost consisted of a 66-pound (30kg) CQR anchor and a 70-pound (32kg) Danforth anchor. About 200 feet (60m) of chain was attached to the CQR anchor. There were 33 feet (10m) of chain and 260 feet (80m) of rope attached to the Danforth anchor. The third anchor, which the skipper let go, was a small CQR anchor to which about 200 feet (60m) of chain was attached. The skipper was aware that the small CQR anchor was unlikely to hold for long because of the small span of anchor chain and the adverse weather conditions. He states, however, that the anchor was still holding when he went to sleep. The skipper states that before he went to sleep, the land astern of the yacht was showing on the radar as being about 5 miles distant although he appreciated it might be slightly less because of low-lying land, which would not show on the radar.

The skipper states that apart from feeling tired he went to sleep only because he thought he was close to Opua. At that time he had no idea he was off Great Exhibition Bay and that had he done so, he would have "gone back offshore." He admits that he was "lost," but notwithstanding this, relied on the GPS fix as being accurate.

The skipper decided it would be safer to sail in company with *Aka*, as he knew the passage was "notorious" for bad weather and *Aka's* skipper had been to New Zealand several times before.

The skipper did not have a copy of the *New Zealand Pilot*. However, he was aware, from articles that he had read, that there were numerous off-lying islands in the approaches to Opua. This would have been confirmed by the large-scale chart that he was using at the time of the accident. The skipper was aware that the echoes on the radar, which continued to function normally throughout, did not conform with the land features that he could see visually. Moreover, the skipper states he saw only one island on 16 November.

The skipper states that his wife would probably have let him sleep longer because she knew that he was very tired and because she may have thought that the smaller anchor would have had the same holding power as the two anchors that were lost. The skipper states that his wife was definitely wearing her harness when he last saw her alive. He has no explanation as to why she was still not in the harness after the yacht grounded and was struck by the three waves.

Contributing Factors

The New Zealand Maritime Safety report lists that the following factors contributed to this tragic series of events:

The continuing failure of the steering gear system due to the inability to conduct proper temporary repairs while at sea. The fatigue of the skipper. The loss of the automatic steering system which added to the fatigue of the skipper and his wife. The contamination of the fuel supply to the main engine. The failure of the two GPS units. The lack of any weather forecast data. The inability to transmit on the VHF.

The failure of the skipper to appreciate that the yacht would be set further to the west of the plotted track, due to continuing problems with the main engine, the adverse wind direction and the inability of the yacht to steer closer to the wind.

The decision of the skipper to rely on the GPS position when he either knew or ought to have known that it was unsafe to do so as the only means of determining the yacht’s position and because of earlier faults with the GPS.

The failure of the skipper to consult the larger-scale charts properly, which, had he done so, would have warned him both with regard to the topography of the coastline and the depth contours that he could not have been in the approaches to Opua and that the more likely position of the yacht was in Great Exhibition Bay.

The decision of the skipper to sleep at a time when he either knew or ought to have known that it was dangerous to do so because the small anchor and limited length of chain was likely to drag, having regard to the depth of water and the adverse weather conditions, the proximity of a lee shore and the fact that the skipper was unaware of his true position.

Janamarie II

Janamarie II's story provides us with a different set of lessons. The situation detailed in the following pages took place during a passage from Australia to New Zealand, in November, 1998.

Whereas in the previous (and subsequent) stories the weather involved a high pressure system on its own or in combination with a low to form a compression zone, in this instance we have a simple depression creating the winds.

The New Zealand Maritime Safety Authority report follows.

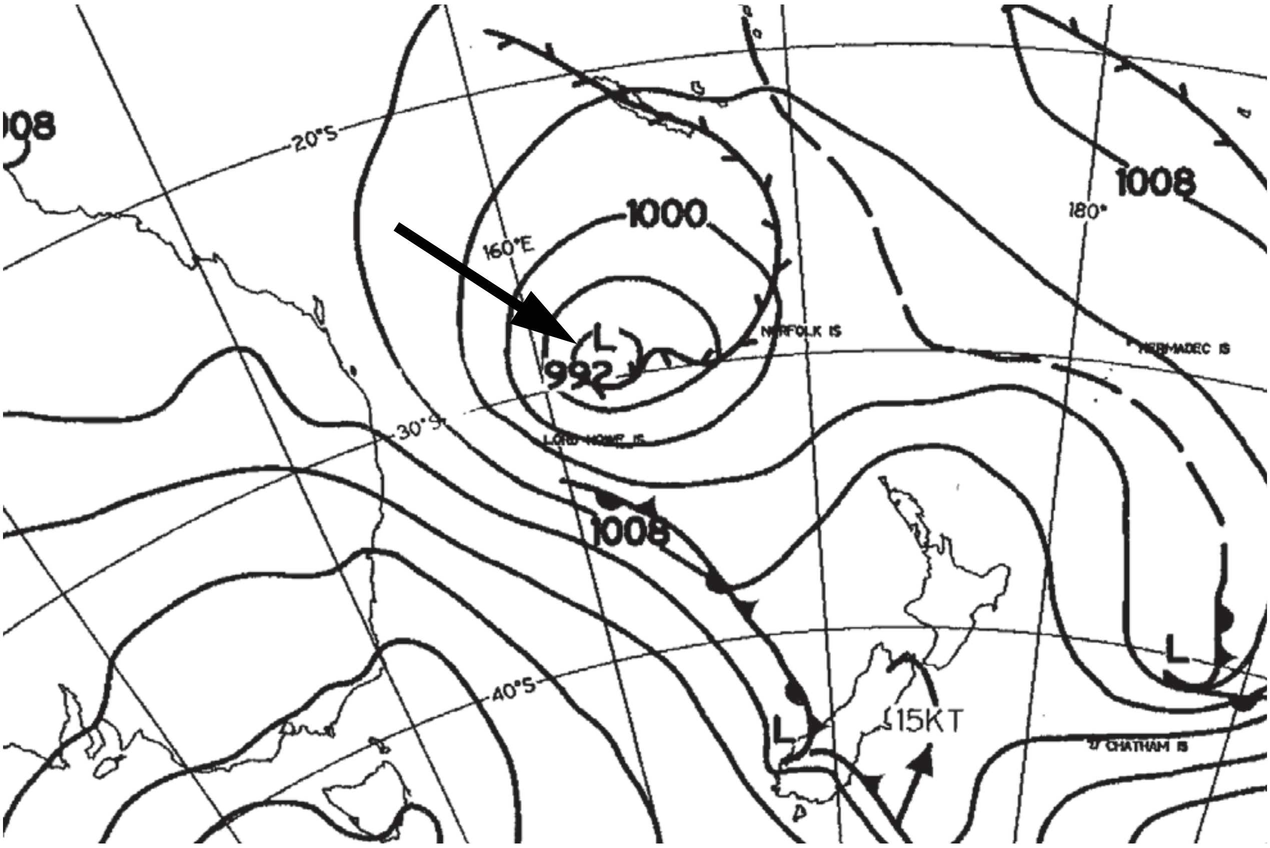
Departure from Australia

At approximately 0900 hours 12 November 1998, the yacht departed Gladstone bound for Opua, New Zealand.

After departure from Gladstone the yacht made good a south-southeast course to pass 20 nautical miles to the north of Middleton Reef. She passed the reef during the morning of the 17th and then altered to an easterly course in the face of southerly/southeasterly wind and sea.

During the afternoon of 19 November, 1998, the yacht was hove to carrying a storm jib in strong southerly winds.

At 2040 hours, *Janamarie II* gave a position and weather report to Russell Radio which read: "29 degrees 18 S-162 degrees 13 E. Hove to, drifting NE @ 2 knots. Have experienced southwesterly



There is nothing on this surface-level fax chart from the New Zealand Met Service to suggest the type of conditions encountered by Janamarie II. As you can see from the position arrow, they were near the center of the depression. The satellite image (next page) indicates this was probably a local baroclinic storm structure, which could have "bombed," creating the winds Janamarie II encountered. The only warnings would have come from the 500mb level faxes.

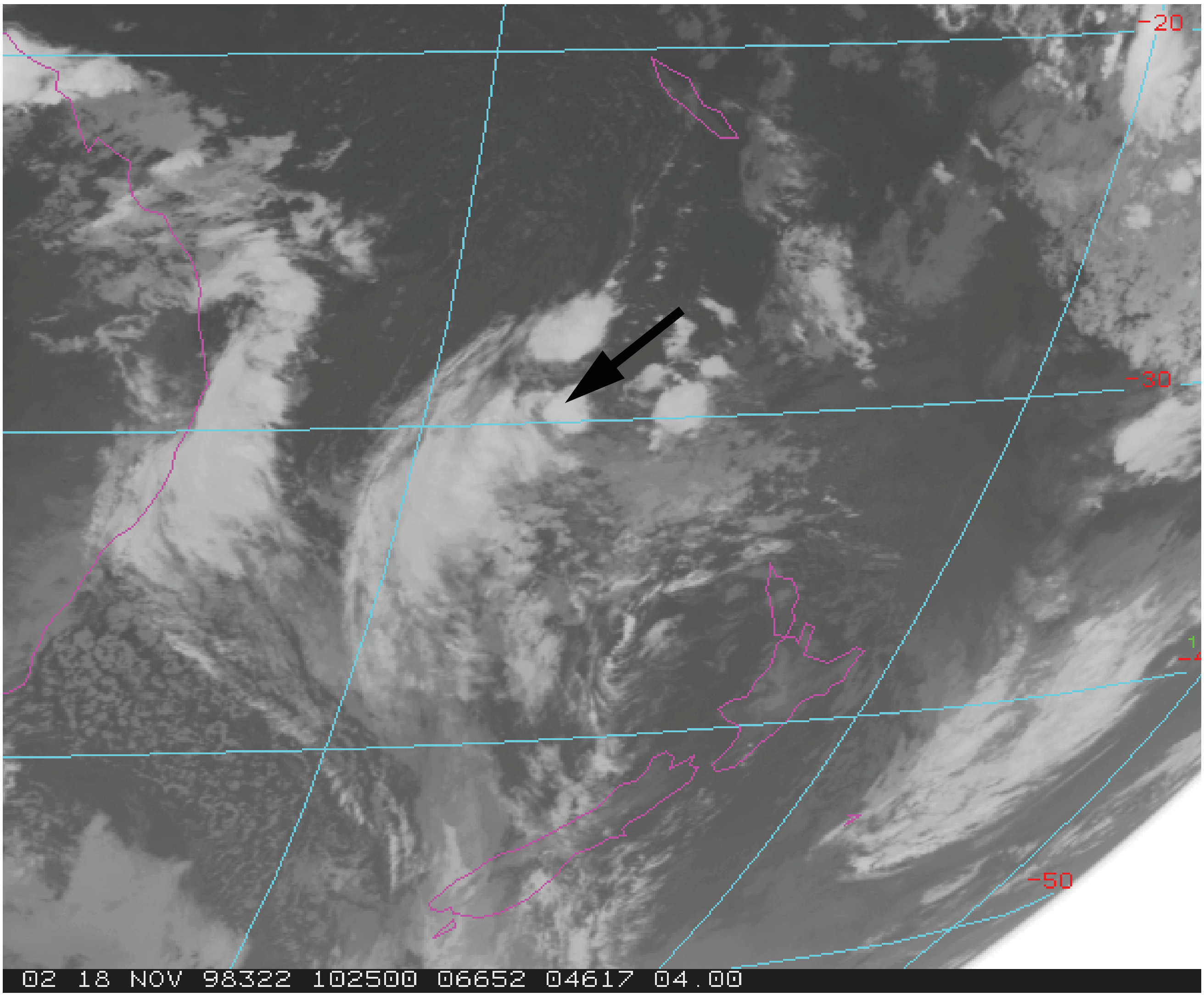
40 to 50 knots during the day and now have southeasterly winds at 35 knots."

In reply Russell Radio gave the position of the center and the expected pressure (980mb) of the depression. Sometime after 2200 hours the mainsail had started to unfurl from the boom, and two of the crewmembers (Messrs Anderson and Mart) donned wet weather gear and safety harnesses, then went on deck to secure it by adding an additional lashing around the sail.

At approximately 2230 hours the wind had freshened to about 80 knots (the yacht's anemometer had stopped working at 79 knots) with seas rising to high.

The skipper decided to rig a sea anchor/drogue (this consisted of a tire attached by a chain to about 326 feet/100m of nylon rope) off the stern of the vessel. Messrs Anderson and Mart then dropped and secured the headsail. The yacht's motor was started to bring the vessel around to run before the weather.

Soon after Mr. Lay went onto the after deck to put an additional lashing on the mizzen sail; while doing this he secured his lifeline to the mizzen shroud.



University of Wisconsin, Space Science and Engineering Center

The arrow indicates the approximate position of Janamarie II on this satellite image, which was taken within a couple of hours of the capsize. They appear (based on the very tight cloud spiral shown here) to be caught in a localized baroclinic depression. A storm that shows up this small in the satellite images, has an area of extreme winds that is probably less than 100 miles in diameter.

"The *Janamarie II* was a 50-foot/15.2m ketch-rigged yacht, constructed of GRP with teak decks. She was fitted with a 108-horsepower engine and was surveyed to Category One. She was equipped with the following navigational and communications equipment: One 406mHz and two 121.5mHz EPIRBs, single sideband radio transceiver, a ham radio transceiver, VHF radio, weather facsimile, GPS, and radar.

"The skipper built the vessel in 1977 and had subsequently undertaken 27 ocean passages in her.

"Mr. Lay held a Commercial Launch Master Certificate issued in 1990. In addition, he held a Queensland Master Class 5 certificate of competency. Mrs. Lay had accompanied her husband on board the *Janamarie II* since 1977."

Capsize

At about 2300 hours, after he had secured the mizzen sail, Mr. Lay noticed a lifebuoy on the port side of the afterdeck had become loose. While in the process of securing this, the vessel was capsized to port.

Mr. Lay found himself in the water attached to the vessel by his lifeline, and he managed to re-board the vessel where he found his wife in a distressed and injured state. There was no sign of the two other crew members and he presumed they had been washed overboard.

Following the capsize Mr. and Mrs. Lay secured the vessel. They nailed storm shutters over the inside of the broken windows, closed the hatchways and spent the rest of the night using a manual bilgepump to lower the level of water in the vessel.

Daylight was at about 0430 hours, 20 November, 1998. At about this time Mr. Lay located the 406MHz EPIRB, it was in the safety grab bag which had been washed into the engine compartment and had been lodged under the engine during the capsize. The skipper immediately activated it.

About two hours later an aircraft located the yacht. However, a rescue was not possible until the morning of the 21st.

Key Conditions

Mr. Lay monitored the weather forecasts prior to departure on the local media. When the vessel was at sea it received weather facsimiles from the Australian Meteorological Service and also communicated with Russell Radio for weather bulletins and position reports.

The vessel experienced adverse weather for the whole voyage with the exception of the second day where they made good a distance of 158 nautical miles. This was consistent with the skipper's analysis of the weather charts he had received.

The weather forecast did not predict the depth of the depression or the severity of the sea and winds that were experienced.

This was the first occasion Mr. Lay had deployed the sea anchor/drogue.

At the time of the capsize the crew were in the following positions: Mr. Lay was on the port side of the afterdeck securing a lifebuoy. Mr. Anderson was sitting on the helmsman's chair. Mr. Mart was sitting on the steps leading down to the bridge deck forward of the wheel position, removing his wet weather clothing. Mrs. Lay was sitting on the steps leading from the bridge deck to the main cabin.

The damage to the yacht included: six broken armor-plated glass windows, bent or broken masts, loss of all navigational and communications equipment and lifesaving equipment. The life raft and lifebuoys had been washed off the deck.

Contributing Factors

The prevailing weather off the New South Wales/Queensland coast was moderate to strong southeasterly tradewinds with accompanying sea and swell. This weather made a voyage from Queensland to New Zealand difficult as the course required to make good is directly into the predominant wind. The weather was adversely affected by the formation of a depression to the north and east of the coast.

The depth of the depression and the changing directions of the winds around it caused a confused high sea and swell.

The depression was moving eastwards slower than *Janamarie II* (it may have stopped moving altogether), and this resulted in the yacht overtaking it—hence the deteriorating weather that was experienced.

During previous voyages the maximum wind force that had been experienced was 60 knots, and the yacht had handled this with ease.

Prior to the capsize the vessel was moving comfortably. The skipper did not have any fears that the boat would not be able to handle the conditions that they were experiencing.

The fact that *Janamarie II* was overtaking the depression should have been apparent from a decrease in barometric pressure, along with the change in wind angles and cloud cover.

Opinions and Recommendations

The depression was not forecast until noon of the day previous to the accident; it is unlikely that Mr. Lay could have taken any other action to avoid the center of the depression.

The skipper could have taken the precaution of fitting storm shutters over the bridge deck windows. He points out that the shutters were designed to be nailed over the windows, and this would cause severe damage to the coachwork.

Mr. Lay, however, had reason to think that the windows were unbreakable. Some years prior to this accident, a forward shroud broke. This resulted in the rigging screw on the end of the shroud crashing into one of the windows without breaking it.

A sea anchor/drogue may be set off the bow or stern of a vessel: the skipper's preference for this depends on the design of the hull and the weather conditions prevalent at the time. Mr.Lay suggested that he set the anchor over the stern to protect the steering gear, which could be damaged if the yacht slipped backwards down a wave into a trough.

It is suspected that the sea anchor/drogue deployed by the *Janamarie II* was too small for the size of the vessel. According to Mr. Lay the vessel was "laying ahull." This would support the theory that the drag of the sea anchor/drogue was insufficient to keep her stern to the prevailing seas. If she was lying nearly beam to the seas it would have allowed the yacht to be "knocked down" by a large sea.

"Mr. Lay had no experience in setting or riding to a sea anchor/drogue: this is a common situation even with the most experienced sailors. The reason for this is that a sea anchor/drogue is only used in the most extreme weather conditions and at such times practicing is not normally foremost on people's minds."

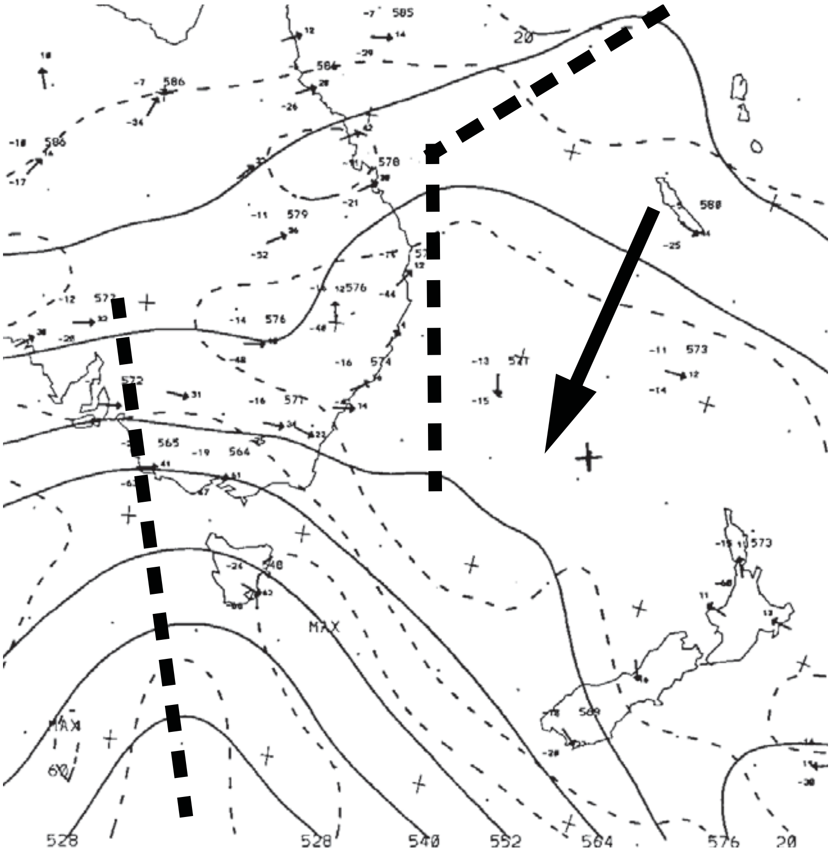
500mb Warning Signs

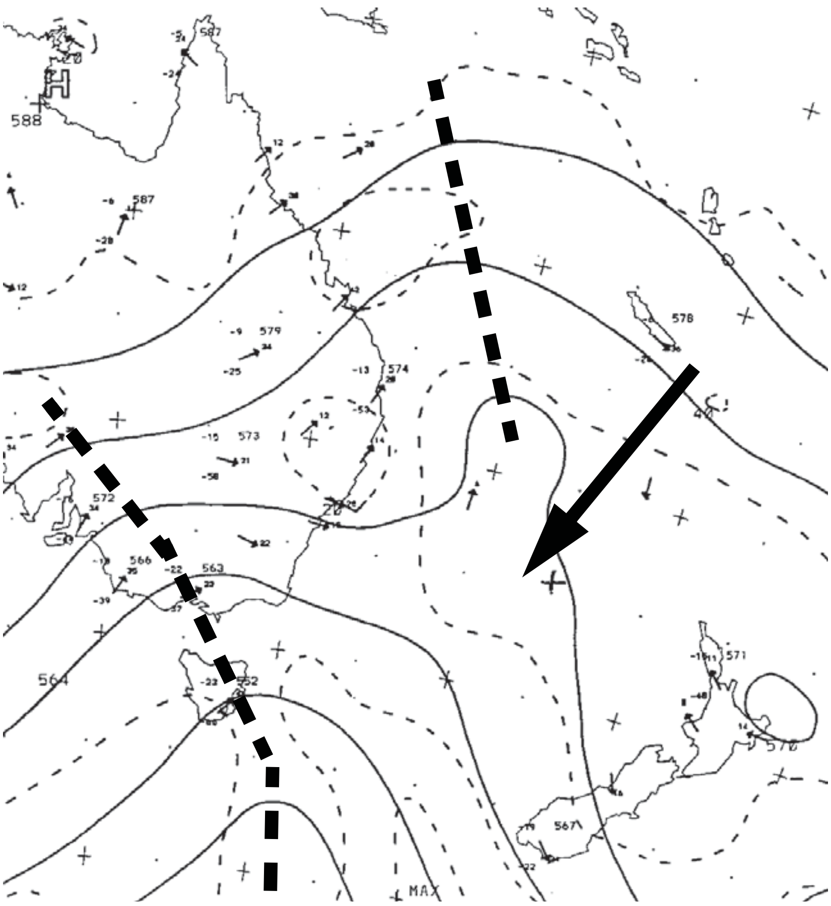
You will be hearing throughout this book about warning signs for weather risk factors. Among the very best are the 500mb weatherfax charts. Often when there is no hint of trouble on the surface charts, you will see major risk factors developing at the 500mb level.

Of all the skills you can acquire to keep yourself out of difficult weather, understanding what happens at the 500mb level is the most important.

Versions of the following charts were broadcast by the Australian Bureau of Meteorology as a regular part of their daily fax SSB service. Had you been watching these for the week prior to leaving Australia, and kept up with them en route, you would have known that the possibility for a "bomb" existed. The probability would not be high enough for the pros to announce it, but there was evidence on hand to slow down or heave to until the situation clarified itself.

All of this data on 500mb charts may seem a little intimidating. However,





We start off early in the morning on November 18. The arrow points to the approximate position of Janamarie II. The heavy dashed lines show what are known as upper-level short-wave troughs. These provide the venting mechanism which allows a surface low to develop. If there is no trough in the upper atmosphere, the surface low will be anemic, or won't develop at all.

It is the rhythm these upper level troughs exhibit which gives you the advance warning, so it is best to watch for ten days to two weeks before your departure date.

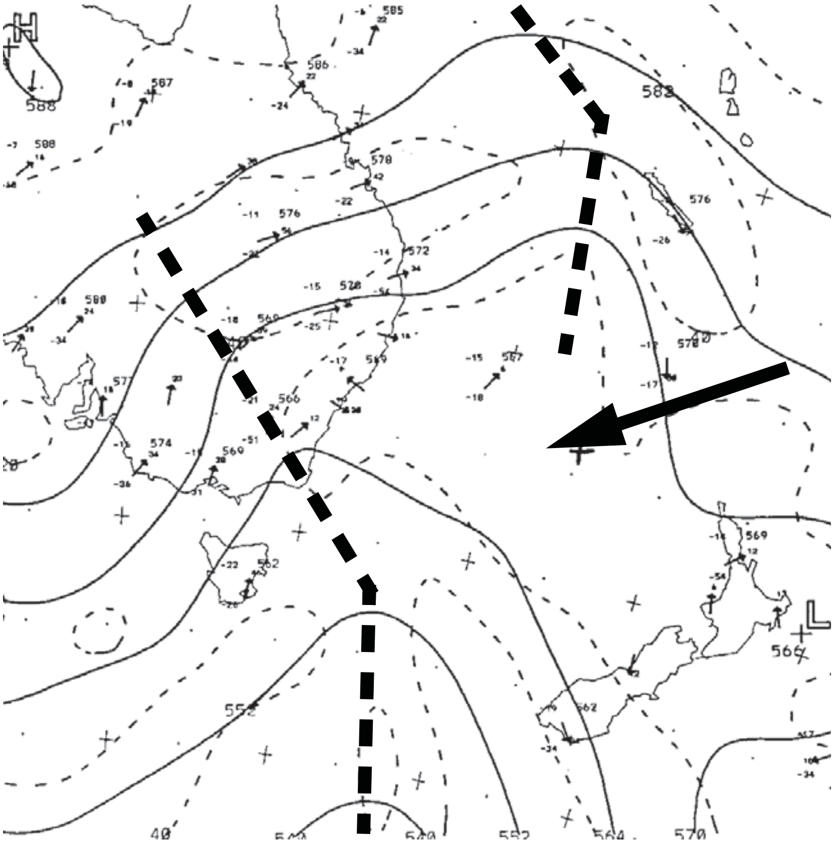
In the first chart, there are two troubling signs. The first is a vigorous trough below and slightly west of Tasmania. The second is another short-wave trough, this one quite weak, stretching up into the tropics between the Queensland coast of Australia and the Fiji/New Caledonia area. The risk here is a combination of these two troughs. If this occurs, there is a probability of aggressive deepening of the surface low associated with these systems.

In the second 500mb chart, below, run off in the afternoon on the 18th, we see the westerly trough rotating east, which is normal. The subtropical trough to the north is showing signs of development. Between the two, there are signs that they may come into phase, and overlap each other. This would reinforce the development of any surface depressions in the area.

At this point the risk potential has just taken another jump, and it is time to think about a safe harbor or heaving to. Try to move west of what is developing (these systems will typically move east as they mature).

with a modest amount of effort, you can get up to speed on this most valuable of forecasting tools. Your passages will be faster, more comfortable, and much safer as a result.

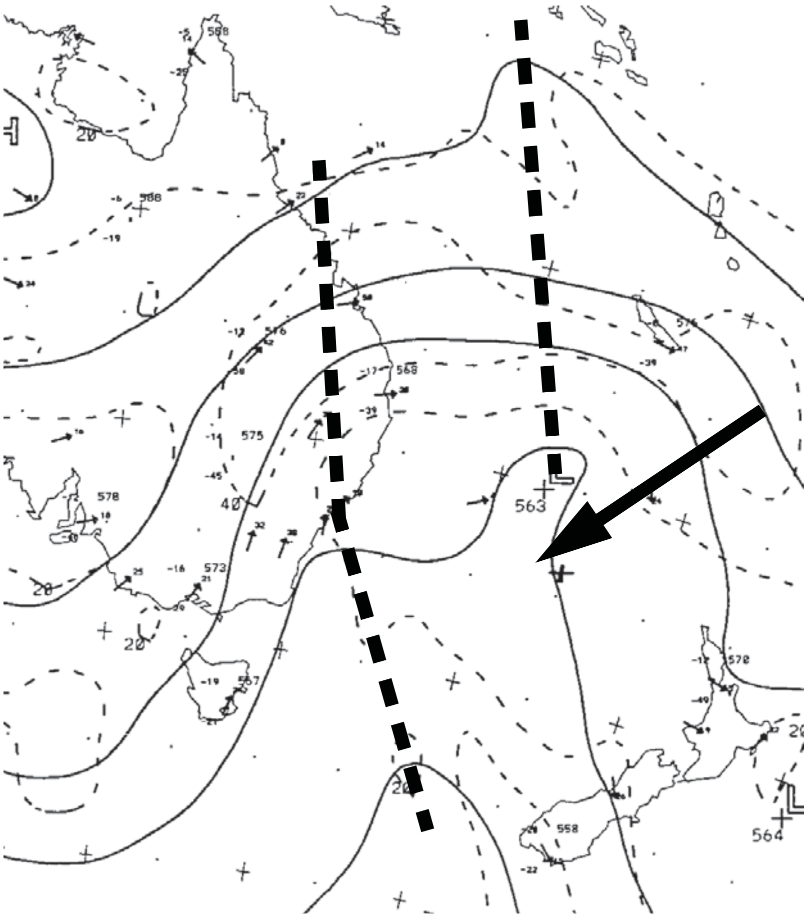
You can find 500mb data from around the world on the Internet. The time to study is now, before you head offshore.



The next two charts are for the early morning on the 19th and then the afternoon of the same day.

The western short-wave trough is continuing to rotate through, while the trough to the north is developing but remaining more or less in one place.

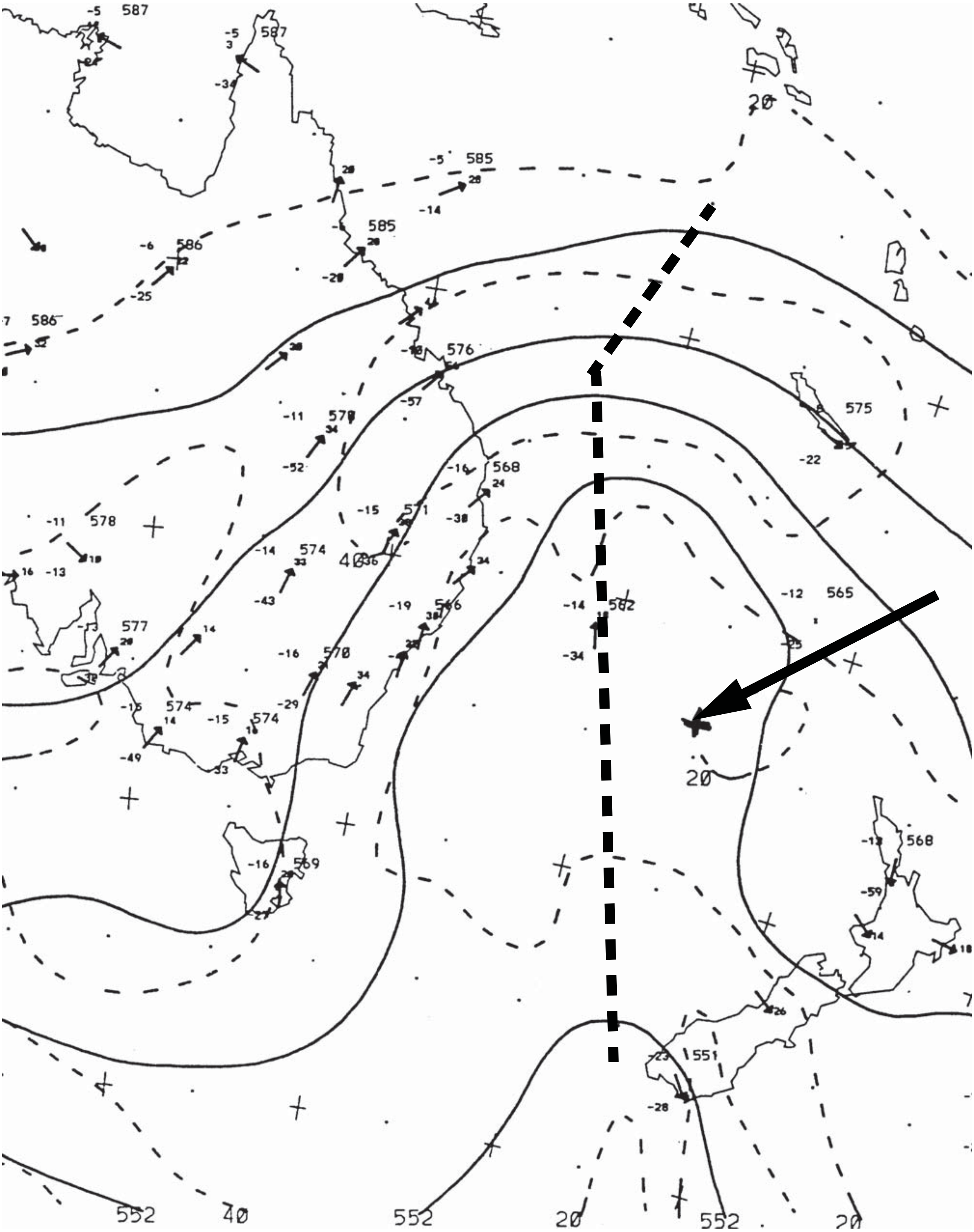
Note that the heavy dashed lines, representing the trough axis, are continuing to get closer to each other.



Twelve hours later, the computer is showing the troughs getting into phase. You now know to expect a severe surface depression. Even if the surface forecasts don't show severe weather approaching, these 500mb charts indicate a high probability of the weather "bombing."

At this point, it is difficult to tell what is the best evasive course to take. If you had surface pressure readings from other boats in your region, you could use them to find the center of the rapidly developing storm system.

Without this outside data, the best bet is to prepare the boat for the worst. Fit storm shutters, check lashings, get any drogues or parachutes ready, and bend on storm canvas. Heaving to or heading west would also help.



Early morning on November 20, when Janamarie II is running off towing warps. The two upper-level troughs have now merged, providing a strong source of venting to the surface low which has been brewing. In addition, there is a source of cool dry air from the southern latitudes. These are exactly the ingredients required for the system to "bomb."

The combined trough axis (heavy dashed line) is to windward (west) of the boat (indicated by the heavy arrow). Janamarie II is in the worst possible location relative to the upper-level trough. The odds are that if they were just a couple of hundred miles to the west, they would be seeing nothing more than gale-force winds.

Bruce Burman

Freya was a Stan Huntingford-designed 45-foot (13.8m) Explorer. With a beam of 13 feet (4m), she displaced roughly 20 tons. Freya had a full-length keel with cutaway forefoot, and keel-attached "barn door" rudder.

FREYA

The Burman family left Nuku'alofa, Tonga, with the second group of yachts on November 19th. By the fourth day out, they were running down the 179 degrees West longitude line, 20 miles behind *Shakti*. In the light winds they were powering at 5 1/2 knots.

By the fifth day at sea the distance to *Shakti* had opened to 40 miles. The next day it was 44 miles, and by the seventh day it had stretched to 86 miles. At the morning roll call on their eighth day at sea, the distance between *Shakti* and *Freya* had grown to 134 miles. The following morning, Friday the 27th, the distance was 140 miles.

One hundred and forty miles in the context of an 1,100-mile passage does not seem like a great amount. After all, divided over eight days this is just 17.5 miles a day or 3/4 of a knot. The boats were not racing, so why push?

As you know from the preceding pages, the boats were all concerned with getting the passage over as quickly as possible. Less time between the tropics and New Zealand meant less exposure to the weather. The Burman family was no exception, but their boat was inherently slower than some of the other boats in the light winds and close-hauled sailing.

Weather Issues

One of the problems in approaching the North Island of New Zealand during a squash zone is that the winds frequently blow much stronger than the isobar spacing would lead you to believe. This is the result of a number of factors including the impact from the topography of the island itself.

The weather data Bruce Burman had at his disposal was based primarily on New Zealand Met Service warnings issued over VHF, and SSB from Des on Russell Radio.

For Bruce Burman, Mike Fritz aboard *Salacia*, and others further behind, at the 0700 single sideband schedule Russell Radio was indicating a gale of 40 to 50 knots—no big deal in a well prepared vessel.

During the preceding day, *Freya* had experienced steady winds from the northeast, and the barometer had been stable, according to Bruce's recollection.

The movement of the barometer in a situation like this one is extremely important. With the low bearing down against the high, any increase in barometric pressure would indicate an expanding high, sure to bring winds that were not only stronger but gustier as well.

At this point you have three choices:

- ❑ Head back to the north to try avoiding the coming squash zone and lee shore of New Zealand. The only problem with this approach is that you would be giving up hard-won distance towards your destination with the odds of getting a further beating as a low passes over your region after the high pressure dissipates or moves off to the east.
- ❑ Move as quickly as possible and try to make it into the Bay of Islands before things really deteriorate. However, this may bring you onto a lee shore during adverse weather, where a navigational error could be deadly. There is also the issue of visibility. At night, or in conditions of rain and low clouds, the entrance to the Bay of Islands can be tricky even for those familiar with the area. If this is your first visit to New Zealand, the approach in inclement conditions will be dangerous.
- ❑ The third choice is to heave to, hold station against the blow, and time the arrival for daylight and/or when visibility improves.

Deploying a Parachute Anchor

At the Friday morning schedule with Russell Radio, *Freya* reported that she was doing 7 knots on a course of 190 degrees magnetic, right for the Bay of Islands. The wind was blowing 25 to 30 knots from the east. By midday the wind had begun to pick up and by early evening it was blowing a steady 45 knots, and gusting higher.

At 1900, while still roughly 140 miles from the Bay of Islands, Bruce decided to deploy their 18-foot (5.5m) diameter Para-Tech parachute anchor. Deployment was directly off the bow and went smoothly.

The anchor was attached to the boat with 450 feet (138m) of 3/4-inch (19mm) three-strand nylon from New England Ropes (with a 16,700-pound/7,800kg breaking strength), secured to a bow cleat. The rode had never been used before.

Every two hours he would go forward and ease out 2 feet (0.6m) of rode, to make sure that there was no chafe. This was accomplished by removing several turns from the cleat, and then easing the rode by hand.

In between Bruce dozed below using an egg timer set for 20 minutes to wake himself for a quick look around the horizon.

The boat sheared around some, hanging onto the parachute directly off the bow, but not so much as to make it really uncomfortable on board.

"I was lulled into a confidence I shouldn't have had. I thought everything was just fine." Bruce later said.

What follows is researched by Phillipa Warwick in New Zealand. Phillipa has been kind enough to allow us to excerpt from her notes.

Knockdown

Despite the building sea, the Burmans lay comfortably all night until between 0400 and 0500, when Marianne and their son Heath's sleep was abruptly cut off by an ear-splitting explosive thud as a wave slammed *Freya* onto her port side and rolled her to an inverted position.

Bruce heard the wave coming above the sound of the wind. *Freya* righted almost immediately, but Bruce is not sure if she continued all the way around or came back the way she'd gone over.

Marianne describes the scene:

Inside *Freya* the freezer lids had come off and flown around the cabin like guided missiles, one hitting the SSB radio and rendering it inoperable, another ending up wedged behind the companionway.

I realized we would all have to get shoes on right away as I stepped barefoot onto the cabin floor into shards of broken glass from the one glass item on the boat, a water pitcher from the freezer. Plastic jars of jam were splattered and broken eggs were everywhere. Drawers came out in the aft cabin, and film canisters rolled all over the place. The bathroom drawer came out and with it scissors, earrings and precious black pearls, which we had diverted to Moorea to buy, rolled away. Floor panels had been torn loose. Miraculously we were all okay.

A light shining through the cabin window from outside dragged us out of our dazed shock and up on deck to see if we had collided with *Salacia* whom we thought was close by, but it was the light in our life raft which the knockdown had forcefully deployed. It had been bolted through the cabin roof but the force of the sea had broken the stainless steel bands, knocked it from its cradle, and inflated it. In stunned disbelief we scanned the deck to view the devastation on the outside. The dinghy davits with solar panels, wind generator, and SSB antennae were torn off; and the forward hatch was broken open.

We suspected the mast was compressed at the base, because the shrouds were loose, and the mast was rocking back and forth. The VHF antennae and Radome on the main mast were damaged.

In spite of the mess below and lost gear on deck, *Freya* came through this knockdown reasonably well. The immediate problem was damage to a large composite timber and acrylic hatch on the forward end of the doghouse.

This structure was 2 feet (0.6m) square, and had been torn loose from its hinges (which were screwed in place rather than through-bolted) coming to rest in the starboard lifelines.

With a few hundred gallons of seawater in the interior, Bruce's immediate concern was to get the hatch repaired. He tied it back in place using lines stretched between the teak handrails on either side of the trunk cabin. He then placed the inverted and deflated RIB over it.

As Bruce was making repairs, he saw that the sea anchor was gone. His first thought was anger with himself that he had allowed it to chafe through. Closer inspection revealed it had snapped off 10 feet (3m) forward of the bow. The nylon rode was stranded for 18 inches (450mm). It had failed at the moment of wave impact.

When *Freya* didn't make the 0600 schedule, Des had a sinking feeling in his stomach. Intuition told him something bad had happened. He knew these people only by their voices, but felt a bond with them. He contacted

Bruce Burman's tactic of heaving to and awaiting better conditions is the same one that virtually every experienced sailor would have used, based on the weather data available and the type of boat involved.

Bruce tried setting a small scrap of sail but didn't like the way *Freya* sailed forward towards the parachute, so he eventually ended up hanging directly back from the para-anchor under bare poles.

When we asked Bruce about lying ahull after the parachute anchor was lost, he said: "At the time I didn't think about getting the boat to head into the waves. I was intent on getting the hatch covered. I have since realized that I could have gotten the three corners of the jib together and streamed it off the bow as a sea anchor. But at the time, I just didn't think of it."

Bruce was now focused on what practical things could be done. As each new situation arose he came up with a plan of attack. Action—any action—was preferable to doing nothing. To do nothing would be to admit defeat. Marianne was adding up the facts—loss of communication and life raft, worsening weather conditions, and the worst thing for parent, their only child on board.

the Maritime Operations Center and alerted them. He suggested they try calling *Freya* on 4445 kHz, and alternatively listen on 4051 kHz, the frequency used by the cruising yacht net.

Cleaning up, screwing down loosened floorboards, and generally securing the boat kept Marianne, Heath, and Bruce very busy below while on deck the weather continued to deteriorate.

They attempted to send a Pan Pan on the VHF, but the broken antennae gave them very little range. They then attempted to repair the SSB to no avail.

At approximately 0730 some 2 1/2 hours after being knocked down, the line holding the life raft chafed through and it was lost.

Activating the EPIRB

"Okay, that's it, we've lost our life raft. We've got to turn the EPIRB on…now!" said Marianne.

Bruce hesitated: "Maybe we should wait. We've repaired the hatch, and we still have the dinghy. If we stay below we'll all be okay now. The storm has to pass soon."

"Dad, I think we should turn the EPIRB on." Heath wanted to do something, anything to help his mother feel better. He was amazingly calm and matter of fact. There was no shouting or panic, just a determination to do something to help.

Within minutes of the EPIRB being activated, details of *Freya*'s crew, yacht, location, and next of kin were flashing across a computer screen in America. Bruce's father in the United States received a chilling telephone call from the US Coast Guard in Seattle. "Is *Freya* under sail? Could this be a genuine call for help or is it an accidental EPIRB activation?"

Bruce's father assured the caller that this would definitely be a genuine call for help. "Yes, they are under sail on their way from Tonga to New Zealand. Can we please keep in touch for any news of them?" he asked.

The EPIRB was deployed and soon after this, the National Rescue Coordination Center (RCC) in Wellington, New Zealand had a search-and-rescue operation underway.

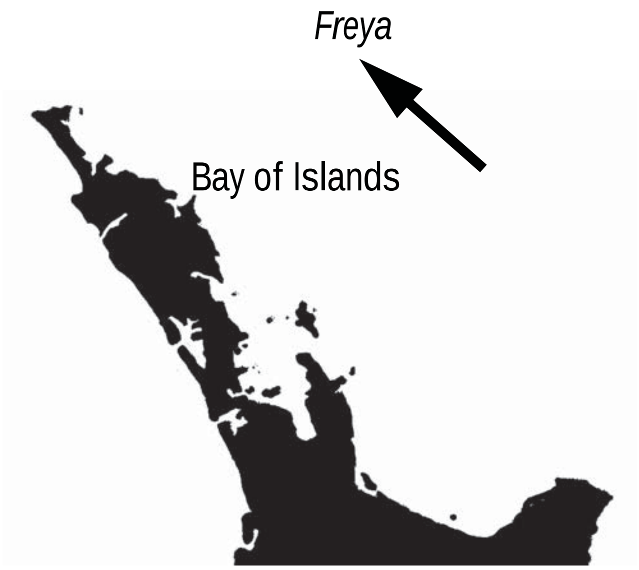
By 0755, Saturday morning, in response to *Freya*'s EPIRB distress signal and Des Renner's report of their missed morning schedule with Russell Radio, the RCC had requested an all-frequencies distress relay be put out for *Freya*. They asked the Northland Emergency Services Trust (NEST) helicopter to fly to the area and for a fixed-wing aircraft to provide top cover.

However, by 0800 a "missed alert" EPIRB signal was received by RCC, indicating *Freya*'s EPIRB had been turned off. The distress relay was cancelled while further attempts were made to contact *Freya*.

Soon after, at 0853 the EPIRB was transmitting again. *Freya* had not made the 0730. She was the only yacht not accounted for on the cruising yacht's 4051 net.

A Mayday relay was set up and a Class III (highest priority incident) was declared. Up until this time the Search-and-Rescue Mission Coordinator had been operating from a cell phone, but now he proceeded to the National Rescue Coordination Center in Wellington. There he was to be joined by a marine duty officer, an air traffic officer, a police inspector, and a Maritime Operations Center radio operator.

Reg Ellwood, rescue helicopter pilot for Northland Emergency Services Trust (NEST) in Whangarei, was at home when the Mission Coordinator from RCC called at 0755. They were requesting search-and-rescue assistance for *Freya*, reported to be in distress approximately 100 nautical miles



northeast of Whangarei.

By 0915 Reg, co-pilot and winch operator Steve, paramedic Tony, and Northland Water and Dive Rescue Squad volunteer Aaron were airborne in the rescue helicopter. By 1000 they were in the search area. Tony, Steve, and Aaron glued their eyes to the waves.

"We're going to be lucky to find them in this sea. I keep thinking I've seen them, but when I look again, there's nothing!" said Tony.

Reg calculated the drift that would have affected *Freya* in the time since the EPIRB signal was set off, and headed in that direction. Steve kept calling *Freya* on the VHF. They were all having similar thoughts: "What if we've lost them already—are we too late?".

At approximately 1010 Marianne's voice came through very faintly.

Company

On board *Freya*, Marianne wedged herself against the saloon bulkhead as she replied, "Rescue helicopter, this is *Freya*. It's good to hear your voice. Where are you at the moment?"

"Yeah, *Freya*, we have your last reported EPIRB position and we're in the vicinity now conducting visual search. Can you hear us?"

Bruce flew up the companionway frantically straining for a sound above the gale and searching the sky. "Negative, rescue helicopter, but we have a crewman on deck trying to spot you."

It was difficult to hear what Steve aboard the helicopter was saying to her. She could see the indicator on the VHF moving but the signal was faint and kept cutting out and the noise of the wind was deafening. "*Freya,* what is your situation with regard to injury and damage?" Steve asked.

Marianne gave the following damage report. "We have lost our life raft, the SSB radio's inoperable, VHF antennae are damaged, waves are around 25 to 30 feet (7.5 to 9m). We've been knocked down once, no major injuries at this stage but we have a child on board. I'm very concerned. We would like (if at all possible) to be taken off please. Over."

The wording of this was important. A rescue cannot legally take place unless people request to be taken off. "Thank you, *Freya*. Do you have radar on board?"

"Negative, rescue helicopter—not anymore."

The rescue helicopter continued to search, making sweeps of the area. At approximately 1108 they were forced to turn back to refuel.

On board *Freya,* almost one and a half exhausting hours later at 1230, the VHF radio again came to life and Marianne, Bruce, and Heath heard the

One of the situations we find occurring over and over again during rescue attempts is a difficulty in communicating.

It is not unusual for the distressed vessel to have no functioning radios aboard. Consider what would have happened here if the Burmans and the pilots had not been able to communicate.

The safest way around this problem is to have a dry cell powered handheld VHF radio, securely sealed against water damage.

welcome sound of voices from the Westpac One aircraft which was now in the area and searching for them. Marianne couldn't make out the name of the caller over the noise of the storm: "*Freya*, this is …, we're conducting visual search now."

Bruce was out in the cockpit in seconds…"Okay. We're looking out for you," said Marianne.

The aircraft had made several sweeps of the storm-lashed area without a sighting, when Bruce suddenly yelled down the companionway to Marianne. "There they are! Tell them we're off to their port side. Tell them I can see them!"

Westpac One quickly spotted the yacht and relayed a message from the RCC. "*Freya*, can you turn your EPIRB on, please. We got a signal from you earlier, but it is not transmitting now."

Marianne and Bruce were shocked to hear that the last signal received from their EPIRB was at 1005.

Westpac One radioed *Freya*'s position to the RCC and communicated rescue plans back to *Freya*. Relief and hope spurred on the exhausted family as the aircraft departed after reporting that a ship was on its way to rendezvous with *Freya* at 1600. "Only a little while longer and we'll be out of this," they thought.

More Knockdowns

Within what seemed like minutes after the aircraft's departure the weather conditions worsened, and *Freya* took another knockdown.

The forward hatch was completely torn off. The floorboards, which had been screwed back down after the first knockdown, came flying free.

The fourth knockdown was the most devastating in terms of damage. It is likely that they were either rolled or pitchpoled, as the boat was facing in the opposite direction relative to the wind and seas. The mast was lying in a tangle of rigging over the starboard side.

Freya was sinking. And Marianne—close to panic—knew they would go down with the boat if help didn't come soon. The water was over their ankles on the cabinsole, but miraculously the electric bilgepumps were still working.

Bruce didn't believe the boat was lost. He needed to keep thinking of things to do to fight back. He said later, "When you run out of things to do is when you lose hope."

In the meantime, the rescue efforts by the ship were not going well. At 1051 the RCC had requested the Maritime Operations Center to task a ship in the area to divert to *Freya*. The tasked ship reported some time later that they were unable to reach *Freya*, which was drifting at a fast clip to the southwest. At this rate, she would hit the coast before a rendezvous could be achieved.

Back in Kerikeri while refueling the rescue helicopter, Reg talked to the RCC regarding *Salacia* from whom they had copied a distress call while searching for *Freya*. *Salacia* also needed search-and-rescue assistance, but there was no confirmed position at this stage. A GPS position for *Freya* had

"I'm sick of all this stuff flying around—floorboards and beer cans!" Heath angrily picked up the broken floorboards and threw them into the forward cabin.

Bruce grabbed the hammer, ripped the lid off the food locker under the seat and nailed it into place across the gaping hatch hole from inside the forward cabin.

Freya's situation had suddenly become very precarious with help still some hours away. Marion and Bruce knew they were in big trouble. Within ten minutes they took two more knockdowns.

just come in from the Westpac One. "Since we don't have a position for *Salacia*, I want to go back for the people on *Freya* rather than wait around."

Reg was impatient to go back for *Freya*—quickly, before she drifted too far. "Westpac One says conditions are far too dangerous out there for winching people off," said their contact at the RCC.

But Reg had made up his mind. "I'd like to find them and assess the situation when we get there." Reg knew how he would feel if he was on a yacht in those conditions.

By 1300 they were heading for the position reported by Westpac One. Thirty minutes later they were in the area where *Freya* was last sighted.

Conditions seemed to be particularly bad in the immediate vicinity. They were flying through rain bands and the cloud base was down to 100 feet at times, making the whole scene very eerie. Reg noticed that the air data windspeed printout indicated 70-knot winds. "Things have gotten much worse since we were last out here. I never imagined it would be this bad," said Steve.

Reg grimly agreed."I've never seen a sea this violent."

There was no sign of *Freya* when suddenly they heard it: "Mayday, Mayday, Mayday…this is *Freya*. We have water over our…(the signal cut out) … and require immediate assistance...over!"

When making a Mayday call, you need to stop transmitting every 30 to 60 seconds so that you can hear if someone is trying to reply.

"We've got to get them off that boat! Reg said.

Steve responded, "*Freya*, *Freya* this is rescue helicopter, ….received. We're in the area and looking for you now…over."

There was no response from *Freya* to Steve's message and he heard them repeatedly calling Maydays while trying several times to get a message through to them. "They must be holding the button down. I can't get through to them. They can't hear us!"

Steve could hear how frightened they were. A few minutes later, Tony had spotted something at 3 o'clock out of the starboard window, but they were already past it. Visibility was approximately 325 feet (100m) as they turned and scanned the ocean where Tony had seen something moments before, but there was no sign of anything now as the rescue helicopter slowly made its way back.

They were almost past *Freya* again when she popped up out of a trough, and this time they had her. "Look at her! Look at the decks—there's nothing left!," said Tony.

Freya's decks were stripped completely bare. There was nothing there, no mast, no rigging, no equipment—nothing. "The mast is gone. That's one less hazard —let's get them off." said Reg. "We have plenty of fuel. Let's take our time and get this right!"

From here, things happened fast. Trevor Tuckey of the volunteer Northland Water and Dive Rescue Squad was rostered on that day and got a phone call at his home in Whangarei from NEST. He was needed to replace Aaron who had become violently air sick. He raced to meet the helicopter as it stopped in Whangarei and Aaron—still barely conscious from air sickness—was offloaded while Trevor threw on his wetsuit and boarded the helicopter. In the rush, nobody noticed that Aaron was still wearing the helmet that Trevor needed.

Helicopter Rescue

Marianne and Heath were desperately sending Maydays on the VHF every 30 seconds. About 20 minutes later the VHF came to life; the rescue helicopter was overhead. Things happened fast.

"We're sending a man down on a line—we'll drop him in the water then trawl him over to you and try to get him on board. Stand by."

Hi-line techniques for those being rescued (per NEST):

- ❑ Keep wind 30 degrees on port bow.
- ❑ Maintain vessel heading unless otherwise instructed by helicopter crew.
- ❑ Accept (catch) hi-line in clear area on port quarter.
- ❑ Deck crew should wear gloves.
- ❑ Take in slack as hi-line is lowered.
- ❑ Don't attach the hi-line to any part of the vessel.
- ❑ Pull in the swimmer when the winchman signals.
- ❑ Maintain tension on the hi-line at all times.
- ❑ On recovery of the hi-line (by helicopter) maintain tension until the weights are in your hand, then release them clear of obstructions.
- ❑ Static electricity can build up in the hovering helicopter. A static discharge wire is attached to the end of the winch cable. This should be grounded to the boat or the ocean and not to the bodies of anyone on deck.

The preferred position for a rescue of this nature is with the helicopter parallel off the port side so the pilot has good visibility of the target. But as *Freya* was lying beam-on to the sea, Reg had no option but to position the helicopter at a right angle off the bow, hovering into the 70-knot wind. This meant it was going to be extremely difficult to get a man on board the yacht in these huge seas. The helicopter was sometimes 65 feet (20m) above the yacht and at other times just 15 feet (4.5m).

Bruce watched from *Freya* as Trevor Tuckey, clad in a hooded wetsuit (and without his helmet, which was back on shore), was lowered into the water on the port side. Co-pilot and winch operator Steve had 70 feet (26m) of line out to keep Trevor in the water when suddenly the yacht hit a huge wave and came surging up to meet the helicopter.

"Back up Reg! We're going to have that boat in here with us if we're not careful." Steve yelled.

Steve watched in horror as the slack cable coiled dangerously around Trevor in the water and the yacht surfed towards him. He knew he had to get Trevor back up; but if the cable wrapped around him, it could kill him.

He hit "lift" on the hand-held winch control, but as Trevor came clear of the water, he swung around with his back to the yacht and slammed into the bow, his head missing the anchor by inches.

Seconds later, Steve pulled Trevor safely back on board the helicopter where he lay dazed on the floor. He was hurt—he had been banged on the head and had blood oozing from between his teeth.

Tony, the paramedic, checked him out while Steve and Reg formulated a plan to lower weights on the end of a hi-line down to *Freya*. The hi-line would then be held by a crewmember on the yacht and used to guide the winchman down from the helicopter.

Now that Trevor was injured, Tony would go down on the winch. They quickly briefed Bruce via the VHF on how to manage the hi-line from his end.

It took sometime to get the two 22-pound (10kg) weights on the end of the hi-line on board *Freya*, because the action of the sea kept fighting them off. Somehow Bruce eventually managed to grab the weights and take in the slack as instructed. The hi-line was now ready to guide the rescue swimmer down to the yacht.

Up in the helicopter, Trevor suddenly came back to life. Going down to get these people was his job and he was determined to do it. He was reaching over to hook himself into the winch when, in one sickening split second, the hook from the hi-line slipped off the winch, bounced across the floor, and vanished out the door.

Undaunted, the rescue team slowly and deliberately prepared a second hi-line with the remaining 22-pound (10kg) weight bag while Reg re-briefed *Freya*.

The helicopter was talked in again, and Steve lowered the hi-line successfully to Bruce waiting on *Freya*.

As Trevor disappeared out the door on the winch, Steve called after him, “Don’t lose any more hi-lines!”

Down on *Freya*, Bruce did a perfect hi-lining job, landing Trevor on the bow. The helicopter crew held their breath as they watched him crawl back towards the cockpit while *Freya* hit another big wave and started to roll. “He’s on the leeward side—he’s going under!”

If the boat rolled and tangled the rescue line, the helicopter would have to cut itself loose.There would then be no way for any further rescue on this trip.

Finally in the cockpit, Trevor yelled to Bruce and Heath, “You and the boy—over here—get these strops on!”

The strop is a simple padded arrangement which fits around under the armpits. “Hold on to the boy. Put your arms around him!”

Bruce had been on the verge of suggesting that he, as skipper, should be the last off, but quickly changed his mind. Reg had instructed Trevor to get Bruce and Heath off together first, because he felt Bruce was stronger and would be better able to hold on to Heath during the rescue.

Within seconds, Trevor was ready and gave the signal to Steve, who winched Bruce and Heath skyward to the helicopter.

Steve grabbed Heath to swing him backwards in through the open door but the hook attached to his harness smashed into the door frame. Anxious seconds went by as Steve backed them down, grabbed the loop on the back of Heath’s strop, and hauled them through the opening to safety.

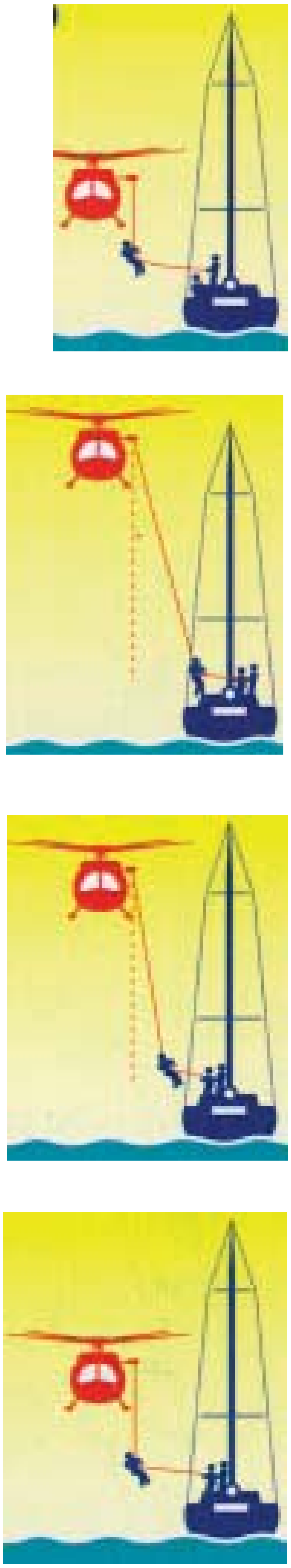
Below, Trevor felt *Freya* settling deeper into each trough as the waves continued to wash over her and pour into the cabin. He could feel her going down.

Agonizing moments passed while Trevor got Marianne secured into the strop, told her to stand up ready, then gathered the hi-line ropes, looping them carefully around his left hand. Watching all this, Steve fervently wished he hadn’t told Trevor not to lose any more hi-line. He just wanted to get Trevor and Marianne safely off the boat. He didn’t care if the hi-line was lost. Trevor gave the signal and Steve hit the winch button just as *Freya* took off on the crest of a breaking wave.

Trevor and Marianne started up, then slammed across *Freya*’s lifelines and into the water. Trevor felt the looped hi-line tighten around his hand, slicing through the flesh.

Glancing back, he realized with horror the weight bags on the end of it were tangled in *Freya*’s lifelines and Steve was winching him upwards. He had split seconds to get the rope off or lose his hand. He frantically ripped at the coiled hi-line until it fell away into the sea and they flew upwards, only to be hit by another breaking wave and dumped under a second time.

Gasping for air and completely disoriented, they saw the landing gear of the helicopter and knew they were safe.



The NEST hi-line technique, in this case shown with a vessel with rigging intact.

"Let's get out of here!" yelled Steve.

"Got a bit of a scratch there, mate." said Tony as he inspected Trevor's badly lacerated hand. "How bad is that hand, Trevor?"

"It's a bit sore," Trevor replied.

Then a mood of absolute elation took over. The rescue operation had gone well. This was what they had trained for. Adrenaline was flowing freely.

At 1345 the NEST rescue helicopter advised RCC that three people suffering from mild hypothermia had been winched off *Freya* and were now heading for Whangarei.

Lessons—We got in touch with Bruce Burman to review some of the details and ask if he had any additional thoughts:

- He would not go to sea again with composite hatches. Some form of heavily built metal hatch would be on his next boat.
- His next boat was going to be metal, probably steel, with a secure storage area for the life raft so the sea could not wrench it free in a knock-down.
- And about the tactics he'd use the next time? "In my opinion to run off in those conditions, with steep breaking waves, would not be wise. Our boat hove to quite well and might have weathered the storm without any problems. I would probably choose the sea anchor in these conditions because the boat rode so well, and nothing else would do as good a job in holding the bow into the weather."

Rescue Coordination

A huge amount of effort goes into a rescue effort. Most of the work is behind the scenes and rarely comes to light.

There are also significant risks taken by the rescuers—just consider the flying conditions, as well as the danger to the helicopter and crew in boarding *Freya*.

To get that helicopter headed out to sea takes lots of coordination. The RCC and radio logs on the following pages make interesting reading.

We'll start with the first EPIRB alert report, received in Wellington, New Zealand. The next report is the actual e-mail received in Wellington, giving the details.

Following that is a recap of the EPIRB data received by RCC in Wellington. Note the times of "missed alerts," indicating the ACR 406 MHz was only transmitting intermittently. The last report is a recap of the communications and actions taken by everyone on the rescue team.

MARITIME RADIO INCIDENT REPORT

Date: 981128

Incident#: 98/604

Time:0808nzdt

Vessel: Freya Call sign: WCI3928

Site/Freq: NLu-16/71,Zim-2182/2207, Zim-4125/4146, Zlm-6215/6224 Pob:3

Classification: EPIRB, Distress

Details:

0808 nzdt MDO advises EPIRB detected belonging to USA yacht *Freya*/WCLI3928. Position: 34.21S 175.08E. 100 NW Whangarei. MOC to call yacht, if no reply start broadcast using Pan Pan prefix. 0820 nzdt Rang Russell Radio and advised situation. Des advised MOC that when he spoke to the *Freya* at 1906 nzdt last night suggested they call Taupo maritime and set up 2 hrly skeds however, they were reluctant to do so and did not meet Russell Radio on the 0600 nzdt or 0730 sked this morning. Des suggested we also try calling the *Freya* on 4445kHz.

0822-0825 nzdt Called *Freya* on Northland channel 16, 4445kHz and 2/4/6 mHz, no response.

0832 nzdt Rang Rusell Radio advised them of situation.Russell

Radio will also try and find out where vessel is. Des suggest we listen in on 4k051kHz (yacht sked report frequency) currently holding sked.

0835 nzdt Monitored *Destiny* (American yacht) doing skeds. At completion of sked this yacht stated that the only yacht not heard from was *Freya*.

0841 nzdt Des came up on 4k051kHz and got *Destiny* to change frequency 4445 kHz. *Destiny* advised Des that *Freya* is a US yacht. 3 prob. (names provided: Bruce, Marion, Heath...11 year old boy). *Destiny* had not heard from *Freya* since Russell Radio sked last night.

0853 nzdt Updated MDO with above information. He is about to talk with SARMAC and will get back to MOC.

0858-0903 nzdt Called *Freya* on Northland Ch 16, 2/4/6mHz, no response.

0906 nzdt MDO advised EPIRB is on again. MOC to start Mayday Relays. A fixed wing and helicoptor are due in the search area about 1000 nzdt.

0918 nzdt MSA 98/136 broadcast on both Northland Ch 16's.

0920 nzdt MSA 98/136 broadcast on 2/4/6kHz and Ch16.

0930 nzdt MDO advises he is on his way to RCC. Centre will be open by 1000 nzdt.

0933 nzdt MSA 98/136 broadcast 2/4/6kHz and Ch 16.

0938 nzdt Russell Radio rang MOC advising he knows of two yachts possibly in the area (comms VHF only). Yachts: *Salacia*-37ft yacht Beige in colour with teak deck. *Sara*- 36ft sloop all white.

0940 nzdt *Tui Pacific*/P3GB4

0940 nzdt Helo in communications with Russell Radio. Northland maritime calls Helo who advises eta 30 mins to EPIRB position. Current position 35.07S 174.37E.

0943 nzdt Moana 3/FZZW, position 33.47S 173.28E, vessel asked to standby 4125 kHz.

0946 nzdt Union Rotoiti/ZMAR position 36.42S 174.52E, bound for Tauranga from Auckland.

0950 nzdt Korvel 358/DTAN2, position 36.27.4S 175.06.8E, course 125, speed 3lts. Sat-C 451200378, mobile 025391182 (called by this means). Listening ch16 and 4146 kHz.

0956 nzdt Russell Radio to helicopter, description of *Freya*: Beige hull with brown stripe, brown sail covers and dodger.

0958 nzdt *Direct Kookaburra* advises position 33.21.6S 178.37.6E, course 24k0,speed 16 kts. ETA EPIRB position 11.5 hts.

1004 nzdt *Tui Pacific*/P3GB4, position 33.35.0S 177.06E, course 180, speed 14.0kts. Passed to RCC.

1009 nzdt Helimed 1 calls Northland Maritime, then stops transmission and starts talking to *Freya*.

1012 nzdt Californian Orion/3FS13: position 35.05.06S 174.37.8E. Course 125, speed 7.5kts.Passed to RCC

1017 nzdt Westpac 01 (second rescue helo) advises they are bound for *Freya*'s position, but have picked up a 121.5 EPIRB beacon. Their heading is 345 and the beacon is at 300, can MOC relay this to RCC.

Information passed to RCC.

1018 nzdt Helimed 1 advises they have made contact with *Freya*, the vessel has advised it is in distress, disabled and the crew want to abandon, current position 34.16.37S 175.14.41E. Passed to RCC, MDO requests *Moana III* asked to assist.

1019 nzdt Fax from Foylebank/GQUK, position 34.41S 174,35E, course 045 degrees true, speed 3 kts. Vessel presently hove-to and operating on a single engine as problem just encountered on the other engine. (info passed to RCC).

1026 nzdt Called *Moana 3* and ask them to divert, eta 18hrs, passed to RCC.

1051 nzdt RCC requests MOC task *Tui Pacific* to divert to *Freya*'s position. Sat-C message sent to *Tui Pacific*.

1058 nzdt MOC asked to come up on 5680kHz and ask FOP (fixed wing) for current situation, from FOP "still in transit, eta 29 mins., no comms with Helimed 1". MOC asked by RCC to maintain listening watch on 5680 kHz.

1106 nzdt Copied Helemed 1 doing a read back of *Freya*'s position 34.16.37S 175.1? (Helimed 1 unable to get full copy of longitude).

1108 nzdt Helimed 1 advises they are about to return to Kerikeri to refuel.

1112 nzdt Helimed 1 advises Russell Radio that at 1015 nzdt he copied a distress call on VHF from *Salacia* in position 34,27S 174.52E. Current weather in the area: Wind easterly 70kts, visibility 100meters, rain, low cloud, sea state 8.

1115 nzdt Westpac 01 advises they are still getting a 121.5 beacon. "Our heading is 020dg the beacon is 284dg relative to ship's head. Eta for *Freya* 45 minutes.

1129 nzdt Foylebank/GQUK tasked by RCC to head for *Salacia*'s distress position.

1132 dst Foylebank advises they will alter course as soon as they have secured some shifting cargo.

1141 nzdt Foylebank advises they are now on heading for Salacia, eta 6 hours.

1144 nzdt Foylebank advises weather conditions for his area: winds Easterly 40 kts, visibility 1/2 mile, heavy spray, overcast, sea state 9.

1136 nzdt Westpac 01 in comms with Freya. Helo is trying to do a voice DF.

1210 nzdt RCC asks MOC to advise Wespac 01 they are tasking another helo for *Salacia*. Westpac 01 will need take a break in transmission so MOC/Foylebank/2nd Helo can call *Salacia*. Also can Westpac 01 ask Freya to switch on their EPIRB.

1223 nzdt Westpac 01 has visual of *Freya*.

1224 nzdt *Shinano* Reefer/2FNR3, position 35.09.3S 174.27E, speed 3.kts. from Japan bound Auckland. Report passed to RCC.

1226 nzdt Westpac 01 position 34.29.43S 174.58.49E for *Freya* on scene weather: 60-65east sea state 8 overcase cloud 800ft vis 15k00. Wespac 01 requests release from scene to return for fuel. *Union Rotoiti* calls on Auckland Ch16 to see if he is required, advised not required.

1238 nzdt *Direct Kookaburra*/C6dMQ2:position 33-38.7S 177-38.7E Proceeding towards yacht in distress eta 2k000 nzdt, course 25k0, speed 17.5. Inmarsat-C number 430 902 620 (passed to RCC, since vessel has diverted on their own merit, they are happy for it to continue and for MOC to keep them updated).

1239 nzdt RCC requests Westpac 01 return to Kerikeri for refuel and stby for another tasking, RC C advises Helimed will be airborne shortly to go to *Freya*'s position. (passed to Westpac 1)

1244 nzdt Westpac 01 & Helimed in comms.

1354 Helimed 1 advises they have winched all 3 people off *Freya* and are now heading for Whangarei. All 3 people are suffering from mild hypothermia. Last known position of *Freya* was 2 miles. Information passed to RCC.

1510 nzdt MDO requests Coastal Navigation Warning issued for abandoned vessel *Freya*.

The final piece of this puzzle is the Satcom e-mail message from one of the ships which had been requested to divert to *Freya*'s aid.

TO: RCC WELINGTON

TO: MARITIME OPERATIONS NEW ZEALAND

FROM: MASTER *TUI PACIFIC* P3GB4

28.11.98

URGENT

RE. YMSG REF. 405550 AND FURTHER TO MY LAST MSG AT 1300 NZDT, 28.11.98 PLS NOTE THAT THE YACHT IS DRIFTING RATHER FAST TO SW BY DOING APPROX 9 KTS SPD.

IF THE YACHT IS CONTINUING WITH THE SAME SPD, THE EARLIEST TIME WE COULD REACH THE YACHT WL BE AFTER 8.5 HRS (APPROX 22K00 NZDT) WHICH MEANS THT WE HAVE TO CANCEL THE WHOLE OPERATION BECAUSE WITH OUR SPD OF 17 KTS WE WILL REACH THE COAST LINE AFTER 6.S5 HRS (APPROX 2200 NZDT) AND THE YACHT SHOULD BE THERE MORE THAN 2 HRS AHEAD OF US.

IT SEEMS THAT FURTHER CHASING OF THE YACHT DOESN'T MAKE ANY SENSE BCAUS THE YACHT WL BE CLOSE TO THE SHORE APPROX 2 HRS BEFORE WE CAN REACH HER.

PLS CFM.

BRGDS/MASTER

The purported 9-knot drift indicated in this message is an anomaly. *Freya* was probably not moving more than 3 or 4 knots.

Salacia

The following story is based on data sent to us by Fred Rosswold and Thane Roberts, and by some brief e-mail dialogue with Mike Fritz.

It also includes data from the official report of the Maritime Safety Authority of New Zealand.

Unfortunately, because of legal proceedings now going on, Mike is unable to give us a full and direct account.

In early November, Mike Fritz and his crew Julie Black departed Tonga with the first group of boats headed for New Zealand.

Julie, was new to sailing. She and Mike met in Moorea and became close friends. When he proposed that she join him aboard *Salacia*, she agreed. Although she knew little about sailing, she trusted Mike. Mike had single-handed the boat up to that time, and was an experienced sailor.

Salacia was a stoutly built Robert Perry-designed Tayana 37 (11.3m).

Although they had been sailing together for some time now, Julie was slow to acquire her "sea legs." She still had lingering fears about passage-making and was not looking forward to the trip from Tonga to New Zealand.

A few days after leaving Tonga they had to put into Minerva Reef to sit out an approaching low pressure system. They anchored in the relative protection of the reef with 20 other boats until a break in the weather came five days later.

Broken Motor Mount

Most of the boats left together, but *Salacia* was unable to make its way against the strong currents and waves in the pass. Their engine had a broken motor mount, and, in the existing weather, Mike was unable to negotiate the pass under sail. So, he remained behind with a few other boats.

One of the remaining yachts had the necessary part and offered to help him fix his motor mount, but Mike decided to wait and have it repaired after he arrived in New Zealand.

Being to the north of the other boats that we've so far discussed, *Salacia* was closer to the approach of the low center; when the other boats were making it into port or already anchored, *Salacia* was getting hammered by steadily increasing winds.

Salacia was apparently extremely close to *Freya* when the storm hit and actually discussed storm tactics with them via VHF radio.

Salacia and the remaining boats were able to leave when the seas calmed the following day. *Salacia* transited the pass under sail and headed south-west towards New Zealand. When the winds lightened, *Salacia* made slow progress without the use of their motor.

When the winds died completely they were becalmed for four days. They had been at sea for nearly two weeks when Thane and Corinne aboard *Skakti* passed them. Mike requested that they contact Julie's sister to let her know that Julie was fine and would be arriving shortly.

Using a Sea Anchor

Approaching the coast of New Zealand, *Salacia* was caught in the same storm as the Burmans aboard *Freya*. Mike also deployed his parachute anchor with the intent of waiting out the bad weather. It was an army surplus drop chute about 8 feet (2.4m) in diameter. The parachute was bridled between the bow and stern quarter, and adjusted via one of the primary sheet winches. They carried minimal sail to steady the boat's roll.

Salacia was quartering the waves on the bow, which was oriented into the occasional seas coming at an angle to the primary wave system.

At one point, while riding to the parachute anchor *Salacia* was thrown backwards and her rudder jammed. The next day as the planes were overhead looking for *Freya*, Mike radioed that he was holding his own but might need assistance when he approached shore because of his rudder problems.

Attempted Rescue

Mike's first indication that *Salacia* was the object of a rescue attempt came when he heard unusual noises outside. He came on deck to see a huge wall of steel pass precariously close to his fragile craft in the darkness.

He watched as the large freighter passed alongside ripping his rigging from the hull, and causing the mast to come crashing to the deck. If he wasn't in distress previously, he was now.

Mike went below immediately and told Julie to prepare to abandon the vessel, while he went outside to cut free the mast and rigging now banging against the hull. He could see the large vessel turning as Julie made her way on deck. They put on life jackets and attached their harnesses to the boat, awaiting the return of the freighter. Mike tried to communicate with the vessel but both of his radios were inoperative.

After reviewing his options, he decided that he and Julie would have to abandon ship during the next pass by the large cargo vessel. He stopped trying to free the rig and set about gathering the few of his possessions that he was able to put in his small backpack. It was now approximately 0430.

They were in the middle of the worst storm that New Zealand had seen in thirty years, and Julie was terrified. Waves were washing over the boat and they had been knocked down several times. Julie was cold and possibly in the first stages of hypothermia.

As they awaited the return of the freighter, Mike tried to calm Julie in preparation for their imminent rescue.

When the freighter came alongside and threw them a life ring a few minutes later, they were both able to fit into its large diameter. They wanted to be pulled up together. The crew yelled that they could only pull up one at a time. Mike gave the ring to Julie and told her not to worry—in a few minutes she would be aboard the larger vessel and safe.

Later, he told Thane Roberts that he regretted not attaching her harness to the life ring, as he left her in the stern and headed to the bow where a second life ring had been thrown for him.

Before he could reach it, it was pulled into the water. He had to jump into the sea between the two boats and swim for it in the darkness.

When he hit the water, his foul weather gear filled with water. He was barely able to swim to the ring against the strong waves and current. The last time he saw Julie, just before he entered the water, she was in her ring and the rescue line to the ship was taught.

What happened next is uncertain. Mike was pulled to the ship and then up the side to the gunnel. As he was being pulled up the ship's hull, its violent rolling caused him to be thrown against the cold, steel surface like a wrecking ball. If he had used his hands to fend off, he would have fallen out of the ring which was large and difficult to cling to.

Just as he was about to be pulled to safety by the crew, he could hold on no longer and fell back into the sea. A few of the crew saw him fall and threw a second ring with a light, which Mike now swam for. It took all of his strength and seemed like an eternity before he was able to reach the second ring in the cold water. This time he was able to hold on and was pulled on deck.

Mike described the seas as mountainous, but manageable since they were consistent and from the same direction.

Every so often, however, a set of waves would approach which was much larger than the rest. These waves would break over the boat and create tremendous forces on the vessel and its gear. It was during one of these huge sets in the middle of the night that Mike's sea anchor was shredded and his boat started drifting with the waves. However, his rudder had been freed by the same wave, and he discovered that he was able to turn his boat around and head in the direction of Opua.

Under minimal sail and with the windvane steering, Mike felt that *Salacia* was holding her own and making headway toward the shelter of the bay.

It was then that he discovered that Julie was not aboard. When her rescue ring had been raised, it was empty. There was some confusion as to whether she had gotten out of the ring or fallen into the sea during the rescue attempt as Mike had done.

During the next hour until daylight, the ship searched for both Julie and *Salacia*. Neither were found.

New Zealand Maritime Safety Report

We do not want to belabor the issues already presented, but it is important that we all learn as much from this tragedy as possible.

The following data is excerpted from the New Zealand Maritime Safety Authority official report:

Although Fritz on *Salacia* stated that he did not send a Mayday message on VHF, the helicopter Helimed 1 stated that he heard a Mayday call that *Salacia* was in trouble and that the rudder had jammed. After this message was received a search of the area was carried out.

At 1942 hours, a red flare was sighted from *Salacia*. This and subsequent red flares from *Salacia* indicated that they were in distress and required assistance.

At about 2300 hours, after *Salacia* had suffered another knock-down, the rudder freed itself. Mr. Fritz decided to head 350 degrees (000 degrees M) to get clear of Cape Brett and then, when sufficiently clear, to alter course to sail into Opua.

The change of course from south to north had not been picked up by Kiwi Rescue, although a slight alteration of course made good over the ground had been noticed when the positions of the yacht had been plotted over a period of about one hour prior to the rescue. During this period, Kiwi Rescue was employed to guide *Direct Kookaburra* towards *Salacia*.

The infrared video (taken by the Orion aircraft) does not reveal *Salacia* as having altered course until just before *Direct Kookaburra* arrived.

Seeing that the rudder was now free, Mr. Fritz felt he could make Opua safely and did not need assistance. Unfortunately, he could not communicate his intentions to the persons engaged in the rescue.

The RNZAF Orion, Kiwi Rescue, took "on scene command" of the rescue. Throughout the night they had plotted the course of *Salacia* and found that it was drifting in such a direction that it would be very near to the rocks at Cape Brett by 0600 hours on 29 November, soon after daylight. To avoid shipping having to go very close to shore, and because the helicopter was not readily available, it was decided to effect a rescue during the hours of darkness.

The only vessels available to effect the rescue were *Direct Kookaburra* and *Moana III*. The latter became delayed by the adverse weather and would have arrived in the area at daylight. *Moana III* was therefore released and *Direct Kookaburra* was directed to effect the rescue.

Although Kiwi Rescue had flown over *Salacia* on several occasions, Mr. Fritz did not think that if a rescue attempt was to be made it would be carried out at night. He was not aware that

"At 1943 hours a very short message was received from *Salacia* to say that they could transmit but not receive. After this there was no communication from *Salacia* by radio, and therefore no means of finding out what the latest situation was on board. Because of this, the Rescue Coordination Center agreed to the rescue of the crew of *Salacia* at 2218 hours.

"If *Salacia* was not in distress, in no way should distress flares have been set off, even to show position."

Here is yet another situation where failure in communication led to tragedy. This is a common theme that repeats itself over and over again in emergency situations at sea.

Direct Kookaburra was coming to his rescue until he saw it bearing down on him and coming alongside. Mr. Fritz did not hear any sound signals to warn him that they were coming, and was therefore unprepared for evacuation of the vessel.

The weather conditions being extremely adverse during the rescue period made the rescue very difficult, especially getting the ship alongside the yacht into such a position that the persons on board could be evacuated.

Once alongside, the persons on both vessels had to act very quickly before *Salacia* drifted off.

The vessel had to take several turns before it was in a position to carry out the rescue. *Direct Kookaburra* had to be beam-on to the wind to give *Salacia* a lee. This made the vessel roll heavily, about 30 degrees each way. *Salacia* was also rolling heavily. During the first rescue attempt, the mast of *Salacia* struck the side of *Direct Kookaburra,* breaking it.

It is not entirely certain how the evacuation was carried out. The Master of *Direct Kookaburra* was intent on keeping the vessel in position so that evacuation could be carried out, with the added worries of the deck cargo and safety of his own vessel. He was not in a position to see every single event which happened on the yacht.

The Chief Officer on the foredeck was in a similar position, and would be organizing the crew. The crew themselves saw individual aspects of the rescue but not everything.

Mr. Fritz, who was being rescued, also found it difficult to remember exactly what happened.

Mr. Fritz denies emphatically that there were any lifebuoys carried on *Salacia*. They did carry safety harnesses, which they wore, with lines attached to an eyebolt in the cockpit. They also carried rescue harnesses in case somebody fell overboard. Certainly, no lifebuoys can be seen on the deck of *Salacia* in the photographs taken by the crew of Kiwi Rescue.

Mr. Fritz says that when a lifebuoy was sent down from *Direct Kookaburra*, he says that he and Julie (who are both quite small in stature) got into that lifebuoy. He states that the crew could not heave them both up the ship's side, so he had to get out and go to another lifebuoy, leaving Julie in the first lifebuoy alone. He expected the crew would heave her up the ship's side while he went for the second lifebuoy.

In his statement to the police, Mr. Fritz says that as the crew were trying to heave them up, he fell into the water, leaving her in the lifebuoy alone. He had to get into another lifebuoy and the crew hove him up towards the bulwark.

Piecing this conflicting evidence together, it is probable that Mr. Fritz's statement is likely to be the most reliable. It would appear that both did try to get into a lifebuoy, and that the crew of *Direct Kookaburra* told one to get out, so Mr. Fritz got out expecting the girl to get heaved up the ship's side. The crew then sent another lifebuoy down which he had to go forward to retrieve so that he was not in a position to see what was happening to Julie. As he was getting to the second lifebuoy, Julie, panicking, may well have taken her lifebuoy off and tried to follow him, and the crew could not then heave her up.

"*Direct Kookaburra*, being a container ship, could not be considered the best vessel for carrying out such a rescue. It has a high freeboard, approximately 26 feet (8m). At the time the vessel had a large GM, about 6.5 feet (2m), making it roll heavily. There was a large stack of containers on deck, and they were stressing their lashings, which, had they carried away, would have led to the possibility of the containers going overboard.

"Equipment for effecting the rescue was also minimal, consisting almost entirely of lifebuoys, ropes and rope ladders. The vessel lost steerage when making less than 6 knots, making her very difficult to handle."

After Mr. Fritz had been heaved up the ship's side, he fell out of the lifebuoy, back into the sea. Another lifebuoy was sent to him and he was heaved on board. Because of Mr. Fritz falling into the sea, it would be instinctive reaction to rescue him before rescuing Julie, who was still on board the yacht, in relative safety. The yacht, by this stage, was drifting forward and out of reach. Unfortunately, this situation probably made Julie panic even more. Being left alone in the yacht, and seeing Mr. Fritz's predicament while being rescued, would have unnerved her further.

Salacia drifted around the bow of *Direct Kookaburra* with Julie still on board. *Direct Kookaburra* had to make another turn to attempt to get back to *Salacia*. The first attempt failed. At this time, the infrared video taken by the RNZAF shows a "hot spot" (possibly Julie) in the water near to the bow of the yacht. On the third run, the hot spot had disappeared. Some of the hot spots were not apparent until sometime later when the video was reviewed. The *Direct Kookaburra* then completed another turn and *Salacia* passed very close to the hull on the starboard (windward) side. The crew shouted and screamed down to the yacht, but nobody appeared.

Salacia then drifted aft and under the quarter of *Direct Kookaburra*. The infrared video shows the stern of the ship rising on the swell, over the top of *Salacia*. Unfortunately the aircraft passed over the side of the ship just before the stern fell and was unable to see if it actually struck *Salacia*. The Master of *Direct Kookaburra* did see *Salacia* drifting out on the port quarter and shone the Aldis lamp onto it and saw some reflections. After searching, only some debris from *Salacia* was found and no sign of Julie.

Thoughts from Mike Fritz

With the help of a number of cruisers in New Zealand, we were finally able to make contact with Mike via e-mail. He had just returned from a trip to Southern New Zealand in an attempt to clear his mind.

I too would like to let fellow sailors worldwide know what happened so that it may never happen again, and should never have happened in the first place. To be honest it was a mental relief to leave and visit the country and try to get away from all the questions about the accident—which have haunted me more than the incident itself.

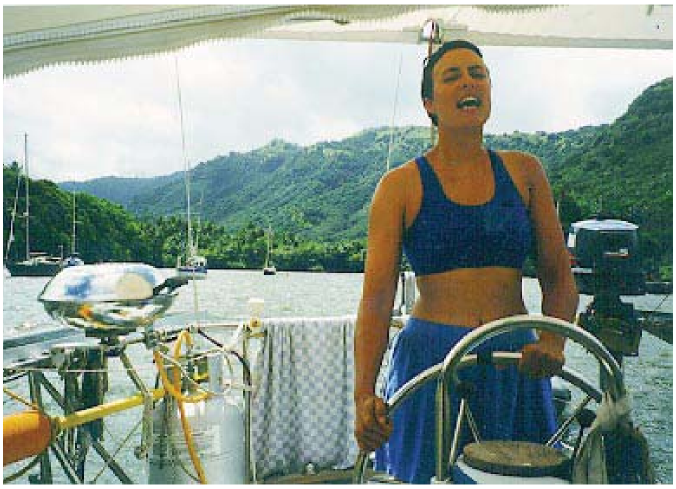
I have been advised not to say anything involving the accident since it's still under investigation.

But I will tell you in general that my little Tayana 37 was a great boat to be in as far as I was concerned. Fear about her integrity was never an issue. The winds were recorded at the 70-80 knot range with gusts and seas in the 25-35 foot (8-10m) range with 50 feet (15m) showing up at least a couple times an hour.

The barometer only did its thing late in the game and then fell like a rock. I measured out a fall of 18mb in less then 24 hours.

I had a partial rolled-out storm jib in heave-to style, and when the wind had somewhat eased, had jibed and was sailing off the coast near the Bay of Islands before the accident.

Both photos Kristin Sandvik



Hio Avae is a Santana 37. At 37 feet (11.3m) overall, she has a waterline of 31 feet (9.5m), a beam of 11.66 feet (3.6m), a draft of 6 feet (1.8m), and displaces 7.2 tons. Kristin is at the helm (above).

Hio Avae

We want to end this section of stories about boats voyaging to New Zealand with the story of *Hio Avae*.

Kristin Sandvik, *Hio*'s owner and master, is like a member of our family. She and our daughter Sarah went to school together, then both spent time cruising with us through the South Pacific aboard *Beowulf*.

By the time we'd gotten to New Zealand, both Kristin and Sarah had the cruising bug themselves and upon returning to California pooled their resources to find a boat to take them back to the South Pacific.

After a long, frustrating search they came across a tired-looking but sound Santana 37. The price fit their modest budget, and soon the two girls were boat owners.

There followed a frenetic period of boat work, odd jobs to support themselves, and personal training before they were ready to depart (for a detailed look at *Hio Avae* and her preparation see page 1,123 in *Offshore Cruising Encyclopedia*).

After a season in Mexico, Sarah decided she wanted to pursue a music career, so Kristin bought Sarah's interest in the boat and continued on.

Kristin picks up the story in Nuku'alofa, Tonga:

Prior to sailing with us aboard *Beowulf*, Kristin had never been to sea. She is, however, a smart, physically fit, and determined young woman. It will come as no surprise to those who know her that she made an uneventful passage from Mexico to the Marquesas, and thence through Polynesia to Tonga.

Watching the Weather

Like everybody else, I was anxious about the passage from Tonga to New Zealand. Like everybody else, I studied the rippling lines of isobars on the weatherfaxes. But I could only pretend to speculate. Despite my best efforts with several weather books, I couldn't figure out what to look for. I put my faith in my cruising friends—particularly Thane on *Shakti*—to tell me when to take off from Nuku'alofa.

But on November 19, the drizzly, overcast, humid, windless afternoon when Thane—and Bob McDavitt, New Zealand's weather

"That evening, Bob McDavitt forecast a low expected to pass North Cape on Sunday, the following night. Southwesterlies would sweep up the North Island coast Monday and Tuesday. A 'quiet high' would follow this low. A 'reasonable trough' would then come through Thursday to Friday, followed again by a high, which would produce light winds for the weekend. I tried to sort out how this weather might affect our trip, but latched onto McDavitt's words: 'This is as good a weather window as you can get for this voyage.' "

guru—said it was time to go, it didn't feel right. I hadn't analyzed the weather charts well enough to know if my reaction was instinct or fear. Maybe it would never "feel right" to depart for New Zealand.

So we—*Hio Avae*, Sandy (my crew), and I—followed the departing fleet. As we motored out of Tongatapu's westward pass, we looked like ducklings, all in a row.

Then, *Hio*'s propeller fell off.

We turned down all offers for help, and the rest of the group sailed on. We returned to shallow water where we could drop the hook and attach the spare prop.

Two days later, "totally propped" and feeling more psyched about the journey, we took off in light southwesterlies. *Hio* sizzled softly across Seven-Up seas. But we couldn't enjoy it. We were too anxious. Everybody gets hammered en route to New Zealand. When would we get hit?

Our nightly ham radio position report at 1600 local, the end of the 21st, found us at 22-11 S, 177-00 W, sailing slowly south. We sailed fully canvassed, as the light southwesterlies continued. We had motored 17 hours, and wanted to conserve our 60-gallon diesel supply. Also, we wanted quiet. Three knots' boatspeed would do for the moment.

The light winds stayed with us. We had to keep sailing, because *Hio*'s engine wouldn't start. The starter motor had failed. We sought advice from friends on the radio net, and worried that we'd have to drift to New Zealand. A longer trip would expose us to more weather. Ultimately, Sandy took the starter motor completely apart and put it back together. He hadn't changed anything, but the starter fired.

The end of the 22nd found us at 22-39 S, 177-16 W, making about 4 knots in less than 10 knots of southwesterly breeze. The sea was calm, the sky clear, and the barometer read 1008. We let the wind determine our course, pushing us southeast, then west, until it dropped altogether. Then, we motored for 16 hours, using the WH autopilot to steer a rhumbline course to our New Zealand waypoint.

That evening, the captain of *Cornucopia* offered his weatherfax weather analysis. He suggested that the approaching low would be "worth watching." The small group of boats in our vicinity were then "stuck" in a high, and expected very light wind for the next few days.

By the 23rd we were sailing again, steering 230 in 8 to 10 knots of breeze from the south-southeast. The barometer remained fairly steady at 1010. Our position on November 24 was 23-52S, 178-46W. We sailed through the night, but by midday the next day, we were back to the "iron genny," happy to point ourselves directly to our Cape Brett waypoint.

We motored through our fourth day (the 25th) ham radio net check-in at 1600, and reported our position at 25-05 S, 179-24 W. The seas remained calm, and the barometer remained high at 1012, but clouds had gathered. We motored on until Des of Russell Radio suggested we slow down to keep our distance from strong weather expected for New Zealand.

Following his advice, we drifted until it was time to prepare Thanksgiving dinner, then cranked up the motor to offer the chefs a steady motion. We shut down again to enjoy our feast and gave thanks for many miles of safe passaging, and for all the people who have supported us in our adventure.

As if saying, "You're welcome," the breeze filled in as I gave my 1600 report on November 26: 25-28 S, 179-49 E, steering 230, making a boatspeed of 5 knots in 8 to 10 knots of easterly wind, over calm seas, barometer at 1010. We enjoyed a beautiful night of sailing, wing-and-wing, tweaking with the Aries windvane to keep us on course.

By the end of the 27th, Thanksgiving leftovers were gone, the barometer was dropping, and we rolled along with a beam-on swell from the east. At 1600, we reported our position at 26-41 S, 179-26 E, steering 200 and making 4 1/2 knots in 10-12 knots of northwesterly breeze. The barometer read 1007.

Barometer signals change with latitude. In the tropics changes will be negligible, and any variation from the diurnal norm of plus or minus 1.5mb is cause for concern.

As you journey towards the higher latitudes the barometer begins to respond more to depressions. But the signals that it gives at 26 degrees, where Kristin is now, are substantially less than what it will show with a depression another 8 or 10 degrees farther from the equator.

The thing to remember here is that the closer you are to the tropics, the smaller the pressure change that is required to create dangerous weather.

Signs of a Front

Looking back, I have to laugh at my log entry from 0700 the next morning (28th). I wrote: "There's been a change in the weather: Classic front with angled clouds, rain, cold, yuck, no wind yet." The barometer had dropped to 1006. As we switched watches, Sandy and I took the jib off the pole, reefed the main, and clucked our tongues at the shifty wind.

Then I went to bed.

At 0900, Sandy called me out of bed. I came slowly, and made hot cereal as I pulled on layers. I didn't want to go out on deck; it was cold and damp out there. I wrote a hasty log entry: 27-52 S, 179-01 E, steering 210, making 6.5-plus knots in west-northwest winds to 20 knots, barometer at 1005, a drop of 5mb in the past eight hours. I noted that we were broad reaching under reefed main and working jib, and didn't blink as Sandy hooted with pleasure from the speed.

My 1000 log entry reads: HAMMERED!

Minutes before, a spark of lightning had sent me packing the GPS and autopilot-brains into the oven. Then, Sandy said: "Uh-oh."

"What?"

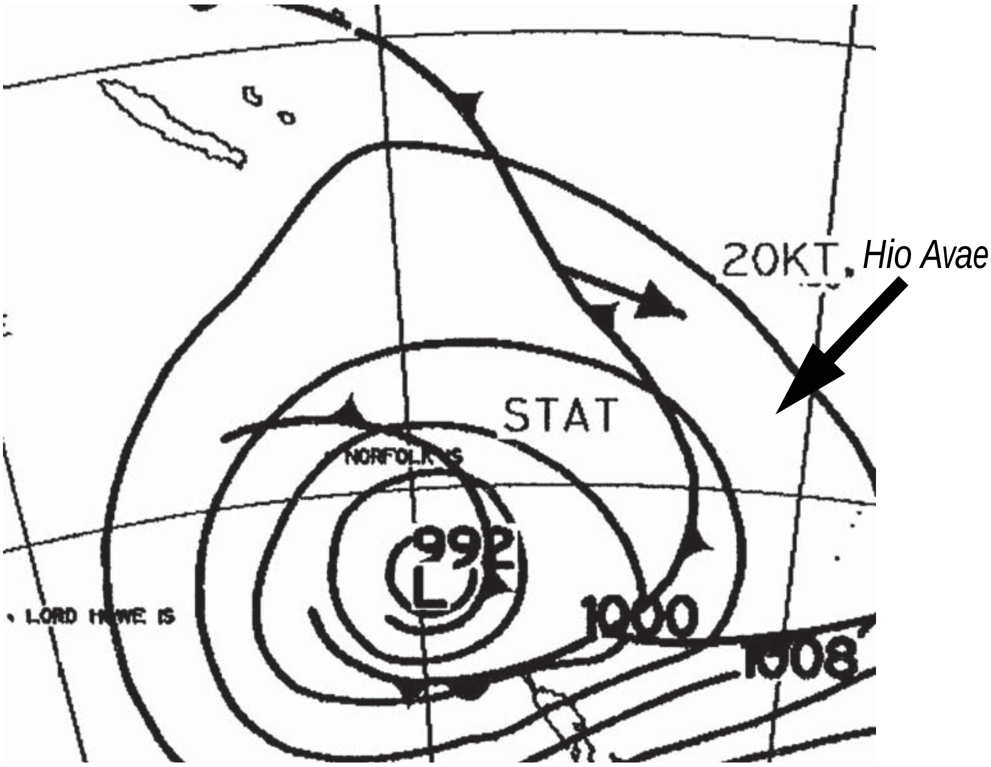
"Wind!" He was looking over his shoulder at the foamy whiteness as the wind bore down on us.

"Run from it!!!"

"Can't." And suddenly we were heeled over farther than I've ever experienced, and I was stripped down and on deck in my underwear. My usual tropical strategy for keeping clothes dry in the rain didn't work at this latitude: I shivered and winced at the pelting I got from the wind-driven downpour. From my squeals, and the sound in the rigging, Sandy estimated the wind at 50 knots. We scrambled to get down every inch of sail. Total insanity.

Hio was over-canvassed and heeled over so that she wouldn't respond to her helm. We couldn't get her to bear off on her own, so I used the engine to make way and set the WH autopilot to steer, while we sorted out the sail situation.

What Kristin and Sandy didn't realize at the time was that they had just gone through a classic frontal passage. The increase wind and the shift to the northwest was probably a line squall associated with the cold front. As such, the odds were that shortly the barometer would start to rise and the wind would drop. Their position is shown by the heavy black arrow.



Finally, we set the storm staysail, returned to hand-steering, and ran to the east. I was chattering and frigid by the time we had *Hio* comfortable in the howling wind. Sandy sent me below to slap myself warm and get dressed.

Rain fell; the seas got lumpier but didn't rise above 10 feet (3m); and the wind dropped to 10-12 knots from the west. We pulled up the main, reefed, to keep up our speed, then discovered that the previous 50-knot punch had ripped a hole around one of the cringle-points. This was the result of our primary reefing strap breaking and the secondary clew line stretching a bit. We dropped the main again (for future repair), and raised the trysail.

Setting the Trysail

Hio Avae is equipped with a powerful Aries windvane and WH autopilot, either of which could steer the boat in gale-force winds.

However, there is something comforting about having the helm directly in your hands when you're not sure of the weather.

We had to experiment with the unfamiliar trysail's sheet leads, but eventually got it rigged properly. We continued to hand-steer (which we would do until night fell and the weather settled) on a course of 200 through rain and confused seas. The barometer reached its low of 1003, from which it would slowly rise over the next two days. At 1600, our position was 28-03S/179-01E. Surprisingly, we hadn't lost any ground to the east; we had tiptoed south.

Three and a half hours later, the wind came up again, gusting to 30 knots from the north, but we were sailing into the sunset before a crazy huge double rainbow, which gave us comfort that the storm had passed over. We continued broad reaching under trysail and storm staysail, making 5 to 7 knots in 20-25 knots of northerly wind.

My grateful log entry reads: "The wind is still blowing, the seas are still boiling, but the moon is out, the sky is clear—it feels like we're sailing the night sky!" With these strong, steady winds and renewed confidence, we could turn the helm over to the Aries while we relived the day's chaos with teasing jabs and nervous laughter.

Sandy and I counted our blessings. Fortunately, we had been two days and several hundred miles behind our original fleet, who experienced more intense conditions closer to New Zealand. Had we left as planned with our friends, even if we had pushed the boat, we would probably have been very close to where *Freya* rolled in seas and winds that I don't even like to think about. Instead, we were hit from behind by 50-knot winds that flattened the seas and scared us silly. We were totally unprepared, despite the fact that we had both seen the change coming.

Fortunately, *Hio* took care of us. I truly believe that *Hio* dropped her propeller blades on purpose, to delay our departure and protect us. And she took care of us while we fumbled through rarely-practiced storm tactic options. At one point in the madness, we tried to heave to, not because conditions required it, but just to practice in case the weather got worse. *Hio* wouldn't heave to, so we kept running, and kept our fingers crossed.

Adding Sail

By 1600 on the 28th, we were able to pull up our number four jib. Our position was 29-58 S, 178-23 E, and we were steering a course of 200, making 5-plus knots in 10-22 knots of fluky west-northwest wind. The barometer had climbed to 1005, and the seas were still confused and relatively large at 10-12 feet (3 to 3.6m).

Des' weather report described the low splitting and heading towards New Zealand's southern coast. He assured us that "nothing dramatic" was forecast for our area.

Fluky gusts played with our nerves through the night, but by early morning, the wind had dropped to zero again, and we turned to our old friend Westerbeke. Sandy's log entry reads: "Let's go north—it's too cold down here!"

We motored for 13 hours. I sewed a lovely patch over the gaping hole in the main as the barometer rose steadily to 1010.

By 1615 at the end of 30th, our tenth day at sea, we were at 32-50S/175-57E, sailing fully canvassed (keeping an eye on the shiny new patch) in ten knots of west-northwesterly breeze. Seas were confused, but small at 2 feet (0.6m). A passing squall stressed us out, called for a reef in the main, then teased us with no significant wind (gotcha!). Once again, we sailed on Seven-Up seas.

Des' weatherfax was down that evening, but his earlier prognosis indicated that we might expect west-northwest winds at 10-25 knots. Des recommended that we make some westing to counter possible southwest winds near the Bay of Islands. Those of us in close proximity who had experienced scary conditions three days before and had heard what had befallen *Woody Goose*, *Salacia*, and *Freya*, had no desire to deviate. *Sara*, *Margarita*, and *Hio Avae* would stick to the rhumbline course—with a teeny bit of secret westing added for good luck.

The wind dropped, and seas flattened. The sea was so calm that Sandy and I spotted the black edge of a manta ray's flipper on

Most sailboats will achieve a high percentage of their "hull speed" with a very modest sail plan, as long as the wind is fresh.

In this case, *Hio Avae* is making really good time in a fresh breeze with just a few snippets of sailcloth set. The trysail and storm staysail represent less than 20 percent of her total working canvas.

"What would I do differently?

My log entry the morning we got hammered is revealing: I knew the weather was changing. 'Classic front with angled clouds…no wind yet.'

"But I hadn't bothered to prepare, save tucking a reef in the main, dropping the spinnaker pole, and telling Sandy to keep his eyes open. Whether it was fatigue (from the stress of worrying about the weather) or denial that bad weather would hit us that kept me from taking more decisive preventative action, I don't know.

"Sandy also saw the storm coming. He saw the gray wedge against the sky and thought: 'Classic front.' But he also felt *Hio* building speed for the first time in days, and got caught up in the thrill of surfing the small seas. We had been putting along for days—Sandy didn't want to miss his chance to RACE!

"When the wind slammed us sideways, we just stared at each other, stunned.

"Ultimately, we did the right things for the conditions. We reduced sail and ran. But it was total chaos. Sandy had never seen the storm trysail out of its bag (where it lives, on deck), and I couldn't remember how we had lead its sheets the last time we practiced with it, two years earlier in San Diego.

"I have learned these lessons the hard way before: be prepared, be familiar with your storm canvas, familiarize your crew; practice.

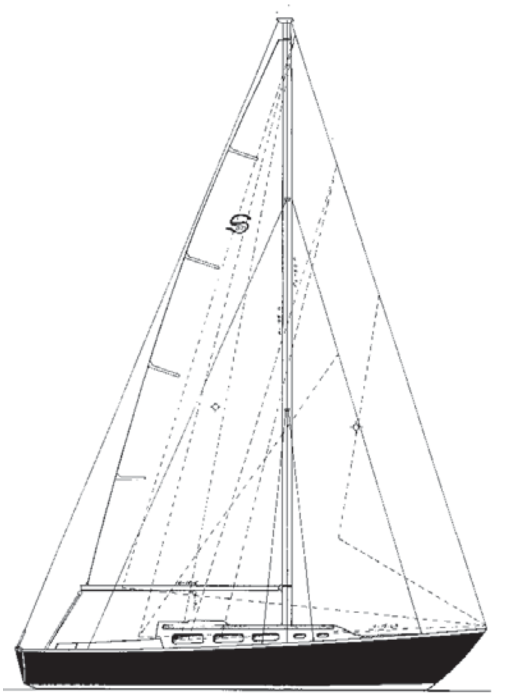
"Now I will pull the trysail out of the bag before each major passage, or with each new crewmember. We will run it up the mast and lead its sheets. We will also raise the storm jib. During passages, we'll heave to for fun. We'll even heave to in a squall occasionally to practice.

"And I will learn about the weather."

the horizon, and motored over to have a closer look. At 1600, day 11, we reported our position at 33-55 S, 174-39 E, steering a course of 200, motoring at 5 knots in zero breeze. We motored through the night until we were in sight of land—the Bay of Islands, gray on a dawning horizon.

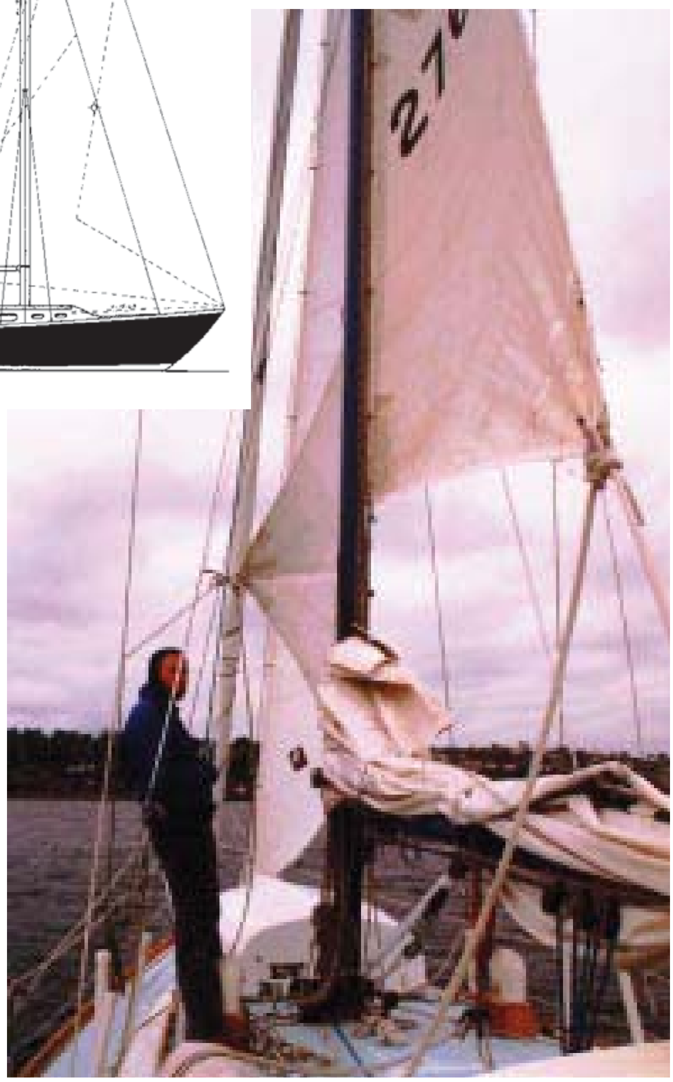
The wind cooperated, and we were grateful. We sailed into the Bay of Islands before a building northeasterly wind under gray drizzle. I danced all the way from the mouth of the bay to Opua, and slept for days.

We had motored 99 hours and had a few drops of diesel left over. We went through some rough weather, but were spared the worst of it. We had been saved from ourselves by a well-found sailboat. We made it.



The Santana 37 sailplan (left) is substantial for its day, enabling Hio Avae to keep moving quite well in light airs.

Below: Kristin testing the storm staysail and trysail.



Kristin Sandvik

Weather Review

Understanding weather is a fundamental requirement for anyone making an ocean passage. Along the coast, you can get away with relying upon the official forecasts, but once you head offshore you need to understand the mechanics of what's happening around you.

This knowledge allows you to make your own analysis of current trends and predictions for the future, and then compare them to what the shoreside forecasters are saying.

In most cases, if there's a difference, it is better to go with what you figure out yourself.

We cover the basics of this briefly starting on page **186**. For those of you interested in a thorough text on this subject, please see *Mariner's Weather Handbook*.

For now, with the events of this section fresh in our minds, we'd like to proceed with an analysis of the weather encountered.

Weather Rhythms

Weather doesn't just happen without warning. There are almost always precursors—warning signs.

These signs take place in the context of what has been happening over time, so it is important to study both current weather data and what is forecast for the future. This way, you develop a feel for the rhythm of what is happening around you.

How far in advance of your departure this analysis process should start is a function of the time of year and where you are. Crossing the Tasman, in a situation such as these yachts faced, you would ideally start studying the rhythms of the weather several weeks before leaving.

Using Historical Data

Historical data is rarely useful for specific passages. There is just too much variation from year to year, and even within given seasons.

Pilot charts, guide books, even the venerable *Ocean Passages for the World* are all based on averages of different voyages, and rarely match up to the conditions found in any specific time and place.

Thus, it is very important to have the skills to analyze what is happening during the season you have chosen to voyage.

Squash Zones

Squash zones occur whenever you have a vigorous high and a low pressure system in close proximity. They account for the majority of all weather difficulties encountered by yachts. Squash zones are one of the few weather phenomena that are difficult to forecast from onboard data, because wind direction and barometric pressure typically remain steady while the wind increases.

However, if you have weatherfax capabilities (and this gear should be very high on your priority list), you will be able to get a feel for how the highs and lows are supposed to be acting, then modify this data based on the conditions you encounter.

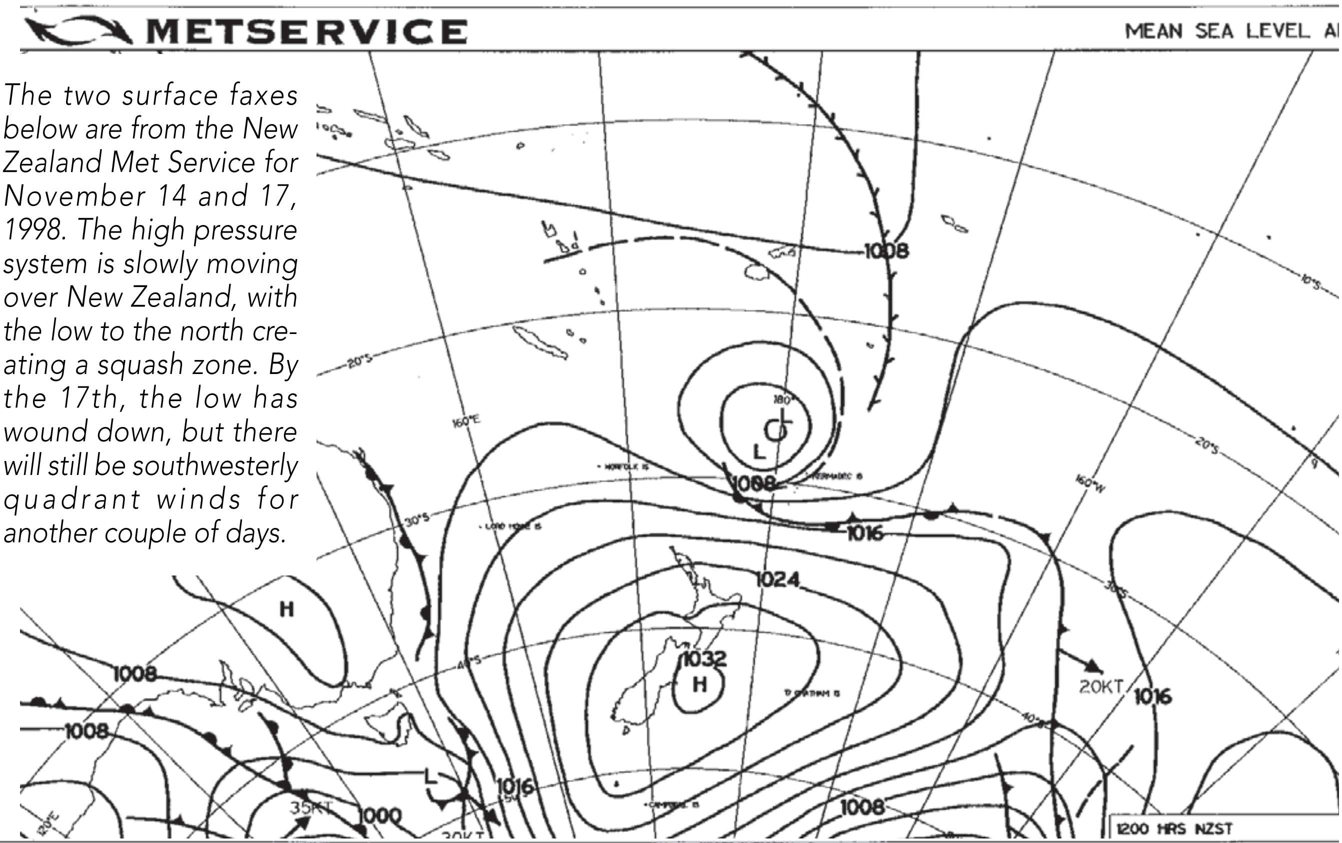
Regional Idiosyncrasies

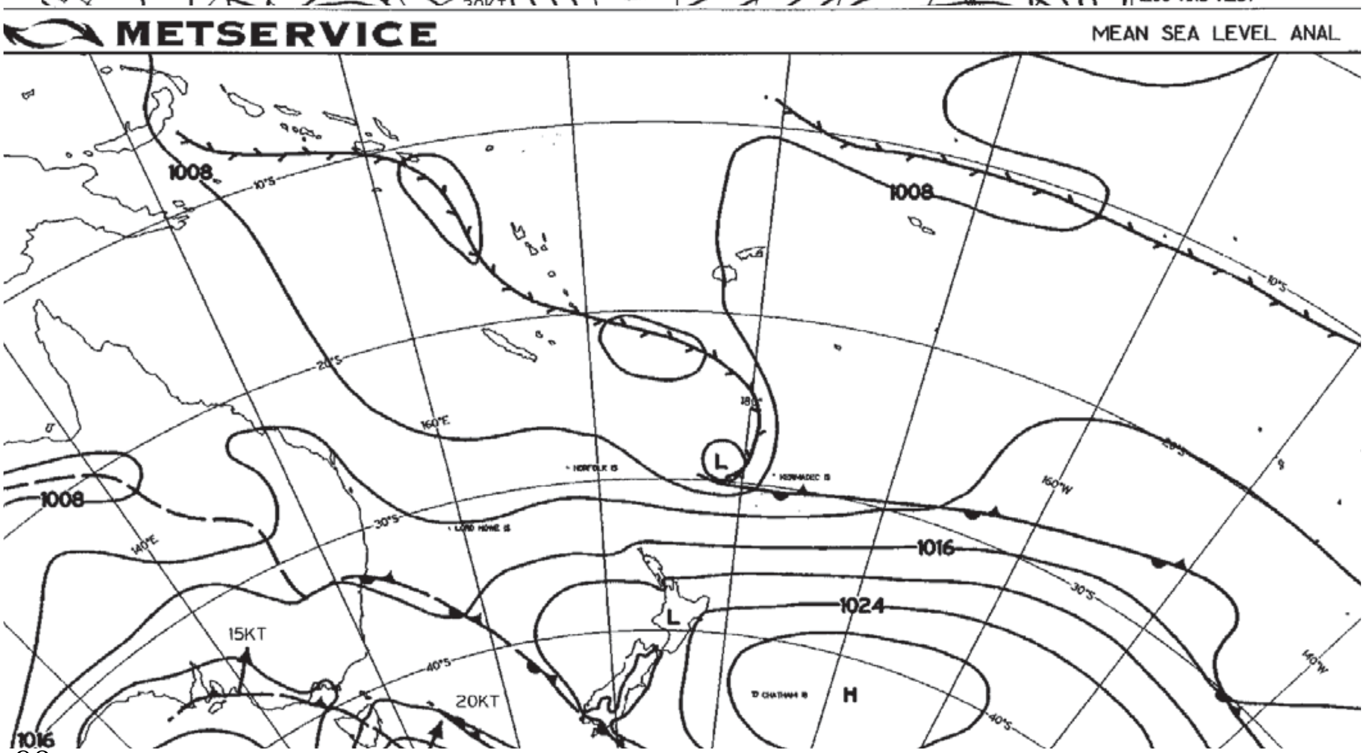
All weather regions of the world have idiosyncrasies, and react to long-term large scale changes such as El Niño and La Niña weather patterns in the Pacific.

In the case of the South Pacific region near New Zealand during the Southern Hemisphere spring of 1998, a strong La Niña was in effect.

Among other things, this tends to increase easterly flow in the tradewind zones; bring the trades further from the equator than is the case during other times of the year; and creating more squash zone activity.

The two surface faxes below are from the New Zealand Met Service for November 14 and 17, 1998. The high pressure system is slowly moving over New Zealand, with the low to the north creating a squash zone. By the 17th, the low has wound down, but there will still be southwesterly quadrant winds for another couple of days.





Sea State

We'll be covering wave and swell development later on in the book, starting on page **198**. For now, keep in mind that irregularly shaped and/or breaking waves cause the most of the problems in heavy weather. The wind may tear your sails, but will not damage your boat.

When the wind blows from the same direction for long periods of time and is not excessively gusty, the seas tend to lengthen, as they grow over time and distance. This allows them to absorb the wind's energy, efficiently minimizing the amount of breaking crests created—assuming that you are in deep water and there is no countercurrent to steepen the waves and cause them to break.

When you look at the comments of the various boats which endured days of strong winds (in the case of *Caledonia* almost a week of gales), you can see that the waves were not a danger.

But when the meteorological conditions change and the wind becomes very gusty or rises rapidly, this uneven application of force to the waves will cause them to break.

If the wind shifts with the passage of a front, the creation of a second wave train, combined with the sudden removal of wind from the primary wave train, typically creates breaking conditions.

Bomb Potential

Meteorological bombs are, fortunately, quite rare. However, they do occur. If you are in the same area as one of these events, you will get hammered.

That is not to say that you cannot survive—the vast majority of boats caught in bombs make it through. The key thing is to have a feeling for the risk factors involved in the developing situation.

A moderate or higher possibility of a bomb is going to affect your strategy.

Both *Freya* and *Salacia* would have made much more strenuous efforts to reach the Bay of Islands—even if it meant a night landfall—had they known how high the bomb potential was.

The problem you have here is knowing that a risk exists at all (the subject of risk analysis is covered in more detail starting on page **187**). The professional forecaster may look at a given situation and say to himself "There's some risk here, but it is not certain, so I'll wait for the next shift to decide if they want to make a severe weather warning."

This is not an irrational act by the forecaster if the risks are low. After all, he does not want to appear unduly alarmist.

But if you are 200 miles from port and know there's even a 5 percent chance of a bomb, you are going to push really hard to make better time.

You probably already understand that weather is the result of a difference in temperature and humidity between adjoining air masses. The greater the differences, the greater the energy source available to fuel the weather.

As we mentioned at the start of this section, spring and fall are the periods of greatest temperature differential on the planet. Hence, they have the potential for the most vigorous weather.

A high pressure system, building over the South Island of New Zealand, is extending deep into the high southern latitudes, where the air is cold and dry. As it rotates in a counterclockwise direction (the Southern Hemisphere weather rotates opposite of that in in the Northern Hemisphere) it is bringing that cold, dry air around its eastern flank and into contact with the low pressure system to the north.

The lows discussed in this section all originated on the edge of the tropics, and were loaded with warm, moist air.

Between these two systems, if you get the right mixture, you have all the ingredients necessary for a major shift in the weather pattern.

Now let's shift our focus to what actually occurred.

Computer Modeling

There are more than a dozen global weather computer models in use today by major industrial countries. Each has strong and weak points, and it is the job of the shore-based forecaster to decide which of the models are doing the best job for the situation at the moment.

When we asked Bob McDavitt about the New Zealand modeling process he e-mailed the following reply:

I regularly check the MRF (USA Medium Range Forecast) and NOGAPS (US Navy). We also access Bracknell (UK), AVN (US Aviation) and ECMWF (European Community Medium Range Forecast) directly. Of the last three, we daily work out which model has initialized best and has the best consistency record. That then becomes the "model of the day." We can electronically blend and mix elements of each model plus our own ideas into the final prognosis.

In my experience Bracknell is top dog, followed by WAF then EC. As for MRF vs. NOGAPS, I find that NOGAPS is better; I'd rank it with BRACKNELL. One bad thing about NOGAPS is that it doesn't do too well with blocking. One bad thing with MRF is that it seems to overwork in local patches (so does the ECMWF).

The MRF sometimes has flights of fantasy but turned out to be the best model for forecasting the Sydney-Hobart race storm last December.

The NOGAPS has a great display and if that's all a mariner works with it'll serve him or her well.

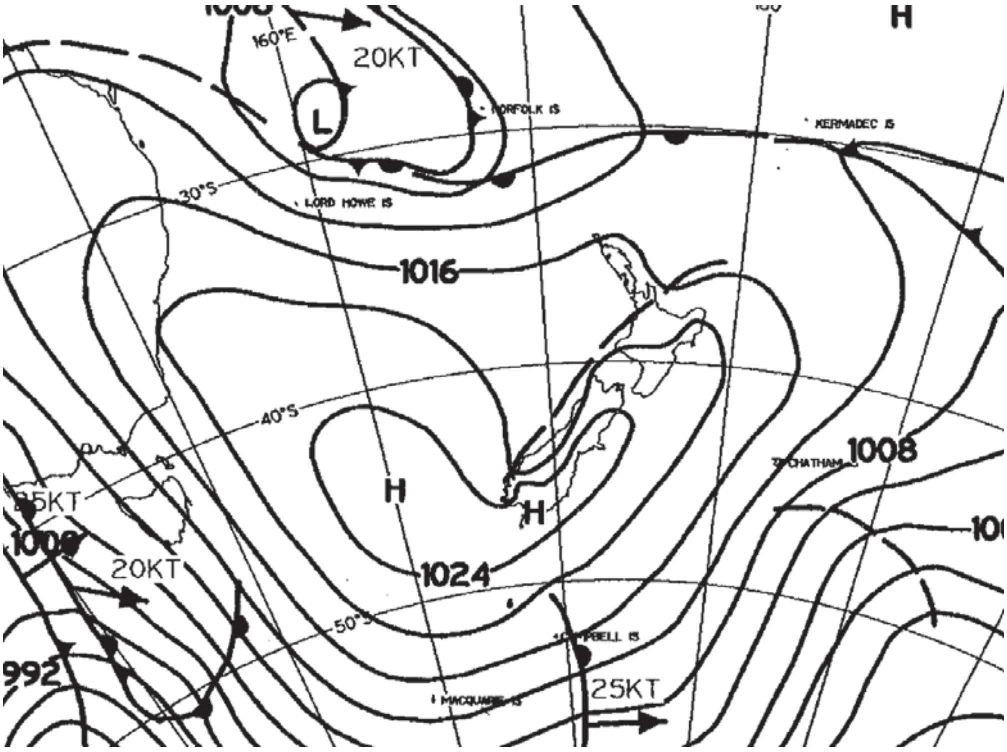
You will be pleased to know that the output of all major world weather models is available on the Internet. For more information on this subject check out www.SetSail.com or *Mariner's Weather Handbook* (page79).

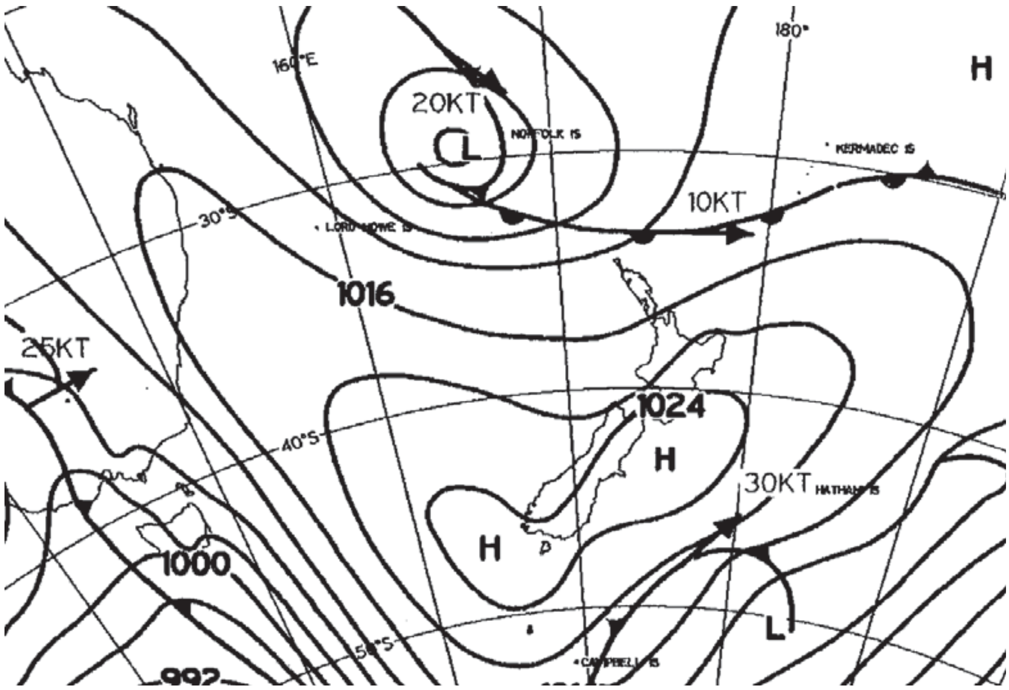
Surface Synoptic Charts

When you are sitting in Fiji or Tonga you can usually copy faxes from New Zealand, Australia, and Honolulu, Hawaii. They rarely agree with one another, because the forecasters are all using their own expertise to decide which of the models they like.

November 27 and 28

The issues facing the boats on the 27th and 28th are complex. To begin with, as we already know, the forecasts issued by the New Zealand Met Ser-





The top chart from the New Zealand Met Service is for midnight on Thursday (0000NZST on the 27th). The bottom chart is for twelve hours later—noon Friday.

The movement shown at 0000NZST (top) of the low is 20 knots, towards the east-southeast. At 1200NZST the low has actually moved more southeast while the high appears to be intensifying. The low driving right at the main mass of the high while the high grows (from cold air sinking down from aloft), is a warning signal.

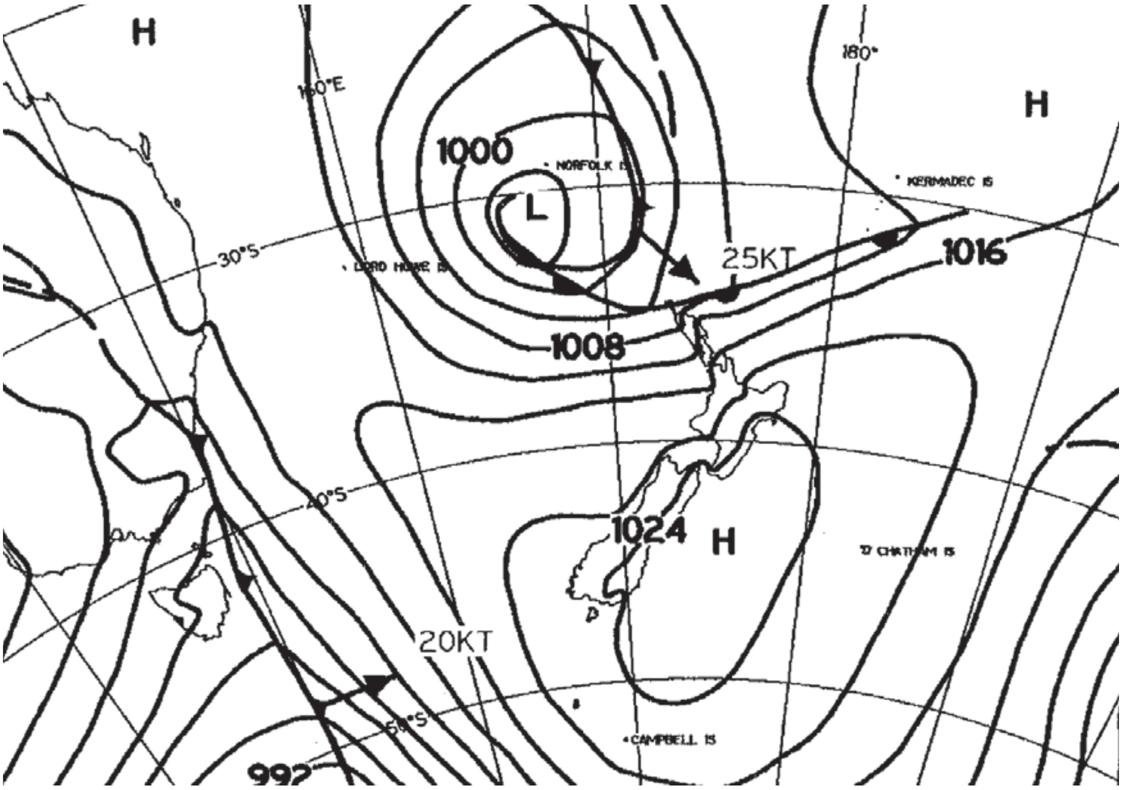
Nothing in the forecasts or on these surface charts tells you directly that there is a risk of a meteorological bomb.

One of the risk factors to look at is the possibility of large quantities of cold, dry air being brought up from the south via the high.

vice gave no hint of what was to come. A quick perusal of the faxes above as well as those which follow will confirm that.

Nothing in these four forecasts gives more than the merest hint of the severe storm-making material. To find out more about those risks, you must look at the 500mb charts.

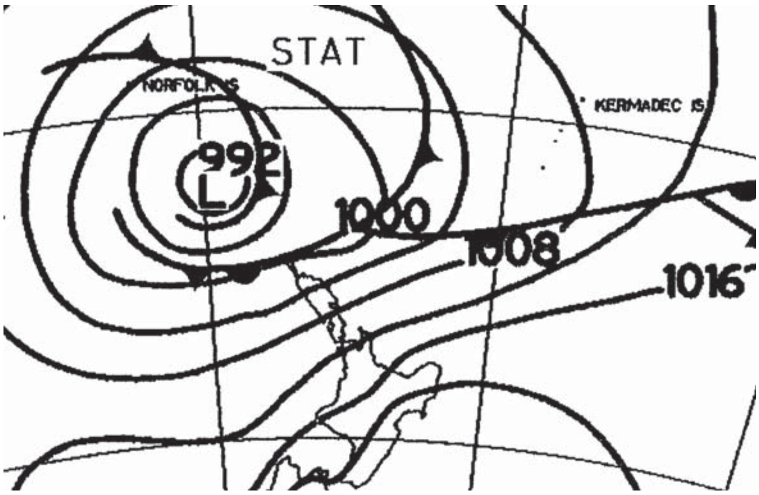
The 500mb level contains the key to everything happening on the surface, and is especially important in forecasting severe events (for more information on this subject see page 128 in *Mariner's Weather Handbook*). The best 500mb charts in this part of the world are available from Australia.



Midnight, Friday (0000NZST on the 28th) and the low has grown substantially while the high remains in place.

There are several features to note on this chart. The first is the sharp corner on the northeast side of the high. Positive curvature like this on high pressure systems accelerates the wind substantially over what would be suggested by the isobar spacing. Next, the pressure flow perpendicular to the coastline, which acts to block the wind, is then going to accelerate in the gap in the mountains north and south of Auckland.

The bottom chart is for noon on Saturday, by which time Freya and Salacia had been abandoned.



Bent Back Warm Fronts

From the extreme pressure drop reported by Mike Fritz aboard *Salacia* (18mb in less than 24 hours) and from helicopter reports of the sudden increase in wind velocity and gustiness, we know something significant was going on with the weather. There are two probable explanations. One is that the center of the storm "bombed" in the process of turning itself into a bent back warm front structure. The other, favored by Bob McDavitt, is that pressure drop and concurrent buildup in wind occurred as a result of rapid southerly movement of isobars towards the high.

It is important to keep in mind that neither of these weather structures on its own (vigorously expanding high or strong low) would have caused the winds experienced. The central pressures weren't high or low enough on their own. What did the trick was the combination of the two, squashing the isobars between them, in conjunction with the topography of New Zealand in this area.

Helicopter Pilot Comments

As the actual weather and sea state are important to evaluating how the parachute anchor performed, we got in touch with Reg Ellwood, the NEST helicopter pilot who rescued the Burmans.

We wanted to see if he had any actual wind, sea state, or pressure data which would shed some light on this subject.

We measure windspeed and direction from our Shadin air data system. With sensors and interfaces to the KLN90B GPS and other aircraft instruments and equipment, we have a large amount of air data available. We are mostly selected on windspeed and direction and have a constant readout.

I remember shortly before the winch, while moving in on *Freya* at about 100 feet (30m) above the water, observing the wind at 070 degrees and 72 knots. The aircraft must be in a reasonably steady state of flight and the wind reasonably steady for the Shadin to indicate.

I don't recollect thinking that conditions were gustier than might be expected in the circumstances. I have previously flown in winds of this strength and higher.

I believe the wind backed up to 20 degrees at times but its predominant direction was 70.

I don't believe there was a large windshift. However, the conditions had most certainly worsened on our second trip out. The sea state was higher and steeper and the wind had increased. Also, the cloud base was down to about 200 feet (60m) and lower in places with heavier rain.

I would have to estimate the wave height at 50 feet (15m) during the winch, based on radio altimeter readings. Some may be lower, maybe the odd one higher. The next day the sea was mild by comparison, and, during the search for the yacht *Salacia*, we carefully measured the sea height at 35 feet (12m). The container ship also involved was rolling 30 degrees side to side.

Conditions did seem to improve markedly towards the coast although cloud cover was still down to 100 to 200 feet (30 to 60m) and visibility very poor.

"On the second trip out to *Freya*, the seas were definitely steeper and more dangerous. I have sailed offshore across the Tasman in gale conditions, and my copilot was ship's engineer on a tuna boat for a number of years in the Pacific. We are agreed the seas were steep and potentially dangerous to a small vessel."

Bob McDavitt's Comments

Successful weather forecasting is obviously very much a black art. In spite of all the supercomputers crunching away in government offices around the world, there is still a human who has to put his or her experience and intuition to work to make the best guess at the right prediction.

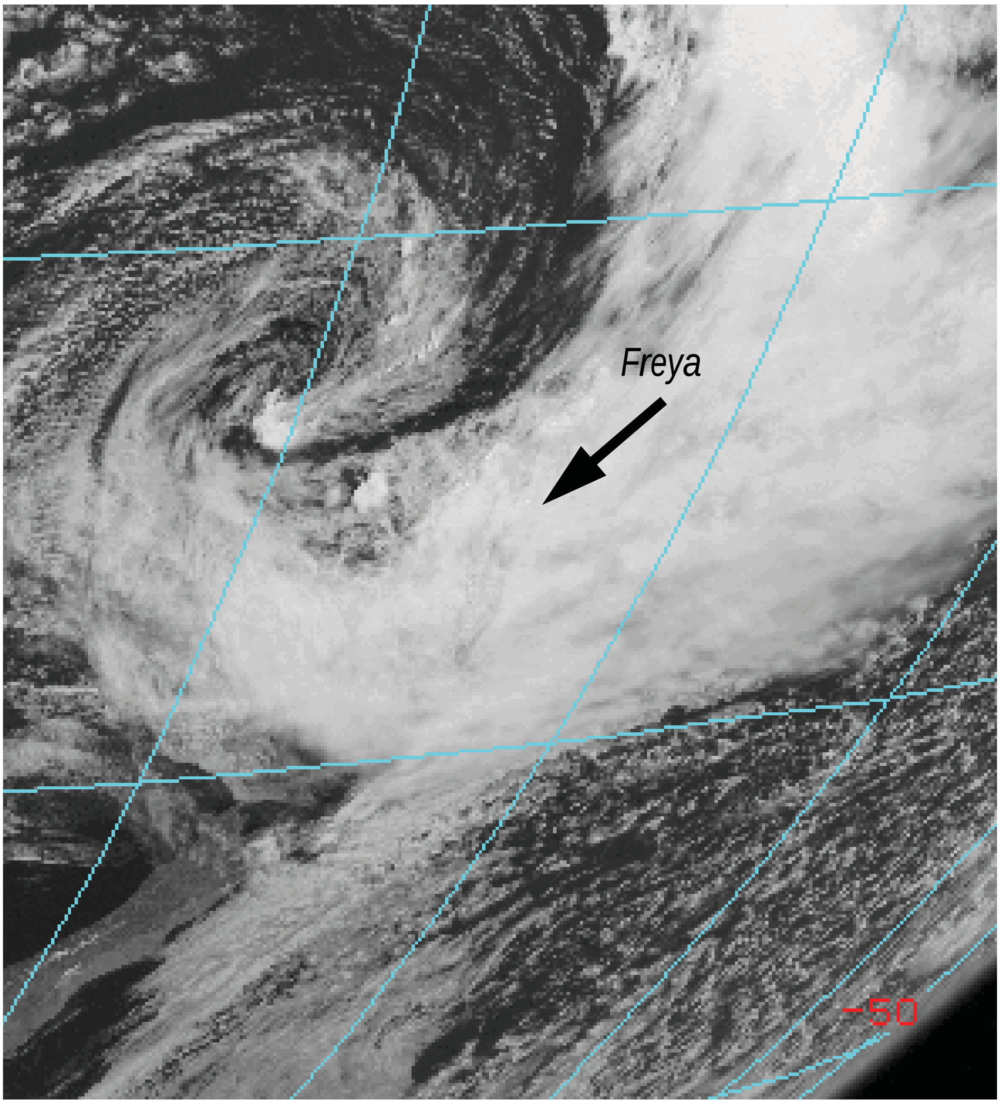
A lot of local knowledge is involved in this process. Don't expect a meteorologist from one part of the world to be able to interpret things as well on an *ad hoc* basis as someone who lives with the problems day in and day out.

You've already heard the cruisers in this section sing the praises of Bob McDavitt. Let's hear now what he has to say about the period we've been discussing:

Every high that develops and spreads its isobars in mid-latitudes will strengthen the trades in the tropics. During a La Niña the Walker cell is stronger than normal with greater upward motion over the West Pacific and greater downward motion over

This is a GMS satellite image in the visible light range taken at 1000NZST on the morning of November 28th—at the same time Freya's crew was being lifted off by helicopter.

The spiral bands of the depression center clearly show a baroclinic or bent back warm front type of structure. Freya's location would normally have been out of the effects, but the strong high pressure system created a squash zone and intensified the winds.



University of Wisconsin, Space Science and Engineering Center

the East Pacific. So there is greater feedback flow at ground level, and thus stronger tradewinds.

So maybe during a La Niña, we can get a stronger squash zone to the north of the highs than occurs in El Niño.

Anyway, these squash zones are normal—mainly in the autumn, as the highs cross North Island. In a typical spring, highs migrate along 30S so that we get lots of westerlies over New Zealand. These westerlies are equinoctial and last spring they were lower than normal.

500mb maps do not help in picking squash zones. The main thing to watch is the intensity of the high. Anything over 1030 is bad.

Once one squash zone occurs, it seems likely that there will be another on the tropical side of the next high. They are called *bongi walu* in Fiji, meaning eight nights of wind.

In November of 1998 we had a run of them thanks to the big highs—not normal. The normal spring brings southwesters to the Northland. Squash zones are usually an autumn/winter problem.

You have to be careful with the "weather window" between the highs, because the lows that form on the western side of a high can accentuate the squash zone just like the one on November 28.

Basically, the best strategy last November was for the yachts to take on the squash zone during mid-voyage, and wait for a non-squash zone for the Northland landfall (even if it meant awaiting a southwester!).

I forecasted for nine voyages last November. I had to get some of them to wait in Minerva for as long as a week, but I got most of them through the worst of the squash zones without incident. Some had it rough for a day or so, one had a dream trip with barely any wind at all. The only yachts that got into trouble were those attempting to make a Northland landfall during a squash zone.

In a squash zone, the actual winds on our northeast coast are stronger than those indicated by the isobars. This is something that has even amazed the visiting America's Cup meteorologists. The locals have gotten used to it. It is caused by a river of wind through Colville Channel whenever the air is stable, so that the reservoir of air that builds up on the eastern side of the Coromandel Mountains has to squeeze through the channel between Coromandel and Great Barrier Island. This river of wind mainly flows from Colville Channel to Bream Bay, but also affects parts of Hauraki Gulf. Not much of it over the Bay of Islands.

The 27th low was nothing special—but the 28 November squash zone ended up with winds stronger than those in Cyclone Drena, with sustained storm winds for longer than Cyclone Bola (1988), the best of the decade.

I think if caught in 50-knot winds near a coast I'd prefer the chosen strategy of heaving to offshore, rather than going inshore.

"Our nautical almanac says that wind speeds quoted in forecasts and warnings are averaged out over large areas. Near a coast, sailors are reminded to prepare for wind speeds from half to double the one we quote."

Sea State

A critical factor in evaluating the tactics used by the Burmans and the effectiveness of their parachute anchor is the sea state.

Helicopter pilot Reg Ellwood told us that the sea state looked normal to him for the conditions, with waves from a single direction. He confirms that the wind was fairly steady from 090 true, in the 70-knot range:

Any time you have wind waves or swells hitting the shore, some of the energy will be reflected back. These reflected waves sometimes bend (refract) in one direction or another depending on local topography and sea bottom shape. This is one reason why it is dangerous to close with a lee shore. The reflected waves can interfere with the primary wind waves, causing instability and breaking crests, sometimes from unusual directions.

To see if this could have been a problem with *Freya* and *Salacia* we asked Bob McDavitt to tell us what he thought, based on the latest *in situ* data from Reg Ellwood:

The waves refract as they come in so that they hit the coastline more directly, then they bounce and then refract again on their way offshore.The coastline runs roughly from the north-northwest to the south-southeast, so the outgoing wave train would be coming from 210 degrees, going to 030 degrees, about 60 degrees off the wind.

But the reflected waves probably only start off with half the

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energy of the incoming waves, and will gradually flatten as they
move offshore (into the wind), so maybe they are not a factor
after about 10 miles offshore. Certainly not at 100 miles off-
shore.
 We know that reflected waves can help steepen the sea in the
region 3 to 8 miles offshore. (That was the case off San Diego
during the America's Cup races on some days.) Within 3 miles of
the coast the interference pattern can be really nasty.
 We know that one factor of squash zones onto a coastline is
what happens to all that water, which gets piled up on itself
at the coastline by the wind strength. On the West Coast of
North America it goes south, accentuating the coastal current.
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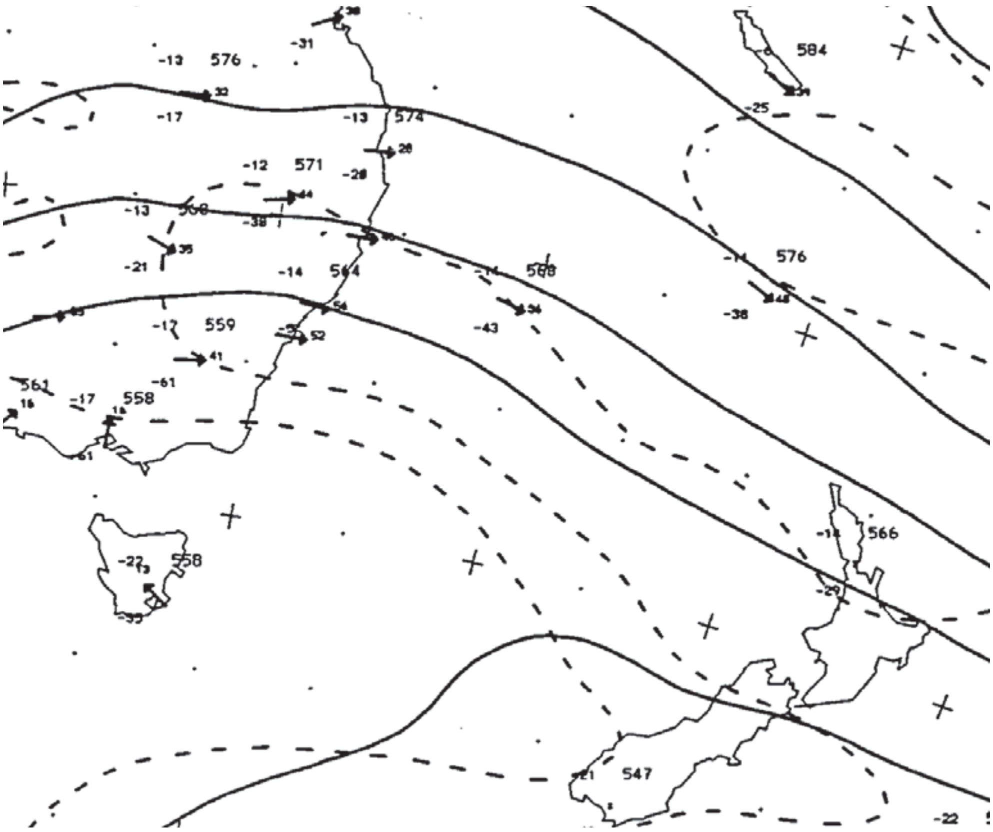
Dynamic Fetch Possibilities

It is possible that the rapid buildup in waves encountered by the Burmans was due to something called dynamic fetch. (See page 246 for more data on this phenomenon.) When you have rapidly escalating wind strength blowing over the same patch of ocean, it can raise a much larger sea than would normally be expected from the wind, fetch, and time. This is the most probable answer for the waves that rolled *Freya*.

500mb Analysis

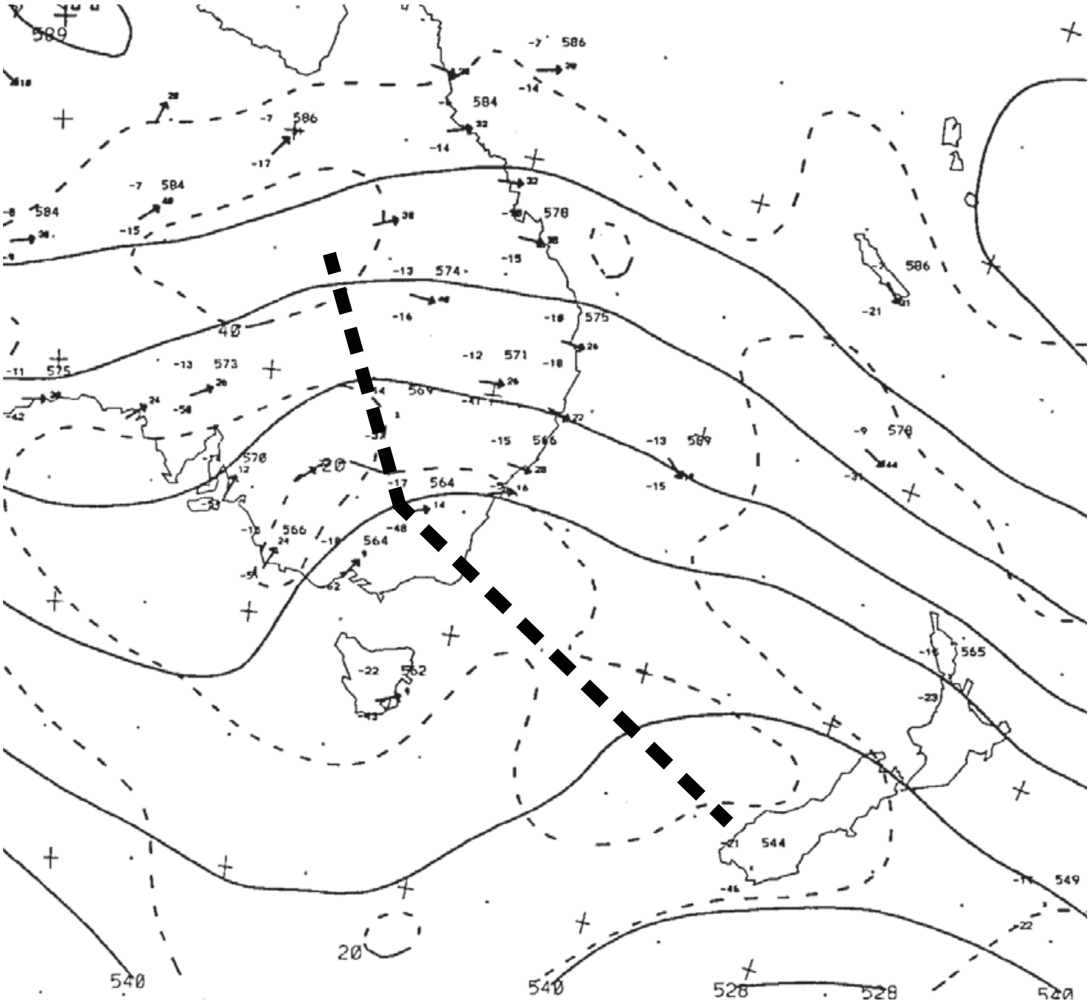
We want to turn now to the 500mb fax charts, which are available from Australia, and cover to just east of New Zealand. A series of four faxes follows. Had you been monitoring these for the week prior to arrival in the New Zealand region, you would have seen a short wave trough developing in a potentially dangerous manner. As we discussed in the chapter on *Janamarie II* these charts can give you an early warning sign that the risk potential is increasing, so you can change your tactics before it becomes dangerous.



November 25, early morning. These relatively flat lines represent what is known as "zonal" flow—when the upper level winds are more or less straight in their course. This is a very unstable situation and typically leads to a vigorous 500mb trough as the zonal flow breaks down.

If you had received this fax from Australia, and were half-way to New Zealand, it should sound a small alarm.

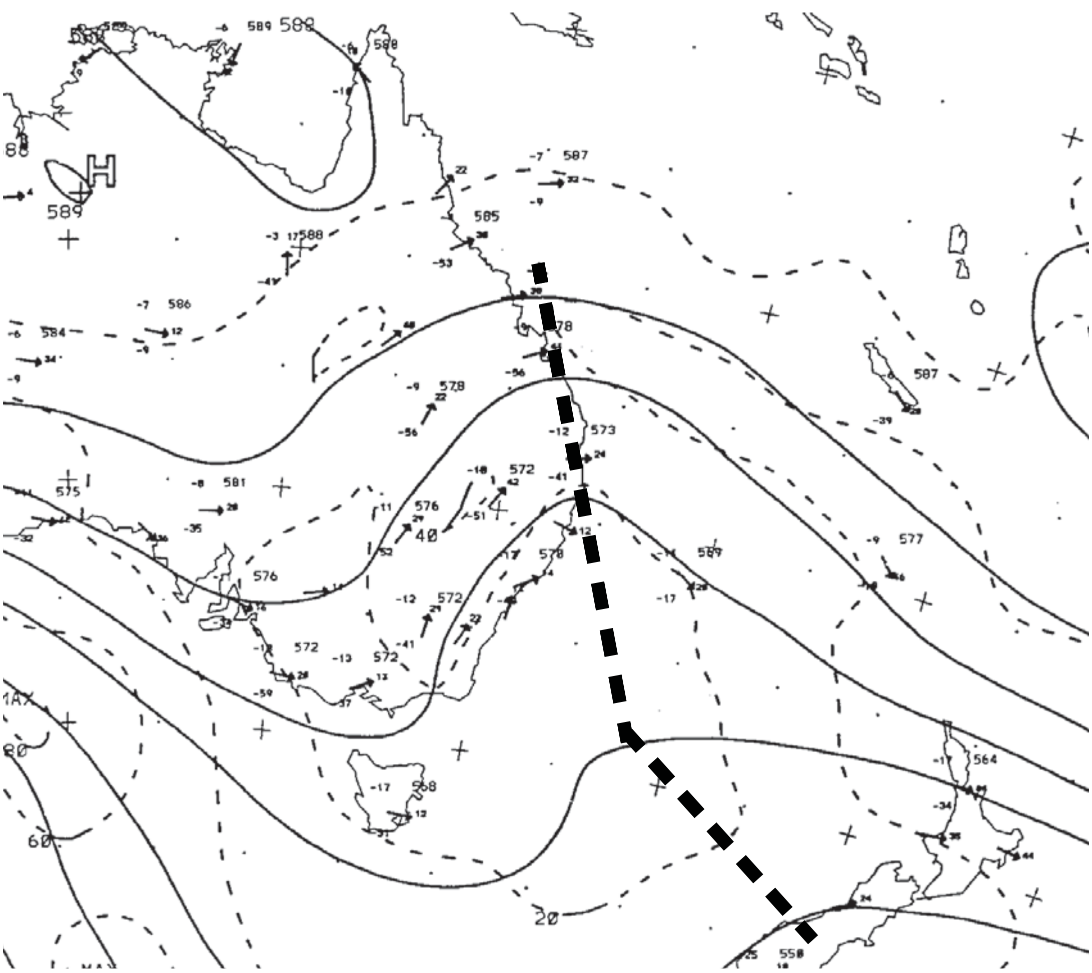
There is typically a day and a half or two days before a strong upper-level trough develops after zonal flow.



The 26th arrives with this data sitting on your fax machine. You can see that the zonal flow is indeed breaking down, and an upper level trough is beginning to form.

From here on out, the way this trough develops, and its rotation, will give us the clues to any risk factors involved.

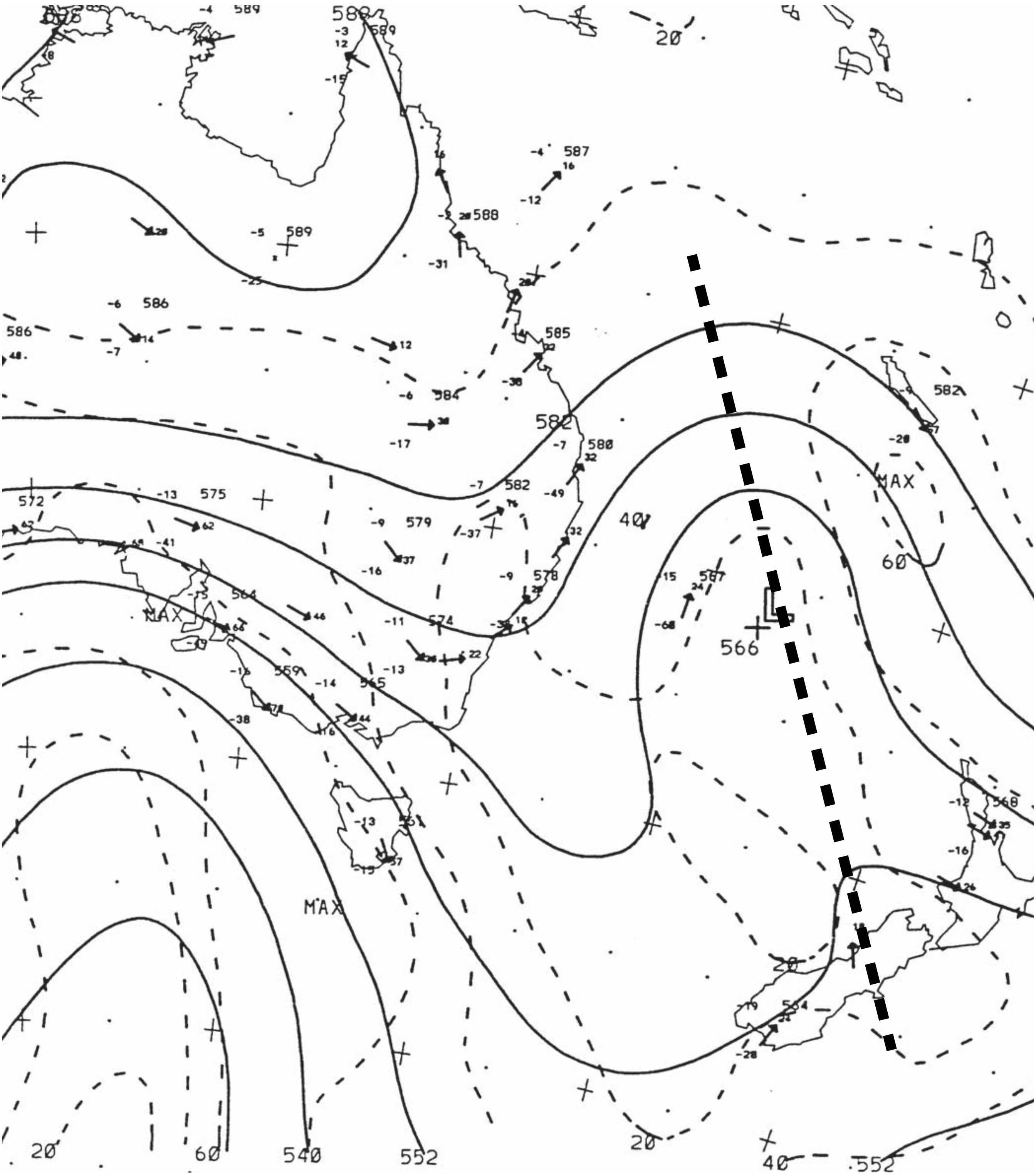
Watch the heavy dashed lines indicating the trough in this and the next two faxes.



24 hours later (morning of the 27th) and the trough is rotating to the east. This is a sign that the trough will intensify and that any surface development will be significant.

One of the factors to remember is that surface-level depressions typically take place a quarter of a wave length to leeward—in this case east—of the upper level trough.

A quarter wave length here is just to the west of the New Zealand coastline at this point in time.



On the 28th we now have a fully developed, aggressive 500mb trough to windward of New Zealand. Compare the shape of this to the previous two days, and note how elongated in a north-south orientation this trough has become. This progression of trough shape—from zonal (elongated) to sharply troughed—is precisely what provides the venting needed for rapid surface pressure drops.

Outside the tropics, if you do not have this type of troughing, large scale surface depressions simply cannot mature. Hence, these charts provide the keys to teasing out the risk factors in any given weather scenario.

500mb charts are drawn by computer, typically with little intervention by forecasters. In this part of the world, they are apt to be less accurate than what you will find from North America or Europe, as there is less raw data to feed into the computer programs. However, they still give warning, as we've shown here and with Janamarie II. It may be of interest to you that there were also warnings at the 500mb level for the Queen's Birthday storm.

Learning from Others

If you think back with us over the preceding ten stories, several factors stand out.

First is preparation. A boat needs to be well prepared before venturing offshore. Maintenance issues that are minor near home can create a cascade of problems offshore. This applies to sails, mechanical systems, the rig, basic structure, and, especially, steering.

In the case of *Woody Goose*, steering problems led directly to their difficulty. Had *Salacia* repaired their motor mount at Minerva Reef, they would have been safely anchored in the Bay of Islands well before their encounter with the rescue ship.

We have seen where boatspeed, or a lack thereof, had a major outcome in several of these stories. You will often find that half a day or less than 50 miles will make the difference between survival weather and a stiff gale.

Had *Shakti*, *Bucephalus*, *Annapurna* or any number of other yachts in this fleet been half a day later in their landfall, they would have been subject to the same weather as *Salacia* and *Freya*.

Boatspeed is a function of your own knowledge, vessel preparation, and above all, sail inventory. There is no substitute for having the right sails at the right time. When these vessels left New Zealand the following fall, they all carried a more efficient sail inventory. If you asked them today what they rate as their most important cruising gear, they would all tell you that a good sail inventory tops the list.

We would be the last to suggest that anyone rely on their engine to keep them out of trouble. But when making risky passages, you can use the engine to get to the next anchorage more quickly by motoring in light air and motorsailing in adverse weather.

With a direct relationship between boatspeed and range from your fuel tanks, you need to know in advance how hard you can press and still have adequate fuel supplies.

Bruce Burman from *Freya* told us, "If I had any idea what we were in for, I would have pushed much harder under power." They could have powered at 6 1/2 knots (instead of 5 1/2) and the difference, over the hours they powered, would have had them safely anchored before the blow hit.

It is common to have less than the amount of fuel necessary to make an entire passage under power. This creates the conundrum of when to power and for how long. A big part of this equation is having a handle on what the weather is likely to do—so you make your powering decisions on the most informed basis possible.

You should always second-guess the professionals. They get it right most of the time, but they do miss now and then.

You are right on the spot, with up-to-the-minute data on wind direction, speed, and barometric pressure. If you understand the basics of forecasting (and it is not that hard) you will be in a much better position to judge the situation and make the appropriate decisions.

While we hesitate to end this first section of the book with such negative experiences, it is important that we all understand that the sea can be an unforgiving task master, and that we learn from the experiences of others who have gone before us.

The vast majority of the time, things will be fine. Even when the odd gale does hit you, it is almost always a matter of comfort and delay rather than safety.

Still, if you venture offshore, it is prudent to do so as well prepared as possible.

Within the fleet we've discussed, there are at least five boats that used parachute anchors at one point or another. Of these, four had problems. In our opinion, this is not an indictment of the parachute anchor so much as difficulties arising from lack of familiarity with the gear. In all cases these were the first instances of parachute anchor use for the boats in question.

The "analysis paralysis" referred to by Ian McIntosh, the professional skipper aboard *Bucephalus*, is common throughout the cruising community. Among other things, it is the result of a little knowledge being dangerous. We cannot emphasize too strongly how important a thorough understanding of meteorology is to your mental and physical comfort and safety.

We'll discuss the entire issue of drogues and parachutes in great detail starting on page 421. For now, keep in mind that whatever system you use—be it warp, some form of towed speed brake, or a parachute anchor—you should practice with it and understand its proper use before your safety is at risk.

You will recall that two boats made landfall in the Bay of Islands without charts, because they had planned on making Auckland their first stop. With the weather that was coming, one cannot quarrel with their decision at the end of the voyage. It is always best to have details for alternate destinations aboard. Adverse weather or some other emergency may force you to seek a different harbor. It is best to be prepared.

Finally, even though ultimate risks are minor, we should all have an understanding of emergency procedures for abandoning ship during a helicopter or ship rescue along with a secure means of maintaining communication with the would-be rescuers.

We have the unfortunate situation with Julie Black to think back on. Had she clipped her safety harness to the rescue sling, she could not have slipped out. The same holds true for a helicopter hoist with many of the strops in use. If you hold your arms down, you are okay. Raise your arms overhead and you will slip out. (The entire subject on rescue is covered in more detail starting on page 117.)

We wish to conclude this section with some thoughts on chance. With normal preparation and skills, the odds of an unhappy ending are very low. If you prepare yourself with weather know-how, understand your boat, and know how to use its safety and heavy weather gear, your odds are further improved.

But nothing in life is risk-free. Every time you get out of bed in the morning there are risks to your physical well-being. These risks probably increase significantly when you get into your car. If you happen to be driving your car on the weekend, after ten in the evening, the risks are really high. Does this stop you from going to the movies on Saturday night? If not, then the threat of heavy weather should not keep you tied to your marina.

Future Plans

One of the most interesting parts of the story we've just told is the impact of the 1998 spring crossing on all of the cruisers who made it.

All of the participants you've just met will continue cruising. For Thane and Corinne on *Shakti*, Josh on *Caledonia*, and Buddy and Ruth on *Annapurna,* the fall was a time to prepare for and then make another passage—this time from New Zealand back towards the tropics. Fred and Judy aboard *Wings* are spending the winter in New Zealand, tending to various work projects, and will be off to the tropics next year.

I think Fred's comments on the experience could be considered typical:

No one seems to be on the verge of quitting. However, many people were shaken by the deaths of people they knew and had cruised with. It made us all realize how close we are to tragedy each time we go to sea. We also realized how rough this stretch of water is. We'd all heard that before, but now we have more of an understanding of just what that phrase means.

I also think many cruisers, in addition to telling each other that "there but for the grace of God..." have spent some time on quiet reflection. We are looking again at our preparation and equipment, and vowing to be better prepared and equipped next time. We made it last time, possibly through a little luck, and we know where we have room for improvement. We, and others like us, are determined to make those improvements.

Kristin Sandvik's appraisal of the post-November thinking among the cruisers is also worth considering:

Most of us were shell-shocked and giddy upon our arrival to New Zealand. We loved it more than anybody has loved any country ever. Nobody wanted to endure the stress of that passage again, and many cruisers shopped around for property and considered the options for yacht delivery.

Some cruisers have decided to stay in New Zealand beyond hurricane season, for emotional, financial, and other reasons (like wanting to secure a spot to be close to America's Cup action). Also, some cruising partners have opted to do the passage by air, and meet their boats in Tonga or Fiji. Those who aren't ready to head north under sail just aren't.

However, once the cold days of autumn set in, many cruisers who thought they would put off a major passage for another year—or forever—changed their minds.

I was in Tutukaka in May to bid farewell to friends as they headed for Fiji. Every morning, men and women gathered around the daily weatherfax with their coffee cups to study the movements of high and low pressure systems, debate the three-day forecast, and identify the "weather window." At least two distinct groups of boats had already left New Zealand for the Tropics, leaping through so-called weather windows, and both groups had been hit with heavy weather. My friends compared the weather patterns from the previous trips with the current prognostications. Their comprehension of the faxes showed a high level of sophistication, built out of necessity.

I hope to apply that same level of sophistication to my next passage, whenever that may be. I'm staying behind. It's not a fear of the passage that keeps me in New Zealand. I love New Zealand and am trying to get residency. But I expect the call of the sea will lure me out again.

Mike Fritz sounds like he will be looking for another boat once he has finished up tying the loose ends from *Salacia's* "rescue." And the last time we talked with Bruce Burman he was giving serious thought to what sort of vessel they would choose to replace *Freya*.


Richard Bennett

Beating to weather in 60 knots gusting to 80—it can be done with the correct sails and steering technique.

PREPARATION

Heavy weather stories with unhappy outcomes are almost always the result of a chain of events—usually starting with some small issue that is overlooked before heavy weather hits. It may be maintenance, safety gear that is lacking somehow, or a structural problem.

Usually these weaknesses don't seem that important in the context of local cruising, but it is far better to address these issues before you depart. That way if the time comes to do battle with the elements, you have as many factors in your favor as possible. This gives you the maximum leeway and flexibility in choosing tactics.

In this section of the book, you will find detailed discussions of storm canvas inventories, heavy weather self-steering issues, life rafts, as well as the requirements for working on deck in rough going.

We will also be discussing interior safety, avoiding system and rig failure, and preparing the boat before departure.

Last, but certainly not least, we will discuss preparing crew and skipper for battle with the elements.

Much of this material may seem to be superfluous—after all, if you follow the right seasons, watch your weather, and sail prudently, you may never encounter truly severe weather.

But the preparations made for the worst conditions will also stand you in good stead in moderate winds. You will find yourself sailing faster, with less problems in 25 knots of breeze, if you are properly equipped and trained for 50.

There is also a sense of security that comes from knowing that you, your crew, and your vessel are prepared for whatever nature may toss your way.

Risk Assessment

The level of heavy weather preparation required is a question of risk assessment. You wouldn't, for example, bolt down your floorboards, double-lash the dinghy, and remove weather cloths for a short hop in the tradewind belt.

On the other hand, any passage in an area of rapidly changing weather; across strong currents (especially warm ones); or taking place during gale seasons, calls for the highest state of preparation before you depart.

You don't have to be caught in a strong gale to create problems through lack of preparation. A sail on a day with winds in the 25- to 30-knot range, if your gear starts coming apart in the puffs, can create a real mess.

Knockdown checklist:

- ❑ Washboards ready and lockable.
- ❑ Storm covers fitted.
- ❑ All loose gear from deck stored low in the boat.
- ❑ Deck gear double lashed.
- ❑ Positive locks on locker doors, stoves, batteries, floorboards, and fridge doors.
- ❑ Storm canvas checked, hanks lubed.

Preparing for a Rollover

Looking at your systems, sailing gear, storm equipment, and vessel preparation is best done with an eye towards a severe knockdown or rollover.

First on our list is watertight integrity. Seat lockers should have heavy-duty hinges and latches with positive catches, as well as well-sealed upstands so they won't leak when the cockpit is filled with water.

The companionway is one of the most vulnerable parts of the boat. Washboards need to be extremely strong, and the washboards and sliding hatch must have positive locks—typically barrel bolts. This will prevent them from opening unexpectedly in a knockdown or rollover.

Cockpit drains should be extra large, and if they have restricting grates on them (to keep bits and pieces from being lost overboard) the grates should be removed to improve drainage on serious passages.

Dorade vents should be removed and capped. Caps for inside the boat must be handy, in case the cowl or dorade box is lost.

It is amazing how much water will run down your chain where it enters the chain pipe and anchor windlass. It is best if the chain is removed, the anchor secured, and the chain pipe capped or stuffed with rags and taped with duct tape.

Storm covers should be fitted to all hatches. If not, they should be ready to apply when required.

As a preventative measure, it often makes sense to give the windlass a cleaning and lube job, then wrap it in plastic and affix its cover. In really heavy weather, there will be so much water forward that the pre-lubrication and sealing may just be enough to make this vital piece of gear functional at the next anchorage.

Clear the Decks

There are two reasons for clearing the decks of loose gear. First, anything loose on deck will probably be lost early on, even in a moderate gale.

Second, when it does come adrift, the odds are that, for a short period of time, the loose gear will have the potential to do damage to the boat and/or its crew.

Inflatables should be deflated and stored below, anything stored in the hard dinghy should be removed, and it should be inverted. Jerry jugs, sailboards, fender boards, etc. should either be left behind or stored below.

There may be situations where you have sails on deck, either in their bags or tied to the lifelines. Even in moderate gales, this can be a prescription for disaster. A small boarding sea will have the power to remove these from the deck, and they will tend to take what they are attached to as well—leaving your lifeline system bent and broken.

Extra Lashings

The gear left on deck must be heavily secured—and the hardware to which the lashings are attached should be stout.

Padeyes must be through-bolted with backing plates.

Lashings are better if made up from a series of turns with lighter line rather than fewer turns of heavier cordage.

If you have a hard dinghy or RIB on deck, you will want the bow, stern, and athwartships secured. The average dinghy should be secured to at least six padeyes.

If any anchors are left on deck (most should be in the bilge), they will require extra lashings and well constructed chocks.

Life Raft Security

Life raft storage and security is always a conundrum. As you will see in the notes to the 1998 Sydney-Hobart Race storm (starting on page 296); and as we have learned from the *Freya* experience, keeping the life raft aboard in a rollover is difficult.

Yet storing it below, in a soft pack, is not a panacea. Rafts in soft packs can be unwieldy and difficult to deploy quickly.

One answer is to have a built-in locker on deck, which structurally protects the raft from the force of the sea. Another option is to have an extremely strong stainless steel frame which is through-bolted to backing plates.

Storm Windows

The subject of storm windows is important. (They are covered in more detail in *Offshore Cruising Encyclopedia* starting on page 257.) Your storm windows need to be easy to attach. The securing system must be extremely strong to withstand the force of the sea if the boat is rolled or dropped off a wave.

It is far better to fit storm covers before you depart. Once at sea, by the time conditions deteriorate to the point where you think storm covers are required, digging them out from under a bunk and going on deck to install them is the last thing you will want to do—the odds are that they will stay under the bunk until a port or window is lost.

Fit them before you leave.

Center of Gravity

The vertical center of gravity (VCG) is the sum of all the weights in the boat—rig, keel, hull, payload and cruising toys, and their height above the waterline. The higher this is, the less stability you have. Nothing helps the boat withstand punishing wind and waves better than a low VCG.

The further the weight is above the waterline, the more impact. A roller-furled jib that weighs 75 pounds (35kg) might have a VCG of 30 feet (9m) on the average 40-foot (13m) yacht. This is the equivalent of removing 600

Improving center of gravity:

- ❑ Bring anchors and chain off ends of boat and store in bilge.
- ❑ Deflate dinghies and stow below.
- ❑ Remove all deck gear that is not essential to the operation of the vessel and store it low in the boat.
- ❑ Move heavy gear on shelves to lower storage areas.
- ❑ Make sure lowest tanks are used last.
- ❑ Drop any unneeded roller-furling headsails.

pounds (272kg) from the ballast in your keel—not exactly what you are after in heavy weather.

All the weight modern cruising boats accumulate on deck raises their VCG. The effect is rarely noticed because gear accumulates slowly. But if you take it all off one day for a brisk daysail, you will be amazed at the difference in performance.

Weight at the ends of the boat is a factor as well. The further the weight is situated from the pitch center (usually just aft of the mid-point of the waterline) the more it affects your motion. This is especially important when close reaching and beating.

You want to remove as much weight from the ends as possible. For example, take anchors off the bow and stow them below the floorboards, where their weight will enhance stability rather than reduce it.

Windage

Windage is a huge factor in the ability of the boat to beat, heave to, and even hold station with a parachute anchor.

The more windage, the lower the performance. Windage that is located forward—such as roller-furled sails—makes the boat tend to shear at anchor, both in harbor and when on a parachute.

If you expect bad weather, get large roller-furling sails down on deck, brick them, and store them below.

The same applies to leecloths and sailing awnings (although leecloths will help the boat hold her head up when hove to or on a sea anchor).

A dab of 3-in-One oil on storm headsail hanks keeps them working freely.

If you can't get the roller-furled headsails off the headstay, they need to be secured so they cannot unfurl. Rolling extra wraps of sheet helps, but there is still a great deal of load on the furling gear and line.

Securing the Interior

From reading the Burmans' account of their knockdowns, you know that the interior rapidly becomes a mess unless everything is well secured.

If you are prepared, a mast-in- or mast-near-the-water knockdown is no big deal. If you take a really severe knockdown, and the interior stays clean, it is easier for you to deal with the critical issues on deck.

When you are looking at your interior there are two levels of knockdowns to consider. The first is and less than 90 degrees. Here, the main issues are locker doors, drawers, which face athwartships, and loose gear on shelves.

You will want to have positive locks on all doors and drawers—this does not mean finger locks. (For more information on this subject see page 1,013 in *Offshore Cruising Encyclopedia*).

Fridge and freezer doors need to have hinges on one end. Floorboards should be secured as well.

The acceleration (G-forces) with a 60- or 70-degree knockdown are not particularly high. But when you have the mast pointing 30 to 90 degrees below the surface, the G-forces can be quite high.

As we saw with *Freya*, the floorboards screwed down after the first inversion came loose with the second, more violent roll.

The two most potentially dangerous items in the interior are batteries and stoves. Of course these will have positive hold-downs from the builder. But they need to be checked. In the case of batteries, make sure that no battery acid has gotten to the hold-down system. With stoves, always make sure that the locking mechanism on the hinges is functional.

Chafe

Chafe is always a battle—it's something you'll have become familiar with long before the onset of heavy weather.

The occasional flogging and high loads experienced during storm conditions will exacerbate any earlier tendency toward chafe. So, the key here is to understand its causes, and eliminate them during more benign conditions.

A situation that might have lasted for a thousand miles before breaking in moderate trades may go in just a few hours when the boat is loaded up with 50 knots of wind.

Pump Issues

There should be a variety of bilgepumps aboard—both powered and manual. Electric pumps should be mounted well above the floorboards in an easily-accessible locker, with an oversized strainer right where it's easy to reach.

Electric pumps need a manual override for when the float switch fails.

With submersible pumps, you will need to make sure they cannot back-siphon (and flood the boat) when the boat is at extreme angles of heel, or when it's sitting very low in the water. (See *Offshore Cruising Encyclopedia* page 796.)

We always fit a damage-control pump—a high capacity unit that is either engine- or genset-driven or has its own power source.

If you don't have an engine-driven pump you can make a "T" off the engine's saltwater intake. This will be far more effective than most electrical pumps, although not as good as a dedicated pump.

You will also want to have easily operated manual pumps, fitted where they can be comfortably used for hours on end by a tired crew.

Finally, one of the most effective pumps in the world is a large bucket in the hands of a crewmember with water up to his knees (see the *Tzu Hang* story starting on page **199**). We typically carry one bucket for each crewmember. They come in handy for storage and only once, in the early 1960s, did we have cause to use them, but we were very glad to have them aboard!

These buckets should be strongly made, with heavy-duty handles and reinforcement points where the handles join the rim.

Drogues/Para-Anchors:

- ❑ The entire subject of drogues and parachute anchors is covered in detail starting on page **421**. The thing to remember now is that you want your system set up and ready to deploy before leaving port.
- ❑ You and your crew must also be familiar with deployment, proper attachment to the boat, and retrieval.

Storm sails:

- ❑ Your storm sails will rarely be used. They should attach with piston hanks to a cutter stay or extra headstay. The hardware on the sail will probably have been sitting stored for some period of time and may be stiff.
- ❑ Storm canvas should be removed before the passage, hanks worked and lubed lightly, sheets and pennants checked, and then stored where easily accessible.

Engine and Drive Train

Key items to check:

- ❑ Fuel filters fresh.
- ❑ Fuel tank sumps cleaned out.
- ❑ Brackets tight, no cracks.
- ❑ V-belts in good condition—replace if in doubt.
- ❑ Shaft coupling tight.
- ❑ Stuffing box properly adjusted.
- ❑ Oil and coolant levels topped off.

Mounts and brackets:

Engine mounts, pump, compressor, and alternator brackets are subject to pulsing loads—referred to as "torsionals" by engineers. These loads are caused by the firing order and nature of the diesel engine. As a result, the brackets and bolts which hold engine parts in place tend to loosen and/or crack.

If you have four bolts holding a given bracket and one is loose, it puts an additional load on the other bolts. Pretty soon they will all loosen or fail entirely.

- ❑ Make a habit of checking all the accessory bracket and motor mount bolts before each passage.
- ❑ Inspect the brackets for cracks. Pay particular attention to the edges of welds, corners, holes, and bends.

For most passages, whether you have an operable engine or not is a question of time and convenience. Most of the time, in fact, it is more pleasant to face the challenge of making your way without the aid of the iron genoa.

But when you cross a body of water—where the longer you are out, the more risk you face from weather systems—reliable machinery becomes important. This rings true especially when you consider that during the equinoctial gale seasons, periods of calm are often followed by vigorous depressions.

General Maintenance

It is rare that a problem with your engine or drive train will arrive without forewarning. You can catch problems before they become serious if you have a formalized maintenance routine. It is especially helpful to keep your machinery clean, with paint in good condition (preferably a light color).

You will quickly get used to the way things look and sound, so you can spot imminent problems before they become major.

We always clean our machinery spaces at the end of each passage. This prevents a buildup of dirt and oil, and gives us a chance to catch any problems well before we are ready to head off on the next passage.

Fuel

If there is any sediment or algae in your fuel tanks, it will be dislodged by bouncing around in rough weather. These contaminants will then block the fuel filter, in which case engine operation becomes problematic—precisely what occurred with *Woody Goose*.

Keeping tanks clean, using a biocide in your diesel to prevent algae growth, and having oversized dual filters (so while one filter is being changed the engine can run on the second) will all help the reliability of your engine in heavy weather.

Oil

You have probably heard this before, but the single most important thing you can do for your engine is to change the oil on a regular basis. Yes, it is an obnoxious job, but it will pay big dividends at some point in your engine's life.

Vulnerability to Flooding

Look at your engine in the context of a flooded interior. Where is the dipstick? If it does not come close to the top of the engine, and the engine is located low in the bilge, consider making a longer dipstick and housing.

This will prevent saltwater from mixing with oil. The same applies to dipsticks and/or breathers for the injection pump and transmission.

How about the starter motor? How early in the flooding process will it be out of order? Can you seal the terminals to get them to operate when wet?

V-Belts

More problems are caused by poor quality V-belts and/or misalignment than by almost anything else. (See *Offshore Cruising Encyclopedia* page 760 for more data on V-belts.)

Make sure you have the highest quality belts available, and that accessory brackets are properly aligned. Significant dusting (sometimes referred to as the black fuzzies) is a sure sign that your pulleys are out of alignment.

Shaft Coupling

You would be surprised how often vessels are disabled because the propeller shaft comes loose from the transmission coupling.

Keep an eye on yours. Check bolt torque, and if possible, make sure the bolts have safety wire on them.

Stuffing Box

A leaky or improperly adjusted stuffing box won't sink your boat (as long as you are aboard), but it will slow down the speed at which you can power.

And you just may need that extra speed to beat the next storm.

Know how to adjust your stuffing box and replace the packing material or lip seal, if it starts to leak.

Propeller

As you are cleaning the bottom before departure, you should also check the propeller for large nicks which might knock it out of balance. Also, be sure the split pin locking the nut on the end of the propeller hub is in place and in good shape.

STEERING

It is not unusual to have decades-old boats, on which no one has ever checked the steering system. Yet if that system fails, it can be extremely dangerous. The odds are that if there is a weak spot in the system, it is going to fail in heavy weather, when lack of control could have serious consequences.

Make sure that the steering is free and runs easily, and that there are no binding or hard spots as you turn the helm.

Since your steering endures constantly reversing loads throughout its life, the bolts in the system are at higher risk for loosening than elsewhere aboard. Even if the system is hard to access, it is still worth checking before each serious passage.

Quadrant

Make sure the quadrant bolts are really tight. If any are loose, make a note of it, and check that point again in the future.

Inspect the quadrant for cracks. Pay attention to the area around bolt holes.

Look carefully at the attachment points for the steering cables. These are typically eye bolts and can fail either at their threads, or at the eyes.

If you have a hydraulic system (or hydraulic pilot), examine the cylinder mounting bolts. Look at the clevis pin where the cylinder attaches to the quadrant. Check for any signs of leakage or scratches on the cylinder rod.

Sheaves

Sheaves should be lubed periodically. Inspect fastening bolts. Look for cracks. Run your finger carefully over the inner surface of the sheave, checking for roughness.

Steering Cables

Check the entire steering cable for "meat hooks," or tiny breaks in the wire. If you can see or feel a few, more will be hidden inside of the wire. These indicate that it is time for a new set of steering cables. You should carry a spare set of steering cables.

Pay particular attention to the ends of cables where they are swaged or clamped, where they run over the corners of the quadrant, and where they run back and forth over the steering sheaves.

Finally, inspect the cable clamps carefully. Ensure that they are properly installed with the bolt on the tail, and that the clamping bolts are tight.

Steering system check:

- ❑ Rudder bearing in good condition—no excess play.
- ❑ Quadrant and steering sheave bolts tight.
- ❑ Inspect steering chains for cracks.
- ❑ Check cables for meat hooks.
- ❑ Emergency steering system easily accessible. Test relieving tackles.

Rig and rigging survey:

- ❑ Check wire terminations for cracks, broken strands, elongated holes.
- ❑ Check tangs for cracks and elongation.
- ❑ Spreader bases tight.
- ❑ Spreader ends seized.
- ❑ Roller-furling joints tight.
- ❑ Review all welds for cracks and hole elongation.
- ❑ Make sure turnbuckle toggles are free acting. Look for cracks on toggles and turnbuckles.
- ❑ Tighten gooseneck and vang fasteners (and re-check every few days at sea).
- ❑ Be sure all deck hardware is clean and operates smoothly.

Rudder Bearings and Shaft Seal

There are all sorts of rudder bearing systems. Some are as simple as a round piece of plastic, others may have a bronze bushing or roller bearings.

Whatever the system, check the shaft and quadrant for play.

If you have a roller bearing system, you will want to periodically remove the rudder and check that the bearings and their cages are in excellent shape.

There will probably be a shaft seal somewhere along the rudder. It should be properly adjusted. Carry spare packing material.

Attachment

If you have a keel- or skeg-hung rudder, there will be hinges and/or pintels and gudgeons under water.

Look at the fasteners and be sure they are tight and not working. The mating surfaces of the pintels/gudgeons and hinges should not be excessively loose.

Keep an eye out for electrolysis.

Steering Chain

The one item in the steering system that is probably at the greatest risk is the steering chain, which runs from the end of the cables, up and over the wheel sprocket.

Keep this clean, lubed, and inspect each link for cracks where it joins the next link. Carry spare joining links.

Emergency Steering

You are going to have some form of emergency steering aboard. Make sure you have steered the boat with it in a fresh breeze. The odds are that it will be difficult to rig, and require relieving tackles to help take the strain when the wind is blowing hard.

Relieving tackles sometimes require special attachment points, through bolted padeyes in the deck or cockpit.

With rudders that extend to or just past the transom it is often possible to rig steering lines to the aft upper corner, there may be a hole for that purpose.

RIG AND RIGGING

Next to steering problems, it is probably rig-related failures that precipitate the most problems offshore.

Maintenance problems occur over time. They start small, show evidence of the problem, and progress. If you make a habit of inspecting the rig before each passage and occasionally at sea, the odds are you will never have the rig down around your ears.

We have made a habit of going aloft periodically at sea to have a look around. On our older boats, this has typically been every third day, conditions permitting, of course.

Starting on page 327, you will find a story about one of the worst two blows we have ever experienced. It was in the Aghulas current as we were approaching Durban, South Africa.

This was the fourth in a series of gales we'd been through. Prior to its arrival (and before we knew it was on its way), Steve went aloft to give the mainmast a quick once-over.

He found that the lower port shroud had three broken strands showing from its swage terminal. We had a spare aboard so this was not a major problem, but as we started to replace the shroud, a black wall appeared to the southwest.

Ten minutes after the shroud was replaced, we were pounding to windward on port tack, shortened down to staysail and reefed mizzen in 55 knots of wind. We sailed that way for the next 2 1/2 days.

Preparing for a blow: With all of the preceding done before you leave the anchorage, and with periodic checks while underway, the chance of a problem creeping up unexpectedly are substantially reduced.

Still, when you know there's a blow due shortly, you will want to give things one more quick once-over.

- ❑ Check lashings on deck.
- ❑ Re-inspect the bottom end of the rig and boom.
- ❑ Check reef pennants, and make sure storm canvas is accessible.
- ❑ Fit storm shutters and remove dorade cowls.
- ❑ Sit back, relax, read a book, and try to get some rest.

Rig Check

Periodically, at least once every couple of years, we like to pull the stick and have a really thorough look at things. At the same time we disassemble rigging from tangs and re-lube the clevis pins, so they are easily removed.

Turnbuckles are cleaned and lubed as are their clevis pins.

Before leaving on a passage we go aloft and check the wire terminals, tangs, spreader bases, and spreader tips making sure that any seizing or bolts which hold the shrouds in place are in good shape.

Where there are welded tangs, as with head and cutter stays, look for cracks in the weld and hole enlargement.

Make sure that all split pins are in place.

At the same time as you inspect the structure, make sure there are no sharp edges which can chafe or tear headsails.

Roller-Furling

Most roller-furling systems require periodic maintenance.

Make sure the extrusion connections are in good shape, have a look at the upper swivel, and check the control line for chafe.

An additional layer of security can be obtained in heavy weather with roller-furled headsails by wrapping a spinnaker halyard (or spare jib halyard) around the sail in the opposite direction to which it is rolled on the furler.

Booms

Booms seem to have more problems than any other segment of the rig.

The area at highest risk is the gooseneck. Check fasteners, clevis pins (which should be lubed at least once a year), and welds.

The next trouble spot is likely to be the vang attachment on the boom and at the mast base.

Watch for cracks in any weldments and in the slot in the boom through which the vang lug protrudes.

It is not uncommon to have continuing problems with vang and gooseneck bolts loosening up after short periods of time. One way to deal with this is by epoxying the fittings into place. The epoxy gets rid of the movement that precipitates fastener loosening in the first place.

Keep a close eye on all fasteners at sea.

Stock Newport

Working on deck in heavy weather requires concentration and awareness. You should know when the next sea is to hit. As shown here depending on lifelines is never a good idea. It is better to hang on to structure—handrails, rigging, or spars.

Safety on Deck

All vessels have their own motion, their own way of reacting to the sea. Since you will be used to the motion after a few days at sea, anything out of the ordinary will be immediately apparent.

As you move around the boat, make sure you go from handhold to handhold. Never lean out over the lifelines to work. Always use your safety harness. We wear our safety harnesses any time we are on deck under sail—even in nice weather.

Work against the roll of the boat, so you get into the rhythm of keeping your balance.

Avoid stepping on sails that are flaked on deck; they tend to slip out from under foot.

The real danger is in the wave which is out of order, one that is larger than others or coming from a different direction. This may happen on a periodic basis, or may not have happened at all—yet. But "sneaker" waves are a part of life at sea, so be alert for them.

If you sense that the boat is about to be nailed, it is usually best to drop what you are doing and hold on with both hands (or arms). Use your arms to completely encircle an object, and bring your strongest muscles to bear. For example, you can hold on much better by circling your arms around a shroud, than by holding on with your hands. If there isn't time to get both arms around, at least use one arm, bringing the shroud or stanchion into the crook of your arm.

At the Beginning of Your Watch

You are most vulnerable when you first come on deck. The odds are you've just crawled out of the sack, are not fully awake, and are not yet used to the motion of the deck (which will be considerably more active than below).

Stock Newport

There are times when it is necessary to re-reave a reef pennant or tie off a safety line through the reef clew (so the reef pennant can be unloaded). In this case, a safety harness is attached to a halyard, just in case. Still, there's a chance being taken here. If you are cruising, it is a lot easier to head up on a beat and bring the boom over the deck where it is easier to work.

Take a few moments in the companionway before entering the cockpit and get used to the sound of the wind and sea, the motion of the boat.

Then, once you've clipped on your harness and before going on deck, move to a protected spot in the cockpit and spend five minutes getting used to the conditions.

Watch how the boat reacts to the seas; get a feel for the wind strength, direction, and puff cycles; and take note of how the self steering or helmsman is coping.

Only after you are fully acclimated, should you take over on watch. Always stay attached.

Handholds

We've briefly mentioned handholds in the context of working on deck. It is obvious you will want more rather than fewer.

You should be able to move from handhold to handhold, in a fashion that allows you to get a good grip on the next before leaving the last.

In positioning handholds, consider the reach of the crew. Its easier to use your arm when it is outstretched than when it is bent. Handholds along cabin trunks or pilothouses should be set well inboard, so your arm is extended in its strongest position.

When first coming on watch:

- ❑ Spend a few minutes in the companionway or under the dodger getting used to noise of the wind and feel of the sea.
- ❑ Be sure to hook up your harness tether.
- ❑ Use handholds as you work your way to the helm or your watch station.
- ❑ Stay well braced, ready for an errant wave.

Importance of the Cutter Stay

If you don't have a cutter stay to break up the foredeck space, you can always bring a lazy halyard or a topping lift down from the masthead and attach it to a padeye midway between the mast and headstay.

We'll discuss the sail-carrying reasons for having a cutter stay in the section on storm canvas (starting on page 133). It is also important in the context of working on deck.

Without a cutterstay there is a huge amount of open area between the mast and headstay. The only handholds will be at lifeline height or below which are much less efficient to use than something at chest height.

Most of our boats have removable cutter stays. We typically leave them out for daysailing to make tacking easier. But when we go to sea we install them, even when we don't expect to use storm canvas, because they do such a nice job of breaking up the foredeck.

Lifeline systems should always be suspect, and never totally relied upon. One of the areas of highest risk are the pelican hooks at gates. We always make a habit of tieing these off with a bit of light line, so they cannot accidently open.

Lifeline Systems

We want to finish this section with a word on lifeline systems. On most boats, lifelines are at 24 inches (0.6m) above the deck, which is just the right height to trip you overboard—32 inches (0.8m) is much better.

Most builders fit wire bales rather than solid ones, and these are known to fail with some regularity.

Bases should be strong and through-bolted, using a large backing plate. Remember, if you are flying overboard, your body is accelerated, and the force on the lifelines is likely to be several times your weight.

Give lifelines the same inspection at their ends which you give to the standing rigging, and always tie off pelican hooks where the lifelines open (for a detailed discussion of lifeline systems see page 912 in *Offshore Cruising Encyclopedia*).

It is always better to work to windward of a boom or sail than to leeward. If a sheet fails or is unexpectedly eased, you are not in the way. At the same time, it is best to avoid leaning against sails or booms—if they are eased you are likely to end up flying to leeward.

Stock Newport

Rick Tomlinson

Personal Safety Gear

This is a very involved subject, the details of which are discussed at length in *Offshore Cruising Encyclopedia* (page 235).

For now, we want to emphasize the importance of staying attached to the boat. The odds of recovering a crew who has gone overboard in heavy weather are slim, even on a fully crewed vessel. For those sailing short-handed, it is close to impossible.

The key to staying with the boat is taking care of yourself, working carefully from handhold to handhold, and staying alert to the sea.

However, if you do get pitched overboard, you will look to your safety harness system for initial salvation. The way this gear works, from how it distributes the load on your body to the towing position relative to your personal waterline, and your ability to breathe, is crucial to getting you back aboard in a functional state.

With the right gear, you have the best chance of being able to get yourself back aboard. With the wrong gear you may be in such pain that you are just a dead weight, which makes recovery much more difficult.

The conventional harnesses above have wide waist-bands to distribute load to the rib cage if the wearer is pulled up short against the tether. In order for these to work when you are hanging over the side they must be worn snugly—otherwise you might slip out.

Sydney-Hobart Data

From the 1998 Sydney-Hobart Race we have some sobering data on safety harnesses (for a full report on this storm and its aftermath see pages 168 and 291):

Four harnesses slipped over people's heads while in the water and being lifted.

One harness strop failed when stitching on the webbing tether failed. Manufacturers confirmed that sunlight and poor care reduce the life of webbing and stitching on harnesses.

Experience over the years has indicated that you should avoid attaching your safety harness to the rig or rigging. If you end up in a severe knockdown or rollover, there's a good chance the rig will be lost, and what you're attached to will no longer be part of the boat.

If you are working in the cockpit—i.e., steering or standing by on the sheets—you should be on a short tether. Padeyes need to be positioned so that harness tethers are tight in the event of a wave slap. Any slack in the tether will let your body accelerate to leeward. If the cockpit and wheel design allows for it, the ideal situation is to have two pennants in use, opposing each other.

Choosing a harness involves more than picking one off the shelf. Aside from evaluating the test data supplied by SSF, the best thing is to put on a harness, then test it under load.

Try this from the local yacht club dinghy hoist, or with a halyard aboard your boat.

Women face a different set of comfort problems. The SSF testers varied in what they liked. In the end, they suggested testing in the marine store with a firm pull parallel with the spine.

Five crew from yachts that were inverted reported difficulty in undoing harness clips. Moving around the deck, coming on deck or going below (when harnesses had to be unclipped), created a short-term risk of being washed overboard.

Length of harness lanyards created problems for some wearers, in that users reported being "washed" to the full length (approximately 6.5 feet/2m) by waves. Some crews overcame this by "shortening" the lanyard, by wrapping it round a winch. Others used more than one strop. At least one yacht reported having harness tethers with three clips, one at each end and one in the middle.

Webbing jacklines stretched when wet and under load and were regarded by crews as suspect. One jackline failed.

Seattle Sailing Foundation Tests

The Seattle Sailing Foundation (SSF) has been doing empirical testing and development on behalf of all sailors for several decades now. Their initial program was responsible for the creation of the "Lifesling" and excellent work in man-overboard recovery techniques.

During 1998/99, they undertook an exhaustive series of tests aimed at defining the personal safety harness, as well as evaluating all products on the market.

The full details of their tests are available on the CD-Rom edition of this book. We are grateful to the Seattle Sailing Foundation for allowing us to pass on this data to you.

In the Water

Tests started with various volunteers being towed while overboard with a variety of harnesses. They then evaluated the comfort and functionality of each unit tested.

One of the immediately apparent conclusions was that the angle at which you were towed and where your head was held (relative to the water) varied considerably. A key factor, then, is the towing position of the body in the water.

Another factor realized right away was the need to get the boat stopped as quickly as possible. The person being towed is virtually helpless, even at a moderate speed such as 4 knots.

Having the towed person to leeward is also important. The boat then provides some lee from the seas, and it is easier to get him or her back aboard, since the vertical distance between the water and deck edge is considerably less. Whether it is worth tacking the boat to exchange a windward-to situation for a leeward condition would depend on the situation—short-handed, if you cannot get the person back aboard to weather, there is no choice but to try a tack.

SSF found that longer tethers were easier on the overboard testers as more of the body was then in the water and thus supported. With a short tether, they were left hanging—a very uncomfortable situation.

All photos Seattle Sailing Foundation

This is a view we all hope fervently to avoid ever seeing—but it is important to consider how a harness works when you are being towed by the boat.

A long tether is an advantage in that it allows the water to support part or all of your body. This reduces the discomfort of hanging in the air. However, you need to breathe and when the boat is towing you at speed, there are waves to contend with, not to mention the wake which your own body produces. A key design issue is that the harness tows you head up. Not all do.

The top left harness is a Gill. Top right is from Forespar. Bottom left is from Henry Lloyd.

Harness Construction

There are a variety of harness styles. The safest and most comfortable, when you are suspended, are those with leg straps. However, these are more difficult to put on, so they may not get used as often.

Stitching should always be in a contrasting color so that is it easily inspected for chafe. There should be reflective patches on the shoulders.

Ideally a supple material will be used so that the harness is comfortable to wear in the tropics when the odds are you'll have just a light shirt (or less) under the webbing.

The way you hang from your safety harness is an important consideration as it will probably be necessary to assist those getting you back aboard and the more comfortable you are, the more you can help.

Here are four different harnesses being tested from a dinghy hoist. Top left is from West Marine. Top right is from Musto. Bottom right is a commercial model from PBI/Sala which includes leg straps. The bottom left is from Raudaschl. Of all of the harnesses shown, and of those tested, the models with leg straps gave by far the best support. The only problem is that they are difficult to get into and out of, and thus may not get as much use as the shoulder-only models.

All photos Seattle Sailing Foundation

Rick Tomlinson

The very safest harness is one with a crotch or leg strap. The only problem is that this is more difficult to get into.

Tethers

Tethers between the harness and the boat are typically sold separately. We feel it is important to have two tethers on each harness—a short one, about 3 feet (0.9m) in length, and a second pennant which is as long as possible without tripping on the bottom when it is attached to itself (usually about 6 feet /1.8m).

With two tethers you can move from spot to spot without ever unclipping, and choose the shortest practical length for where you are working or sitting.

The hardware on both ends of the tether is equally important. It needs to be strong, easily operated with one hand, and relatively immune to accidental opening. Our personal preference is the Gibb hook for the outboard end and a standard 6,000-pound (2,800kg) breaking strength stainless steel snap shackle for the inner end. We like to have a short tether on the clevis pin of the inboard shackle. (The inboard shackle is used in case you are trapped under an inverted boat and need to get free.)

The SSF tested a variety of hardware and tethers. They found that 47 percent of the tethers tested failed under shock loads that simulated a crewmember falling overboard.

Most commercial tethers are made of webbing with stitched ends, and it is the stitching that generally fails. Our preference has always been to make our own tethers, using 3/8-inch (9.7mm) line tied in a bowline with the bowline sewn (with sail palm, needle, and waxed twine) so that it cannot accidentally release.

Seattle Sailing Foundation ideal harness:

- ❑ Easy to adjust and lightweight.
- ❑ Easy to get into.
- ❑ Not too hot.
- ❑ Reflective tape on shoulders.
- ❑ Pocket for safety gear such as personal EPIRB, strobe and/or whistle.
- ❑ Stitching in contrasting color so it is easy to check for chafe.
- ❑ Material should be comfortable against bare skin.
- ❑ Built-in flotation.

Jacklines

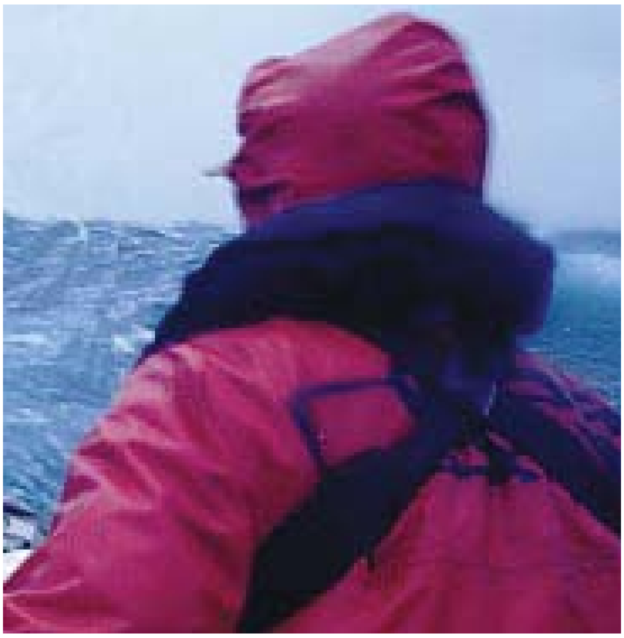
On flush deck vessels jacklines need to be run along the deck, over hardware and running rigging, so that you can attach before getting out of the cockpit.

With a trunk cabin it frequently makes sense to run the jacklines along the top of the cabin, as close to the centerline as possible. This reduces the dis-

Look at how this harness crosses in the back, and then think about raising your arms over your head in an attempt to help pull yourself back aboard.

With arms raised there is nothing to keep this harness from slipping up and over your head.

A crotch strap or horizontal rib webbing is a necessity.



Stock Newport

tance to the lifelines and keeps the decks clear but unfortunately necessitates unclipping and reconnecting from the point at which the jackline ends at the forward end of the cabin, when you are going to work at the bow.

The points to which the jacklines are attached, whether cleats or specifically installed padeyes, must be extremely strong.

Jackstays on deck should be made from webbing, which lies flat on the deck and does not roll out from under foot as will rope or wire. On top of a cabin, stainless wire or low-stretch rope (such as Vectran or Spectra) is a good choice.

It is common to use tubular nylon for this purpose, typically 6,000-pound (2,800kg) breaking strength. However, nylon stretches substantially under load. This is good for absorbing shock, but the stretch allows you to go further overboard.

The alternative is to use a high-modulus webbing like Spectra. This is used by sailmakers for reinforcing the corners of high-tech sails, and is extremely strong with virtually no stretch—check with your local sailmaker for costs and availability. (It is typically about four times more expensive than nylon, but the cost may not add up to that much overall.)

Whatever material you use, do not leave it out in the sun when anchored as this degrades the strength.

In addition to jacklines along the side decks, we like to have two connected to the padeyes at the companionway hatch. These are long enough to allow us to work in the cockpit, and hook up before ever leaving the security of the cabin sole at the foot of the companionway.

SSF ideal tether:

- ❑ Quick release shackle at inboard end.
- ❑ Both 3 and 6 foot (0.9 and 1.9m) long tethers.
- ❑ Boat end of tether equipped with patented Wichard locking snap hook, or Gibb locking hook.
- ❑ Stitching on webbing a minimum of 3 inches (76mm) long of contrasting color to webbing for easy inspection.
- ❑ Snap shackle to have easy-release lanyard, possibly equipped with ball to help in pulling open.

All photos Seattle Sailing Foundation

A sobering look at some of the failures encountered when the Seattle Sailing Foundation began to test gear. Upper left, a single braid tether which failed at the stitching made by Captain Al's. Upper right, a West Marine harness after nine drops in the test machine—still functional with just some deformation on the hardware. Bottom right, Helly Hanson failed tether and broken hook. Bottom left, a broken Wichard snap hook.

Lower left, our preference for a tether is dual braid dacron, tied with a bowline, with the end of the knot sewn shut. Foolproof, easy to inspect, and strong. At the harness end we always fit a snap shackle (lower right) so the tether can be released in an emergency.

On the bottom of the opposite page is our favored tether end hardware, a Gibb hook. Strong, almost foolproof, these are operable with one hand, leaving your other hand free for hanging on while you connect the tether to the jackline.

Bryan Savage

THETA VOLANTIS

Theta Volantis is a ketch-rigged Sundeer 64. She is 65 feet (20m) long on deck, 64 feet (19.7m) on the waterline, with a beam of 15 feet, three inches (4.7m). She displaces about 22 tons, and has a shallow but efficient keel drawing just six and a half feet (2m). The rig on Theta Volantis is about six feet (1.8m) taller than the standard ketch rig.

Lets turn now to the North Atlantic in the autumn of 1994. The vessel is *Theta Volantis*, and her story bears on the subjects of both storm canvas and self steering. (Both of these topics are covered more starting on page 133 and page 159.)

We first met the crew of *Theta Volantis*, Brian Savage and his wife, Colleen Ryan, some years ago when we were beginning our Sundeer production series program. They were interested in a larger boat on which to cruise full-time, and the Sundeer 64 had caught their eye.

Brian and Colleen are hardy British sailors with extensive racing and cruising experience in the waters around the UK. They write monthly columns for *Yachting World* magazine and publish a series of wonderful scuba diving guides to the tropics.

We'll let them tell you about their sailing experience:

All of our prior experience in heavy weather was in a smaller boat (41 feet/12.6m), and as most of our sailing was in the English Channel and North Sea we had done quite a bit of heavy weather sailing, especially beating. We are also used to big tides and the effect on sea state of tidal races etc. (It's also usually very cold and wet!)

Our 41-footer was a fractionally rigged sloop which went to wind very well and had manageable-sized headsails for short-handed sailing downwind. From the South Coast of the UK we have sailed as far north as the Baltic, as far south as Biscay and west to Ireland. We did several offshore double-handed races (to Ireland, France and Spain). We won the Brixham to Santander

(UK South Coast to Spain) two-handed race and won our class in a two-handed race to Ireland. The Irish Sea is one of the places in which we found some of our worst weather. A lightning storm took out our instruments and autopilot and we had to hand-steer all the way.

After spending the summer working the boat up on the East Coast of the US, Brian and Colleen were ready to head back across the pond to the UK.

We would not have been overly excited about a fall passage across the North Atlantic, but Brian and Colleen were looking forward to it. Aboard as crew they had two relatively inexperienced friends.

Theta Volantis uses a Robertson autopilot. (Almost all of our other yachts have fitted WH autopilots.)

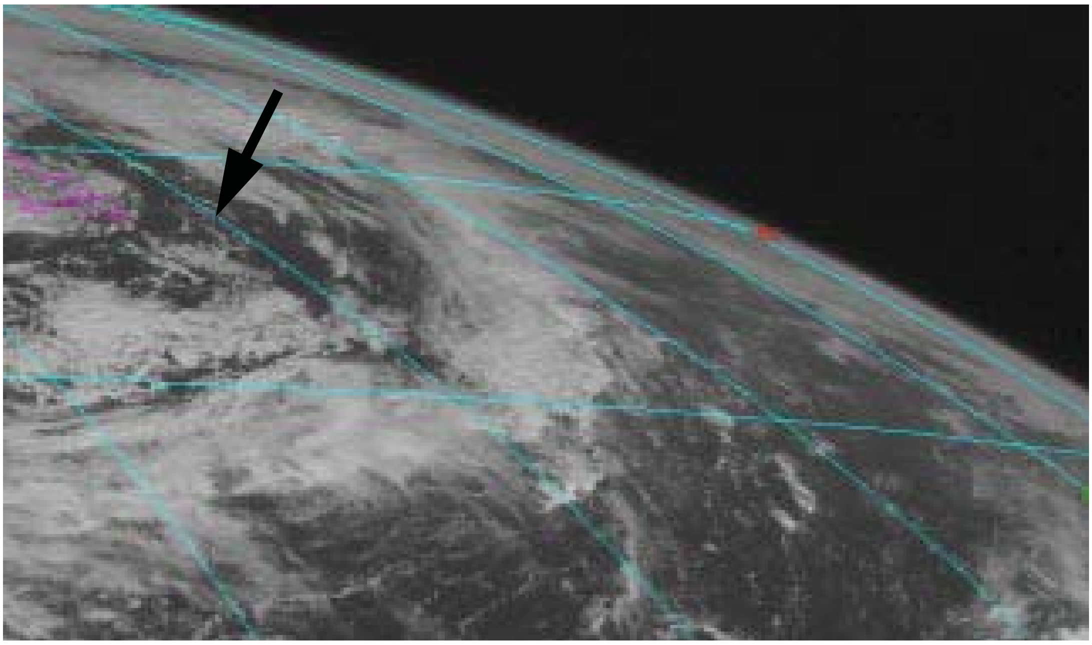
Colleen picks up the story from here:

Sunday, October 2, 1994.

We have been at sea for nearly a week and experienced a bit of everything. Our departure point on Monday 26 September was from Sandy Hook in New York Harbor, heading towards Gibraltar. We had been greeted by headwinds and the wind had not eased round to the south until Wednesday when we finally got the gennaker and mizzen genneker flying, but only for a few hours.

Nature Abhors a Vacuum

On leaving, the weather maps showed a big hole where the Azores high should have been and hardly an isobar to be seen in the whole Atlantic. Nature, abhorring a vacuum, now filled it with a spiteful low that spat lightning and squalls at us all night. The boat



Mid-afternoon on October 3, and you can see that one frontal boundary has passed to the east of Theta Volantis, and something else is building up to the west, behind her.

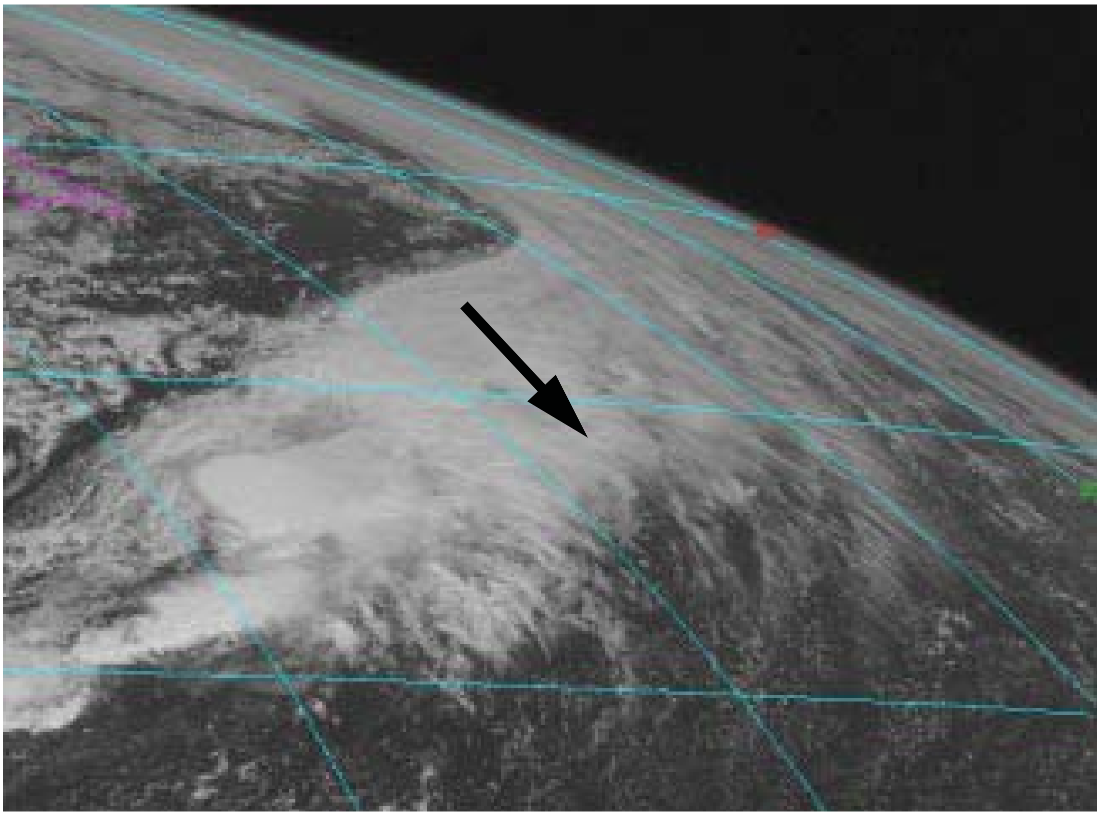
was experiencing her first rough weather and was coping well.

By Friday the front had passed and the wind backed northwest as the barometer started to rise. The weekend delivered more blustery weather and lightning storms at night, as 45-knot squalls caught us up and passed over us.

Mistake number one was not to rig a jibe preventer, as we were not running dead downwind and thought it unnecessary. But we had not allowed for the very big seas that build up in Atlantic gales, coupled with a tired helmsperson missing the characteristic signs of an impending jibe. The mainsail battens cracked in sequence as they smashed against the runners.

After the crash jibe, we reefed the main but didn’t run a jibe preventer to the bow. The broken battens allowed the leach to bend back over the spreaders and we were afraid of doing too much damage to our new sails. So, mistake number two followed: we kept the boom sheeted in to protect the sails and ran a preventer line through a block on the toerail. Another big wave tipped us onto a jibe course, the block gave way and the sheet skillfully flicked it through the deckhouse window making a 12-inch (0.3m) hole. We dropped the main and ran under headsail while we pondered how we could effect repairs. A sheet of wood was finally glued over the hole, and we contemplated the start of our second week at sea.

Tuesday, October 4, 1994. The log entry reads: “Gusts not so strong now, and the barometer is still rising so it must be improving.” The barometer was reading 1016 at 1400 hours. Our weatherfax pictures from the US Navy confirmed that the front had passed and there was nothing else behind us. The wind should abate and the sea settle, which would allow us to effect some repairs to the main battens.



October 4, and the frontal line has passed well to the east. However, the boundary to the northeast is well defined, and there is a dense cloud mass to the west about 5 degrees longitude. This could be a secondary low, bringing warm, moist air up from the tropics to mix with the colder, drier atmosphere of the primary depression further north.

The Weather Deteriorates


Bryan Savage

Colleen and Bryan making port in the Azores.

The weather not improving, the wind seemed to have steadied at 40 knots or more and the barometer was starting to fall again. We were running under just the genoa, but when the wind started to increase and the barometer continued to fall, we switched to a staysail hanked on to the inner forestay. By 1930 hours the wind was up to 55 knots.

The helm was manageable and Brian and I reduced our watch periods to one hour as we needed to concentrate in order to keep the seas on our aft quarter. We kept the wind between 120 and 150 degrees, heading as southward as possible to get out of the path of whatever was coming.

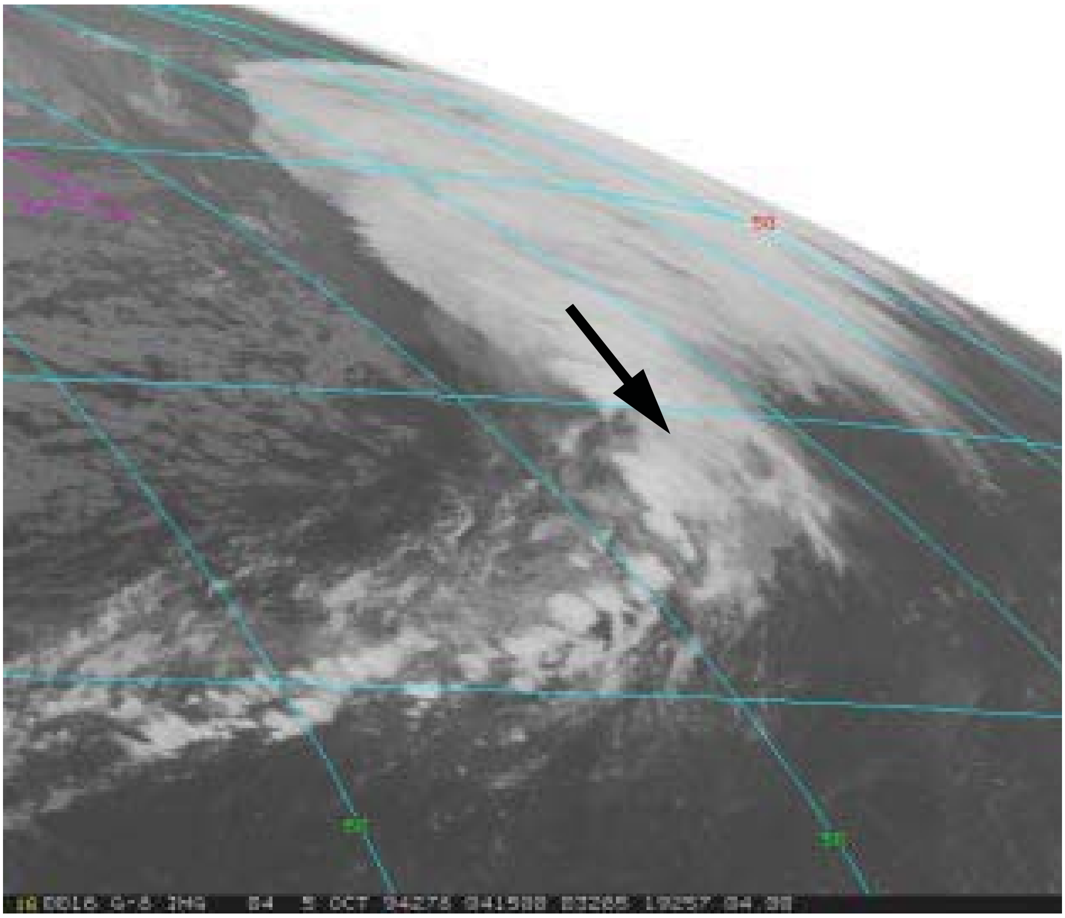
Later that evening we were getting gusts to 60 knots and there was still nothing on the weather maps to show what was happening. There was a low passing to the north of us whose front stretched way down towards us, but nothing was showing why we had such strong winds. It was disconcerting to know that the weather centers did not know about this depression yet.

As we crested each wave, the wave train disappearing off to leeward looked like the cover picture of *Heavy Weather Sailing* by Adlard Coles. We know this because during off-watch periods it was becoming well-thumbed!

Water in Our Seaboots!

Midnight Tuesday Brian took over the watch. The wind was now 60 knots with gusts to 70, and although we could still readily steer the boat, the seas had built and huge breaking waves were crashing over us, filling the cockpit. I realized how deep the water was when I felt it run down inside my boots. The boat was steering well, and by keeping the wind and sea train at between 120 and 150 degrees, over the port quarter, it meant that as each wave lifted under us, we surfed across the face rather than straight down it. The boatspeed was consistently 12 to 14 knots but the boat seemed to relish the conditions, remaining very easy to steer, albeit with large wheel inputs required. Apart from the odd breaking wave filling the cockpit, under the circumstances, we felt in good shape.

We had a cockpit conference: Should we go forward and take down the staysail? Should we trail warps? We decided no on both counts. We did not drop the sail because we believed there was more danger in working on the foredeck than leaving the sail up.



Mid-day on October 5 and Theta Volantis has moved to the east along with the front, albeit much more slowly. The frontal boundaries marked by the cloud mass are less distinct in this image. However, there is substantial convective (thunderstorm) activity showing up southwest of their position. Once the frontal boundary passes over them during the late evening hours, the winds will shift to the northwest.

We did not believe it could take the rig down so the worst that would happen is the sail would blow out, and we would deal with the resultant mess when the blow was over.

Trailing warps would have also been a difficult maneuver and we felt that we could still steer the boat okay, so we did not think they would help much. We never considered lying ahull or going below.

The Barometer Plummets

Wednesday, October 5, 1994. In the early hours of the morning the barometer had fallen to 996 (20 points in less than 12 hours) and we had 65- to 70-knot sustained winds. We were becoming concerned about the sea state if the storm was to last much longer. The winds in the troughs was almost the same as at the wave tops, at least 50 knots or more.

It is always difficult to judge wave heights, especially in the dark, and we can only report that when they broke over us they were several feet above our heads. When it was time for the next watch change we decided that we would both stay on the wheel. It sometimes took two of us on the helm to stop ourselves from broaching. Thank goodness for two wheels.

However, the risk of a serious broach was mounting. The problem was that it was becoming increasingly difficult to helm the boat between 120 and 150. Closer than 120 meant that we accelerated across the waves, and the spray was like a firehose in our faces so we couldn't see the instruments.

Colleen and Brian kept Theta Volantis on a 120- to 150-degree heading, relative to the wind (bottom left of image). This allowed them to maintain good control over the boat, and avoid dropping into the troughs at a high rate of speed with the risk of stuffing their bow and/or broaching. Their Sundeer 64 can reach at high speed while maintaining control, so when a wave broke behind them, they still had steering options (middle of image).

Towards the end of the blow they were caught by a gust which registered 79 knots (maximum reading) on their wind instruments. Concurrently they were knocked down to a right angle by the a breaking sea (lower image).

The Sundeer 64 is designed to skid sideways on its topsides once it reaches a 45- to 60-degree angle of heel. This allowed them to absorb the wave impact over time, reducing the chances of a complete inversion.

At this angle the staysail was working properly, with airflow across it, and it was very difficult to overcome this effort so far forward and bring the boat back onto course. Further aft than 150 meant that we were in danger of blasting straight down the waves into the back of the one in front, or worse, of pitch-poling if a real biggie broke underneath us.

If the boat was steered between 120 and 150 it was fine, but we were increasingly drifting out of this safety zone.

At 1530 local time a screaming gust hit us; the windspeed shot up to 79 knots and the boat rocketed off at 90 degrees to the wind. At the same time a wall of water slammed into the side of us and rolled the boat over. Brian and I were thrown on our sides. We never knew what the full strength of the gust reached, as we were both hanging onto our lifelines and any other bit of gear we had managed to grab. The angle we reached was difficult to determine, but as we were hanging vertically across the deck, the masts must have been close to parallel with the sea.

Slowly *Theta Volantis* righted herself and the water began to rush out of the cockpit. Brian moved to take control of the helm again and I felt the staysail sheet. It was slack. The sail had given out. (We later discovered the sail had not blown but the hanks had opened! Then it had flogged to pieces.) Under bare poles we were sailing again across the waves at about 10 knots. The boat was very easy to steer to keep the wind and seas between 120 and 150.

I think at that stage we both thought, how many of those can we take? But something seemed different. The windspeed suddenly dropped to 35 knots and the direction veered through 90 degrees. The front was through. We'd made it.

Sea State

Mistake number three was putting on the spreader lights so that we could assess damage and decide what, if any, deckwork needed to be done immediately.

That night the seas had matured into massive mountains of water, which, in the dark, we had steered through instinctively. In the glare of the spreader lights, they looked unmanageable in a small boat and we were glad when we turned them off and once again could steer blind and gather our thoughts in the privacy of darkness.

We first did a damage check, cleared the decks, and then set the genoa (we desperately needed to catch up on some sleep). The sea state was awful for a good 24 hours afterwards. Once we had rested, we put up a reefed main and mizzen to get some speed to drive us through the seas.

Wednesday, daylight; Barometer is up to 1024! Finally the weather charts are showing our storm. It seems that the powerful low to the north of us had spawned a real nasty new low on the trailing edge of its front, this apparently being a risk with fast-moving, well-defined lows. The new low always tends to be intense, and as it was right over us, we can confirm this.

The maps were also showing big confused seas as a result of crossing swell patterns. We decided to make an unscheduled stop in the Azores to kiss the ground, recuperate, and repair the boat.

Lessons Learned

1. Don't try to cross the North Atlantic in late October. (In our defense we'd planned an earlier crossing but had not taken our outfitting yard's non-adherence to deadlines into account.)

2. The real lesson was how easy it was to steer the boat under bare poles with the wind over 60 knots. So next time, if there was a risk of it reaching 60 knots, we would run under bare poles. (With hindsight, our cockpit conference resulted in the wrong decision—assuming we would have survived dropping the staysail, and no one would be going to the bow in those conditions.)

The strategy of sailing between 120 and 150 degrees worked very well, particularly in an easily driven hull, which can readily surf under control of the rudder. A heavy-displacement boat, whose rudder becomes sluggish in a surf, might not find it the best strategy.

For us, getting the helm over early was the key—you couldn't afford to let the boat start a broach because too much helm was then required, and the rudder would stall. But so long as you stayed in the rhythm of the waves it was okay.

It was just the final gust as the front went through that put too much load on the steering, because we still had the staysail drawing us up. Once that went, even in the 70-plus-knot wind we could steer all right—in fact bare poles were the way to go as we were still doing over 10 knots but could steer with very little load on the helm.

In fact, probably only in the final broach did we run out of rudder. The boat was incredibly easy to steer, bearing in mind the circumstances. We could both handle the helm. I (Colleen) never found it unmanageable, although of course it was tiring after an hour.

3. The big "however" to bear in mind is that there comes a limit for any boat. What if the windspeed hit 90 or 100 knots? Would we have come through it in such good shape? When the wind had hit 50 knots, we both thought (hoped?) that this was very bad weather, and it was very unlikely to get worse, but it did.

4. The deckhouse was a major safety feature. When things got really bad the off-watch could sleep in the deckhouse, so they could be on deck in seconds if needed. Or, if sleeping down below, the deckhouse was like an acclimation zone, which allowed the new watch a few minutes to assess the conditions and course. We'd never do any serious sailing without one now. It significantly adds to safety by reducing the tiredness of the crew.

5. The staysail filled the forward triangle from the cutter stay back, less about a foot (0.3m) on the bottom. Yes, a storm jib would have been better, but as we didn't expect the wind to keep building, maybe we would never have gotten around to making the change. If we planned to sail where we expected a lot of heavy weather, we'd be better off with a roller-furling staysail, but that would leave a problem of where to put a storm jib. If you were expecting a bad time I suppose you could swap the staysail down earlier.

Heaving To

We asked Colleen and Bryan if they had considered heaving to. In theory, this would have allowed the storm to pass over them much more quickly, than it had when they ran along its same general direction.

We thought that we should steer the boat while we could, as it gave us more control over the boat and our angle to the waves.

Heaving to would have been our next option had we gotten too tired or had the conditions gotten worse. It would have meant turning into the waves and winds, which was not a pleasant thought at the time.

We did briefly consider trailing warps, but getting it all out and ready to go was too demanding and dangerous.

I wouldn't say we had a lack of inertia, but we did feel in control right up to the end, and didn't feel the need for a radical change. (The worry, of course, was how much worse it was going to get.)

The brief time we spent under bare poles convinced me that next time I would go to that when we hit 50 to 60 knots. The autopilot on vane control, or even the windvane, I'm sure would keep the boat at 45 degrees to the following sea, with the boatspeed right down at a controllable number. I would also go to just a staysail earlier—I think we changed down at 50 knots.

Storm Canvas

In order to have an array of tactical options from which to choose in heavy weather, you need to have some variety in the storm canvas which can be set.

Careful thought needs to be given to the wind ranges and sailing angles for which the storm canvas is designed.

A nicely set storm jib, flying from a temporary cutter stay (photo above). It is blowing a steady 60 to 65 knots, gusting higher. If this storm jib were set on the bow, it would be difficult or impossible to feather into the wind as the boat climbs wave crests and/or is hit by gusts.

Wind Speed and Angle

The ability to control your speed—not going too fast or too slow—is critical to safely and comfortably managing your boat during heavy weather.

The sailing angle plays a critical part in this equation. If you are beating—to keep distance from a lee shore, or because it is the safest tactic in the sea state—you will need smaller sails than if you are broad reaching or running in the same wind and sea conditions.

Understanding Use of Storm Canvas

In almost all situations, the time to set storm canvas is before you need it. Unless you are pushing to outrun a weather system, it's easier to change down before it's necessary—winds are less and the seas are smoother.

Often a trysail set by itself provides the best balance (left photo). The sail area is down low; the sheet can be bridled between windward and leeward side to center the sail if required; and the center of effort is further aft than when just a storm jib is set, allowing the boat to feather into the waves and wind more readily. Extra mast bend helps to stabilize the mast.

Conventional storm sails are typically sized for strong gale conditions and are too large for storm-force winds. The photo below shows a typical IMS racing rule storm jib and trysail. In the 50-knot winds here, they are fine. Another 10 knots of breeze and this boat would be down to trysail only. At 75 knots more she would be over-canvassed with a full-sized trysail.

Both photos Richard Bennett

If you wait until you really need smaller sails, the existing conditions on deck are going to be far less inviting, and there will be a strong tendency to put off changing down.

The reality is that, in most cases, boats that are caught out with oversized sails, try carrying them through the blow so the crew can avoid the hassle and risk of working on deck.

Sail Combinations

Where storm canvas is flown has a big impact on how well the boat can cope with wind and seas. The closer storm sails are to the center of lift for the hull and keel, the more flexibility you will have in choosing a course.

Off the wind, placement of sail area is not as critical as when reaching or beating. Don't assume that you will always be running before a storm. There are times when beating is the best course of action: For example, when lack of sea room or breaking seas might make running too dangerous.

Ideally storm jibs will be flown on a cutter stay, set well back from the stem.

Richard Bennett

Here is a moderate gale combination: a full-sized number-4 jib together with trysail. A deeply reefed main could be flown in lieu of the trysail. However, this would subject the main to extra stress. With the trysail set in moderate conditions you are ready for the weather to get worse.

A storm jib flown from the headstay can be used for beating in moderate conditions, but in really strong blows you will not be able to hold your bow up high enough with the sail this far forward.

On many vessels, especially more modern, lighter boats, if you have to choose one sail for beating, the trysail does best (see the data on *Bin Rouge* in the 1998 Sydney-Hobart Race starting on page 266).

For purposes of this discussion, consider that the terms "storm jib" and "storm staysail" are interchangeable. The sails are effectively the same—the difference is where they are flown.

Sizing Storm Sails

One of the results of the 1979 Fastnet Race was an addendum to the offshore racing rules specifying storm sail size. This was based on the designs of the day: moderate displacement (by today's standards) with relatively small rigs (again by today's standards).

The rule states that the storm jib shall not be larger than 5 percent of the height of the forward triangle squared, with a luff length not longer than 65 percent of the height of the forward triangle.

If you are sailing on a 40-foot (13m) yacht, with a forward triangle height of 50 feet (15.3m), the storm jib area would be 50 x 50 x 0.05 or 125 square feet (12 square meters).

Richard Bennett

Slightly smaller than rule-size storm sails in 40 knots of breeze. The boat is standing up well, and should be able to carry these sails into the low 50-knot range, after which she will probably go with the trysail.

If she is forced to beat, and has to change down from the trysail to storm jib, there will be a problem keeping the bow up.

For really heavy weather they would be better off with a somewhat smaller trysail and two sizes of storm jib—the one shown and another about 50 percent larger which would offset the lack of power in the smaller trysail when the winds were lighter.

For trysails, the rule stipulates an area 17.5 percent of the area of the mainsail.

These sail sizes are okay for heavier boats in moderately strong storms, but for lighter boats and/or those with taller than average rigs, or for use in truly difficult conditions, you will need to have smaller sails aboard.

If you walk into most sailmakers and say "I want a storm jib and trysail for my XYZ 35" you will get sails sized based on the formula above.

We think it is better to have a good look at the conditions you expect to be sailing in, the stability of your boat, and its rig size, and then make a decision based on actual parameters, rather than an arbitrary formula.

Richard McKay at Halsey Lidgard Sailmakers in Auckland, New Zealand, says about storm sail size that, "Depending on the boats, we do offshore boats at half maximum racing category requirements and coastal yachts at full size. The biggest complaint I hear from the offshore sailors is that they cannot get a storm sail small enough for their yachts. Whereas the coastal skipper, with an offshore-sized sail, doesn't think he is fast enough."

Dan Neri at North Sails tell us, "We have designed most of our storm jibs at 90 to 100 percent of the ORC maximum. The reports back from the North reps who were in the Sydney-Hobart were pretty consistent in the opinion that the storm jibs were too big. I think it is safe to say that these boats would be better off with sails as small as 75 or 80 percent of ORC max."

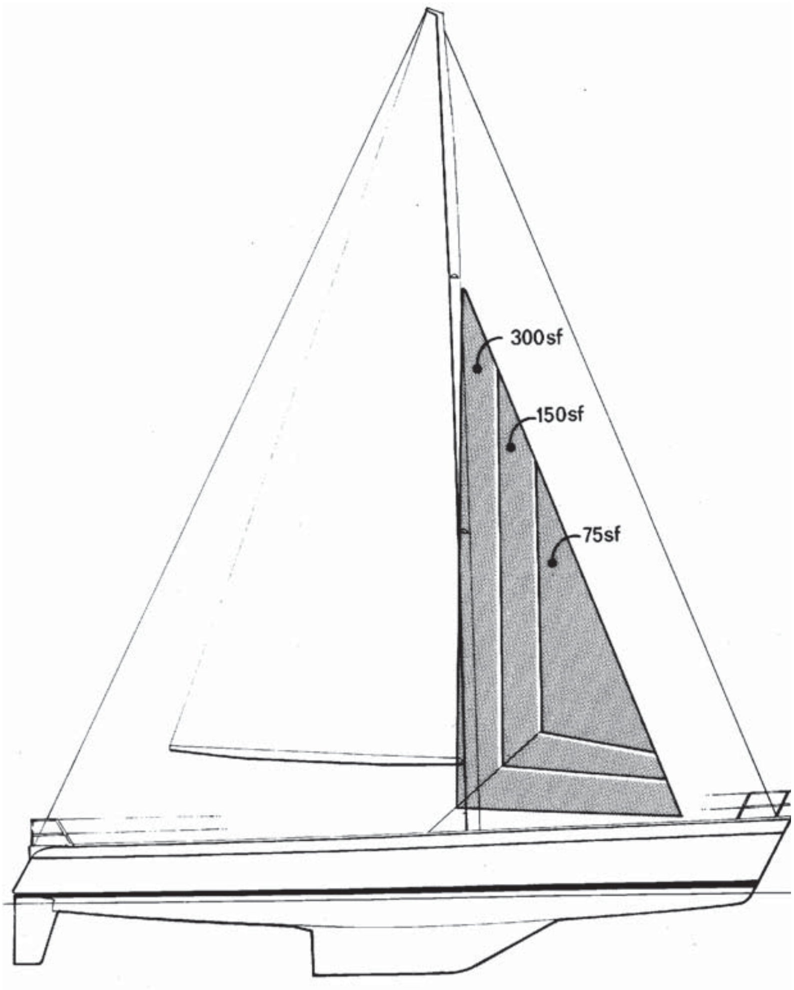
When we talked with Dan, he was building a storm jib for his own boat, a Roger Martin 38-foot (11.65m) light-displacement cruiser. "For comparison, the ORC rigs for my boat specify a max storm jib is 125 square feet (12 square meters). The sail I have built is just 85 square feet (8 square meters), so it is 66 percent of ORC. If I did not carry a staysail, I would have made the storm jib larger, but I think if I ever have to use it, I will be happy with the smaller size."

As you are beginning to see, there is not a lot of science to sizing storm sails. Also, there is the issue of wind range to think about. Are we talking 50 knots or 65? Are we going upwind, or down?

For our part, as designers, we've usually suggested to our clients that they carry two storm jibs designed to be flown on the cutter stay.

The first sail is typically about 75 percent of the size that would normally be specified for a boat of the stability range of the design in question. The second, which we call a hurricane jib, is half the size of the storm jib.

To my knowledge none of our clients have ever used their hurricane jib, but if they are ever caught in a blow like the Sydney- Hobart or the one which hit New Zealand at the end of November, 1998, they will be happy to have this sail aboard.



*On our Deerfoot 2-62 series (one of which is Bucephalus, mentioned starting on page **38**) the cutter rig was designed for three sails on the inner forestay. The largest is a working staysail, flown with reefed main to about 35 or 40 knots of wind. Next came the storm jib, conventionally sized, and then a hurricane jib.*

The Scientific Approach

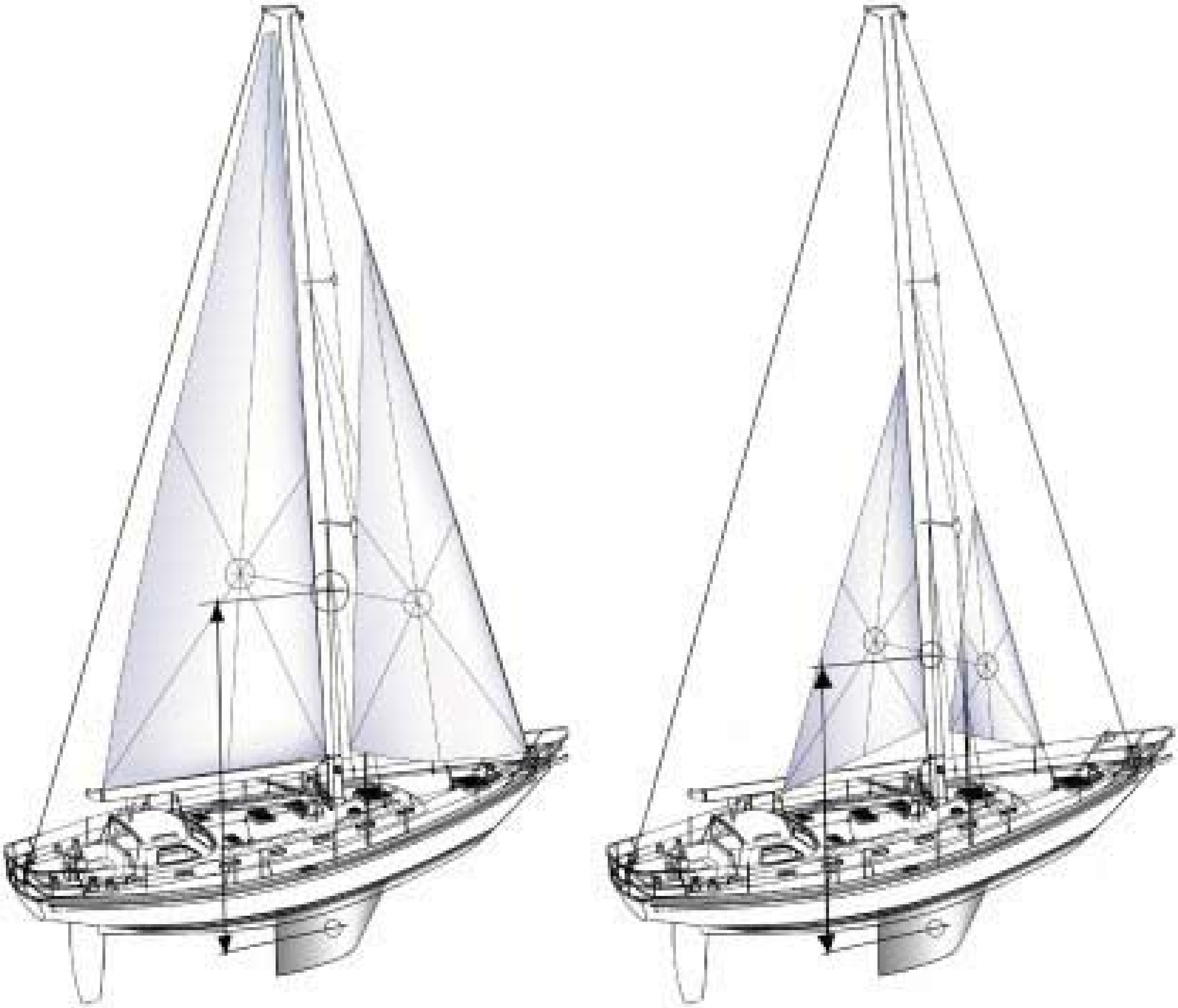
In the process of interviewing designers and sailmakers about this subject, we talked to Angelo Lavaranos who had what we think is a simple and elegant solution to the sail area in question.

If you know how the boat sails with certain sail area in a given wind strength, you can interpolate from this data to determine how much sail area is required for a higher wind range.

Your designer can do this quite accurately for you. Or if you want to give it a try on your own, here's the approach.

Take the lower wind sail area, and multiply it by the lever arm of the area (the geometric center of the lever arm to a point which is 0.4 of the total draft below the waterline). This figure is then multiplied by the force in the wind to get a standard condition.

Let's try this for a mythical 40-foot yacht. Say you find that sailing to windward in 20 knots apparent wind you are comfortable with a full mainsail and number-3 jib. The total sail area with these sails is 800 square feet, and the geometric height above 0.4 of the draft is 20 feet. The heeling



The drawings above will give you an idea about how to ratio from working canvas to storm canvas in various wind strengths. Start out by calculating the geometric center of area. Then measure the distance from this point to 0.4 of the draft up from the keel to get the lever arm.

moment is 800 times 20 times the force of the wind at 20 knots, or one pound per square foot, for a total of 16,000.

Now let's ratio this up to 50 knots of wind. We know that the wind force at 50 knots is roughly 6 pounds per square foot. To keep the forces even you divide 16,000 by 6, for 2,666. This is the number which the smaller sails, times their lever arm, must equal for the same heeling force on the boat.

Let's say we go with a storm jib and trysail (a sail area of 300 square feet.). If the lever arm on these two sails is 15 feet, we come up with a moment of 4,500. This indicates we've got too much sail area up for 50 knots. However, if we drop the storm jib and go with just the trysail, the sail area drops to 200 square feet, and with the same lever arm, the moments are 3,000, so we are pretty much in the ball park.

Do You Need a Trysail?

The need for a trysail is a function of the stability of the boat you are on, the condition of your mainsail, the wind strength in which you are sailing, and rig configuration.

Off the wind, a trysail is less a requirement than a convenience. On the wind, and reaching, especially if you are trying to beat off a lee shore, the need increases.

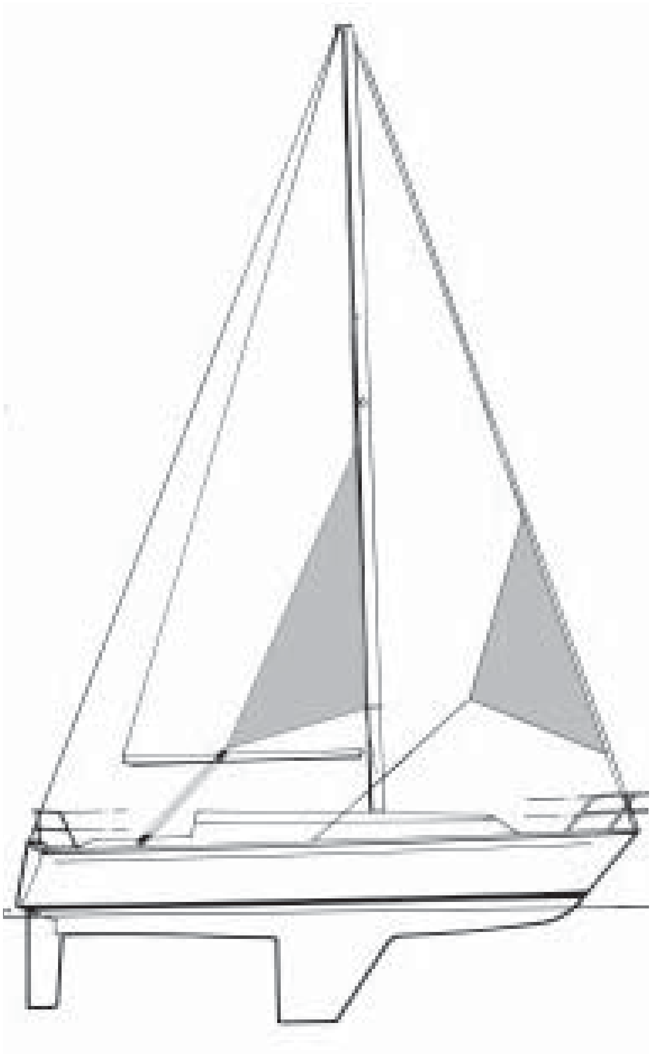
If you are on a ketch, you may do fine with a storm jib on the cutter stay and deeply reefed mizzen (this is the approach we have taken with our ketches).

Cutters, with their relatively small mainsails set well aft and cutter stays also set aft, can get away without a trysail most of the time.

For the cutter, however, there are two problems with this approach. The first is that you will be using your mainsail deeply reefed more of the time than is good for the sail. This is hard on the main, shortens the sail's life, and leaves you with a sail set that is structurally less than optimum for really heavy conditions.

On our *Intermezzo II,* a 62-foot (19.4m) design with a traditional-cutter rig, we took the no-trysail approach. However, today, I suspect for offshore work we'd specify a storm trysail.

Sloops can get away without a trysail in moderate conditions, using a deeply reefed main. But once the wind is really strong, and/or you are trying to beat, the trysail becomes important.



The proportions shown here are for storm-force-and-above wind strength. These sails are smaller in scale than the norm based on ORC regulations.

Trysail Attachment

If you are sailing short-handed, it is essential that the trysail have its own sail track.

This allows you to stow the sail on deck, already attached to the mast and ready to go.

Without a separate track, you are forced to feed the slides (flat or slug type) into or onto the same track that the mainsail uses. This may require the removal of the mainsail. If the mainsail is left attached, the first slide goes on quite high above the deck. With your arms over your head, controlling the sail can be problematic.

Even with a full racing crew, setting a trysail on the mainsail track is very difficult. As a result, it should be done well before sea and wind state gets to the point where rigging it becomes excessively dangerous.

Sheets should be bent on to the sail in advance. These should be spliced on or tied with a bowline. The bowline needs to be sewn so it cannot flog open.

The head of the track will have extremely high loads and needs to be well reinforced.

The safest approach in attaching the tack of the trysail is to secure a line through the tack ring and around the mast, then have a pennant down to the deck or to a pad eye lower on the mast.

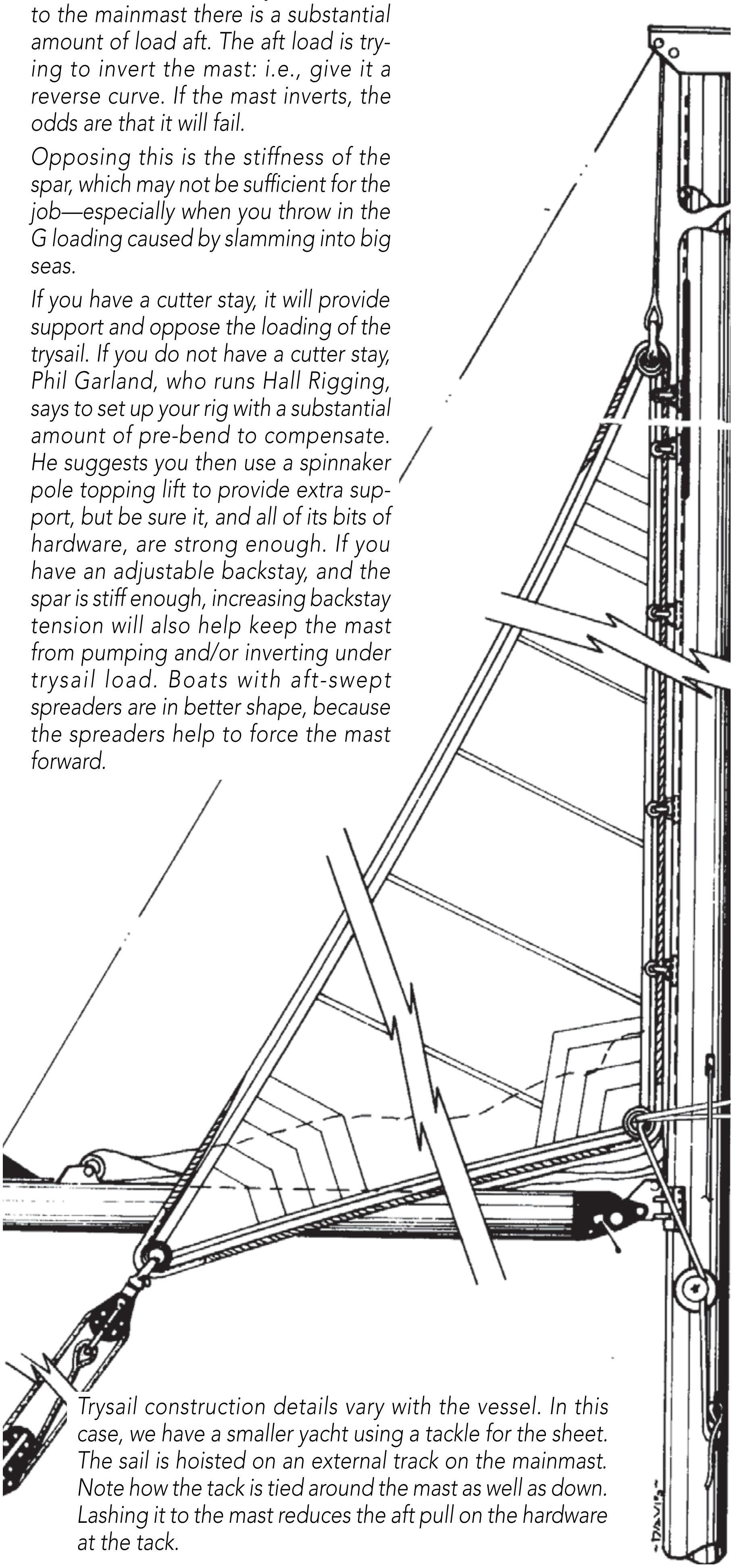
Yachts under 40 feet (12.2m) frequently find that the trysail begins to make sense in the upper 20-knot wind range, when a second reef would be called for in the mainsail. It is often easier to set the trysail than deal with the second reef, and then you are ready for lots of wind.

Trysails can also be used in light sloppy conditions to steady the boat when the main flogs too much in leftover seas.

Where the head of the trysail attaches to the mainmast there is a substantial amount of load aft. The aft load is trying to invert the mast: i.e., give it a reverse curve. If the mast inverts, the odds are that it will fail.

Opposing this is the stiffness of the spar, which may not be sufficient for the job—especially when you throw in the G loading caused by slamming into big seas.

If you have a cutter stay, it will provide support and oppose the loading of the trysail. If you do not have a cutter stay, Phil Garland, who runs Hall Rigging, says to set up your rig with a substantial amount of pre-bend to compensate. He suggests you then use a spinnaker pole topping lift to provide extra support, but be sure it, and all of its bits of hardware, are strong enough. If you have an adjustable backstay, and the spar is stiff enough, increasing backstay tension will also help keep the mast from pumping and/or inverting under trysail load. Boats with aft-swept spreaders are in better shape, because the spreaders help to force the mast forward.



Trysail construction details vary with the vessel. In this case, we have a smaller yacht using a tackle for the sheet. The sail is hoisted on an external track on the mainmast. Note how the tack is tied around the mast as well as down. Lashing it to the mast reduces the aft pull on the hardware at the tack.

The line around the mast provides resistance against the aft pull of the clew, which tends to be much higher on a trysail than on a higher-aspect-ratio mainsail. This approach also provides some insurance against the extra loads of a knockdown.

Securing the Main Boom

It is common practice to lower the outer end of the main boom and lash it on deck. This lowers the center of gravity of both boom and mainsail, reduces windage, and in the event of a rollover, reduces strain on the mast from water hitting the boom. It also makes flying the trysail easier.

If you have a hydraulic or mechanical vang you will have to remove the clevis pin on the outboard end of the vang. Be sure it can be easily removed before you head offshore.

The end of the boom must be well secured. Just tying it to a lifeline stanchion is not enough. (One crew in the Sydney-Hobart was lost due to a lowered boom coming adrift in a knockdown.)

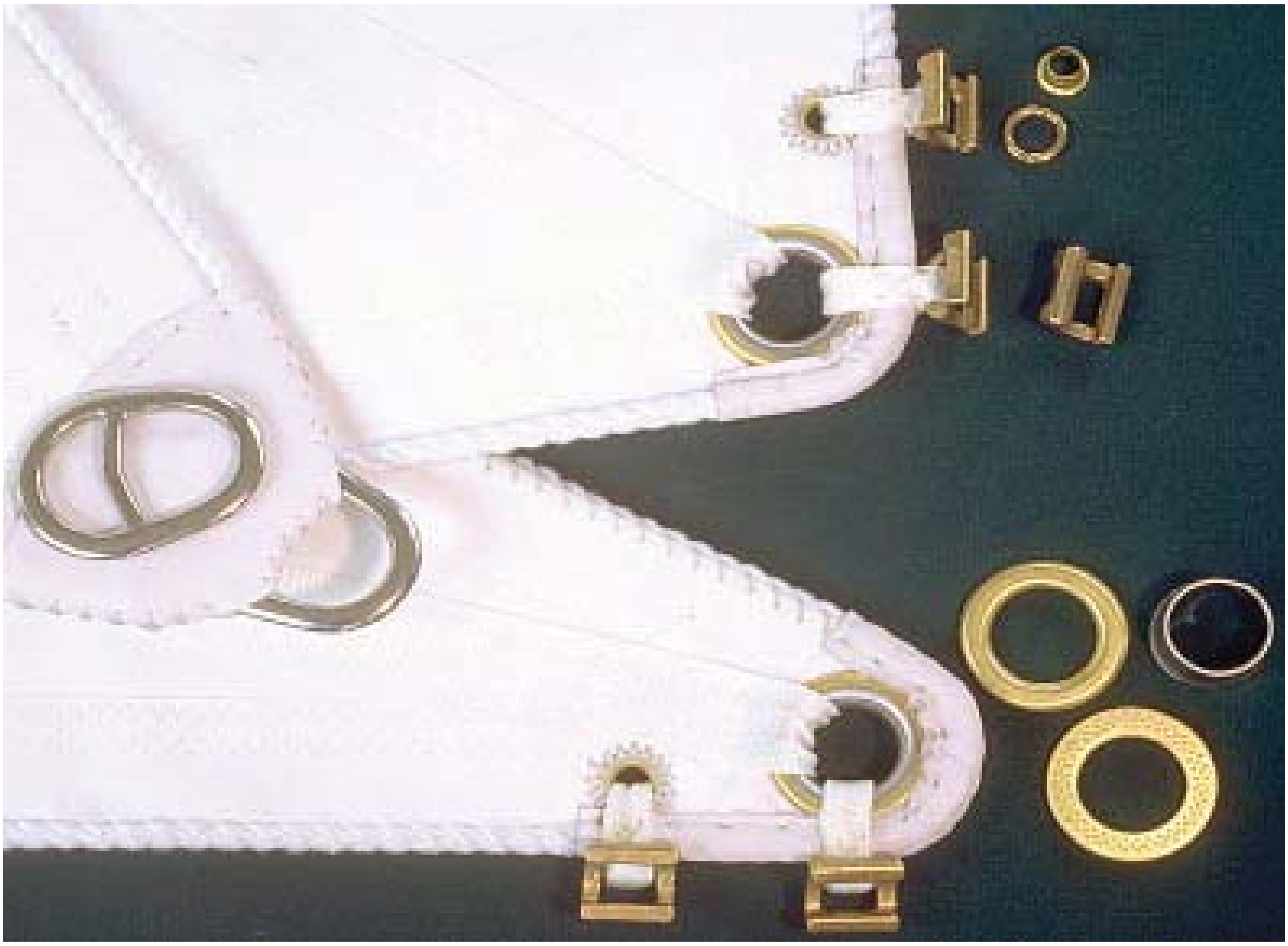
If you do not have a secure lashing point for the end of the boom, add padeyes to each side of the boat to accommodate it.

It is always a good idea to set the trysail before departing, to check the hardware and sheet leads and to familiarize the crew with the process. This trysail is aboard Mahina Tiare III. John and Amanda Swan get a lot of use out of their storm sails while teaching heavy-weather techniques to their students.

There is always a compromise in how high the trysail is hoisted. Low, as shown here and the center of effort and heeling force are low. In extreme sea states it is sometimes better to have the trysail flown higher, where the chance of it getting hit by a wave is reduced.

Mahina Tiare III (lower photo) heading towards a moderate gale. Trysail and storm jib are set and the boat is moving along at a reasonable clip, about 6 knots in 25 to 30 knots of breeze.Off the wind they will be able to carry this rig into the 55-knot range.

Both photos John Neal


Port Townsend Sails

Trysail head and tack details for a 35-foot (10.7m) yacht. This is a traditionally constructed sail with hand-roped edges, an approach still in favor with Carol Hasse and her crew at Port Townsend Sails. Note the double slides at each end and the extra Dacron webbing through the corner rings.


North Sails

This is a higher tech storm trysail built for a 65-foot (20m) sloop in New Zealand by North Sails. There are nine layers in the corners (the clew is shown here). Basic sail cloth is 10.8-ounce Dacron. Dacron webbing is used to attach the cringle to the sail.

The upper wind range for this 327-square-foot (31-square-meter) sail is 60 to 65 knots.

Carol Hasse of Port Townsend Sails

Carol Hasse, along with her crew at Port Townsend Sails, has built her business by blending the best of traditional and modern sailmaking techniques. Her clients tend to be an adventuresome lot, and spend quite a bit of time offshore. Carol has spent a lot of time thinking about small boat storm sail construction details, and her thoughts are worth considering. Carol picks up the story from here:

On storm jibs we highly recommend sewn-on piston hanks. This allows us to sew a piece of leather under the hank to prevent chafe. These hanks are thicker, and will wear longer before chafing through on the headstay, and you can easily replace them. On large boat sails we use a pressed ring to which the hanks are attached. But on smaller boats the size of the pressed rings makes this impractical so we use traditional hand-sewn grommets. The pressed grommets are so light that they tear out easily (hand-sewn grommets take twice the load of pressed grommets). Another problem is with corrosion. We've seen saltwater corrosion cause the pressed grommets to fall out of the sail while it is stored.

For clews on storm jibs and trysails we use external D rings attached with Dacron webbing.These allow the sail to flog without damage to the corner where a pressed ring might pull out. These are also a lot easier to repair should the need arise. Heads and tacks, where the pull is steady, allow us to use pressed rings.

For the luff of storm sails we use a traditional luff rope, typically matched to the halyard material. This provides chafe as well as stretch resistance. We also use a luff rope on the foot of the trysail. The foot of the jib is typically done with tubular Dacron webbing inserted into the tabling.

For panel layout on storm jibs we like to use a "scotch-cut" mitered panel layout. This makes sure there are no panels parallel with the foot. If the leech is damaged, you have time to get the sail down, whereas with a conventional cross-cut sail it will tear leech to luff quickly.

Panel layout on the trysail is cross-cut, with panels running parallel to the foot.

We fit a leech line to the storm jib as this makes it possible to have a nicely shaped sail without flutter when properly trimmed, in case you have to beat off a lee shore. The leech cord is tied off inside a Velcro pocket, and the bitter end is made fast to a loop of webbing sewn on the sail. We do not fit leech lines to trysails as these sails can be oversheeted if flutter is a problem.

We make our seams 1 1/2 inches (38mm) wide. Three rows of three-step stitching are used. This combination of seam width and stitching allows room to restitch the sail if that becomes necessary without oversewing the old stitches. A V138 or V207 thread is always used.

Trysail attachment hardware is always webbed on. This is stronger and more resistant to accidental loosening than shackles. It also spreads out the load more evenly in the sail grommet and attachment hardware. The head and tack ring have hardware directly attached, so the sailing loads cannot start to peel the head or tack away from the mast. There's a second attachment point within a few inches. Intermediate slides are typically set at 12 to 14 inches (300 to 350mm), about half the spacing for conventional slides.

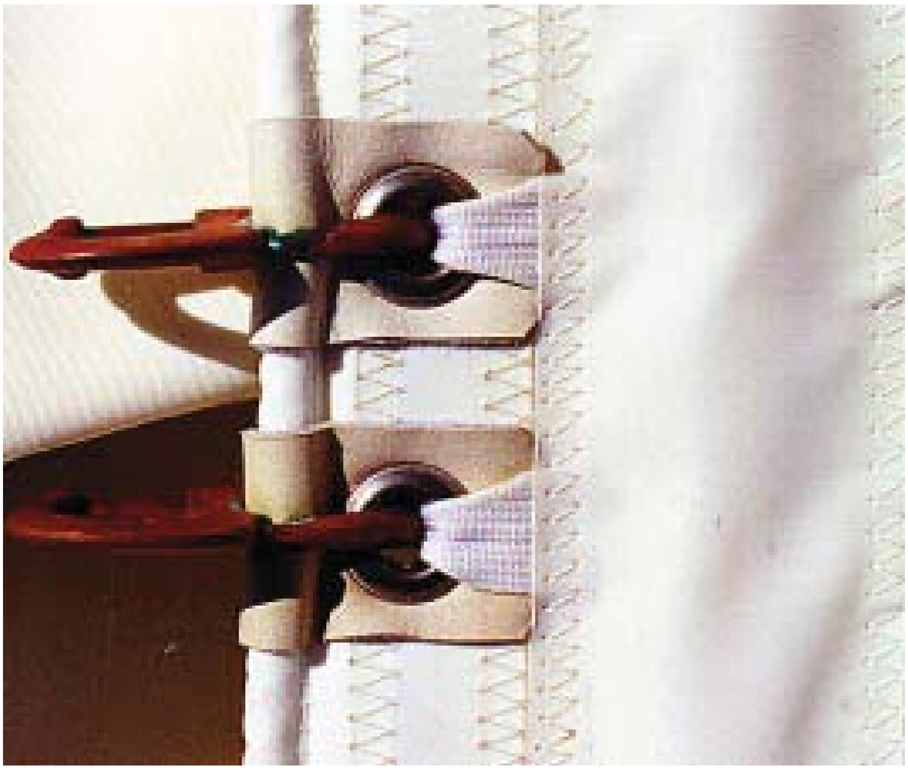
The storm jib on these pages is from Beowulf, an extremely powerful 78-foot (24m) design. The sail inventory on Beowulf was designed and engineered by Dan Neri now production manager for North Sails in the US.

These are not the details you would get with a "conventional" storm sail. Yet the difference in cost is small—Dan estimates less than 10 percent more of the total sail price. If you are caught out in storm-force winds, and your safety depends on your storm canvas, this extra investment is an inexpensive insurance policy.

The top (left) photo shows the head of the storm jib, including double hanks, and a pressed head-ring, which is webbed to the sail for reinforcement and in case of ring failure.

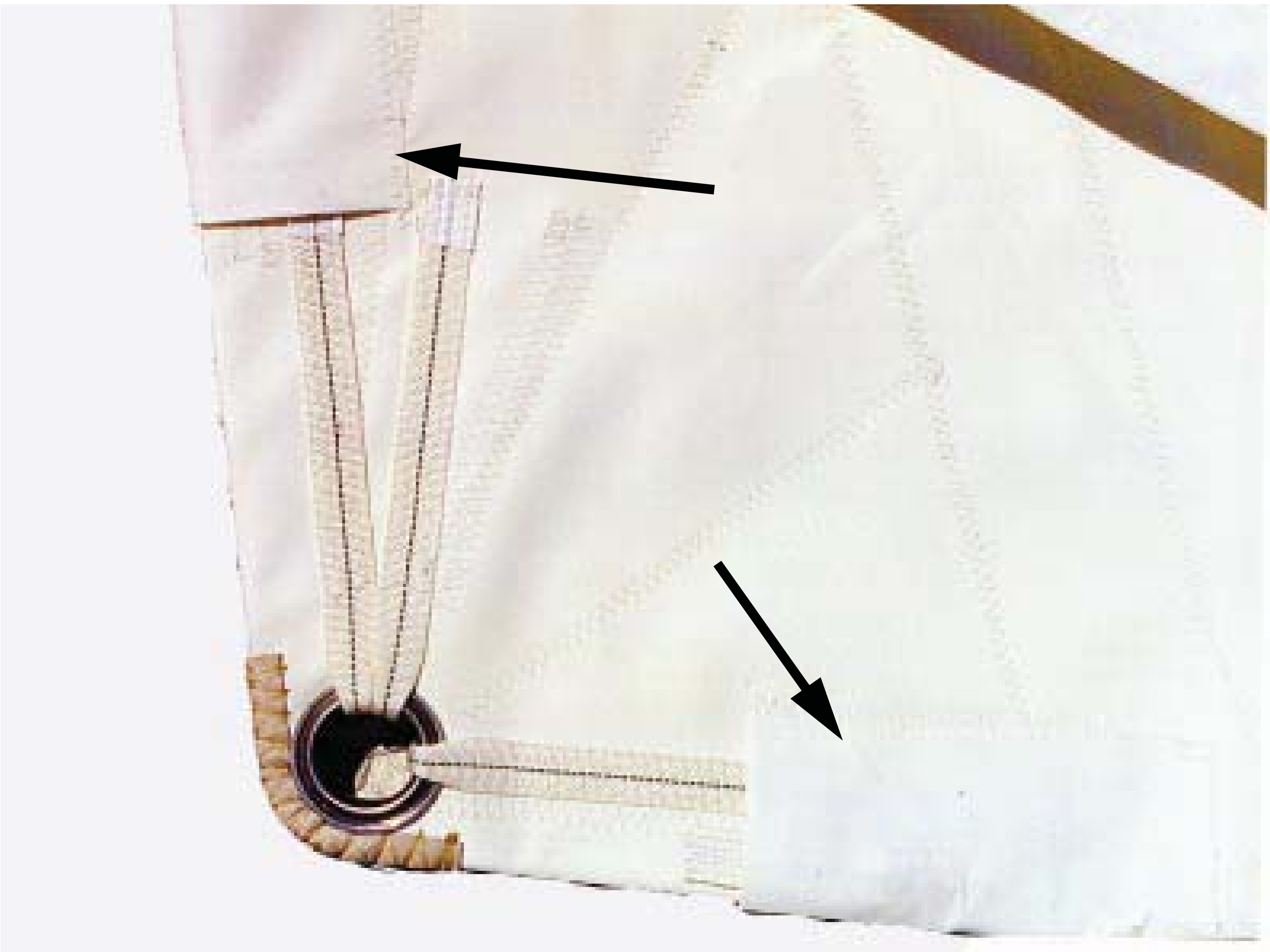
The bottom (left) photo shows a detail of how the hanks are connected to pressed rings (not grommets) with leather chafe patches and Dacron webbing to distribute ring loading back into the sail cloth (and again act as a backup).

On the opposite page, the top photo is of the clew, in this case a pressed ring, along with its Dacron strapping. The sewn covers (arrows) provide extra chafe resistance on the edges and conceal the end points of the leech and foot lines.



Both leech and foot lines terminate near the tack (bottom photo). There is a sewn loop of Dacron webbing to which one end of the adjustment tackle is attached. The metal jam cleat is riveted to the sail. The end of the adjustment tackle is coiled back into a Velcro pocket.

The leech line runs over a block at the head (top left photo) and then down a pocket along the luff.



Sailcloth

The actual loads storm sails see from the wind are not that high. Yes, the wind force is much stronger. But the sail area correspondingly is reduced, so total loads do not go up.

There are two main threats to these sails. The first is the sea. If a boarding sea catches a sail the loads jump enormously.

Second, if the sail is not set properly—the sheet lead is too far aft, for example—the sail will flog violently. Or, the sail will be trimmed for a broad reach and a wave slews you around closer on the wind and the sail starts to luff.

Flogging or luffing will make short work of any but the stoutest sails, and if there are any weak spots—tears, chafed stitching, or sun damage—the flogging will find them rapidly.

Once the sail starts to fail, it will go quickly. By the time you can get it down and on deck (assuming this is possible), the sail will, in all likelihood, be reduced to a pile of ribbons.

With this in mind, let's talk first about sailcloth. All of the sailmakers we talked with recommend using conventional Dacron fabrics. Laminates and high-modulus materials (which are laminates by definition) do not have the flog and tear resistance required for this line of duty.

Most recommend cross-cut construction, where the panels of the sails run horizontally.

Burns Fallow at North New Zealand recommends that storm sails be made from one weight heavier fabric than the mainsail or number three jib. Richard McKay at Halsey Lidgard goes up one or two ounces; he likes to use the softest fabrics, and suggests that on larger vessels the sails be built from two plies to ease handling.

Craig Middleton at North in Cape Town, South Africa normally uses a sailcloth up two ounces from the mainsail.

Dan Neri at North Northeast looks for balanced weaves in their Dacron sailcloth (as opposed to high-aspect weaves used in radial construction). The balanced weave adds more durability, and if the sail does begin to suffer damage, it will not spread as quickly.

Roller-furling storm sails: An alternative approach, if you do not have a cutter stay and have a roller-furled primary headsail is to use a furling storm jib with the luff set on a Vectran halyard. If this approach is taken, you will want to set the roller-furled storm jib well before it is required, preferably before you leave port. This way it is in place, ready to go when needed.

Obviously the free-flying roller gear must be strong, as should be the halyard, any stoppers, and winches.

On *Kondor*, the sistership to *Beowulf*, we took this approach with both storm jib and heavy staysail. However, it should be noted that the potential use of these sails is much reduced because this design is so powerful.

Storm Jib Design

There are several considerations in storm jib design. The first is that the clew should be raised well above deck level, so that the sail is easier to trim and there is less chance of catching water in the foot.

The second issue is the tack. If your boat is quite wet forward, or there are larger than usual seas coming on board, you will want to raise the sail up a bit on the headstay.

In some sea/wind combinations, you may find the wind much reduced in the troughs, you may not have enough power to keep the boat at sufficient speed to maintain safe steering control (although this is rare). If this occurs, you will want the option of raising the storm jib 10 feet or so (3m) off the deck.

All these design considerations affect to where the sheet ends up on the rail. If you have lots of options, this is not a problem. However, if you find that you do not have the right spot for a well designed clew, flown from a high and low position, it is worth thinking about adding some extra attachment points. (Keep in mind that the sheet position will be aft when beating and forward when broad reaching.)

Halsey Lidgard Sails

A high-clewed storm jib in the furious fifties aboard Ceramco New Zealand in the Whitbread Race. The clew is cut high so the sail will trim well off the wind as well as to windward. A high clew also keeps water out of the foot of the sail.

Trysail Design

The first decision to be made is where the trysail is sheeted. All of the sailmakers with whom we've talked favor sheeting the rail or the spinnaker blocks if the rail does not extend far enough aft.

However, Stephen Boyd from Hood UK says that when they made the trysails for the last BT Global Challenge, Chay Blythe specified that the sails sheet to the end of the main boom.

Our own preference is to get the boom out of the way.

Whatever your approach, you will want the option of bringing the clew of the sail to the center of the boat. You need to make sure that this can be done without the sail flogging and decapitating the crew.

Most sailmakers told us they prefer to use a cross-cut panel layout for trysails. However, Tim Woodhouse of Hood likes to use a radial panel layout, with panels radiating out from the clew towards the head and tack.

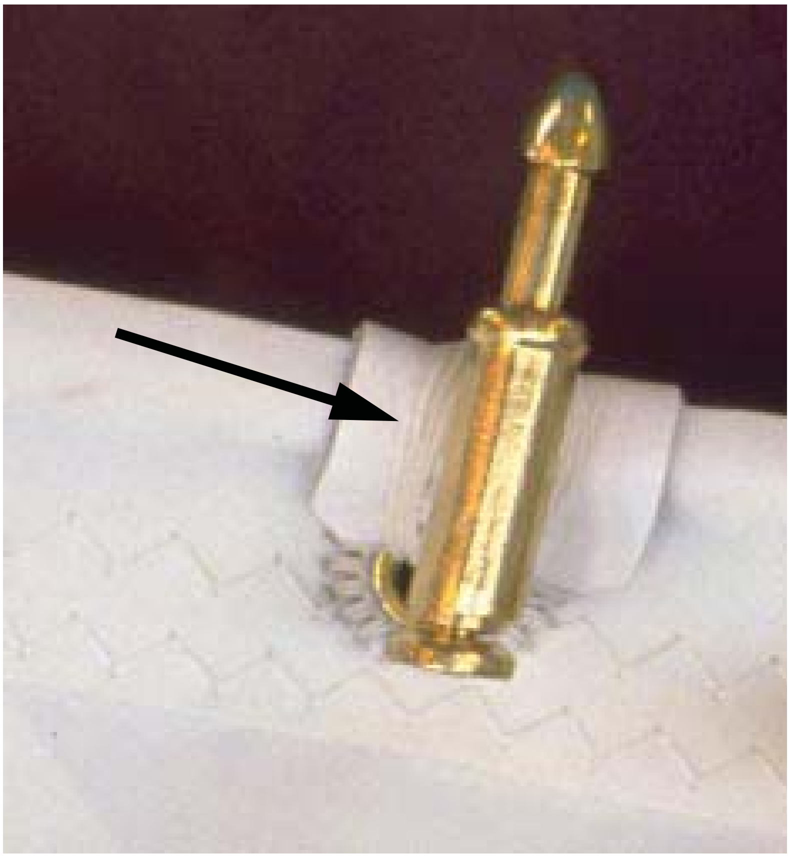
Edge Details

As you can imagine, resistance to fluttering and flogging is paramount in the design. This is typically accomplished by cutting hollow into the edges of the sail.

Burns Fallow at North New Zealand specifies a 1 1/2 percent hollow on the leech and foot for storm sails. He adds that they design their storm sails with "take-ups" to add some shaping to the back edge of the sail.

Stitching:

- ❑ Although all modern sails have glued seams, we like to look at the stitching as the first line of structural defense.
- ❑ For storm canvas all the sailmakers we spoke with agreed that it should be a triple zig-zag stitching with heavy UV-stabilized thread.



Corner, hardware, and edge details are far more critical on storm sails than working canvas. These two photos show the work of Port Townsend Sails. Note, in particular, the extra reinforcement patch, triangular in shape, under the luff hank. This helps to spread the load from the hank and sail tape into the basic sail cloth.

These hanks are attached to sewn grommets, something you rarely see anymore because of the amount of labor involved.

The detail below shows an extra piece of leather (arrow) between hank and luff rope to provide extra chafe protection.

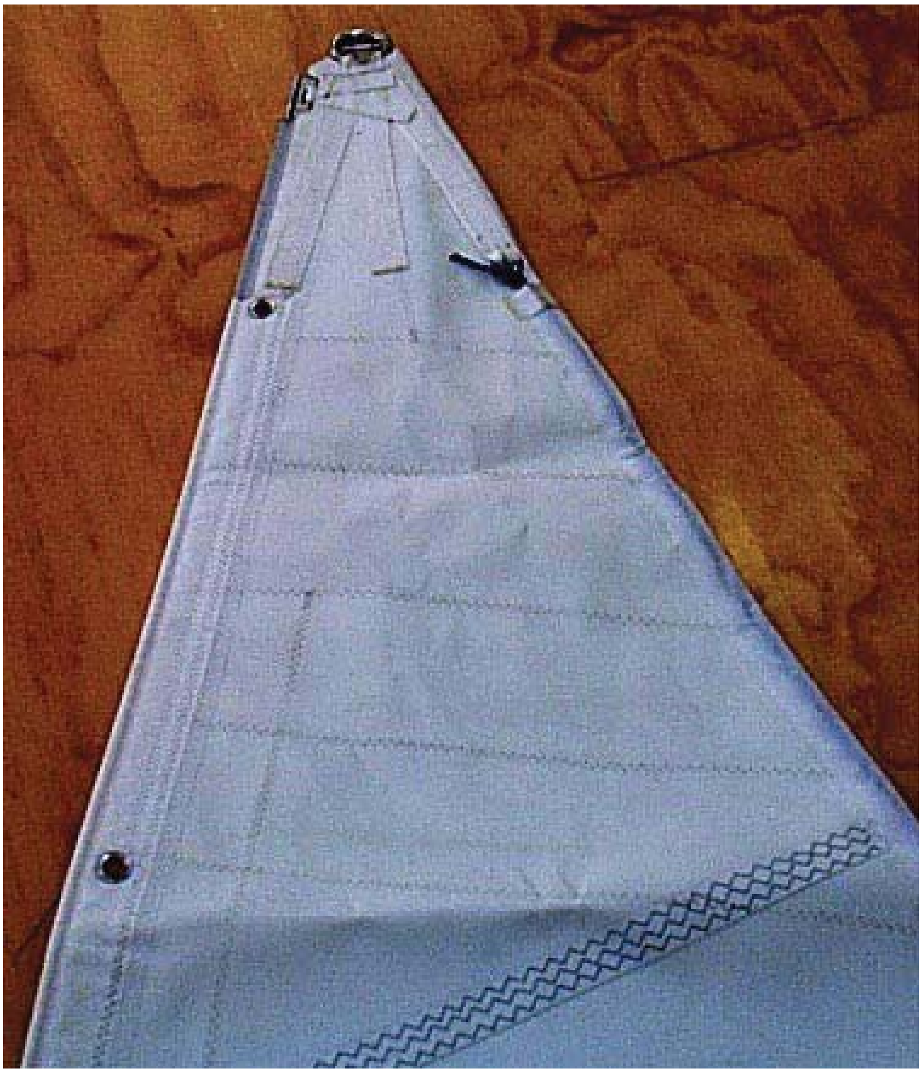
Both photos Port Townsend Sails

This stops it from over-straightening (which leads to fluttering) as the sail stretches with usage.

How the edge is constructed is a major issue. You cannot just sit back and throw material at it. If it becomes too heavy, it will have more problems with fluttering. The edge detailing must be done with care.

Halsey Lidgard uses two tapes up the luff, with a pre-tensioned retaining rope. For leech and foot they use a 3/4-folded tape with leech cord.

Dan Neri at North New England says that "the leech and foot on sails for boats over 40 feet (12.2m) LOA are typically built up with a flat tape, and then capped with a folded tape. The flat tape is insurance against the seams opening (if either the flat tape or folded tape is too wide it will actually cause the edge of the sail to rattle because the edges are hollow). If the tapes are installed correctly the edge of the sail should be tight simply because the tabling is not going to allow the fabric to stretch, but the sailcloth will stretch just inside the tabling."



A North Sails New Zealand storm jib for the same 65-foot (20m) design as the trysail previously shown. This sail is set up to be used with a removable Aramid (Kevlar) inner forestay. There are nine layers of reinforcement in the corners. The basic sail cloth is 10.8-ounce Dacron and the sail is 243 square feet (23 square meters). Hanks will be added for attaching it to the removable stay.

Hardware

Attachment of the storm jib presents us with a conundrum. Do we want the hanks stronger than the sailcloth, in which case the sailcloth goes first and the sail is ruined? Or is it better to have the attachment hardware be a little less robust than the sailcloth, so if the sail is overstressed (by water), the hardware will give, and you have a chance to save the sail?

Our own feeling is that if the hardware goes in storm conditions the sail will be ruined before anyone can wrestle it to the deck. Therefore it is better to make sure the hardware is bulletproof.

In this context there are two considerations: the first are the head and tack of the sail where loads are highest. The second is the luff area in between, where loads are much less.

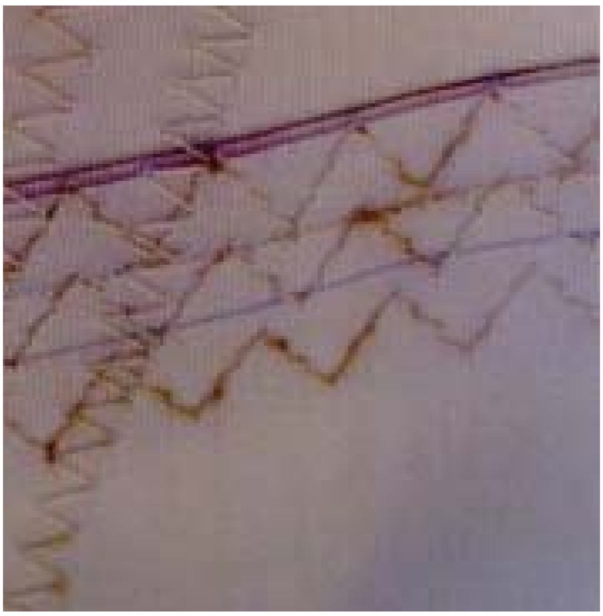
Most sailmakers double or triple up the hanks at the ends of the sail. In between they will typically be spaced at about two-thirds the normal distance.

You then have a choice of sizes. Hanks represent a small part of the total cost of the sail and it is always better to go larger. You can choose between stainless steel hanks, made by Wichard, and bronze hanks. Dan Neri finds that they often specify the Wichard hanks on larger yachts. We have stayed

Stock Newport

Fasizi deep in the Southern Ocean, broad reaching in 50 knots down a nice sea. The tack pennant (arrow and inset) keeps the sail well clear of the deck and any waves which wash aboard periodically.

Triple stitched seams (photo below) are the norm with storm canvas. This seam has just enough space for these stitches. If it were an inch (25mm) wider, it would allow for future re-stitching.



with bronze hanks, preferring not to have the risk of chafe between a stainless hank and stainless headstay.

All of the foregoing pre-supposes there is a stainless cutter stay on which to attach the hanks.

If you have a roller-furled headsail and no cutter stay, you are faced with removing the bigger jib, getting it stowed, and hoisting the storm jib into the luff groove.

Even fully crewed and running off so the sail is in the lee of the mainsail, this is going to be a chore. If you are cruising short-handed it will be impossible.

For storm jibs, which are built to fit into the luff groove of roller-furlers, the standard practice is to periodically place eyes through heavy local reinforcements so that the storm jib can be tied to the foil if required.

Deeply Reefed Mainsails

There are many yachts which use a third reef in the mainsail instead of a trysail. This is simpler than having a separate track and additional sail. However, you are then using your everyday working sail in extreme conditions. If the sail has any weaknesses, the wind will likely find them.

Both photos Stock Newport

Deeply reefed mainsails typically require that cringles be tied up along the foot between the tack and the clew. These reef lines should be of the lightest line possible, commensurate with handling ease. The cringles themselves need to be reinforced so that they are stronger than the line. This way, if the reef pennant at the clew slips or breaks, the cringle lines will also break, rather than tear the sail.

The advantage of the trysail is you have a specialized sail, that is only used when really needed and so remains virtually in new condition.

If you do use an extra reef or two in the mainsail, there are several things to consider. First, the mast track will need to be reinforced where the headboard sits with the deep reefs. The hardware attachment at the headboard will also likely need to be beefed up for trysail-like loads. The reef should raise the end of the boom a bit, so that it doesn't trip in the sea when you are well heeled.

Gale Sail

Another approach to the roller-furling conundrum is the Gale Sail, developed by Etienne Giroir (the ex-pat Frenchman who brought us the ATN spinnaker snuffer).

Etienne has a rather clever approach to a storm jib, if you do not have a proper cutter stay.

The luff of the gale sail wraps around the furled jib, and then hooks back on itself.

If you are running in heavy going the main boom may end up being rolled into the waves. This puts huge loads on the gooseneck fittings and the boom. Ideally, reef clews will be raised so the boom end rides above the waves when heeled. Any preventers which are rigged should have a breakaway function so they relieve the pressure if the boom does get dragged.

The Gale Sail attaches around the roller-furled headsail. The ideal time to set this sail is well before it is needed, by running off dead downwind and keeping the sail in the lee of the mainsail.

Here's what Etienne has to say about his Gale Sail:

The maximum windspeed that the Gale Sail can be set at is the same as a regular storm jib, with the added advantage that the crew doesn't have to free the roller-furler to hoist it.

The way to attach and hoist the sail is the same as any other sail—however, the jib sheets have to be furled down to the deck level, and the clew ring and the knots of the sheets have to face aft since the Gale Sail rides on the front part of the roller-furler.

I know that a good sailor is able to hank the Gale Sail on going upwind in 35 knots of wind if necessary, in the dreaded event of a lee shore, but since bearing away makes it so much safer and quieter, I would recommend it every time. I have sold around 250 Gale Sails so far, and the most common feedback is that the world cruisers use it much more often than they would use a regular storm jib: as soon as it is blowing more than 30 knots, like in the West Indies in the winter, or in San Francisco Bay in summertime, the Gale Sail with one reef or two in the mainsail is plenty for the small cruiser.

The Gale Sail (opposite photo) is an interesting compromise for occasional use in moderate gales. However, for serious heavy-weather work, it would be better to have a hanked-on storm jib or staysail on an inner forestay.

Both photos ATN

Using Roller-Furled Working Sails

You will find several sea stories in this book indicating the use of partially furled segments of headsail in storm conditions. In all cases, this takes place off the wind.

There is simply no way one can roller-furl a headsail to storm jib size and use it reaching or to weather with any degree of efficiency: The sail will be much too baggy.

It is also hard on the roller-furling gear and the sail itself.

If you ever do intend to use your jib in a roller-reefed configuration, be sure the roller-furling line, and the leads and cleats, are up to the strain, which can be enormous.

The cordage of choice for this application is a Vectran core with Dacron cover. As strong as wire, you are able to use smaller diameters to get plenty of wraps on the roller-furling drum. The standing part of the line, that which runs down the deck after the sail has been furled, can have an extra Dacron cover to increase its diameter, making it easier to handle.

Stock Newport

Roller-furling headsails can be used in storm conditions off the wind, if there's no other choice. But their baggy shape makes them far less effective when reaching or beating (left photo). It is also hard on the sailcloth and hardware.

Rick Tomlinson

Double-headsail rigs often make a lot of sense with storm canvas. A storm jib or storm staysail is flown on the inner stay and the hurricane jib is flown on the outer stay. This creates substantial flexibility in changing sail area as wind conditions vary. Double-head rigs can be used to windward, but interference between the sails makes them less efficient than a single, larger sail. Reaching, however, they can be quite effective, especially if there is minimal overlap between the sails.

Reefing headsails make sense in moderate winds, up to a maximum of gale strength. Beyond this wind strength the extra weight on the foot, as well as its tendency to catch water, make, a properly sized storm sail a better bet. We've carried reefing headsails on two of our yachts and have found them more difficult to reef than just changing to sail.

Port Townsend Sails

Heavy Weather Running

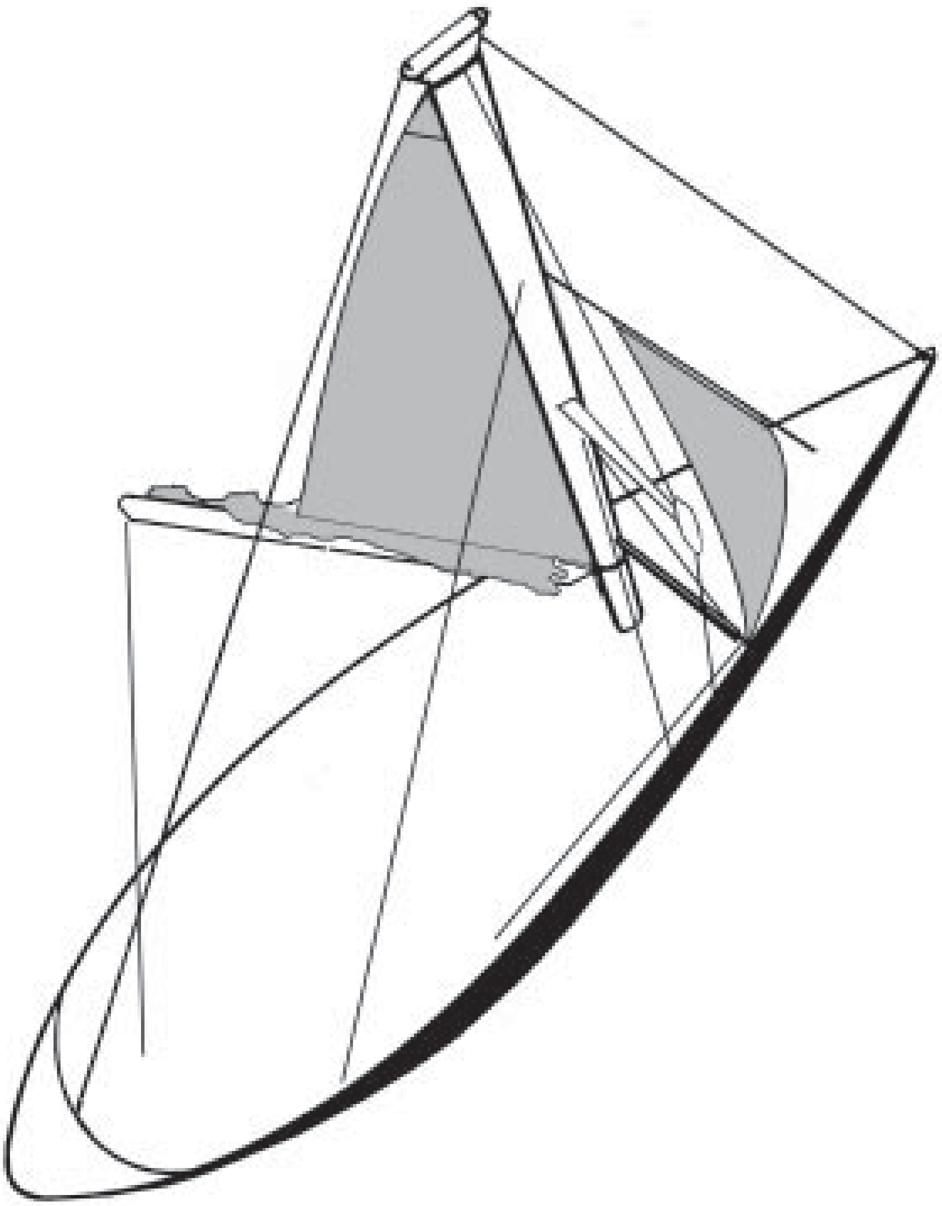
You may eventually find yourself running before a major storm with a storm jib set. If the wind is too far aft, the sail will not fill to leeward, in the lee of the mainsail. It will also not stay filled to windward.

As a result the sail will alternately fill and collapse, each time with a thunderous bang, which will make you wonder how the sail or rig can stand the shock loads.

Even if the sail is sheeted amidships it will crack back and forth.

There are two ways to solve this problem. The first is to head up 15 or 20 degrees so the sail will fill to leeward of the mainsail. The second is to fly the sail to weather, with the sheet through a jockey pole/reaching strut—the spinnaker pole will be unwieldy for the crew to handle and will probably not have a fair lead for the sheet.

Keep this in mind at the time the sail is designed because it will affect clew height.



The reaching strut can be used to pole out a storm jib flown on the cutter stay. This allows you to run at deep angles without having the storm jib crashing back and forth across the foredeck.

You will want to be sure that a foreguy and afterguy are used to hold the strut in place, and that there is chafe protection between the shrouds and reaching strut extrusion.

Most reaching struts have open outboard ends to make handling the spinnaker guy easier when transitioning from a run to reach and visa versa. This is not a good idea when the strut is used as a whisker pole. However, it is usually possible to drill a couple of holes at the end of the fitting which allow for a bolt, or loop of line. Either of these will keep the storm jib sheet from jumping free of the strut.

Back to *Theta Volantis*

Let's go back to the fall storm in the North Atlantic in *Theta Volantis* for a moment. The staysail exploded when they rounded up during a 79-plus-knot gust and were slapped by a breaking sea (see page **130**).

Our feeling is that it was the sea rather than the wind that damaged the sail.

We know from Brian and Colleen's inspection that the mid-luff-hanks failed (they bent open), and then the sail flogged itself to death, before they could get it squared away.

The staysail filled the forward triangle and represented far too much sail area for these conditions.

The fact that it stood up to this abuse for several days is quite amazing, and gives us an excellent data point for the future.

We got in touch with Tim Woodhouse, President of Hood Sailmakers in Newport, Rhode Island, to get some details on the way the sail was built.

Tim's first comment was, "In my opinion, the forestaysail was built to storm specifications in terms of strength and cloth weight, but at 277 square feet would have been much too large to be seaworthy in winds over 50 knots."

"The forestaysail was built from 10.2-ounce Hood high-tenacity Dacron, cross-cut construction, single-ply foot and leech tapes (14 ounce) three rows of three-step stitching on 1.5 inch (37mm) wide glued seams and number three hanks with a stretchy rope luff."

Had the mid-luff hanks been a bit stronger, and the clew lifted well off the deck instead of just a foot (0.3m) above it, this sail probably would have made it through unscathed.

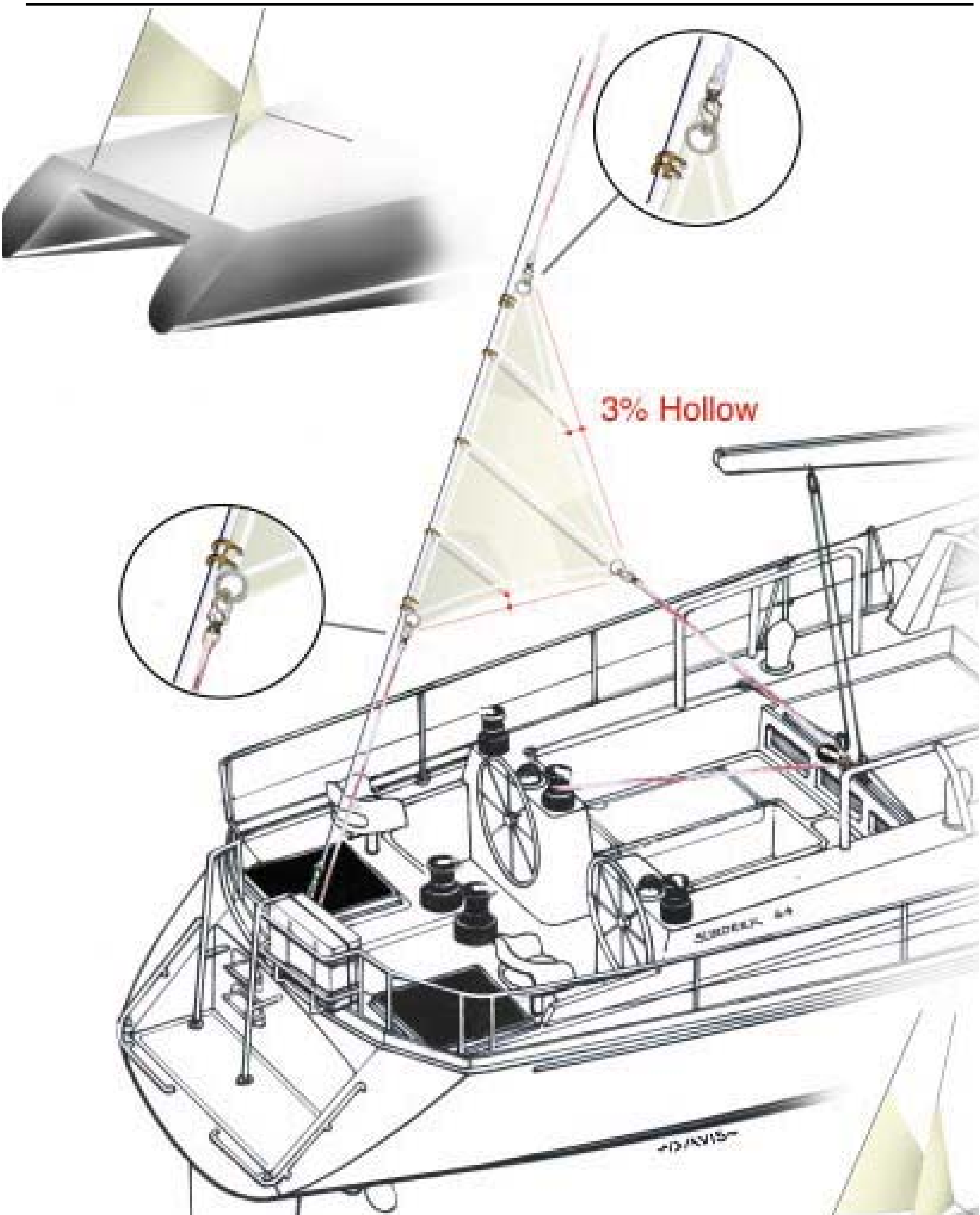
Tim also believes the current IMS formula for storm sails creates sails that are too large for storm conditions. "We would reduce them by 50 percent, depending on rig configuration, displacement, and yacht itinerary. For example, a masthead 40-footer (12.2m) with 18,000 pounds displacement is allowed approximately a 120-square-foot storm jib. I would recommend 60 square feet for winds in excess of 50 knots."

Single-stickers can also benefit from what is called a back staysail (drawing on opposite page). This is a sail hoisted on the permanent back-stay which acts almost like a mizzen.

Riding Sails

We want to close this section with a discussion of riding sails. Riding sails are usually thought of in the context of a ketch or yawl, which are typically used to keep a boat quietly head to wind at anchor.

The mizzen sail can also be used to good effect when hove to, or when lying to a parachute anchor (see the Birch Kelly story on page **466** for a firsthand account of how this works). The ability of these sails to keep your head to wind can have a significant safety impact. The less you shear and the better you can control your angle to the waves, the less risk there will be of a knockdown.



On multihulls and single-stickers with split backstays double "toed-in" riding sails can be set. These are actually more effective as they always operate with an angle of attack.

If there is no backstay (as with a multihull with swept spreaders rather than permanent backstays) the stern sails can be hoisted on low-stretch (Vectran or Spectra) pennants using the main halyard.

Both mizzen and aft-staysail will benefit, when used in this feathering mode, by certain construction details.

In the case of a mizzen, you will want the sail to be cut extremely flat, and to have deep reefs which can be used in extremely high winds. Obviously, the mizzen sail, and the spar to which it is attached, need to be strong enough to take really high loads.

You will find that having a fully-battened mizzen pays substantial dividends both in general sailing and when hove to. The battens need to be stiff and strong (for more details on full-battened sail construction, see page 87 of *Offshore Cruising Encyclopedia*).

The back staysail involves a bit more engineering detail. Because this sail is set on the backstay, you have less shape control than with a mizzen sail set on a boomed spar, and the edges are more difficult to control.

In terms of sail geometry, a back staysail will ideally have three sheeting points. The first is on the centerline, sheeting the back staysail to the mainsheet traveler or a padeye on the centerline forward. The second and third are to each rail, which will help you adjust the angle of the boat to the wind and seas (since the seas are often at a 15- or 20-degree angle to the wind, by pulling the riding sail in one direction or the other you can get the bow pointed higher into the waves).

Sail size depends on boat stability and how badly the boat shears at anchor. A good test is to rig a storm or hurricane jib on the backstay while you are hove to in a stiff breeze. Once you determine the wind level at which a given-size sail works well, you can interpolate up in wind strength (and down in sail size) by squaring the difference in relative wind strengths (since wind force goes up with the square of the windspeed). Generally speaking, many boats will do well somewhere between a half and a quarter of the size of the storm jib.

The sail shape should be shaped as close to that of an equilateral triangle as possible to reduce the edge loading and keep the center of effort low.

Construction details and sailcloth weight should be the same as with a storm or hurricane jib. The only major difference is the hollow of the forward vertical edge and the foot. Where 1 1/2 percent is the norm for a storm jib, we prefer to see 3 percent on a riding sail.

These sails should be fully battened.

If you use your riding sail at anchor, it is going to suffer a certain amount of degradation from continuous exposure to sunlight. This means the sail will be at less than optimum strength when used in heavy weather. If you are going to use it at anchor, make allowance for this by specifying heavier sailcloth, stronger thread, and extra stitching.

Self-Steering

The most important ingredient for success in heavy weather is the ability of crew and vessel to adopt a variety of tactics commensurate with the conditions found at any given time during the storm. A major factor governing this is the crew's ability to maintain steering control, whether by hand or use of self-steering gear.

To the extent that the vessel can be efficiently self-steered, the crew will be able to put off assuming direct steering control. The longer this is postponed, the better rested the crew will be and the better they will be able to cope with the conditions they find on deck, when it finally becomes necessary to relieve self-steering gear.

In this context there are a number of design, equipment, and technique issues that come into play.

Sail/Hull Balance and Steering Loads

Let's talk about what you can do to make the most of your hull and rig design. (We'll discuss the design factors that affect steering control starting on page 608).

First, it is important to understand that for most boats it is the angle of heel rather than the location of the sail area, which is the greatest cause of weather helm.

If the location of the sail were the major factor, then with the jib all the way forward you would have huge amounts of lee helm. In fact, on many yachts if you carry a headsail in winds strong enough to heel you 25 to 30 degrees, you will have weather helm.

So, to reduce weather helm and steering loads, you want to keep the boat sailing upright.

Sail shape is also extremely important. Sails that are too full, or have leeches pulling in rather than twisting off, create lots of induced drag, which heels the boat and creates weather helm. Flat sails, with nicely twisted leeches, reduce weather helm.

In moderate conditions, experiment with different lead positions for the jib and try allowing the main to twist off. When you are sailing in a fresh breeze, consider using a flatter, smaller headsail, as opposed to one rolled down in size (which will be much fuller).What you learn in moderate airs about reducing weather helm and improving steering will help when you encounter storm-force winds.

Powerboat Steering

Powerboats do not have the same type of steering control as sailboats. This is a function of their hull shape and rudder size.

They typically require a human input sooner than sailboats when running from or heading into breaking seas.

However, there are a number of variables within the control of the skipper which will affect how long it is before he or she has to take over from the autopilot.

Among these are the autopilot control settings (discussed in more detail later on in this section), the settings of active stabilizers (sometimes they

In order for the rudder to give good control it needs a flow of water over it. Unless you have a prop turning in close proximity to the rudder, as in the case of a powerboat, the speed of the vessel traveling through the water becomes the source of steering power.

The work the rudder is able to do (its lift) is a function of boatspeed squared. A small increase in speed means a huge increase in steering ability. A small reduction in speed means a large drop in steering ability and rudder responsiveness. A vessel traveling at 8 knots will develop 1.77 times the steering force on the rudder as one traveling at 6 knots.

- ❑ When going downwind, the basic rule is to travel only as fast as you need to maintain good steering control.
- ❑ In some designs, there is no top speed, you just keep pushing the boat. The faster you go, the easier it is on boat and gear, and the better the self-steering system will work.
- ❑ Other designs are not controllable after a certain speed and must be slowed before they lose control of rudder.

are better turned off when running in heavy weather), and the speed at which the boat is moving.

All of these factors vary with boat design, as well as sea and wind state. In order to get a head start on the learning curve, it is important to experiment with all of these variables before you get into heavy weather.

Sailboat Broaches

A broach occurs when you are running or broad reaching and the boat begins to swing out of control, pivoting to windward as it goes down a wave face.

The right speed upwind:

- ❑ The steering loads are less as the boat is more evenly balanced and most boats will self-steer or require very little steering input to keep them on a desired track.
- ❑ A yacht, which might require seven knots of speed to stay in good control downwind, will be fine at 3 knots pinching to windward.

In some cases, the broach is started by a wave slap on the transom, which begins to rotate the boat. As the boat heads closer to the wind, apparent windspeed goes up rapidly and the apparent wind angle moves forward.

These changes increase wind force exponentially and the boat then begins to heel. On sailboats which have a tendency to round up with heel (weather helm) this will magnify the problem, bringing the boat closer to the wind. In a second or two, the boat is lying abeam of the wind, well heeled over, most vulnerable to a breaking wave.

If you are steering manually, you may sense the wave coming or feel the first fingers of the gust, and before the boat gets loaded up with turning force, you head off downwind. As you turn away from the wind, the heel and the resulting turning forces are reduced, and the boat stays under control.

A windvane or autopilot cannot anticipate the way a helmsman does. It can only react once the boat begins to change direction. Since this is in effect after the turning process has begun, in order to successfully counter the building forces the self-steering system must react quickly, with lots of rudder angle.

Powerboat Broaches

When a powerboat broaches, the same hydrostatic forces are at work as with a sailboat. The stern is slapped by a wave and begins a turn. In some designs, the bow may dig into a wave at the wrong time, and the boat pivots around, or a beamy hull that has been heeled by a wave may take over and swing you around.

In breaking seas, a powerboat is more vulnerable than a sailboat, because it has a more limited range of positive stability. Where a sailboat will come back from a knockdown well past 90 degrees, many powerboats will not recover if they go past 70 degrees.

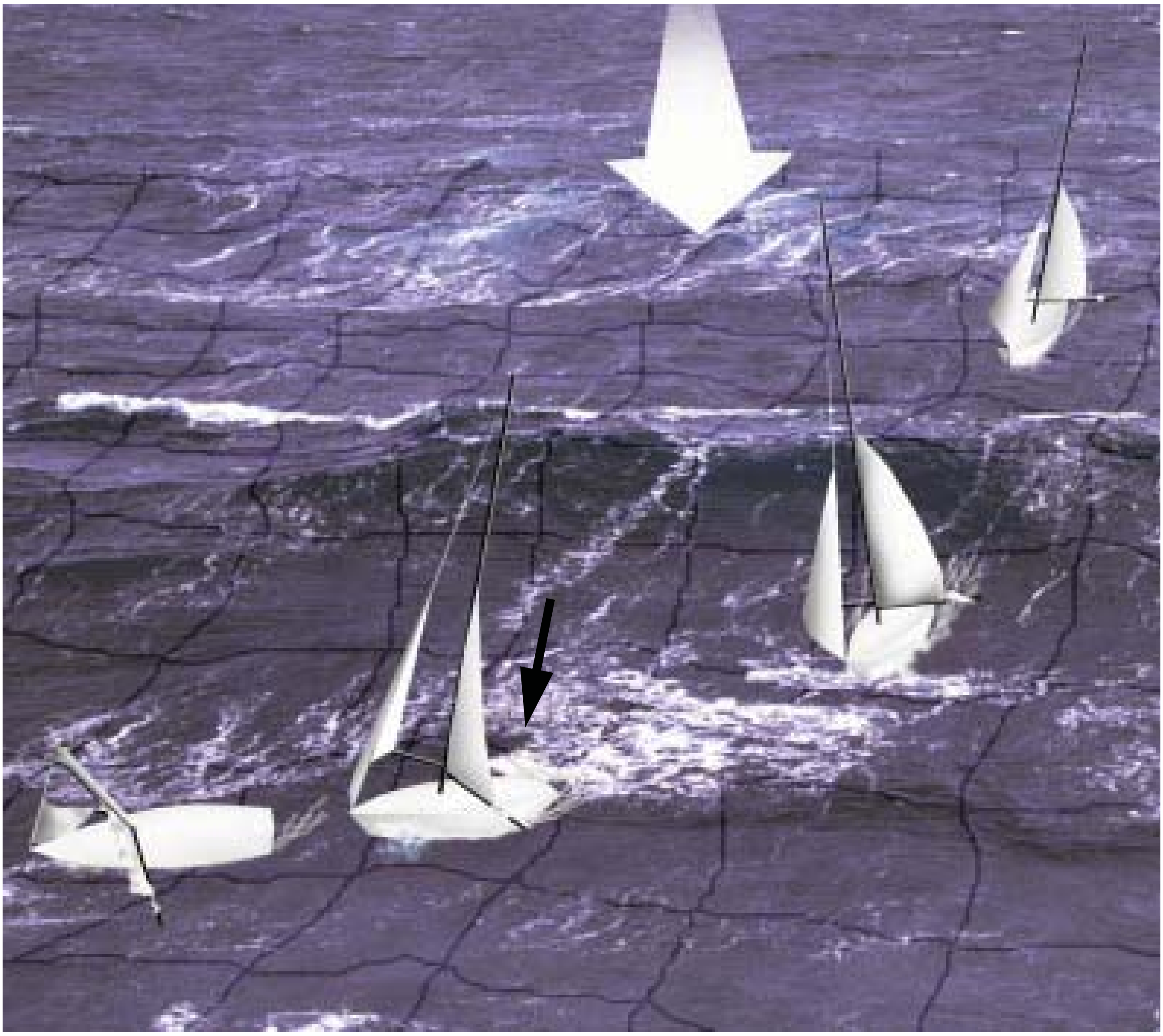
Therefore, a powerboat crew will probably have to relieve the pilot sooner than would be necessary on a sailing vessel.

Windvane or Autopilot?

Whether you have an autopilot or windvane, there are several important factors to consider. The first is speed of reaction. You want the fastest possible reaction to changes in heading—we're talking fractions of a second here.

Next, you want a really powerful system, one that is capable of spinning the rudder very quickly.

This means the pilot or vane must be oversized for normal weather.



Avoiding a broach at deep sailing angles is a function of boatspeed, steering control, and how the waves catch you. In the scenario above the boat is sailing at a speed somewhat slower than the waves, but surfing in control down the faces. A cross chop in the trough (arrow) catches the stern and and the boat begins to pivot. By the last (left) position, the boat is beam-on to the overtaking crest. If the crest begins to break heavily, the boat is in a vulnerable position for a knockdown.

In many cases, servo-pendulum windvanes will react faster and have more power than small boat autopilots, and, as a result, do a better job.

A good example of this is in the description of our passage between Mauritius and Durban in the Indian Ocean (see page 327). At the end of this passage we found ourselves in 55 knots of southwesterly storm force winds, blowing against the Aghulas current. Virtually all the waves were breaking, and we had *Intermezzo* beating slowly under storm staysail and small mizzen—with her Aries servo-pendulum gear steering. Speed varied between 2 and 3 knots, and the Aries was able to keep us on course despite breaking crests hitting us in the bow, amidships, and in the stern (and frequently washing right over the boat).

The one advantage of an autopilot in this type of situation would be the ability to fine-tune the course for wind and sea variations. But to do that

The WH autopilot control head on Beowulf is typical of what we've used on our clients' boats for over 15 years. Note the three manual controls for gain, counter rudder, and yaw (also known as dead band or sea state).

The "gain boost" button in the upper right corner is a key feature in the WH Storm Pilot operation. When you hit this button with your thumb it doubles rudder gain, cranking in twice as much course correction as normally used. This helps to pull the bow down quickly when you are slapped by a wave on the stern and start to round up. Once the rudder has a good grip, lift your thumb and gain returns to the normal setting, avoiding the problem of overshooting the course and sailing by the lee (or accidentally jibing).

type of job, as we said earlier, it needs to be fast-acting and very powerful. The Benmar pilot we had aboard in those days wouldn't have been able to cope with the conditions.

Windvane Technique

One of the factors affecting how fast a windvane will react is the size of its air rudder. Sometimes you will have a really large air rudder for use in light airs and when running in light to medium conditions. But in severe weather, it may prove to be too powerful and responsive, causing excessive movement of the rudder.

It makes sense to carry several sizes of air rudders, one of which is small for heavy-weather usage.

You cannot always get the vane to steer a precise course. Sometimes wind and sea conditions combine with the boat's tendency to round up, making it difficult or impossible to hold a given course. When this occurs, it may be advisable to change course 10 or 15 degrees to see if the windvane will settle.By jibing or tacking, the angle of the seas may become more favorable giving the windvane better control.

The key is to experiment and stay alert to changes in external forces which require you to adjust the course, the vane, or the sailplan.

Using an Autopilot

Assuming the autopilot has the reaction speed and power to do the job, it does have some advantages.

Chief among these is the ability to fine-tune the steering characteristics if your controls allow it (some pilots have all their controls internalized where they are set by a technician and cannot be user-adjusted. These are fine for moderate weather, but do not give you the flexibility needed in severe weather).

Picking the right course when you are reaching is difficult. You experience the maximum turning force from heel and the waves that can set you off course by hitting your bow or the stern.

In heavy going, it is often simply not possible to make safe progress on a reach, especially where you are depending on a self-steering system to handle the helm. Instead, you need to pick a course which allows the boat and self-steering system to respond to the seas before the boat gets so far out of balance that it rounds up or broaches.

In the image above, the first boat (closest) is broad reaching through a trough. In the next position, it is just riding over a wave crest, and has headed off the wind a bit more to allow for a wave slap on the stern quarter from the crest close to port. This is where you would want to crank up the rudder gain control to make sure the rudder had lots of power. As soon as you feel the rudder bite, reduce the gain to normal. In the third and fourth position the boat has headed up taking advantage of a smooth spot—gain is still set to normal. The last (furthest away) image shows the boat has headed down again on a crest, with rudder gain once again cranked up for a few seconds while the boat accelerates.

A broad reach is much easier to maintain while self-steering. When the seas are not breaking, or breaking occasionally, a course is normally maintained without a great deal of effort. In this series we start off with the nearest boat in a trough between seas. The next boat has crossed a crest in a smooth spot and is continuing on course.

The third boat has started to head up. This could be from a wave slap, or perhaps a puff of wind. This is the point at which you will want to apply maximum rudder gain. Or, in the case of a WH Storm Pilot, hit the rudder gain button for a few seconds. Once the bow begins to respond, and head back down wind, reduce the gain to normal setting (or release the gain boost button on the WH Pilot).

The following comments are based on our long experience with WH Autopilots from Bainbridge Island, Washington. We've used these units for years on our boats and have found them to be reliable, fast acting, and extremely powerful. The controls indicated are available on all upper-end yacht and commercial pilots.

Running off becomes progressively more difficult as waves increase and come at you from different directions. No matter how large or stable your vessel, even a small wave slap on the bow or stern is going to create a large turning moment that the self-steering gear will have to overcome. The biggest risk is of an accidental jibe, putting you in an unwanted hove to position with headsail backed, while the boat sits beam-on to the breaking seas.

To avoid accidental jibes, it is typically best to sail 15 to 20 degrees above a dead run. Watch the seas and wind so if there's a shift, you are ready to adjust the pilot or vane gear. Major wind shifts are typically accompanied by changes in barometric pressure—sometimes that change (usually a climb) precedes the shift by a few minutes to an hour or more. So keeping a close eye on the barometer will give you an early warning that you should pay attention to the helm.

No matter how good the autopilot is or how well your boat steers, the autopilot still cannot anticipate the sea conditions. It's happy to supply the muscle, but you need to supply the brain power.

Start with understanding the variable controls on the autopilot: dead band (called sea state on some pilots), rudder gain (how far the rudder turns), and counter rudder (how fast rudder correction is applied). A discussion of these controls is outside of the scope of this book. The best way to become familiar with them is to read your owner's manual, then experiment every chance you get. Keep a written log of the settings that seem to work best in each situation.

In general, the more control or the faster acting you need your pilot, the less dead band is desired. If this is set at minimum, the pilot should begin to apply corrective action to the rudder the instant it senses it's off-course. In normal conditions, to reduce power consumption and rudder load, dead band is set at 3 to 5 degrees. Rudder gain is typically set at the minimum required to keep the boat on course.

In heavy weather and/or at high speeds where you need additional gain so that the rudder can kick in faster and apply more correction per degree of heading change, but not so much that the boat tends to oversteer going down waves.

Here's an idea of how you can help your pilot. Say it is blowing a steady 40 to 45 knots. You are running or broad reaching with storm staysail and double-reefed main. As the puffs hit, or the seas try to slew the stern around, you assist the pilot by momentarily increasing the rudder gain. You may even do this before the sea hits or just as you feel the boat begin to heel in a gust.

Your bow turns downwind and rapidly begins to accelerate. Once you feel that the boat is under control—that the rudder has a good bite on the water and is doing an effective job—start to reduce the gain back towards the normal setting for these conditions. If you do not reduce the gain, the boat will overshoot the correct course and you may find yourself by the lee, in danger of jibing; a very uncomfortable feeling.

When you think about it, this is exactly the same way you would hand-steer. When you first feel the stern lift to the wave, or the beginning of a gust tickle your neck, you kick in some downwind rudder. Then, as the boat accelerates, start to pull off the extra rudder angle, finally bringing the helm back to neutral before you reach the right angle on the wave.

What you're doing with the autopilot gain control is almost the same thing. Increasing gain tells the pilot to crank in some more rudder. Decreasing it tells it to reduce rudder.

Using a vane or pilot to steer downwind in breaking seas means you have to supply the brains while the self-steering gear supplies the muscle. In this image, we are running at a speed somewhat slower than the waves.

The boat in the foreground (bottom) is heading up in the trough to build speed, so that the rudder will respond better to steering commands. The crew will want to have boatspeed at maximum before they turn downwind as the crest (middle boat) passes them by.

With either pilot or vane this means aggressively changing course to windward 10 to 20 degrees, to accelerate in the wave trough. Then, with the boat lined up perpendicular to the waves the crest passes. You reassess the situation in the next trough.

If the wind is blowing hard and boatspeed is adequate, the self-steering gear can be left alone, But if the boat begins to slow, or you sense or feel a wave about to slap the quarter as it overtakes you, then extra rudder gain is cranked on the pilot.

Richard Bennett

Heavy Weather Life Raft Issues

The use of a life raft in heavy weather brings with it special issues. Chief among these is capsize resistance.

By definition, in heavy weather we have breaking seas and high winds. Opposing this is a small, round object, with a huge amount of windage and (in most models) not a lot of stability.

With conventional life rafts, those which employ small-sized water ballast chambers, you can expect to spend a lot of time upside down, or re-righting your raft.

For a firsthand look at this scenario, and some hard-won lessons, we turn to the experience of the *Winston Churchill* crew in the December 1998 Sydney-Hobart Race (for more data on the race see page **260**).

Winston Churchill

The *Winston Churchill* was what some would call the consummate traditional offshore design. She was from the drawing boards of Sparkman & Stephens and was built in Australia in 1942. She had moderate displacement (20 tons), with a significant underwater keel and rudder. She was 50 feet (15.5m) long overall with a range of positive stability calculated at 124 degrees in her IMS handicap. Her construction was of composite timber.

As conditions deteriorated on the second day of the race (December 27) the crew was considering heaving to. The boat was having a difficult time with the breaking seas and storm-force winds, and with darkness coming on they were concerned about their safety.

They were close reaching across the seas on starboard tack, headed more or less for Hobart, with the skipper (and owner) Richard Winning at the wheel.

Knockdown

At around 1700 a large, breaking sea picked the boat up and threw it down into the trough, knocking it down well beyond horizontal. Seven feet (2m) of coaming on the port side were smashed, three windows in the aft cabin were stove in, and some planking below the waterline is thought to have sprung.

The batteries were on the port side, underwater, and the crew couldn't start the engine to utilize the damage control pump.

Within four minutes, the water was 2 feet (0.6m) above the floorboards.

When it became apparent the vessel would sink, the crew donned life jackets and began preparing to abandon ship. *Winston Churchill* carried two life rafts.

A Mayday call was put out over VHF; the SSB having been rendered inoperable by the inrush of water.

Winston Churchill was running downwind under bare poles now at 5 to 6 knots. The crew were concerned that it would be difficult to launch the rafts at this speed, and keep them tethered to the boat, so they decided to wait until just before she sank before launching the rafts.

Stepping Up into the Raft

As the boat filled with water, it gradually slowed until, roughly 30 minutes after the knockdown, she began to settle.

The crews took to the life rafts, four in a round raft (a four-man Petrel) with an EPIRB transmitter, and five in a six-man rectangular-shaped raft (a Prosaver). The crew stepped "up" into the rafts.

The two rafts were tethered together and had drogues to keep them from capsizing. However, within minutes, the tether between the rafts parted as did the rodes to the drogues (which had been doing a reasonable job stabilizing the rafts against the seas). The crews indicated that there was severe loading on the connection between the rafts, and they were about to cut the line when it failed.

Small Raft

The crew of the smaller raft tied off the entrance and secured themselves in the interior. At about 2100 that evening, a few hours after taking to the rafts, they were capsized by a breaking sea.

One of the crewmembers cut the lashing lines to the opening, exited the raft, and used his weight to right the raft.

When the raft was righted it was quite full of water. A search for the bailer revealed that a majority of the survival-kit contents had been lost during the rollover.

The raft was bailed with a boot and plastic bag. Shortly thereafter it capsized again.

As dawn on the 28th approached they found that the lower ring of the raft was losing air pressure. It appeared that the broken antenna on the EPIRB had caused the leak. A sponge was used to plug the hole as the repair kit had been lost. The tube was partially reinflated and the crew continued to bail.

Life raft lessons from *Winston Churchill:*

- Capsize resistance is a major factor in heavy weather. These were extreme conditions, but capsizing has been reported as a problem even in moderate gales.
- Staying with the raft in a capsize is difficult; some form of harness, connected to hard points in the raft should be utilized.
- Lacing on entry doors should be usable in a variety of situations—when it is wet and when the raft is inverted—so it's not necessary to cut the lacing in a capsize.
- External grab lines on the raft are important for use when righting the raft and staying with it, should the crew be tossed out.
- Assume the raft will be capsized and precious equipment lost unless it is well secured. Grab bags, emergency supplies, and bailer must all be tied with a lanyard to some point inside the raft.
- If there is an EPIRB with an extendable antenna, care must be taken so that it cannot damage flotation chambers.

The wind was dropping and sea state moderating and there were no more capsizes. However, the raft continued to be filled with water from waves entering the open door.

At about 1600, an aircraft was sighted and a parachute flare was fired. The aircraft failed to respond. Shortly thereafter, another aircraft was spotted and a second (the last) parachute flare was launched. This was seen by the air crew and a few hours later the crew was rescued.

Larger Raft

During the time that the drogue was attached to the raft, it stabilized it quite well. However, after the drogue rode failed the motion became extreme.

The six crew tried to stabilize the raft, and themselves, by intertwining their legs.

The raft was capsized and the emergency grab bag lost. The crew decided it was too dangerous to send someone outside to right the raft, and that an absence of grab lines would make staying with the raft extremely difficult.

They also reported that the canopy of the raft was loose, banging their heads in the motion, an that the entrance door was difficult to secure against the waves

The raft seemed to be reasonably stable in its inverted position, but the crew began to feel they were running out of air. An 8-inch (200mm) hole was cut into a reinforcing patch in the floor (now the roof) of the raft to admit fresh air.

Shortly thereafter the raft was righted by another wave. The crew observed that the roof was damaged, and that the empty inflation bottle had come loose and was damaging the raft.

Late on the 27th or early on the 28th, a large breaking sea caught the raft and tumbled it down the wave face eight to ten times. Three of the crew were tossed out of the raft and ended up in the white water about 300 feet (90m) away. A fourth crewmember had been attached to the raft with his harness and was able to clamber back aboard. The two remaining crewmembers were unable to recover the others as the raft drifted rapidly away.

During the remainder of the night, the raft was capsized numerous times. However, the surviving crewmembers were able to hold on. The floor of the raft and the canopy completely fell apart during this period and the two crewmembers held onto the center support arch as a means of staying with the raft.

At about 1700 on the 28th, they saw an aircraft and signaled by waving one of their yellow foul weather gear tops. The aircraft saw them and returned. While waiting for rescue, the crew continued to mark their position with a strobe light and flashlight. The two crew were picked up shortly thereafter by helicopter.

Capsize Resistance

Many years ago an entrepreneur by the name of Jim Givens thought there might be a better system. Over a number of years, Jim developed his "toroidal" ballast chamber—in effect a huge water ballast chamber residing underneath the floor of the life raft.

This ballast chamber provided the stability to resist wind and wave impact. The Givens raft has been credited with surviving in some pretty impressive conditions.

Now the Switlik Parachute Company, long a life raft manufacturing company, also builds a raft with a large (although differently shaped) ballast chamber.

If you are going to be using your raft in heavy weather, it should be one of the above types.

When to Use

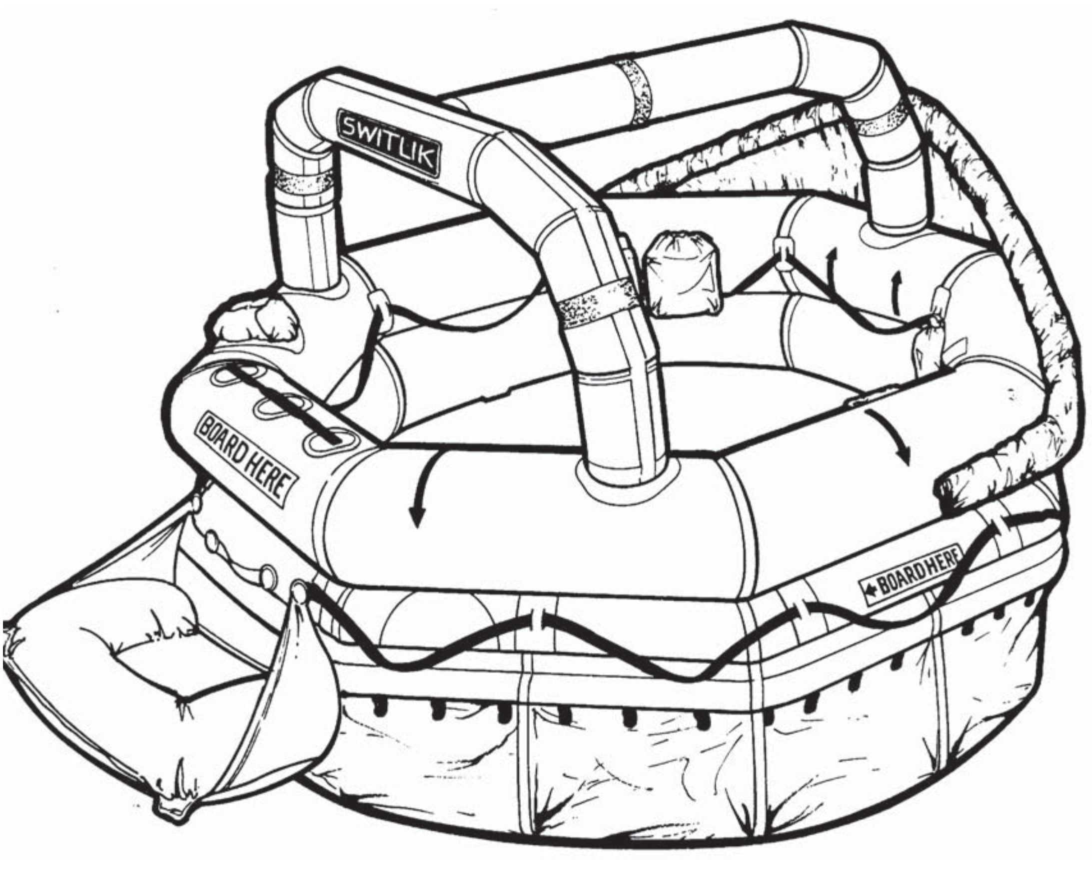
There is a tendency to get into life rafts at the first sign of major difficulties. Short of a fire or a collision that breaches the hull, every attempt should be made to avoid using a life raft. There are literally dozens of examples of sailors who have gotten into a raft, believing it to be safer than their boat in heavy weather, and died from exposure or drowning as a result of raft capsize. In most cases abandoned vessels were later found afloat.

Recent examples of this range from the Queen's Birthday storm, to the many that died in the 1979 Fastnet Race. Life rafts are a difficult environment in a moderate gale, in truly severe weather they can be extremely hazardous.

You may be surprised to learn that, overall, more people have probably died in life rafts while their boats are later found afloat, than have died on a boat.

The old adage "always step up to the life raft" is very true, especially in heavy weather.

If your interior is secure, and you are relatively safe from flying debris, most experienced sailors will tell you that you are better off on the boat than on a raft.



The Switlik search-and-rescue life raft. This design includes a toroidal ballast chamber below the raft which fills with water for stability in breaking waves. The canopy is removable for ventilation and easier boarding. It ties in place with two-inch (50mm) Velcro straps. These might prove to be a problem in breaking seas. Note the handholds both inside and outside of the raft.

Thierry Dubois awaiting rescue in the Southern Ocean after his Vendee Globe racer remained capsized after a knockdown.

PPL

The Switlik raft on Beowulf is stored in one of the cockpit lockers, where it is safe from direct wave impact. When we are at sea the abandon-ship bags are stored alongside. The cover provides an extra layer of protection for the gasket and painter grommet.

Secure Storage

We've touched on the subject of storage already, but it is worth repeating that in order for you to be able to use the life raft, it needs to be aboard.

If you're rolled and the life raft is swept from the deck, which happens more often than not, there isn't much sense in carrying it in the first place.

Launching

Rafts are bulky, heavy, and difficult to launch under ideal circumstances. If there's a big sea running, if the wind is blowing at storm force or above, the problems multiply exponentially.

It is essential that you know beforehand how the raft works, how it has to be handled to get it clearly overboard, and how much time you can expect it to remain tethered to the boat.

If conditions are severe, there will be a very short period of time before the painter is broken by a wave.

Once you commit to using the raft, all crew need to be ready to get in. And before the raft is launched, you will want to have all your abandon-ship gear ready to deploy.

One of the more difficult things to do is to create a storage system secure enough for the life raft so that it stays with you in the event of a rollover. Most of the time, rafts are swept clear of the deck. The raft above survived a rollover on the yacht Sophia during the 1994 Queen's Birthday storm. Note the heavily scalloped teak chocks which keep the raft from sliding. The wide webbing distributes load better than line or thin bands, and has considerable friction as well. A series of light lashings are used to connect the straps to U-bolts which are through-bolted (with backing plates). Multiple light lashings are easier to cut than fewer strands of heavier line.

The raft below is nicely installed as well, although the chocks are not as deep. There would be more danger with this installation that the raft would slide out from under its lashings.

Both photos Kim Taylor

Human Factors

Confidence in the inherent soundness of your vessel, proper preparation for offshore sailing, and carrying the gear necessary to handle storm-force conditions lay the foundations for the right offshore attitude.

The psychology of sailing in heavy going has a major impact on how you deal with the elements. If you or your crew are frightened by the wind and sea, you will have a greater tendency to put off actions that may be necessary to reduce risk.

The constant evaluation of conditions and tactics and the moves you should make during a blow can easily lapse while tumult is at its worst. When crew and skipper may be psychologically impaired is precisely when action is most required.

More experienced crewmembers can reduce the anxieties of novices aboard. Levity is always a good way to ease tension.

There are positive aspects to a real blow. Consider the stories that can be told afterwards! It takes only one storm every ten years to keep you going at the club bar.

Staying cool under pressure, taking action when required, and avoiding inertia that keeps you moribund while events take over are the keys to staying afloat and in good condition during heavy weather.

The emotional state of the crew is directly related to their physical condition. If the crew is seasick (or on the verge), tired, cold, wet, hungry, or all of the above; mental alertness and energy will ebb. The physical condition of the crew is related to their pyschological state. If they are frightened, this affects their physical abilities.

To maintain physical comfort, one must acknowledge that there is a bottom line in the trade-off department when you are choosing and equipping a yacht for offshore voyaging.

Many design features that are nice for living at anchor create problems at sea in bad weather. This statement applies to sail-handling gear, interior layout, rig and hull design. No salesperson talks about storms, reefs, or unpleasant conditions when you are buying your boat. And while life-threatening storms are rare, you have to know deep down that you have the best combination to take what comes. If your cruising confidence is based on this preposition, you will be far better off physically and mentally.

The other side of this equation is in your range of personal skills. The more knowledge you have of weather and seamanship, and how these elements interact with your vessel, the less tendency you'll have to become frightened and sink into physical and mental despair.

Physical Conditioning

Most of the time that you cruise, being in good physical condition is not a safety factor. But when things begin to go wrong, it can mean the difference between a safe outcome and something less desirable.

Being in good physical condition means that there is less risk of injury. When you do finally get into some serious weather, where there is a mental as well as physical stress to be endured, the better shape your body is in, the better you'll be able to handle the situation mentally.

It is tough to stay in good physical shape when you're cruising. You do get some isometric exercise at sea trying to hold on, but in general most of the body's muscles lose their tone quickly.

If you are out of shape to begin with, passaging makes it worse.

The only answer we know of is to get into shape before you head offshore, and then maintain some form of physical exercise regimen when anchored.

Just How Bad Is the Weather?

Heavy weather is as much a frame of mind as a physical state. What we may consider a little uncomfortable—a moderate gale—others with less experience might think a severe storm.

By pushing the boat in light to moderate gales and finding out the right combination of storm canvas and sailing angles, your threshold of anxiety is increased. On the other hand, if you avoid going sailing on those brisk days when it is blowing 25 or 30 knots, then when you get caught in a moderate gale you are going to think your life is in danger.

Push yourself to learn how to handle your boat. As your confidence grows, so will your concept of what constitutes heavy weather.

Mal de Mer

Seasickness is exacerbated by physical or psychological discomfort. We have always made it a habit to take seasick preventatives before the onset of bad weather. Even those in the family with "iron stomachs" down pills, just in case.

Being able to perform normal functions below is important. If you can eat, use the head, wash, and change clothes in some reasonable manner, your mental outlook will be better than if you cannot. Just washing your face and brushing your teeth can be a major morale booster.

Seasickness is not helped by unpleasant odors. You may find that the water in the keel sump turns up some really foul odors when the boat starts to roll.

The best preventative measure for this, aside from good ventilation, is to periodically clean the sump. When this was a problem for us in past years, we'd make it a habit of dumping a bucket of fresh water laced with bleach into the sump before each passage.

Pre-Cooked Meals

Having galley supplies that lend themselves to consumption under inclement conditions is a good idea. We always lay in a store of nutritious foods that fulfill the primary heavy-weather requirement of being easy to prepare and consume. Crackers, nuts, popcorn, dried fruit, granola bars, prepared sandwiches, casseroles, and stews have also withstood the tests of time and many thousands of ocean miles.

Rest

Rest is perhaps the most significant factor in maintaining mental preparedness. Being well-rested before a storm, and being able to nap or sleep during it, will leave you in the best possible physical and psychological shape.

Mental and physical strength should be husbanded during the initial parts of the storm—because if conditions really deteriorate, you will want to be totally alert and as well-rested as possible.

Key crewmembers need to save their energy for the worst stages of the blow. If there are less experienced crew aboard, use them for standing watch and/or helming chores early on. Then try to relax, eat and drink to maintain your strength and avoid dehydration, and get some sleep.

Where to Sleep

Motion varies throughout the boat. The further away you are from the pitch center, the more violent the motion.

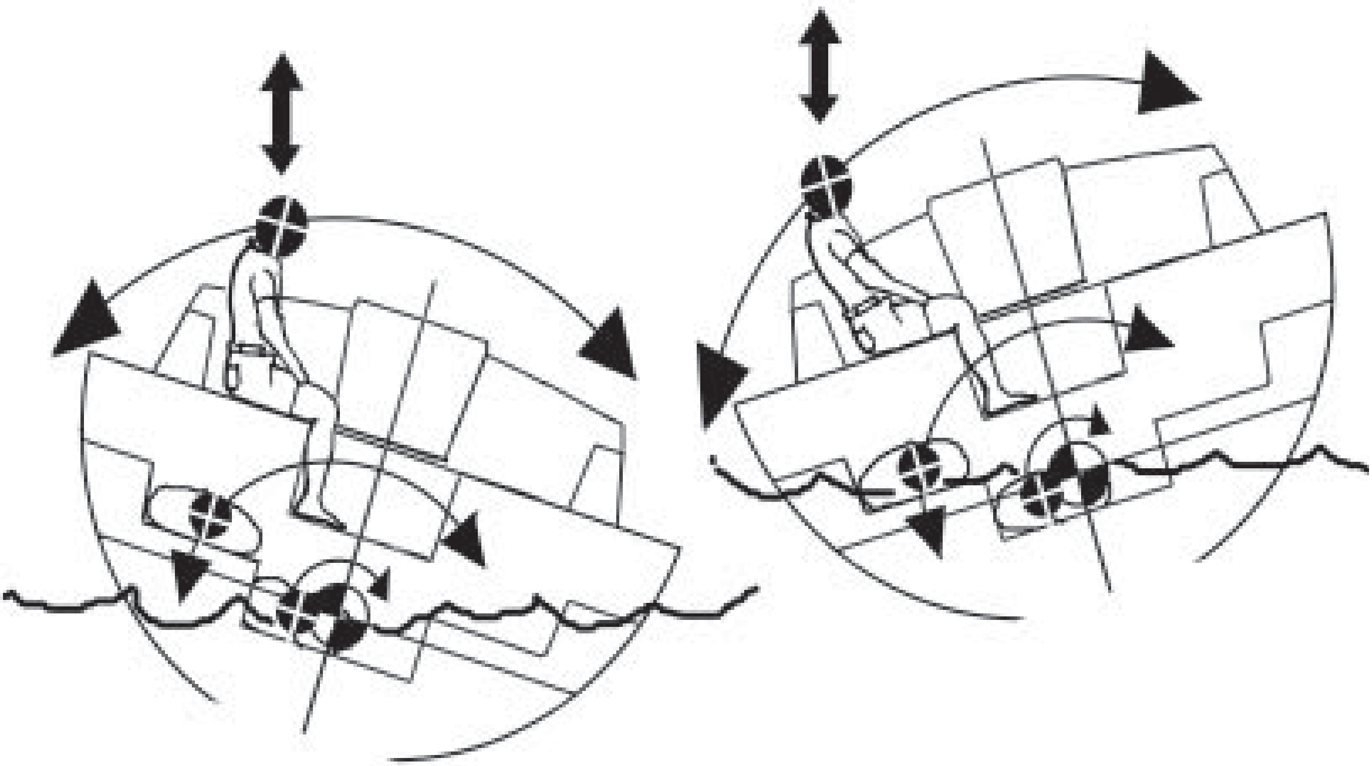
Generally speaking, most boats pitch about a point just aft of the longitudinal center of the waterline.

The other issue is height. The higher you are, the more side-to-side rolling you'll feel. There will be a considerable difference in motion between the cockpit seats and main saloon settee. Even between the settee and cabin sole you will find a difference.

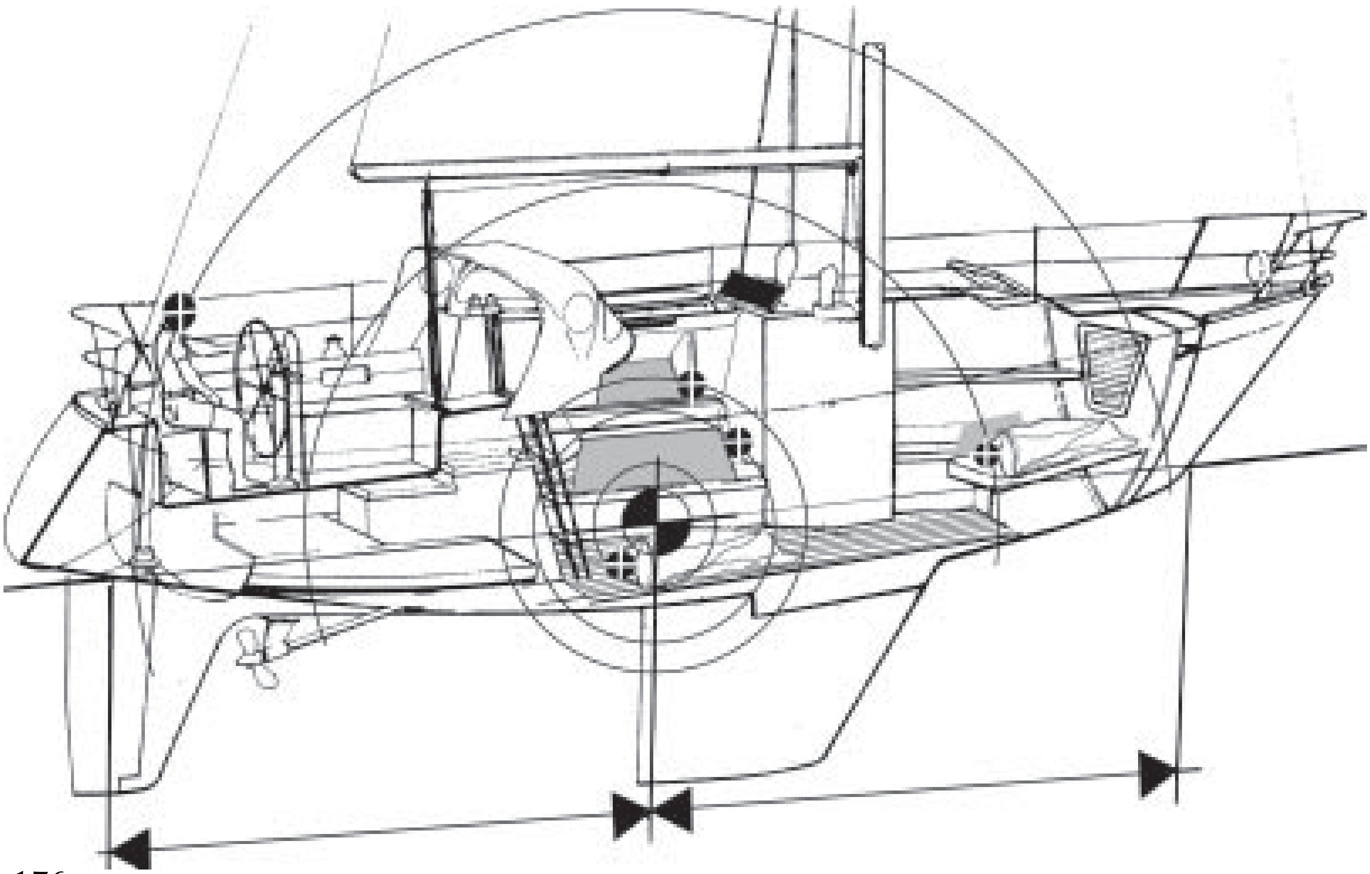
It is not unusual to find the crews on small boats sleeping on the saloon floor where motion is the least. However, this brings with it a risk factor in the event of a knockdown or rollover, in which case those on the cabin sole will find themselves flying through the air.

Staying warm and dry:

- ❑ It is critical to maintain a comfortable body temperature. Discomfort leads to inaction; morale drops and fear grows. Staying warm in temperate latitudes is easier to accomplish than staying cool in a tropical blow.
- ❑ The right clothing for hot or cold climates is essential.
- ❑ Efficient air circulation systems (dorades, fans) are a necessity when in the tropics.
- ❑ A source of heat in the high latitudes is essential in heavy weather. In more temperate regions, you can get by with adjusting your clothing layers.
- ❑ For colder climates, there are wonderful layering systems. Most of the new fabrics wick moisture away from the skin. If you are perspiring from activity, you don't start to get cold as soon as you sit down.
- ❑ Many of the new fabrics also dry quickly; an essential quality on a long passage.



The distance which your body resides from the pitch center has a huge impact on the motion you sense (motion is sensed with the inner ear). In the two drawings above, compare the arc which the head travels through in the three positions shown as the boat rolls. On deck, it will be almost the full beam of the boat. On the main saloon settee it is about 70 percent less than on deck, and on the cabin sole there is almost no relative motion. The same holds true with your longitudinal position. The further you are away from the pitch center—typically a little more than 50 percent of the waterline aft from the cutwater—the more pitching acceleration is felt. These same factors are at work with weight spread around the boat. The further the weight is from the center of gravity and/or the pitch center, the more negative effect it has on motion, heel angle, and range of positive stability.



Kim Taylor

Sometimes the crew needs a little incentive to keep the current unpleasant conditions in perspective. A photo of what awaits at the end of your passage—a lovely deserted beach perhaps—does wonders for morale.

Safety Concerns

In heavy going it's always best to assume the boat is about to be knocked down and move about the interior accordingly. This means bracing your body against furniture to leeward, and always using the handholds, even when it feels like they are not required.

This minimizes the chance of your body becoming a projectile if the boat is whacked by a breaking sea.

In really strong weather, the off-watch will want to spend as much time in their bunks as possible. If these bunks are in tight areas—pilot berths for example— and have good leecloths, there is little room for your body to be thrown about, even in a rollover.

Only once in all our sailing did we feel it necessary to stay confined. This was aboard *Intermezzo* in the Aghulas Current storm (see page 327). For 1 1/2 days, during the height of the storm, whichever adult was off-watch remained in a pilot berth, as did our daughters Elyse and Sarah.

Efficient Passagemaking

Sustaining fast averages:

- ❑ Maintaining boatspeed often takes more work on the part of the crew.
- ❑ All members need to be alert to the vessel's needs, sail trim, and sail selection.
- ❑ If you practice this all the time, not just when it is critical to safety, when the time comes where it does matter that everyone aboard will be prepared.
- ❑ This leaves more time to think about passage tactics and the weather.

Practice sailing fast. After a while you will find that fast is fun. Making a quick, efficient passage is something to savor long after the trip is over. Once you get into the habit of staying on top of sail trim and changing sail inventory as required, it will begin to take less mental and physical effort. Your pleasure will increase and your anxiety levels will drop.

The best way to deal with heavy weather is to avoid it entirely. In this endeavor nothing is more important than pure boatspeed which reduces passage times to a minimum.

The faster you go, the less you are exposed to the vagaries of the weather cycle; navigational risks posed by current and drift are reduced as well. Speed gives you more flexibility with landfall timing.

While this may seem obvious, the necessity of pushing—which requires more effort on the part of the crew—may not always be apparent.

As you read through the many experiences that follow in this book, keep an eye out on the timing and distances frequently involved. Sometimes the difference between a huge blow and safety is a matter of hours after 1,000 miles of sailing. Or the difference between hurricane-force winds and a moderate gale might be a matter of 20 or 30 miles in position.

It is also important to be able to sail efficiently in adverse sea and wind conditions. This widens the array of heavy weather tactics from which you can choose.

Sail Inventory

Nothing is more important to fast passage times than an efficient and versatile sail inventory. Keep in mind that sails are your source of power. Efficient sails—those with good shape (and the ability to maintain that shape as the wind comes up)—not only make you go faster, but reduce heel and allow a better motion. So, you get comfort bonuses along with boatspeed. (You will find a substantial amount of data on this subject on pages 71 through 134 of *Offshore Cruising Encyclopedia*. Details on storm canvas inventory start on page 133 of this book.)

There are always budget and space constraints when outfitting for long-distance voyaging, and lots of trade-offs to be made. Our suggestion is that the sail inventory be at the top of the priorities list.

Boatspeed Preparation

A clean bottom is essential to a fast passage. A layer of smooth slime is enough to add 10 percent to wetted surface drag. A beginning layer of grass will add another 10 percent or more, depending on length. The lighter the winds, the more critical this becomes.

The prop must be polished to be at maximum efficiency under power. Even a thin film of scale will reduce propeller output by 20 percent or more.

Sail Trim

It is imperative that you and your crew understand the essentials of sail trim. This means not only how far the sail is pulled in or eased, but the amount of twist in the back end of the sail.

Most headsail designs require that the lead position be moved forward as the wind goes aft and you ease sheets—and moved aft as the wind goes forward and you trim.

The difference between a properly sheeted headsail and one which is off a bit is not only a lot of boatspeed, but a pile of weather helm, heel angle and diminished comfort.

How Hard Should You Push?

Knowing how hard to push comes from knowing your boat. In most cases the boat will take a lot more punishment than the crew. Generally speaking, the crew will slow the boat down before it is required by prudent seamanship.

It is, however, important to know what the boat can take. If you push hard early on and generate a personal database on what the boat will handle, then when keeping the boat moving becomes a safety issue, you will understand how long to keep your foot on the throttle.

Learning to sail fast:

- ❑ For most cruisers, the concept of pushing their boat to extract maximum daily runs is foreign. "We're not racing anyone" is an often-heard refrain.
- ❑ But learning to sail fast takes time, experimentation, and experience. The time to gain that experience is now, before boatspeed becomes a safety issue.
- ❑ The very best system for learning to sail efficiently and fast is to do some racing, if not in your own boat, then with someone else. Even better is to find yourself a sailing dink and join the "beer can" and weekend races for the summer.
- ❑ A summer's racing will teach you more about boatspeed than a circumnavigation.

Using the Engine

We've never been big on relying on the engine to get out of trouble. But when it comes to reducing passage times, if the breeze lightens up and there is a need to make a fast passage, the engine comes on.

When should you cease sailing and begin to motorsail?

It will be a function of the distance left to cover, risks involved, and range under power.

Since range is a function of boatspeed (the slower you go, the better the range) the equation can get a little complicated.

There are several important things to keep in mind. You need to have a reasonably accurate database in the log for fuel consumption in varying situations. This includes beating, motorsailing with some help from the engine, and powering in calm conditions. The time to generate this data is when you first start cruising—before fuel and speed management become a safety issue.

Timing Landfalls

Timing your landfall, arriving with good light, the proper sun angle, or at the correct state of the tide can be a critical safety issue.

If the landfall takes place in threatening weather, these issues become even more vital.

If weather is a potential threat, we feel it is best to push hard until we are within three or four hours of our landfall, and then slow down.

Of course, if weather is not an issue slowing down the average rate of speed, half a day out may make more sense.

Weather Tactics and Passage Times

The biggest potential impact on passage times is how you play the weather. Play it right, and you have good sailing angles and the best wind. Play it wrong, and sailing angles deteriorate and windspeeds become less than optimum.

Often a tack or jibe at the correct point in a passage can reduce the time at sea and increase comfort by a significant percentage.

Obviously, understanding the weather is critical to your heavy weather tactics. What we want to emphasize, however, is that this is equally important to keeping you out of heavy weather in the first place.

Down the South African Coast

The raft-up on the international pier by the yacht club in Durban, South Africa (above) holds an eclectic mix of boats from all over the world.

Among the yachts there are new friends to be made, and old acquaintances to catch up with. Between the social scene, and the weather on the South African coast, it's hard to pull away.

Move with us now to Durban, South Africa. The wind howls through *Intermezzo*'s rigging as she tugs at her dock lines. Snugly secured to the Point Yacht Club dock we are weathering yet another southwesterly gale.

For three weeks now, we and a number of other visiting yachts have been waiting for a clear stretch of weather—just enough of a breather to allow us to travel the 230 miles down the coast to East London. Every night we crowd around the club television to listen to the latest weather report and study the synoptic map. It's not that we really want to leave. The club facilities are wonderfully located—tucked behind a lovely park in the middle of a beautiful, modern city with laundry, supermarket, and library only a few blocks away. We could stay forever, but new ports beckon.

Just 230 miles doesn't sound far in the context of the 13,000 sea miles we have covered in the last year, but this short passage is likely to be among the hardest we will do. Late spring and early summer in this part of the world bring a succession of fast-moving high pressure systems with interspersed vigorous lows. These compact systems generate strong southwesters that by themselves wouldn't be too bad. The real problem is the Aghulas Current. Running south at 3 to 8 knots, it opposes the wind, creating mountainous, steep waves in the process.

Add a sharp drop at the edge of the continental shelf to swells arriving from the Southern Ocean, and you can understand why professional mariners consider this coastline the most dangerous in the world. Even though we have a lot of faith in *Intermezzo*'s abilities, we prefer not to put her to the ultimate test.

Local Meteorology

And so we wait and wonder what surprises may be in store for us. *Intermezzo*'s tanks are topped off, the fridge is full of fresh supplies, and our heavy number-3 jib is bent on the headstay. A light northeaster teases us, and the forecast "guarantees" two delightful days of clear weather. With a fair breeze and fair current, we should make quick work of this short passage. If we are lucky, we might even make it farther down the coast before the weather breaks.

Three other yachts hastily make their preparations as well. It will almost be a race.

We cast off and pull out of the raft-up in front of the club. With a last round of farewells we motor clear and head for the breakwater. *Intermezzo* lifts her head as the first swells sweep by. Before long, she is plugging along at 5 1/2 knots under the drifter, main, and mizzen staysail. While this part of the world has a reputation for unreliable forecasts, our own instincts have jived with the reports of the professionals, and we see nothing outside the harbor to make us change our mind.

On a passage that runs the same direction as the weather, you may get two or three days' grace, enough time to complete many voyages without undue hardship. But if you are heading towards the systems as we are here, a day may be all the time you have before a major shift in conditions.

You Can't Rush the Weather

One of the axioms of coasting the southern end of the African continent is that you either stay close inshore or go far outside, beyond the influence of the Aghulas Current. This keeps you out of the breaking seas when southerly quadrant winds oppose the current.

However, with the north wind now blowing, we have decided instead to play the current for as much speed as possible and duck inshore if we get caught in a southwester.

Twenty-four hours later we are beginning to wonder about our tactics. The fair breeze has gone around to the south but remains light. We are some 30 miles offshore, and our engine transmission has chosen an inopportune moment to quit.

We are now beating, heading directly for shore. The weather forecast hasn't mentioned a blow, but a dropping barometer and the windshift are

Intermezzo was a very tender vessel by today's standards. She carried a large rig, had a narrow beam, and an even smaller waterplane. She would go like a bat in light airs, but we really had to work to keep her on her feet when the wind blew.

We carried a powerful Aries servo-pendulum windvane (shown here without the air rudder as we are using the autopilot to steer). This fast-acting device, coupled with a balanced spade rudder and a fin keel, did a marvelous job of keeping us on course in adverse conditions.

not good signs. It appears there's another front on the way.

At 3 or 4 knots of speed, even a slow-moving system will be able to catch us before we get to East London. We change up to our heavy number-2 genoa. It will keep us moving, and with a reef in the main we should be able to carry it to 30 knots of wind. Getting close to the beach, across the continental shelf and out of the current, is now our main goal.

Navigational Constraints

Intermezzo is pounding hard. Bone-jarring shudders run stem to stern as she crashes through the almost-vertical waves. It seems only minutes ago that we had a calm sea, and now it is blowing 25 to 30 with 6- to 8-foot (1.8 to 2.4m) waves.

We are torn between reducing canvas, putting our speed at a more comfortable level and pressing on before the wind and sea makes up even more. Pretoria weather hasn't dignified our blow with a forecast, but we are concerned about the continuing rapid drop in the barometer.

That is the basic problem we all face coming down this African coast. We and the weather are on a collision course. And right now there is nothing to do but hang on.

With the wind still building, we are forced to shorten sail. We tuck a reef into the main, and our motion eases somewhat. But we are concerned that *Intermezzo* may drop off a wave face into a trough. The genoa should be furled in favor of the heavy staysail, but we need every bit of boatspeed.

We seem to be crossing varying areas of current velocity. At some points the seas even out a bit; then just as we relax, they become nearly vertical again.

We can see the coastline now. The coastal mountaintops are lost in cloud. Before long we'll reach the continental shelf and the haven of its counter-current.

Three hours later, we are beating our way through the breakwater. It is blowing a steady 50 knots, gusting much higher. The conditions offshore in the Aghulas current must be horrendous. Had we taken it easy coming down the coast—been just 20 miles further north—we'd be out in those breaking seas.

Heavy weather is very much a matter of perception and understanding what it is all about. Where a lot of folks would really worry about working their way south in Aghulas current, they wouldn't think twice about visiting a South African game park. But from our perspective, we'd much rather deal with the Aghulas than an unhappy hippo, like the one we photographed above in Schsloi game reserve. If you make a mistake with the weather you have a chance to recover. Make a mistake with a hippo and you're finished with this terrestrial journey!

We can never be 100 percent certain of the weather to be encountered. We can reduce risks but never totally eliminate them.

Passage plans must take into account the characteristics of the vessel and the area through which it will be travelling.

- ❑ Are there intermediate ports to use in the event that weather threatens?
- ❑ How difficult are the entrances?
- ❑ Can they be negotiated in foul weather, with a sea running, or at night?
- ❑ Will you be on a lee shore?
- ❑ How seaworthy is the boat?
- ❑ How fast can she travel under power (including range) and under sail? The wind often dies in the approach path of a major storm system, and with good powering speed/range, you can scoot out of harm's way.
- ❑ How prepared for heavy weather are the boat and crew?

Lindsay Turvey

Wind and Waves

Most passages take place in pleasant weather. If you choose your seasons correctly, keep an eye on the weather systems, and look upwind (typically west) for potentially adverse conditions, the odds weigh heavily in your favor. In fact, in over 200,000 miles of voyaging, we've only been in dangerous weather for a total of less than 72 hours.

But yachts do get caught in situations beyond the scope of the vessel or crew's abilities. In almost all cases they are surprised by the conditions. There seem to be more boats getting caught unawares these days than in the past, despite enormous strides being made in forecasting techniques, computer modeling of the atmosphere, and the availability of weather data on the Internet and via SSB, ham radio, and weatherfax.

We suspect this is due mostly to the fact that more people are taking off on long voyages before they get a good handle on weather analysis, forecasting and tactics.

On the other hand, if you understand the subject, have up-to-date sources of data, and watch the mid-and long-term trends in the weather, you'll probably never need to use the heavy weather techniques discussed in this book.

If you're caught in a blow, understanding the meteorology taking place around you is an important part of making the correct tactical decisions—a strong case can be made that it is the most important ingredient in heavy weather tactics.

As discussed earlier, it's not the wind that causes the problem, but rather the seas it raises. This is a subject much more difficult to get a handle on. In fact, the chaotic nature of waves is such that there are very few easily identified and reproducible rules of thumb for them. However, there are some basics which in our experience apply across the board. We'll be covering these in the chapters on oceanography which follow.

We'll start this section with an overview of weather and tactics, and then move onto waves and how they are created. For those more interested in a detailed look at analysis, forecasting, and weather tactics, we have written *Mariner's Weather Handbook.*

Heavy-Weather Avoidance

A primary aim of understanding weather is to avoid its more unpleasant aspects. Given what we know today about onboard forecasting and what's available on the Internet and via facsimile reception, the odds of being caught out are rare. Yes, the professional forecasts do miss on occasion, but there are still plenty of signs to alert you before you leave, as well as while you're at sea—if you know what to look for.

The key to knowing the best weather tactic is being able to analyze where you are relative to the storm center. You should not rely on external forecasts to accurately give you this data. If you understand the basics of analysis and forecasting, you can easily confirm the external forecast or make your own.

Weather Tactics If You're Caught

In every storm there's a safer, more comfortable position, even if you cannot avoid the blow entirely.

Some courses will take you towards stronger winds while others will take you away from the most dangerous quadrant of the blow. Sometimes running will take you with the storm, keeping you in its grip for a longer period of time, so beating or heaving to may be the best course of action. In other situations running may take you away from the direction the storm is traveling.

The time element involved between raw data being received by the forecaster, the forecast being made, and the dissemination of that forecast varies throughout the world. In the US, the Marine Prediction Center will broadcast a first cut at the surface analysis within 3 1/2 hours of starting a computer run. More detailed data is broadcast at later intervals. However, in some parts of the world it is not unusual for a forecast to already be 12 hours old by the time you receive it. If you happen to be in some of the better cruising grounds, the forecasts may be totally based on satellite imagery, without benefit of sea-level data.

Outside vs. Onboard Forecasting

If you keep track of barometric pressure, wind direction and velocity, cloud development, and sea state, you are much more likely to make an accurate forecast for your patch of ocean than a forecaster, working with a supercomputer in some government office thousands of miles away.

Still, in the past decade, the world-scale meteorological models have gotten a lot better. This is a function of computer power, better programming, and more accurate data. With more ships, planes, earth stations, and satellites reporting than ever before, the computer programs have much better data from which to start their projections.

When you couple this data with satellite imaging in the infrared, visible, and water vapor spectrums—which forecasters use to confirm computer analysis (or throw it out)—the end product transmitted to us at sea is of far higher quality today than even five years ago.

This data is necessarily on a macro scale. The generalized report, while it may be pretty accurate on a macro basis, can be quite far off at your specific location.

By comparing the forecast data with your own conditions, you will have a pretty good feel for where your local weather is coming from, and how to use it to best advantage—or how to limit your exposure.

The Weather Puzzle

Weather data you receive from outside sources is only one piece of the larger puzzle. If what you hear (or read, in the case of a fax or navtext,) agrees with what you are seeing *in situ*, then it is probably safe to think the assumptions behind the forecast are accurate. On the other hand, if your conditions are different, it is almost always better to go with an onboard analysis, especially if safety issues are involved.

Risk Analysis

Weather represents the ultimate in chaotic behavior. With so many variables interacting, you cannot always know exactly what is going to happen in any given timeframe. Yet in all of the weather events that we've discussed so far, there were early warning signs of the potential for severe weather.

The key is recognizing these risk factors, then looking at them in the context of: crew skills, vessel capabilities, alternate harbors of refuge, the boatspeed you have at your command, and the amount of risk you are willing to assume.

All weather is based on variations in temperature and humidity in adjacent air masses. The larger the difference, the greater the potential for severe surface-level conditions. The key to risk factors exists in the potential for temperature and humidity differentials.

Here are some of the common weather scenarios for which we've learned to watch.

Tropical Lows

Any wiggle in surface-level isobars in the tropics is cause for concern. If this low pressure area of warm, moist air migrates away from the equator and connects with cool and dry air from the higher latitudes, typically from a high pressure system, you have the ingredients for a "bomb." The Queen's Birthday storm in 1994 started this way.

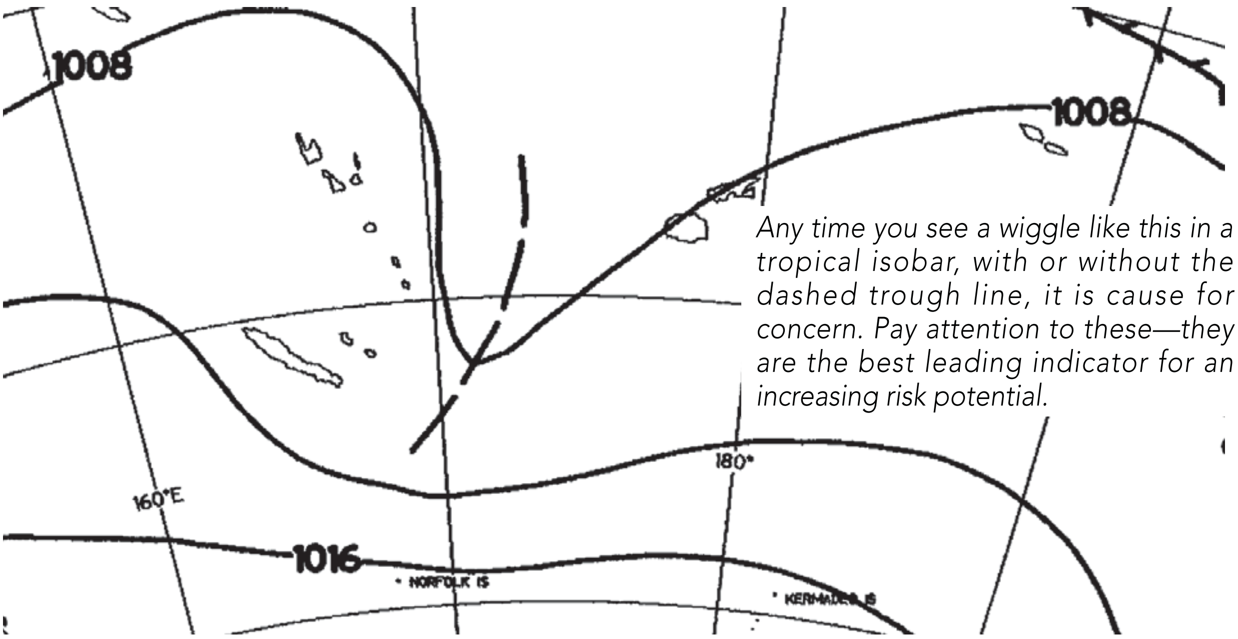
Or, that wiggle or closed isobar can become a tropical storm or hurricane. However, we are fortunate that tropical storm formation can be watched by satellite, and risk factors inherent in an area of thunderstorm activity show up quite early.

By watching the steering currents in the tropical region, you will be able to assess if it is safe to proceed, or if you need to make an early dash for a hurricane hole.

Within the tropics, any variation from the daily normal fluctuation on the barometer, typically plus or minus 1.5mb, is a cause for concern.

It's easier than you think:

- ❑ The entire subject of weather forecasting may seem intimidating, but in reality the basics are really quite simple. Once you get a feel for a few simple rules and practice a bit, you are on your way.
- ❑ The time to hone your forecasting skills is when you're ashore, and when you're cruising in moderate weather.
- ❑ Expect to have to work through a good weather text several times before you are comfortable with the concepts.
- ❑ As you get into the subject matter, even if you're ashore, practice making predictions. Match your growing ability against the local weather gurus. You will be pleasantly surprised how quickly you become relatively skilled.



Any time you see a wiggle like this in a tropical isobar, with or without the dashed trough line, it is cause for concern. Pay attention to these—they are the best leading indicator for an increasing risk potential.

When a tropical storm transitions to an extratropical structure, the area of ocean covered by storm-force winds is much greater than with the tropical storm phase. Additionally, in the higher latitudes these weather systems can move at speeds as high as 50 knots (more than 1000 miles per day) with dramatic pressure drops and extreme wind and seas.

Tropical to Extratropical Transition

Every year a certain percentage of tropical storms make the successful transition from tropical structure to that which is required to sustain themselves in the higher latitudes—Hurricane Mitch pasting the Caribbean 1500 rally in 1998 was such an event.

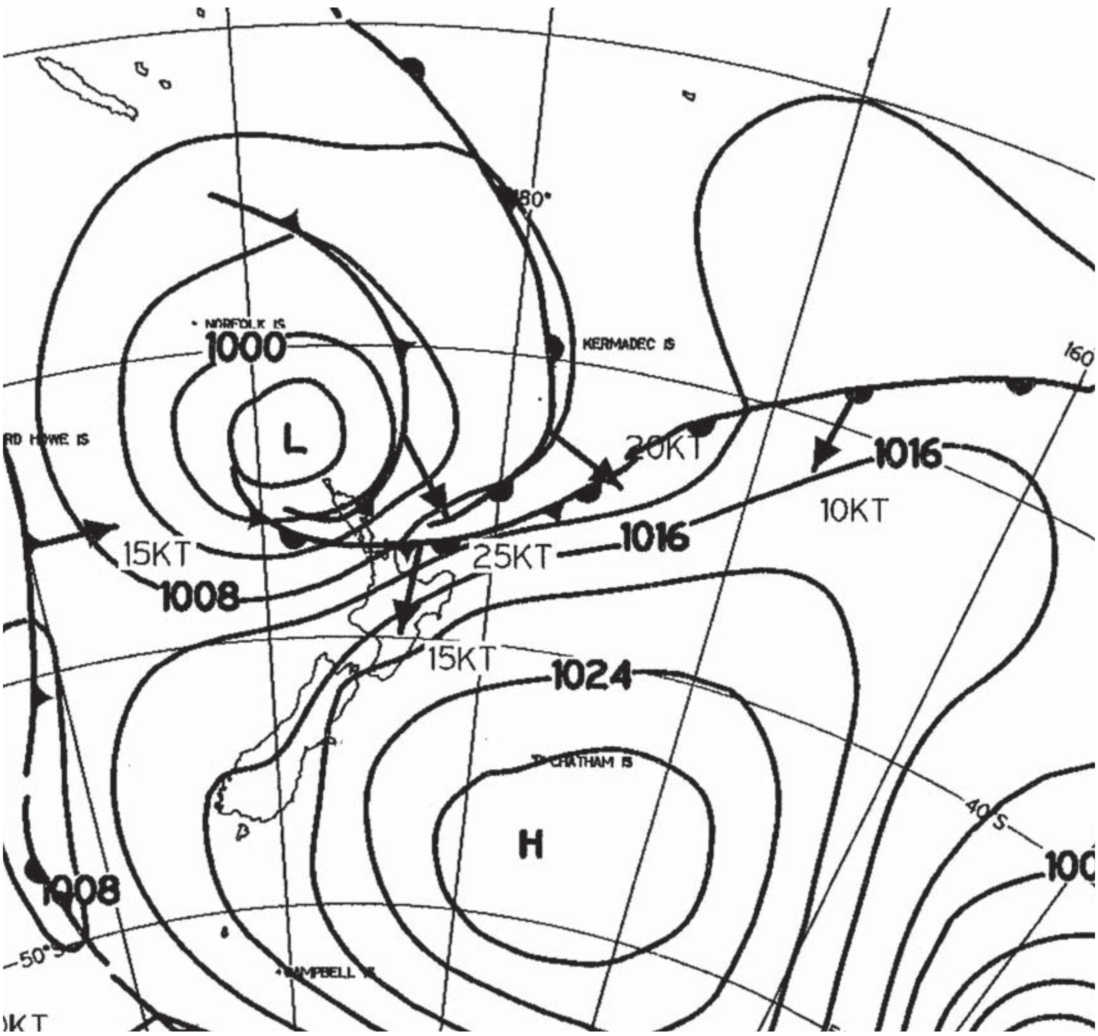
The upper level atmospheric conditions necessary for this to occur are well known—the tropical storm becomes embedded in the flow around a subtropical high pressure system. As it edges its way out of the tropics, a new venting mechanism must be established or the tropical storm dies. This venting is provided by an upper level trough. The probability of a trough is readily visible on the 500mb fax charts.

Compression Zones

Wind is a function of the pressure gradient (which is shown on fax charts as the spacing of isobars). The tighter the spacing, the stronger the wind. Where you have weather patterns made up of a succession of highs and lows, if one system stalls and the other runs into it, the isobars become compressed. This usually takes place as a fast-moving low pressure system runs into a slower high pressure system.

When this happens, significant increases in wind strength will occur with little or no change in wind direction or barometric pressure. Compression is frequently a factor in storms at sea, and features in many of the stories in this book.

With compression zones, the barometer typically stays steady as does the wind direction, while windspeed increases. It is our feeling that this phenomenon accounts for most of the heavy weather problems encountered by yachts. The western end of the South Pacific, in the area of New Zealand and Australia seems to have more than their share of these systems.



Warm Ocean Currents

Any time a mass of cold air comes in contact with a warm ocean current, the potential for severe weather increases. The warm current provides a source of heat and humidity, which increases the local vertical mixing of the air currents. The greater the temperature and humidity differential, the stronger and gustier the winds. This is why the Gulf Stream can be so dangerous when hit by cold, dry air coming off the continental US. Anytime you see a source of colder, drier air—be it continental front or arctic high pressure system—if it catches you when you're in the Gulf Stream the odds increase for serious weather.

Warm ocean currents typically cause the biggest risk factors in heavy weather. Not only do they stack up the seas when they oppose the wind, but the change in temperature also provides fuel for the storm system.

This feature also contributes to the weather and sea state problems often found in the Aghulas current off Africa and the South Australian current off the southeast corner of Australia.

You will find many of the sea stories in this book take place in areas of warm water currents frequented by masses of cold air.

Secondary Lows

It is not unusual to find secondary lows forming off mature frontal systems. The secondary lows are usually smaller, typically on the equator side of the primary depression. Sometimes they combine with the primary system, bringing a new source of warmth and humidity up from the subtropics. When this occurs rapid development of severe weather often results. This is thought to be the mechanism that triggered the Fastnet gale in 1979 (see page **599**), as well as the storm chronicled by the crew of *Theta Volantis* (page **124**).

Upper Level Troughs

In the section on the passages to New Zealand, we discussed how everything that happens on the surface is related to events in the upper atmosphere. The keys are a series of semi-permanent and itinerant upper level atmospheric "waves." When a vigorous upper level short-wave trough forms and then comes into phase with a long wave, surface weather development is apt to be fast and severe.

Understanding the 500mb charts is a key ingredient to avoiding bad weather.

This data is shown on 500mb fax charts which are available from USCG facsimile broadcasts and on the Internet. They are also broadcast via facsimile by some international weather stations. Recognition of these warning signs is pattern-based—you watch the charts for a period of time, noting the shape and speed of the upper level features and how they are progressing. After a while, you will get a feel for what looks like it has the potential to become a problem.

Bent Back Warm Fronts

Bent back warm fronts (also known as comma-head storms, Kaiser Shapiro fronts, or baroclinic storms) are the most dangerous of all weather systems we face at sea. They develop rapidly, with pressure drops as great as 65mb in 24 hours.

The clues to their formation are found on the 500mb charts. Look for a significant series of short-wave troughs where the wind flow on the downwind (typically east) side of the trough is confluent (coming together).

Seasonal weather patterns:

- Longer-range weather patterns are of greater concern to cruising sailors than locally generated weather patterns, and on a macro scale are to some degree predictable.
- Weather patterns vary tremendously over the course of a year; both in the potential damage they may cause and in their predictability.
- As a general rule, summer months—whether north or south of the equator—offer the mildest weather, except where tropical storm development can occur.
- Equinoctial weather (spring/fall) can be the worst in terms of speed, movement, and development, making equinoctial gales among the hardest to predict.
- Winter storms are generally easier to predict, if a bit colder.

Local Compression Zones

An especially dangerous type of localized offshore breeze can be generated by stationary high and low pressure areas rotating asynchronously. The wintertime "Santa Ana" winds on the northern Mexican and southern California coastlines are one example of this effect. The switch from light, pleasant sailing to roaring northerlies is usually abrupt. If you are anchored in an exposed location, say the northeast side of one of the offshore California islands, when the Santa Ana arrives you will suddenly find yourself on a dangerous lee shore.

The right ingredients to create a Santa Ana condition can exist for weeks with nothing untoward happening. As a result, many sailors in these areas tend to ignore the potential danger. At night, a high barometer and a clear, sharp sky are precursors. During the day, abrupt shifts in temperature and a definitive dirty cloudline towards the mainland are telltale signs.

Hurricanes vs. Extratropical Storms

Whenever you are heading to or from the tropics, choosing the right season to leave becomes a major issue.

There is a trade-off in risks. If you are heading towards the tropics from a temperate zone, it will be at the end of the summer or in early fall. At this point the trade-off is between a late hurricane or early equinoctial gale.

Returning from the tropics to temperate latitudes the issue is reversed. The later you wait in the spring or early summer to make the passage the greater the early hurricane risk becomes, while the extratropical storm risk is reduced.

Consider that the typical tropical storm or hurricane moves at between 7 and 15 knots, and usually takes three to five days to mature from a group of thunderstorms to storm or hurricane status (typically giving you plenty of warning). Once the tropical system matures, the radius of storm- or hurricane-force winds is generally moderate. Even large storms rarely have more than 100 miles in diameter worth of hurricane force winds.

Now look at extratropical equinoctial gales and storms. These can develop rapidly, sometimes as fast as in 12 to 24 hours. Gale- and storm-strength winds can cover as much as 600 or more miles of ocean and the systems can move at 25 to 50 knots. The seas produced by these rapidly rising winds which cover so much fetch, are typically much larger, and influence an area many times greater than that of a pure tropical storm system.

In short, the extratropical gale/storm systems are generally harder to avoid and more dangerous than their tropical counterparts.

This consideration should be a major part of your thinking when deciding on what part of the season to make the tropics-to-temperate (or reverse) voyage.

Coastal Passages

Coastal journeys entail less risk weatherwise than longer, offshore passages. Weather data is apt to be more reliable and harbors of refuge closer. Thus, weather factors are not quite as important as they are when you venture offshore, when you will be at risk with the elements for many days. However, visibility, always a function of weather, is far more important close to shore.

Long-Term Rhythms

While weather is essentially a random, chaotic series of events, there are certain long-term rhythms that affect what happens, both on a year-to-year basis and within given seasons.

The El Niño and La Niña events of the Pacific basin have a worldwide impact on hurricanes, rainfall, frontal formations and the tracks of highs and lows across the major oceans. These can be year- or multi-year-long events.

The Madden Julian Index of the Indian and Central South Pacific Oceans reflects shorter-term weather oscillation. These are pulses of increasing and decreasing rainfall moving from the Indian Ocean, across Indonesia, and then into the Central Pacific to the area of Tonga (the international date-line).

Typically these bring two weeks of disturbed weather, then a month of settled conditions.

During some years the waves are weak and difficult to detect. Other years they are very pronounced. There is some data to indicate that, in the summer, cyclones will form during the wet phase. The cycle itself can be used as a leading indicator for these events.

Another factor is volcanic activity. If there has been a major eruption, at Mount St. Helens or Mount Pinitubo for example, it can change weather patterns on a global basis for several years. Smaller eruptions will have a months' long impact on regional weather.

Pilot Charts

We should talk for a moment about pilot charts and books which advise on the best course for a given passage.

These charts and texts are based on average data. As such, if you get an average year, with weather that fits the norm, everything will be fine.

But our experience, and that of most other cruisers, is that weather is rarely average.

So what do you do for passage planning?

If you are sitting at home or at the dock and toying with the idea of heading off, this type of resource will help you dream. But when the time comes to get serious about the passage, the best thing to do is to go to the local weather office and see what they have to say about the current short- to medium-range prospects. Better yet, get on the Internet and look at the long-range forecasts from the easily accessible global models.

Tropical Storms

These storms have different characteristics in various parts of the world, and while they have some degree of predictability and tend to display set patterns in formation; speed, direction, and movement; wind development; and size, they do not follow the same patterns as open weather systems.

For example, Western Pacific typhoons are generally larger and have higher windspeeds than their Atlantic or Eastern Pacific cousins, and they follow less of a seasonal pattern. Western North Pacific typhoons have been known to develop in all months of the year with some degree of frequency, although they tend to occur more often in summer months.

Pattern recognition:

- ❑ The majority of weather analysis and forecasting is based on pattern recognition. Over time you begin to recognize relationships between the highs and lows at the 500mb level and the surface, and how these interact with each other.
- ❑ In some locations and seasons three or four days of watching is sufficient. In other areas you will want to start watching two or three weeks before your projected departure date.
- ❑ Once underway you will want to continue to study the weather data—both the external forecasts and fax charts and what you find around you—always looking to identify any changes in the pattern.
- ❑ To become good at pattern recognition there is no substitute for taking time to study the weather before you leave.

Picking your window:

- There are two approaches to picking a final departure time. One is to wait until a clear period appears to be developing. It may result from a lull between weather systems, in which case powering may be the best way to move. Or a slow-moving high pressure system or even a double high may bring temporary stability to an area (a high tends to block any deep lows before passing on).
- A second approach is to wait until a favorable, somewhat stable weather system exists and then ride it as long as possible. This is the "better the devil you know than the one you don't" theory.
- In all cases it's important to look for unforecast risk factors which could cause a problem during your passage period. Remember that most bad weather announces itself at the 500mb level, well before it shows up on the surface.

If you choose to make a passage where the potential for one of these lows to develop is greater than you would like, you must maintain a careful watch of weather reports. Decide in advance how cautiously to play this cat-and-mouse game with bad weather. Sailors do make successful passages between revolving storms, but reliable power and good range are prerequisites. You have to be prepared to turn tail and run if the storm begins to head in your direction.

It is often possible to dip towards the equator to avoid tropical lows, since they rarely move into the equatorial zone. You should be prepared to head away from the storm's expected path, even if you must turn away from your destination. Finally, you must always keep in mind that storms are to some degree unpredictable and can jog suddenly or re-form quickly after seeming to have died.

Be careful about the type of landfall you are going to make when tropical storms are about. Overcast skies with heavy rain can extend many hundreds of miles from the storm center. If good visibility is required to close with land, you may have to wait.

Weather Service Conundrum

You cannot always depend on the government forecasts to do risk analysis for you. The professional forecaster may see a low-probability severe weather event on the horizon, but choose to wait until the potential becomes higher before broadcasting an alert. Perhaps the odds are only 1 in 20 that something will develop in the next 24 hours. That's too low for a formal warning. But if you are about to leave port, and know that there's a 5 percent chance of severe weather occurring after your first day at sea, you will probably choose to wait another day and see what develops.

You need to read between the lines of official forecasts to search out potential risk factors. To do this requires that you know the basics of analysis and forecasting. We don't want to sound like a broken record here, but obtaining this knowledge is absolutely critical to avoiding heavy weather (and, if you are caught out, choosing the correct tactics to minimize discomfort and risk).

When you read about the 1998 Sydney-Hobart pre-race weather briefings starting on page 260 you will get a better feel for this problem.

All the warning signs were in place and easily available to the competitors to review, but few took the time to access the data. And the Australian Met Bureau, in their "heads-up" about the race, discussed the likely scenario, not the low-risk potential for a major blow.

In the process of researching this blow in Australia, the local sailors and Met Bureau were very forthcoming with their answers. Clare Richards was kind enough to respond to a question on this subject:

> Our written forecasts do not indicate probabilities of the forecast being correct. However, if we have an opportunity to provide a verbal briefing (as was the case for this event), we can provide more information on the current situation and the forecast. In my experience, the forecaster's dilemma is that

there is only so much information that people can absorb in a given amount of time, and that there are always differences in their level of understanding, making it difficult to know how technical we can be. If given enough time for a briefing, we would discuss the existing atmospheric conditions and different (forecast) scenarios as suggested by the computer diagnostics and prognoses. We would then indicate what we believe to be the most likely outcome (what appears in the written forecast) and indicate if there is any uncertainty or other possibilities to watch for.

So yes, it is a dilemma of sorts, but it becomes worse if the people we are forecasting for either don't understand the limitations of computer models, or that a forecast is only the most likely outcome given the information we have. And, as you point out, there is always a possibility that a SMALL event may trigger a huge change. I emphasize "small" because it is often the mesoscale events that go undetected or are not adequately resolved by computer models, which can result in inaccurate forecasts.

We asked Dave Feit, Chief of the National Weather Service's Marine Prediction Center, if there were any formal guidelines for individual forecasters to use when looking at low-risk situations with potentially severe scenarios if things were to go wrong:

We have no formal quantification of risk factors. We want to get as much data into the written forecast and the fax charts as possible, so that our end users can make their own risk assessment. Our individual forecasters are going by experience and instinct. If someone has been burned in the past by missing a certain type of event, then the odds are he'll be more likely to forecast it earlier the next time.

We frequently do case studies on given situations to see how our analysis stood up.

The key thing that both of these professional forecasters are saying is that we, the end user, have to take the forecast data and search out the low-level risk factors for ourselves.

Weather Closure Speed

A major factor to consider when you are working up strategy is the direction you are sailing relative to the direction the weather is moving. In general, westbound vessels sail into weather and eastbound ones away from it.

If you are heading east then, the weather overtakes you. This means there's a much longer period between changing systems. If the low or high is moving at 15 knots and you are going 7 in the same direction, the system will come closer to you by only 190 miles a day. On the other hand, if you are headed towards the weather, the speed of closure in this example would be more like 528 miles a day.

Keep in mind that the speed of closure also affects the speed at which the barometer reacts. When you and the weather are on a collision course you will see a much greater rate of change than when the weather is chasing you. This should be factored into your analysis of the trends in barometric pressure.

We like to check with a meteorologist before a risky passage. This may be a marine forecaster or someone associated with the local airport. While this can be done on the phone, our preference is to visit the met office in person so we can look at the surface and upper level charts and the satellite images (visible, infrared, and water vapor), along with the long-term computer model outputs.

Questions we typically ask:

- ❑ Are we in a short-term weather cycle, and if so, what is the impact over the timeframe of our proposed passage?
- ❑ What are the potential alternate weather scenarios which could develop contrary to the official forecast, and what are the leading indicators that we should watch for at sea?
- ❑ What is the risk factor, however small, of a severe weather event occurring, and what are its leading indicators?

In the end, it may make sense to wait until the long-range weather situation is more stable, or perhaps, an alternate destination will reduce exposure time.

Weather Tactics

If you end up in heavy weather, it is important to have a feel for the trend in the weather leading to the present situation. Within this trend lie the keys to avoiding the worst of the storm system, and/or getting out of it as quickly as possible.

What follows is a very basic approach to weather tactics. It is not intended to supplement a proper course in the subject. Keep in mind that in many weather scenarios, as little as 50 miles can be the difference between survival conditions and a strong gale.

Keep in mind that even in a horrendous weather situation there is always a favored course—likewise, if you're hove to or beating slowly, one tack will take you towards better weather more quickly.

Finding the Storm Center

To be able to develop good weather tactics you need to understand wind circulation patterns. In depressions both in the tropics and outside of the tropics, winds rotate counterclockwise around the center in the Northern Hemisphere and clockwise around the center in the Southern Hemisphere.

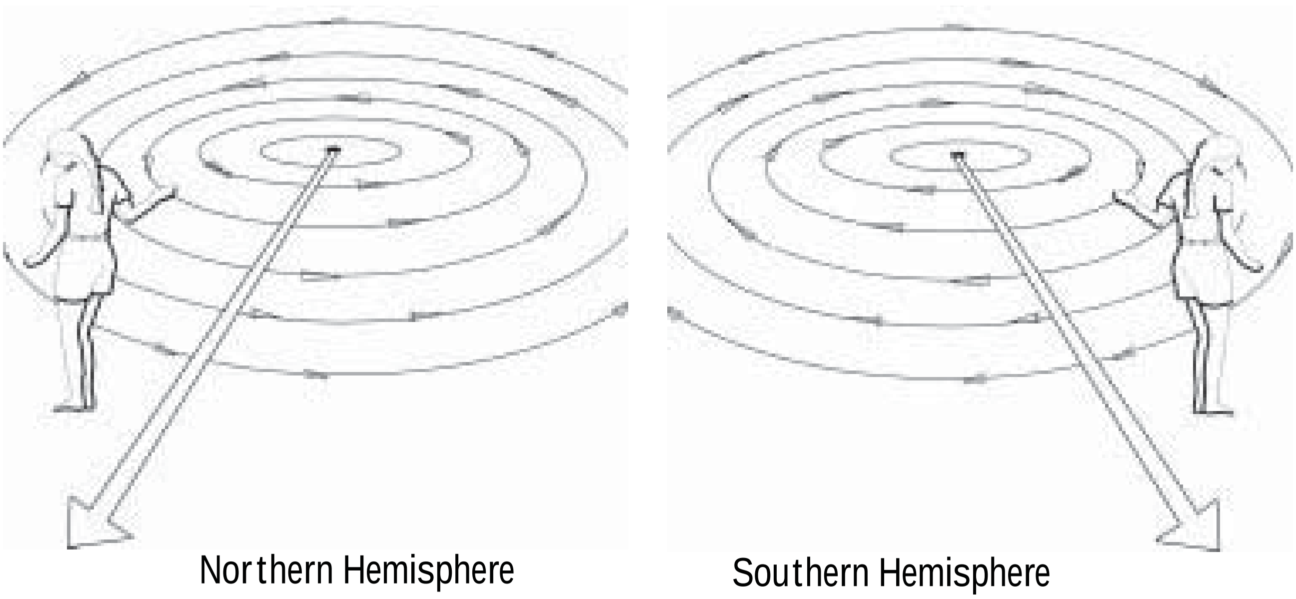
Rather than exactly following the isobar lines shown on weather maps, the wind direction is angled in towards the center.

The amount of angle depends on where you are relative to the storm center and the storm structure itself.

In the Northern Hemisphere, if you stand facing the wind and point with your right arm straight out, you will be pointing toward the storm center.

In the Southern Hemisphere, point with your left arm to find the storm center.

There are also techniques for using clouds aloft, barometric pressure, and wind shifts to confirm the location of the storm center. These are beyond the scope of this work, but can be found *Mariner's Weather Handbook* or any good weather text.



Finding the depression center is typically quite simple. In the Northern Hemisphere, where winds rotate counterclockwise around a depression center, face the wind and point with your right arm extending at right angles to your body (left drawing). This will indicate the center of the low pressure system within 10 to 20 degrees. In the Southern Hemisphere with winds rotating clockwise around the center, face the wind and point with your left arm.

Surface Wind Fields

The wind around a given storm center varies with many factors. One is the type of storm structure. Extratropical storm systems have abrupt wind shifts and changes in velocity based on the location of the warm and cold fronts. In these systems, the winds around the core also vary with the type of storm structure, such as whether it is a Norwegian or bent back warm frontal system.

Tropical storm systems have a different type of atmospheric structure and do not exhibit the same type of frontal passage as do higher latitude extratropical storms.

In both tropical and extratropical systems, the direction of the storm's travel impacts the wind strength you experience. Where the winds are blowing in the same direction as the storm is moving, the circulation wind strength is added to the speed of movement. This has a large impact on wind force, which goes up with the square of the increased windspeed.

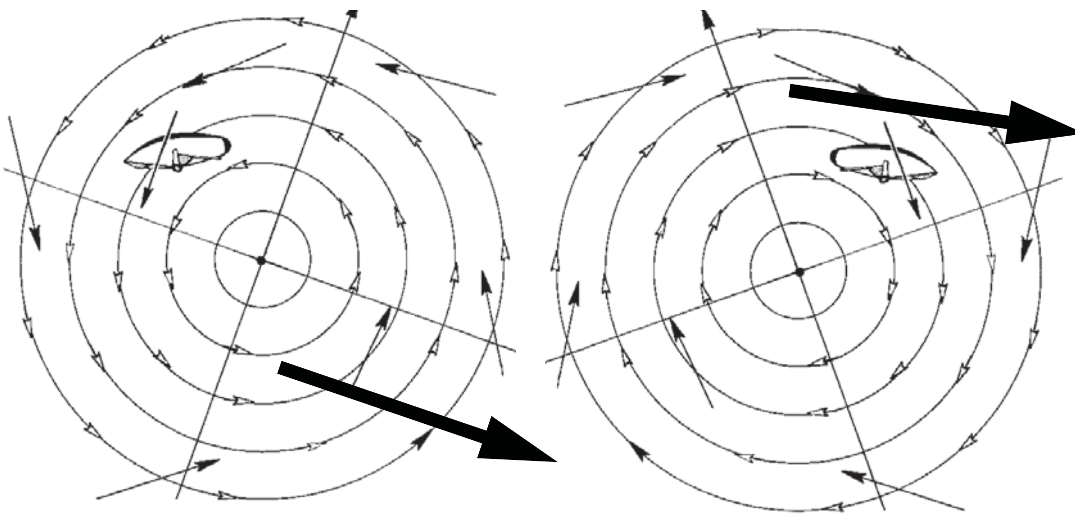
This means that if you are on the equator side of a storm system, where the winds will be blowing from the west to east, and the storm is moving east, you are in a much windier quadrant of the system.

The opposite would apply if the storm were moving to the west, you would deduct the speed of travel from the windspeed.

Keep in mind that extratropical storms can move as fast as 40 or 50 knots, while most tropical storms typically travel at speeds of 5 to 15 knots.

Keep an accurate weather log:

- ❑ In any given weather situation, there are basic assumptions being made about barometric pressure, wind strength and wind direction. Other assumptions involve cloud type, coverage, and direction of movement.
- ❑ We like to make notes in our log about what we expect to happen with these factors and the weather in general, and what signs to look for to confirm the forecast, on which we are basing our strategy.
- ❑ By keeping a written record of this data, we can watch the trends as they unfold. This is far more valuable than just eyeballing the weather when on deck and guessing at the trends.
- ❑ We go so far as to write target barometric pressures on Post-It notes and stick them near the barometer.



When you add the speed of the wind which is circulating around the weather-system center, to its speed of movement, the windspeed and force escalates rapidly. In many extratropical situations it is the winds on the equator side of the depression that are subject to this phenomenon.

When you are on the pole side of most extratropical weather systems, their circulation is typically opposite the direction of travel, in which case the speed of movement is subtracted from the rotating wind speeds.

As with anything to do with weather, you need to take these comments about pole and equator side with a grain of salt. The generalizations above are only true when the storms are tracking in an easterly direction, which is the norm much of the time for extratropical systems. On the other hand, tropical systems often move in a westerly direction, and extratropicals, under the influence of upper level weather, can move in any direction.

Extratropical Storm Tracks

Extratropical storms typically follow tracks dictated by upper level winds. You can get an excellent handle on this by watching the 500mb charts.

You also need to watch for the impact of large high pressure systems which can sometimes block lows, slowing or stopping their travel altogether, while compressing the isobars between high and low, further increasing wind strength.

In heavy weather, you will obviously want to adopt the course taking you away from the storm's track as quickly as possible.

Extratropical Weather Tactics

Questions you can ask about the weather situation:

- ❑ Where is the storm center?
- ❑ What is the direction of travel?
- ❑ What is the likelihood of the wind strengthening or dying?
- ❑ What is the likelihood of the storm track changing?

There are no pat answers to the best weather tactics. By the time you mix in navigational issues, the weather itself, currents, wave shape, and vessel and crew capabilities, the possibilities are endless. All of these factors need to be weighed in coming up with the best approach for the weather.

There are two major questions you should consider: How do you avoid the worst of the storm, and how do you get out of its influence as quickly as possible?

In many cases, the best tactic will be to beat slowly or heave to on the tack that takes you away from the storm center, especially when this tack is opposite of the storm's track.

There are other times when running off will take you away from the storm center, or from a developing system.

It all depends on the storm track, where you are relative to the storm center, and how the system is developing.

Frontal Passage

With the passage of a warm front and then a cold front, you will find a change in wind direction and velocity.

This will vary with where you are relative to the system center and the type of storm structure.

In the Northern Hemisphere, there will generally be a slight clockwise shift in the wind direction with the passage of the warm front, and a more pronounced clockwise shift with the passage of the cold front. The cold front also brings with it more gustiness and typically stronger winds.

In the Southern Hemisphere, the shifts are counterclockwise with the passage of the fronts.

Tropical Weather Tactics

Tropical storm systems vary in two important ways from those found in higher latitudes. First, as mentioned earlier, the area of really strong winds is relatively modest compared to extratropical storm systems. It is not unusual to find hurricane-force winds in an area limited to less than 50 miles in diameter. One hundred miles from the storm center, gale-force or even weaker winds may prevail.

On the other hand, the winds in close to the center can be significantly higher than those found in large ocean storms (although hurricane force and above are found in extratropical systems).

Because of the compact nature of the tropical storm wind fields, making sure you are not caught in the wrong part of the storm is even more important than with higher-latitude systems. This means taking early evasive action; and if you find yourself caught in the "dangerous" quadrant, doing everything possible to avoid being driven into the center of the storm.

In the Northern Hemisphere, if you are caught in the dangerous quadrant, you want to beat as fast as possible on starboard tack; in the Southern Hemisphere you beat on port tack.

On the other hand, if you are in the "navigable" side of a Northern Hemisphere storm, you will be broad reaching on starboard as the storm approaches, with the wind gradually going forward of the beam as the storm passes. In the Southern Hemisphere it is again the opposite in the "navigable" side: you begin by broad reaching on port tack with the wind going to a close reach or beat as the system passes.

If you plot the barometer on a half-hour or hourly basis, in many cases it will start to rise just before the wind shifts. This gives you fair warning of the coming change and time to adopt a new approach to the storm.

This pro-active approach to the weather and to seamanship will get you through the experience with far better results.

Tropical Storm Tracks

As we said earlier, tropical storms tend to move much slower than extratropicals. This is due in part to their structure, and in part to the weather, in which they are embedded.

In most parts of the world, there are typical tracks that storms will follow while in their formative stages. These tracks usually follow high pressure system flow if that high pressure has vertical depth (extends into the upper atmosphere).

Storms that form deep in the tropics will rarely head towards the equator—they normally move parallel to the equator or away from it.

Once the storms begin to reach into the subtropics all bets are off on movement. Here they can speed up, re-curve, and move in just about any direction depending on upper-level wind flow.

Upper-level steering currents are one of the factors to watch, as are areas of warm or cold water, land masses, and upper-level wind shear (or continuity).

Weather Sense

We'd like to close this section with a final pitch to develop your weather awareness. The same mechanics that apply to moderate frontal passages also apply to major storms.

If you understand the basics of meteorology, you will understand what the weather is doing around you.

When you are caught in a major blow, there is a tendency to hunker down and just try to survive. People put their boat, their minds, and their bodies on autopilot—waiting for the storm system to go away and leave them in peace.

A better approach is to stay actively engaged. Watching the weather and keeping track of the barometer, sky, and wind trends keeps you and the crew involved in the battle. This way, when there's a change in the situation, perhaps the front has passed and the wind has shifted, you are immediately aware and can take the next step in your plan of defense.

Rick Tomlinson

Not all large waves are dangerous. Danger is a function of wave shape, boatspeed, and boat direction. Even breaking waves in the Southern Ocean can be ridden with the correct technique and vessel design. In fact, surfing big waves at speed is one of the greatest thrills in sailing.

Sea State

Everything we do at sea is influenced by the existence of wave and swell systems (or lack thereof) and what we expect in the future. Usually this is just an issue of comfort and boatspeed. In the context of heavy weather, however, our safety is involved, since it's the waves, rather than wind, which pose the greatest risk.

In the following chapters we will be passing along some of the science and lore of waves.

Our goal is to give you a feel for the process, by which dangerous seas are created. If you know when the risk of encountering a problem wave is increasing, you can then make the correct tactical decision for the conditions in which you find yourself and the vessel upon which you are sailing.

We want to start this section with some details on a voyage by Miles and Beryl Smeeton, and their crew John Guzzwell, aboard *Tzu Hang*. This is a classic "rogue wave" story, one which has been cited by proponents of various storm tactics for many years.

Tzu Hang was a heavy displacement, 46-foot (14m) long ketch, 36 feet (11m) on the waterline, with an 11.5-foot (3.57m) beam, and 7-foot (2.1m) draft. The hull was well balanced between the modest beam and double-ender configuration. She had a tiny cockpit aft, a bridge deck, and then a very small doghouse.

We met up with Tzu Hang in the Society Islands of French Polynesia in the late 1970s (she was by then owned by Bob Nance), and was still an impressive-looking vessel.

Tzu Hang

The Smeetons, together with their daughter, had sailed *Tzu Hang* from Europe to Melbourne, Australia via the usual tradewind route.

The Smeetons were neophytes when they left Europe, but, by the time they had reached Australia, both they and *Tzu Hang* had been thoroughly shaken down.

On the way down the Pacific Coast, and across the Pacific, the Smeetons had shared many anchorages and meals with single-hander John Guzzwell, who was circumnavigating aboard his own boat.

When John heard that the Smeeton's daughter Clio was headed back to school, and that they would like to take a crack at rounding Cape Horn if suitable crew could be found, he signed on.

Their passage took them through the Bass Straits between Australia's southeast corner and Tasmania, and then well south of the South Island of New Zealand. Crossing the South Pacific, they spent much time in iceberg country, below 50 degrees South latitude. They experienced the usual progression of moderate winds, gales, storms, and drifting conditions.

Miles Smeeton

Miles Smeeton picks up the story (excerpted from *Once Is Enough* with permission of Clio Matison) on their 28th day at sea, roughly 1,100 miles east-southeast of Cape Horn. *Tzu Hang* is running under poled-out twin jibs before a southwesterly gale. She is steering herself without the use of autopilot or windvane with a sheet-to-tiller rig:

It must have been nearly five in the morning, because it was light again, when the noise of the headsails became so insistent that I decided to take in sail. I pulled on my boots and trousers. Now that I had decided to take some action I felt that it was already late, and was in a fever to get on with it. When I was dressed I slid back the hatch, and the wind raised its voice in a screech as I did so. In the last hour there had been an increase in the wind, and the spindrift was lifting, and driving across the face of the sea.

I shut the hatch and went forward to call Beryl. She was awake, and when I went aft to call John, he was awake also. They both came into the doghouse to put on their oilies. As we got dressed there was a feeling that this was something unusual; it was rather like a patrol getting ready to leave, with the enemy in close contact. In a few minutes we were going to be struggling with this gale and this furious looking sea, but for the time being we were safe and in shelter.

John Guzzwell:

"I'd been asleep, nicely snugged down in my bunk when Miles called me. I had been wanting to get some film of heavy weather and Miles said this was it. I wasn't too happy about getting out of my bunk, until I saw what Miles was talking about."

John Guzzwell

All of the photos which follow are lifted from movie film shot by John Guzzwell in the early morning when this narrative takes place. The film is 40 years old, and we are working from 16mm, so the images are not perfect. But they will give you an excellent feel for what things look like in the Southern Ocean after a bit of a blow. This first series of images are of Miles Smeeton. Check out the crest in the background (arrow). It's probably 30 feet (9m) or higher.

"Got your lifelines?" Beryl asked.

"No, where the hell's my lifeline? It was hanging up with the oilies." Like my reading glasses, it was always missing.

"Here it is," John said. He was buckling on a thick leather belt over his jacket, to which his knife, shackle spanner, and lifeline were attached. His lifeline was a thin nylon cord with a snap-hook at the end, and Beryl's, incongruously, was a thick terylene rope, with a breaking strain of well over a ton.

"Got the shackle spanner?" I asked. "Never mind, here's a wrench. Is the forehatch open?" Someone said they'd opened it.

"Beryl, take the tiller. John and I will douse the sails. Come on boys, into battle." I slid the hatch back again and we climbed up one after the other. We were just on the crest of a wave and could look around over a wide area of stormy grayish-white sea. Because we were on the top of a wave for a moment, the seas did not look too bad, but the wind rose in a high pitched howl, and plucked at the double shoulders of our oilies, making the flaps blow up and down.

The wave passed under *Tzu Hang*. Her bowsprit rose, and she gave a waddle and lift as if to say, "Be off with you!" Then the sea broke, and we could hear it grumbling away ahead of us, leaving a great wide band of foam behind it.

John Guzzwell:

"We'd been in the roaring 40s for 30 days and nothing we'd experienced previously was like the day of the breaking wave. In fact, we were at sea another 37 days after the wave and did not see anything like those conditions again, so they are pretty rare, even down there.

"We were trailing warps, running under bare poles. The boat was handling things well, and was under good control. We were running at about 4 knots.

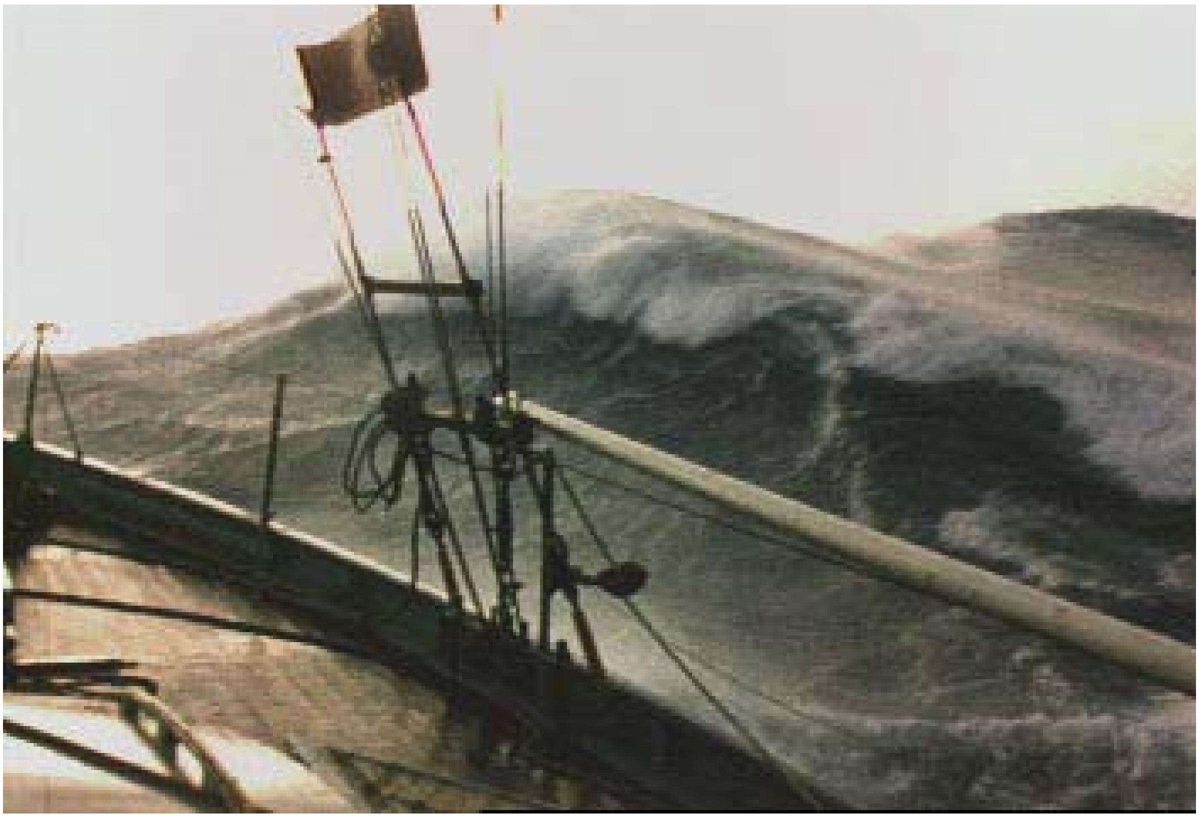
"Every once in a while a really big wave would come along and carry the whole mess of line right up to the boat, and then the boat would take off on the wave until the line became tight again. We probably were not using a long enough warp."

John Guzzwell

With a heavy-displacement full-keeled vessel you need to be carefully lined up with the seas when they break. What Miles Smeeton is trying to avoid is allowing any crests to slap the aft quarter and begin to rotate the boat into a broach. The crest to the left in the photo (left arrow) is starting to break and will not be a problem as it is still far away. The crest under the right arrow is at the same location but earlier in its cycle—this one could overtake Tzu Hang while breaking. This is the one Miles Smeeton will have his eye on.

Both photos John Guzzwell

This next series of four images take place over a period of five seconds. The upper photo starts with John Guzzwell pointing the camera downwind. This perspective always makes the waves look a lot smaller. Two and half seconds later he pans the camera to weather as a breaking crest makes its presence known. This sea is traveling at about a 30-degree angle to the rest of the waves. It is not a huge crest in this image, probably just 6 to 8 feet (1.8 to 2.4m).



Both photos John Guzzwell

The top wave is another second into the sequence. From the image, you would expect some water on deck and a good knock from the wave impact. However, as you can see in the bottom photo, the wave crest has actually broken just off the bow. It was moving at three or four times the speed of Tzu Hang and so bypassed the boat while breaking, which is quite common.

The problem comes when a crest like this breaks against the bow or stern., in which case the boat will be jibed around or swung around beam-on in a broach to windward. It's in these conditions that you need to be alert to "sneaker" waves coming from different directions.

John Guzzwell:

"On this particular day the seas were the biggest I have ever seen. They were fairly steep, and once in a while a big one with the top 15 feet (4.5m) rolling down the crest would come along. And I was thinking, 'By golly, if one like that catches us we'll have a lot of water on deck.'

"On a couple of occasions we'd had a part of a crest catch us, filling the cockpit. One of these times it almost washed Miles out of the cockpit and overboard. But in general the boat was handling it pretty well.

"We were frequently seeing the waves break around us, but never right on top of us.

"The sea had a mean look to it—not like in the previous gales. It had been this way since 0500, and continued for another five hours.

"The barometer had started to rise and the wind had shifted to the northwest, so we knew the front had passed."

Down to Bare Poles

Beryl slipped into the cockpit and snapped her lifeline on to the shrouds. John and I went forward, and as we let go of the handrail on the doghouse, we snapped the hooks of our lifelines on to the rail, and let them run along the wire until we had hold of the shrouds. The wind gave us a push from behind as we moved. I went to the starboard halyard and John to the port, and I looked aft to see if Beryl was ready. Then we unfastened the poles from the mast and let the halyards go, so that the sails came down together; and in a very short time, we had them secured. We unhooked them from the stays, bundled them both down the forehatch, and secured the two poles to the rails. As we went back to the cockpit, we were bent against the pitch of the ship and the wind. Beryl unfastened the sheets from the tiller and we coiled them up and threw them below.

"How's she steering?"

"She seems to steer all right; I can steer all right."

"We'll let the stern line go anyway, it may be some help."

John and I uncoiled the 3-inch (75mm) hawser, which was lashed in the stern, and paid it out aft. Then we took in the log-line, in case it should be fouled by the hawser. By the time everything was finished, my watch was nearly due, so I took over the tiller from Beryl, and the others went below. The hatch slammed shut, and I was left to myself. I turned my attention to the sea.

The sea was a wonderful sight. It was as different from an ordinary rough sea, as a winter's landscape is from a summer one, and the thing that impressed me most was that its general aspect was white. This was due to two reasons: firstly because the wide breaking crests left swathes of white all over the sea, and secondly because all over the surface of the great waves

John Guzzwell

Beryl Smeeton at the helm of Tzu Hang.

themselves, the wind was whipping up lesser waves, and blowing their tops away, so that the whole sea was lined and streaked with this blown spume, and it looked as if all the surface was moving.

Here and there, as a wave broke, I could see the flung spray caught and whirled upwards by the wind, which raced up the back of the wave, just like a whirl of wind-driven sand in the desert. I had seen it before, but this moving surface, driving low across a sea all lined and furrowed with white, this was something new to me, and something frightening, and I felt exhilarated with the atmosphere of strife. I have felt this feeling before on a mountain, or in battle, and I should have been warned. It is apt to mean trouble.

For the first time since we entered the Tasman, there were no albatrosses to be seen. I wondered where they had gone to, and supposed that however hard the wind blew, it could make no difference to them. Perhaps they side-slipped out of a storm area, or perhaps they held their position as best they could until the storm passed, gliding into the wind and yet riding with the storm until it left them.

I kept looking aft to make sure that *Tzu Hang* was dead stern-on to the waves. First her stern lifted, and it looked as if we were sliding down a long slope into the deep valley between this wave and the one that had passed, perhaps 20 seconds before; then for a moment we were perched on the top of a sea, the wind force rose, and I could see the white desolation around me. Then her bowsprit drove into the sky, and with a lurch and a shrug, she sent another sea on its way.

It was difficult to estimate her speed, because we had brought the log in, and the state of the water was very disturbed, but these waves were travelling a great deal faster than she was, and her speed seemed to be just sufficient to give her adequate

John Guzzwell

Thirty-seven days in the Southern Ocean doesn't look like such a hardship!

steerageway, so that I could correct her in time to meet the following wave.

Suddenly there was a roar behind me and a mass of white water foamed over the stern. I was knocked forward out of the cockpit onto the bridge deck, and for a moment I seemed to be sitting in the sea with the mizzen mast sticking out of it upright beside me. I was surprised by the weight of the water, which had burst the canvas windscreen behind me wide open, but I was safely secured by my body-line to the after shroud. I scrambled back into the cockpit and grabbed the tiller again, and pushed it hard over, for *Tzu Hang* had swung so that her quarter was to the sea. She answered slowly but in time, and as the next sea came up, we were stern-on to it again. The canvas of the broken wind-break lashed and fluttered in the wind until its torn ends were blown away.

Frontal Passage

Now the cloud began to break up and the sun to show. I couldn't look at the glass, but I thought that I felt the beginning of a change. It was only the change of some sunlight, but the sun-light seemed to show that we were reaching the bottom of this depression. Perhaps we would never get a chance again to film such a sea, in these fleeting patches of brilliance.

I beat on the deck above John's bunk and called him up. I think that he had just got to sleep, now that the sails were off her, and there was someone at the helm. I know that I couldn't sleep before. He looked sleepy and disgruntled when he put his head out of the hatch.

"What about some filming, John?"

"No, man, the sea never comes out."

"We may never get a sea like this again."

"I don't want to get the camera wet, and there's not enough light."

"No, look, there's a bit of sun about."

As he was grumbling, like an old bear roused out of its winter quarters; he looked aft, and I saw his expression change to one of interest.

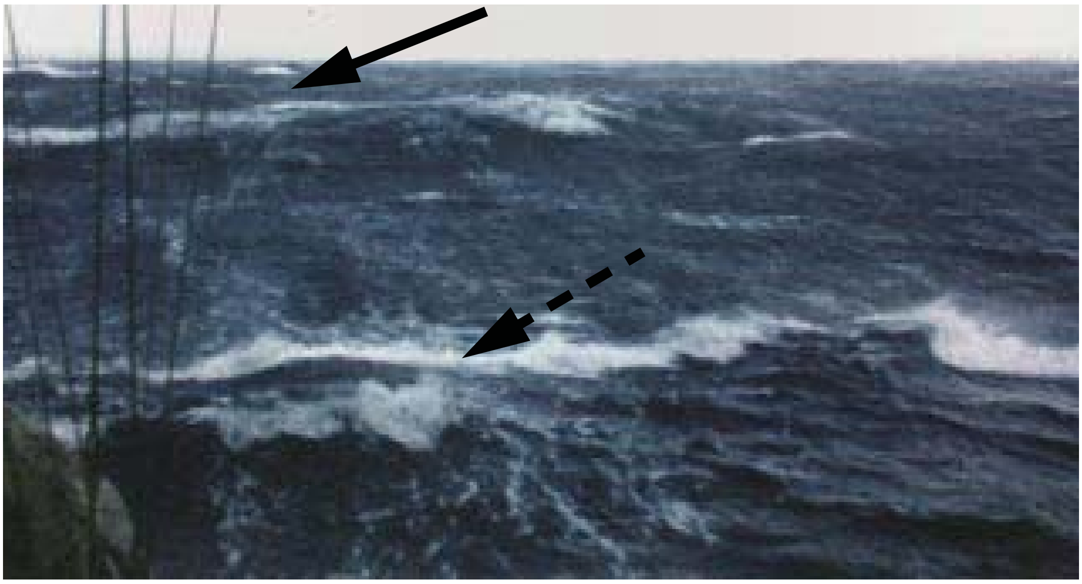
"Look at this one coming up," he said, peering over the top of the washboards, just the top of his head and his eyes showing. "Up she goes," he ducked down as if he expected some spray to come over, and then popped his head up again. "Wait a minute," he said, "I'll fix something up," and he slammed the hatch shut and disappeared below again.

He came up in a few minutes, fully equipped. He had the camera in a plastic bag with the lens protruding through a small hole. He took some shots. The lens had to be dried repeatedly, but the camera was safe in its bag, and we had no more wave tops on board. Presently he went down again.

John relieved me for breakfast, and when I came up it seemed to be blowing harder than ever.

"How's she steering?" I asked him.

"Not bad," he said. "I think she's a bit sluggish, but she ought to do."



All photos John Guzzwell

This series of images were taken at 1-second intervals. Watch how the wave crest in the background (solid arrows) works its way towards Tzu Hang.

There is a second crest, much closer (dashed arrows), which Tzu Hang is riding over with ease.

These types of waves, although quite large, are not a problem as the breaking portions of the wave are moderate in size and not particularly steep.

The problem comes when a really steep face has to be dealt with.

John Guzzwell:

"I've always had the opinion that in ultimate conditions I'd just run before it with warps out. But now I'm inclined to think that para anchors might have something going for them. A lot of commercial fisherman I know swear by them. It kind of makes sense if the boat can lie head to wind as though on a mooring or anchor.

"If you are towing warps, you want to be going fast enough so that you maintain good steering control. But my feeling is that in a lot of cases, if you're short-handed, you have to allow the boat to look after itself. Some of these storms last 24 hours or more and at some stage you simply cannot steer any longer. I'm inclined to think that at this stage it's a very dicey situation, largely a matter of luck. Remember, we were at sea in the Southern Ocean for 87 days and only saw really bad conditions for just one 6-hour period."

I took over again, and he went below; no one wanted to hang about in this wind. I watched the 60 fathoms of 3-inch (75mm) hawser streaming behind. It didn't seem to be making a damn of difference, although I suppose that it was helping to keep her stern-on to the seas. Sometimes I could see the end being carried forward in a big bight on the top of a wave. We had another 60 fathoms, and I considered fastening it to the other and streaming the two in a loop, but I had done this before, and the loop made no difference, although the extra length did help to slow her down.

We had oil on board, but I didn't consider the emergency warranted the use of oil. For four hours now we had been running before this gale, running in the right direction, and we had only had one breaking top on board, and although I had been washed away from the tiller, *Tzu Hang* had shown little tendency to broach to. To stop her and lie ahull in this big sea seemed more dangerous than to let her run, as we were doing now. It was a dangerous sea I knew, but I had no doubt that she would carry us safely through, and as one great wave after another rushed past us, I grew more and more confident.

Beryl relieved me at 0900. She looked so gay when she came on deck, for this is the sort of thing that she loves. She was wearing her yellow oilskin trousers and a yellow jumper with a hood, and over all a green oilskin coat. So that she could put on enough pairs of socks, she was wearing a spare pair of John's sea-boots. She was wearing woolen gloves, and she had put a plastic bag over her left hand, which she wouldn't be using for the tiller. She snapped the shackle of her body-line on to the shroud, and sat down beside me, and after a minute or two she took over. I went below to look at the glass and saw that it had moved up a fraction. My camera was in the locker in the doghouse, and I brought it out and took some snaps of the sea. Beryl was concentrating very hard on the steering. She was looking at the compass, and then aft to the following sea, to make sure that she was stern-on to it, and then back to the compass again, but until she had the feel of the ship she would trust more to the compass for her course than to the wind and the waves. I took one or two snaps of Beryl, telling her not to look so serious, and to give me a smile. She laughed at me.

"How do you think she's steering?"

"Very well, I think."

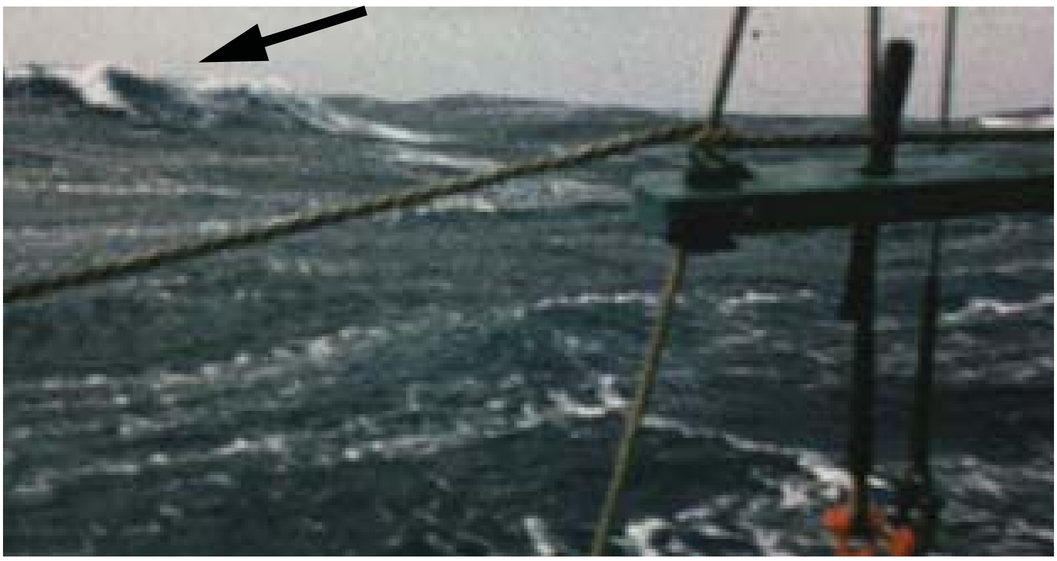
"We could put the other line out. Do you think she needs it? The glass is up a bit."

"No, I think she's all right."

"Sure you're all right?"

"Yes, fine, thanks."

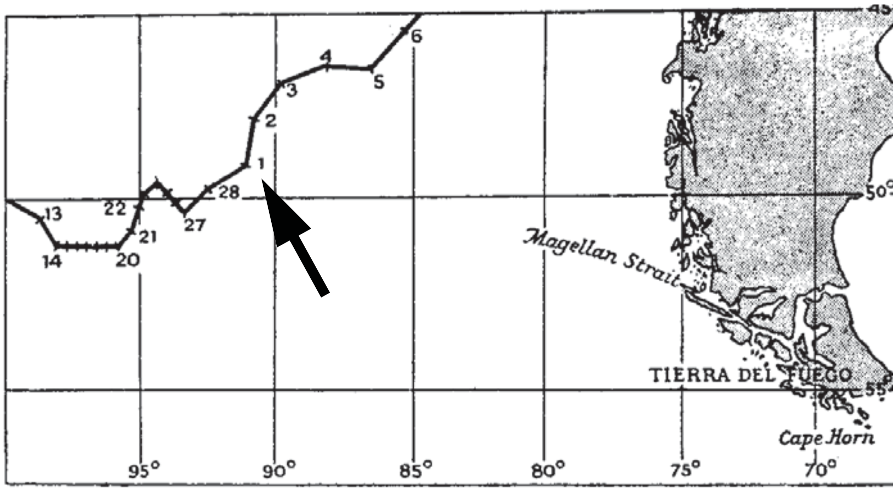
I didn't want to leave her and to shut the hatch on her, and cut her off from us below, but we couldn't leave the hatch open, and there was no point in two of us staying on deck. I took off my oilskins, put the camera back in its plastic bag in the locker, and climbed up into my bunk. The cat joined me and sat on my stomach. She swayed to the roll and purred. I pulled my book out of the shelf and began to read.



All photos John Guzzwell

Three images looking to starboard. Seas never appear as large when you are looking forward or abeam. However, in the background you can see a 15-foot (4.7m) crest about to break (arrows).

Remember, these photos have been taken after they've been running in this storm for several days, yet the seas do not appear that bad—except for the odd really large crest, which is, of course, what you must be on constant guard against.



After a time, I heard John open the hatch again and start talking to Beryl. A little later he went up to do some more filming. As the hatch opened there was a roar from outside, but *Tzu Hang* ran on straight and true, and I felt a surge of affection and pride for the way she was doing. "She's a good little ship, a good little ship," I said to her aloud, and patted her planking. I heard the hatch slam shut again, and John came down. He went aft, still dressed in his oilskins, and sat on the locker by his bunk, changing the film of his camera. Beneath him, and lashed securely to ring-bolts on the locker, was his tool-box, a large wooden chest, about 30 inches by 18 inches by 8 inches (762 by 457 by 203mm), crammed full with heavy tools.

My book was called *Harry Black*, and Harry Black was following up a wounded tiger, but I never found out what happened to Harry Black and the tiger.

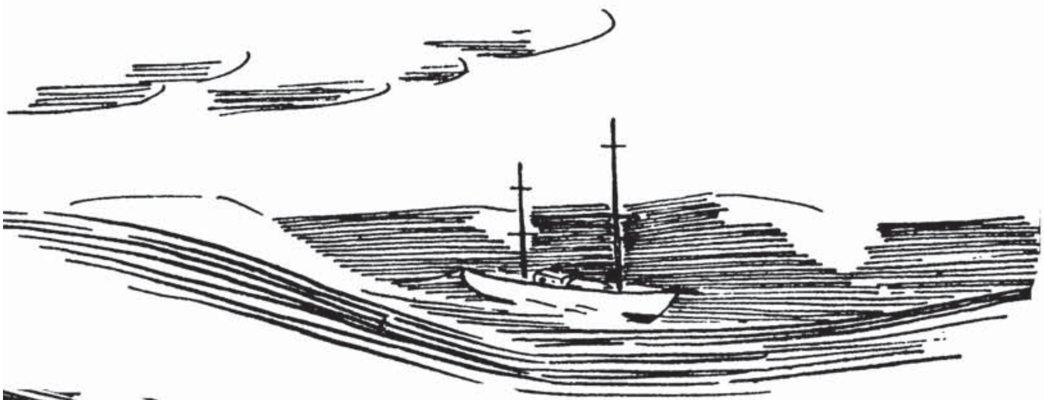
John Guzzwell has been sailing off and on for almost 50 years. In that time he's covered more than 100,000 miles, including a fair amount of sailing in the high latitudes, where one is more apt to find adverse conditions (John's circumnavigation in the late 50s aboard *Trekka* is covered in his book *Trekka Around the World* available from Fine Edge Productions).

In all of this, he has been in two truly severe storms: the one aboard *Tzu Hang* on the Southern Ocean and another nasty blow off the coast of Australia aboard *Trekka*.

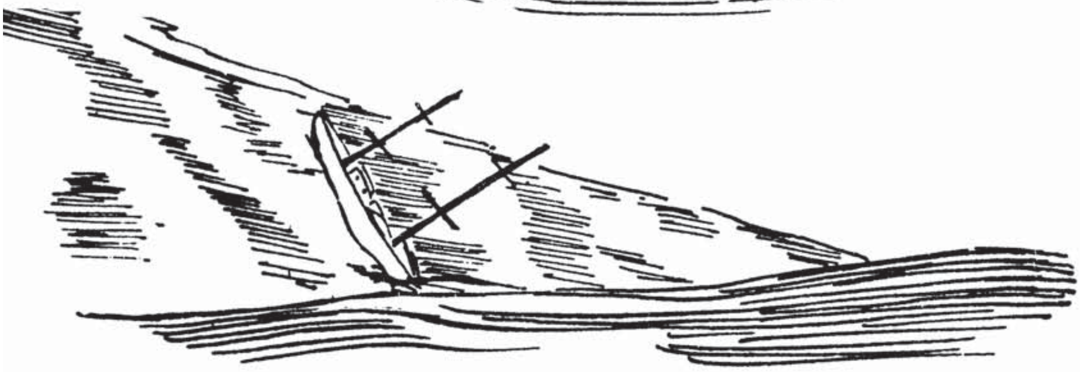
When John went below, Beryl continued to steer as before, continually checking her course by the compass, but steering more by the wind and the waves. She was getting used to them now, but the wind still blew as hard as ever. In places the sun broke through the cloud, and from time to time she was in sunshine. A wave passed under *Tzu Hang*, and she slewed slightly. Beryl corrected her easily, and when she was down in the hollow she looked aft to check her alignment.

Close behind her a great wall of water was towering above her, so wide that she couldn't see its flanks, so high and so steep that she knew *Tzu Hang* could not ride over it. It didn't seem to be breaking as the other waves had broken, but water was cascading down its front, like a waterfall. She thought, "I can't do anything, I'm absolutely straight." This was her last visual picture, so nearly truly her last, and it has remained with her. The next moment she seemed to be falling out of the cockpit, but she remembers nothing but this sensation. Then she found herself floating in the sea, unaware whether she had been underwater or not.

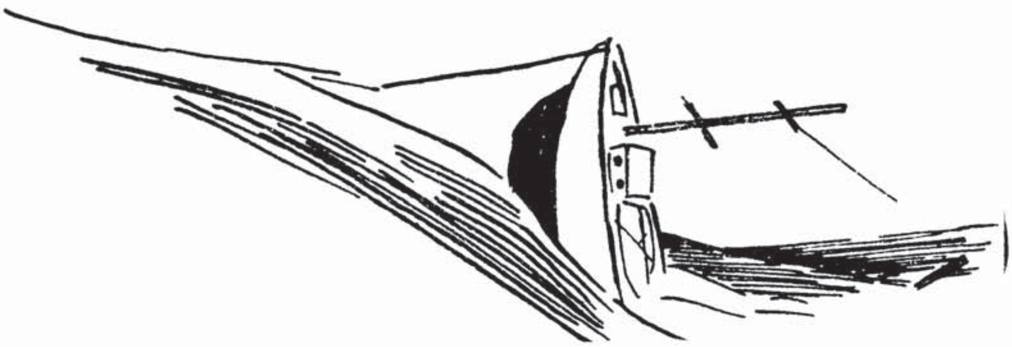
She could see no sign of *Tzu Hang*, and she grabbed at her waist for her lifeline, but felt only a broken end. She kicked to tread water, thinking, "Oh God, they've left me!" and her boots, those good roomy boots of John's, came off as she kicked. Then a wave lifted her, and she turned in the water, and there was *Tzu Hang*, faithful *Tzu Hang*, lying stopped and 30 yards (27.4m) away. She saw that the masts were gone and that *Tzu Hang* was strangely low in the water, but she was still afloat and Beryl started to swim towards the wreckage of the mizzen mast.



This series of drawings is from Miles Smeeton's book. In the top drawing they are running off and towing a hawser straight astern.



Next, a huge vertical wave picks them up and Tzu Hang accelerates down, digging in her bow.



In the third drawing she trips over her bow.

The wave continues to push her stern around and over and she falls on her beam ends.

As the wave passes by she rolls around and ends up facing into the seas, in the opposite direction from that in which she has been traveling.

Pitchpole

As I read, there was a sudden, sickening sense of disaster. I felt a great lurch and heel, and a thunder of sound filled my ears. I was conscious, in a terrified moment, of being driven into the front and side of my bunk with tremendous force. At the same time there was a tearing cracking sound, as if *Tzu Hang* was being ripped apart, and water burst solidly, raging into the cabin. There was darkness, black darkness, and pressure, and a feeling of being buried in a debris of boards, and I fought wildly to get out, thinking *Tzu Hang* had already gone.

Then suddenly I was standing again, waist deep in water, and floorboards and cushions, mattresses and books were sloshing in wild confusion around me.

I knew that some tremendous force had taken us and thrown us like a toy, and had engulfed us in its black maw. I knew that no one on deck could have survived the fury of its strength, and I knew that Beryl was fastened to the shrouds by her lifeline, and could not have been thrown clear. I struggled aft, fearing what I expected to see, fearing that I would not see her alive again. As I went I heard an agonized yell from the cat, and thought, "Poor thing, I cannot help you now." When I am angry, or stupid and spoilt, or struggling and in danger, or in distress, there is a part of me which seems to disengage from my body, and to survey the scene with a cynical distaste. Now that I was afraid, this other half seemed to see myself struggling through all the floating debris, and to hear a distraught voice crying, "Oh God, where's Bea, where's Bea?"

As I entered the galley, John's head and shoulders broke water by the galley stove. They may have broken water already, but that was my impression anyway. John himself doesn't know how he got there, but he remembers being thrown forward from where he was sitting and to port, against the engine exhaust and the petrol tank. He remembers struggling against the tremendous force of water in the darkness, and wondering how far *Tzu Hang* had gone down and whether she could ever get up again. As I passed him he got to his feet. He looked sullen and obstinate, as he might look if someone had offended him, but he said nothing. There was no doghouse left. The corner posts had been torn from the bolts in the carlins, and the whole doghouse sheared off flush with the deck. Only a great gaping square hole in the deck remained.

As I reached the deck, I saw Beryl. She was thirty yards away on the port quarter on the back of a wave, and for the moment above us, and she was swimming with her head well out of the water. She looked unafraid, and I believe that she was smiling.

"I'm all right, I'm all right," she shouted.

I understood her although I could not hear the words, which were taken by the wind.

John Guzzwell:

"Obviously a light boat (strongly built of course) has a better shot at surviving. There is not as much boat to get hit, and it is sitting on top of the water rather than in it.

"But any boat of our size would have been in trouble in the conditions we had that day aboard *Tzu Hang*, and there was nothing inherently wrong with the design of *Tzu Hang*. She had done very well in the conditions up till that one wave. You just don't get the type of conditions we experienced anywhere except the roaring 40s. The fetch, distance between wave crests and wave heights in the Southern Ocean, and frontal passages all come together. I still have the opinion that when it gets really bad down there it is going to be nip-and-tuck for anyone.

"Immediately after we were rolled, the boat came up with no dog house, no rudder, no hatches and the rig over the side. We were waterlogged, down to 18 inches (450mm) of freeboard. I figured it was all over but Beryl said she knew where the buckets were and that got us started saving the boat. If we'd have gotten hit with another breaking sea, or if this had been at night instead of the day, we'd have never made it."

Once Is Enough

Just what did the wave look like that caught Tzu Hang? Here's a photo from Once Is Enough. This was thought to have been taken from a steamship off Cape Horn many years before. The wave in the foreground isn't too bad, but take a look at the wall rearing off on the horizon. Also, note the "soft spot" on the wave (arrow) to the right. If you were on deck, saw this coming, and had the boatspeed and maneuverability to move away from the breaking crest, you just might make out all right.

The mizzen mast was in several pieces, and was floating between her and the ship, still attached to its rigging, and I saw that she would soon have hold of it. When she got there, she pulled herself in on the shrouds, and I got hold of her hand. I saw that her head was bleeding, and I was able to see that the cut was not too serious, but when I tried to pull her on board, although we had little freeboard left, I couldn't do it because of the weight of her sodden clothes and because she seemed to be unable to help with her other arm. I saw John standing amidships.

Incredibly he was standing, because, as I could see now, both masts had gone, and the motion was now so quick that I could not keep my feet on the deck. He was standing with his legs wide apart, his knees bent and his hands on his thighs. I called to him to give me a hand. He came up and knelt down beside me, and said, "This is it, you know, Miles."

But before he could get hold of Beryl, he saw another wave coming up, and said, "Look out, this really is it!"

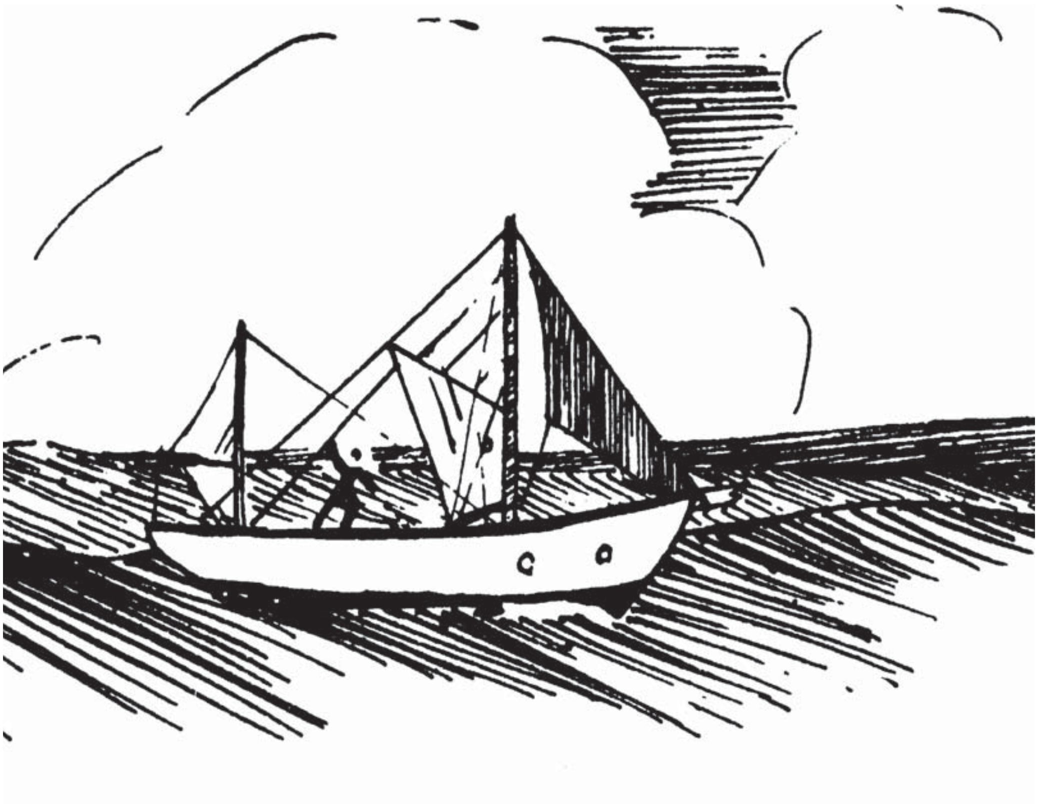
There may have been more to the sea conditions encountered by *Tzu Hang* than just the wind.

John Guzzwell said that some time after his experience with the Smeetons, he was speaking with W. Albert Robinson who had passaged in the same area aboard his schooner *Varua*. In a significant storm, in roughly the same area of ocean, *Varua* had encountered severe breaking seas.

Some years later Don and Reane Douglas and their children were cruising in the same area aboard a Bill Garden-designed Porpoise ketch. They were caught in a blow, encountered breaking seas, and were rolled in almost the same spot.

John Guzzwell checked with the British Admiralty a couple of years after being rolled and found that the nearest soundings—some 40 miles away—showed several thousand fathoms of depth.

The odds are that there is an unsurveyed seamount or plateau in this region which affects surface waves or perhaps a local opposing current.



Tzu Hang's crew went to work at once; bailing the boat, securing the open deck areas as best they could with sails, and working through a variety of jury rigs, of which this drawing represents the last. A little over a month later, they were secure at anchor in Chile.

Beryl called, "Let go, let go!"

But I wasn't going to let go of that hand, now that I had got it, and miraculously *Tzu Hang*, although she seemed to tremble with the effort, rode another big wave. She was dispirited and listless, but she still floated. Next moment John caught Beryl by the arm, and we hauled her on board. She lay on the deck for a moment, and then said, "Get off my arm John, I can't get up."

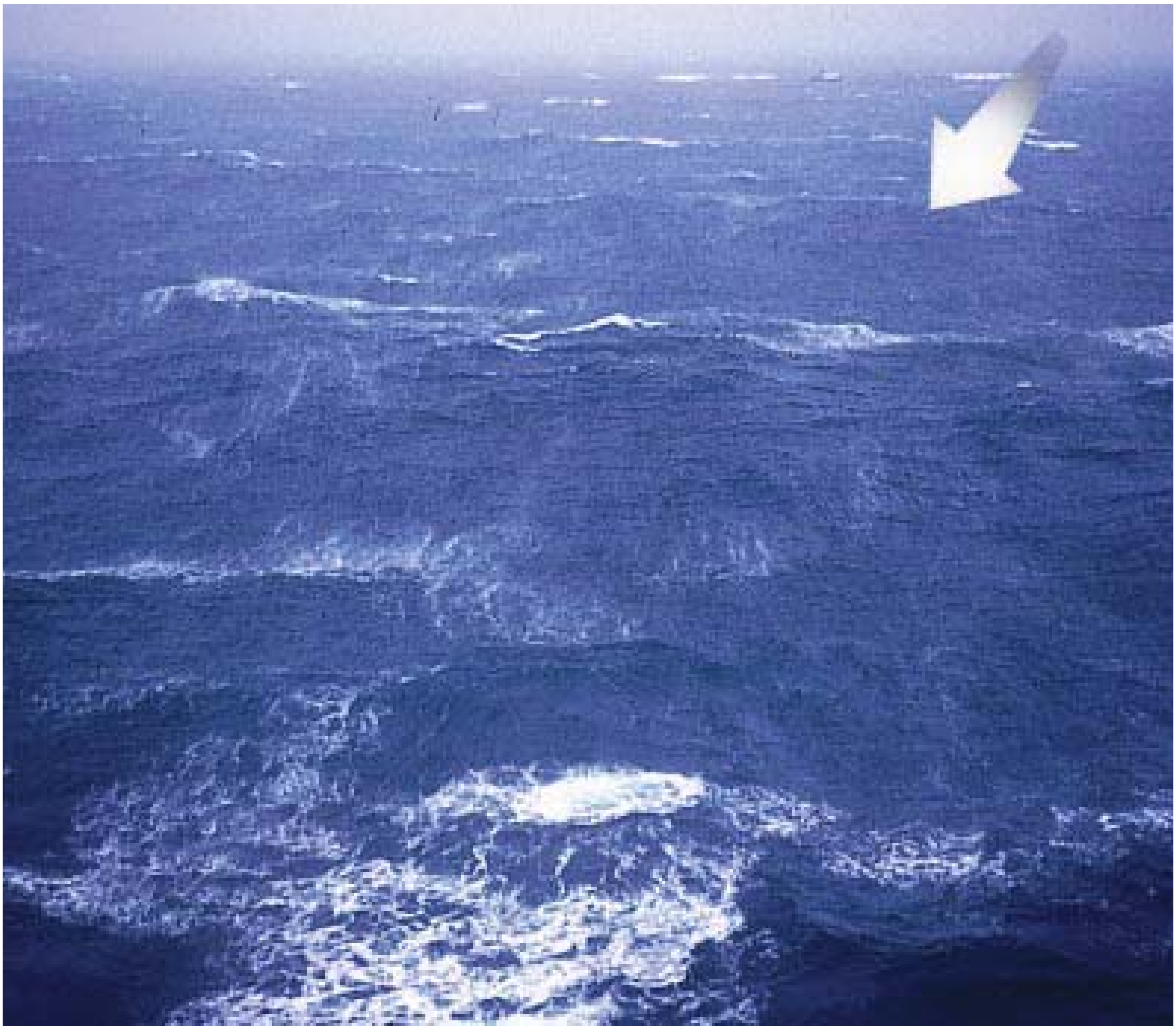
"But I'm not on your arm," he replied.

"You're kneeling on my arm, John."

"Here," he said, and gave her a lift up. Then we all turned on our hands and knees, and held on to the edge of the big hole in the deck.

Up to now my one idea had been to get Beryl back on board, with what intent I do not really know, because there was so much water below that I was sure *Tzu Hang* could not float much longer. I had no idea that we could save her, nor, John told me afterwards, had he. In fact, he said, the reason why he had not come at once to get Beryl on board again, was that he thought *Tzu Hang* would go before we did so.

After this first action, I went through a blank patch, thinking that it was only a few moments, a few minutes of waiting, thinking despondently that I had let Clio down. Beryl's bright, unquenchable spirit thought of no such thing. "I know where the buckets are," she said, "I'll get them!"



Dag Pike

WAVES

Waves have been studied now for centuries. Approaching the millennium, we have satellites measuring wave heights on oceans around the world, floating buoys reporting wave data, and thousand of ships reporting in with wind and wave information.

There are hundreds of professionals at universities digesting this data, writing formulae, and postulating theories.

In the dozens of textbooks which have been written on this subject over the years, there are thousands of complicated mathematical equations.

Yet if you try to find a scientifically accurate description of the shape of a breaking sea in the open ocean, the odds are you will not succeed.

We have spoken to or corresponded with scientists around the world and not a single one has been able to quantify wave shape for us (other than mathematically) in the open ocean.

So what follows is a distillation of the formulae, statistical studies, practical experience by mariners from around the world, flavored by our own experience at sea with the addition of the study of waves in model tanks from various universities around the world.

An important factor to remember about breaking waves is that they are sporadic. You will have miles of moderate-sized waves, and then a large breaking crest will seemingly appear from nowhere. Even though the odds of being in the same place at the same time with one of these breakers is low, it is still best to be prepared. The photo above is of the North Atlantic in a winter storm—the winds are blowing 50 to 60 knots.


Stock Newport

Thirty to 35 knots, a fresh breeze, and a nice field of whitecaps dissipating wave energy. In the early stages of a wind like this, the waves will release quite a bit of the wind energy in this form. As the wind continues to blow, the waves spread out, retaining more energy in the form of vertical height.

Wind Energy:

- ❑ Waves get started with wind forces. In light airs you will have just a few ripples. Then, as soon as the breeze drops off, the ripples disappear.
- ❑ As the breeze increases in velocity and duration, waves grow in size. With a constant amount of wind the waves will continue to grow over time until a maximum size is reached.
- ❑ Wind energy gets fed into the wave in the form of height and kinetic motion. While the wave may appear to be moving, the water particles of individual waves are actually rotating about a circular orbit.

Whitecaps

In any given situation, a wave can only absorb or hold a certain amount of energy in the form of height and circular motion. When this level is exceeded, the wave forms a whitecap.

If you look at this from the perspective of the circular motion of the wave molecules, this process is easier to understand.

Before a whitecap is formed, the molecules orbit around in a circular motion within the wave. Molecules on the upwind wave face are in effect moving vertically, towards the top of the wave. When the wind increases faster than the wave can initially speed up, the molecules do not have enough energy to climb all the way to the top of the wave and then rotate back down the (leeward) backside. Because they lack the necessary energy to make it to the top, they fall back down the face causing a whitecap.

As this whitecap spills down the wave face it's dissipating energy, and effectively limiting the height to which the wave can grow.

Only by speeding up, and increasing the distance between crests, can the wave absorb more energy from the wind, without breaking down into a whitecap.

Once the wind is removed or the waves spread out beyond the initial forming area, they are referred to as swells.

With the powering force of the wind removed, swells deteriorate over time from internal friction, although they can travel thousands of miles before they die.

Both photos Keith Taylor

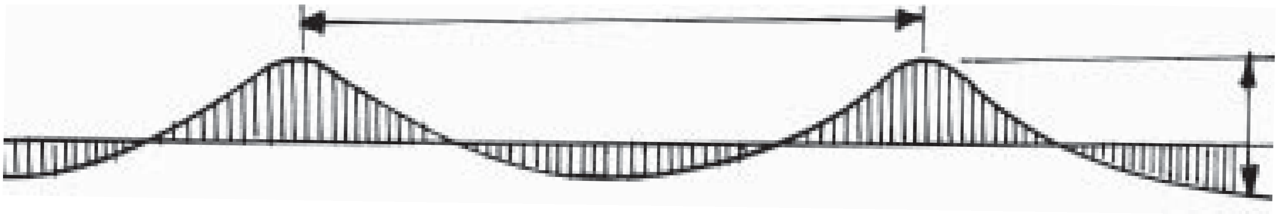
In the early stages of wave development there will still be odd peaks here and there. These are two examples, neither of which will do any damage—except to give you a good drenching if they catch the topside at the wrong moment.

Wave Shape

Waves are shaped by many influences: wind strength, time wind is blowing, distance over which the wind is blowing, the speed at which the storm system is moving, and current and bottom conditions.

Most of the time, waves look like an inverted cycloid, with their peaks much sharper than the intervening trough.

The height of a wave is typically measured as the distance between the bottom of the trough and top of the crest. The wave's length is the distance between peaks.



Wave period is defined as the distance between wave crests. The height of the wave is measured from the trough to the crest. Wave speed is a function of period—the longer the wave period, the faster the speed of the wave.

Wave Speed

Waves move at various speeds, influenced to some degree by the same factors which affect their size. In deep water, the length between the crests is a function of the time period of the waves. Longer periods mean a longer distance between crests.

One rough way of determining wave length is with the following formula: length (in feet) = 3.4 times wave period (in seconds) squared.

So, if you were hove to and were measuring the time it took for crests to pass at 12 seconds, the formula would work as follows: 3.4 x 12 x 12 = a wave length of 490 feet. For swells, the formula is more like 5 times the period squared.

For swells in open water, you can use the following formula to determine their speed: speed (knots)= 3.03 times the swell period in seconds.

For wind-generated waves, however, there is no pat answer for speed. They arise from a system that is simply too chaotic for prediction.

Now we come to a critical concept: In any given wave-generating system, there will be waves of different size and period generated over time. In other words, if you have a deep low kicking up a nasty wave system, the size and shape of the waves is going to vary significantly.

As Waves Travel

As waves travel from the area, in which they were initially generated, their period, wave length and speed remain essentially the same. However, the height and steepness is reduced as they move away from the wind source which created them.

The longer-period waves, moving at greater speeds, move ahead of the shorter-period slower waves.

Since waves of a given period can have different speeds (the preceding formulae are just rough approximations), they begin to sort themselves into wave systems of like periods as they travel from their birthplace.

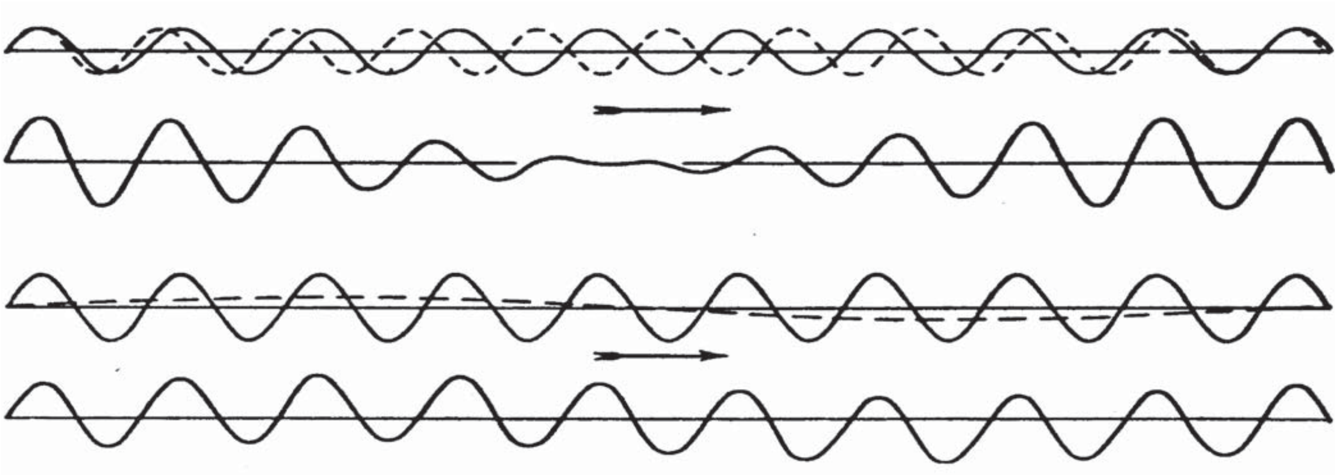
Wave and swell sets of a similar period will have varying height—hence the swell sets with which we are all familiar at the beach.

One last issue to think about: Once individual waves have melded into systems, they advance at what is called a group velocity. This is slower than what you would infer from the formulae previously given, or about one half wave speed.

The first wave in each system or set disappears after each cycle and transfers its energy to the next wave in the system. This wave transfers its energy to the next wave, *ad infinitum*. There is a certain amount of friction associated with the process.

Mixed wave systems:

- ❑ What makes all of this complex is the fact that at any point in time there are many different wave rains and/or swell systems moving through a given area.
- ❑ These collide with each other, reinforce each other, and generally change the seascape.
- ❑ The faster system eventually overtakes the slower. When this happens the waves interact, affecting wave size and shape.This can make the crests higher or the troughs deeper.
- ❑ Crossing wave systems may be coming from a single weather system, which has passed and changed wind direction, or from some storm thousands of miles away.
- ❑ These crossing waves interacting with your primary wave system can cause problems.



It is the mixing of wave systems which creates the chaotic conditions that are so hard to model. In this drawing, the top line shows two wave trains, emanating from the same weather system, running at slightly different speeds. The second line shows what happens as they briefly interact—some waves are taller and others are smaller.

In the third line we introduce a swell system from another storm into the mix. The bottom line shows what happens when the swell and wave systems interact.

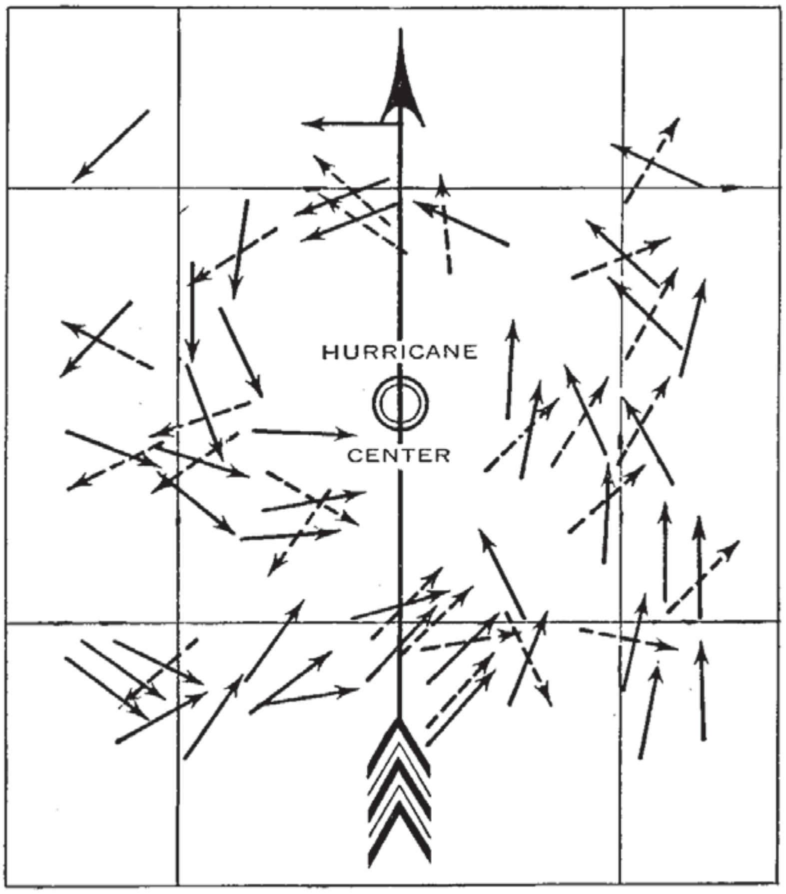
What you are not seeing here are the crossing angles, which really make a mess of any predictions!

Wave and Wind Direction

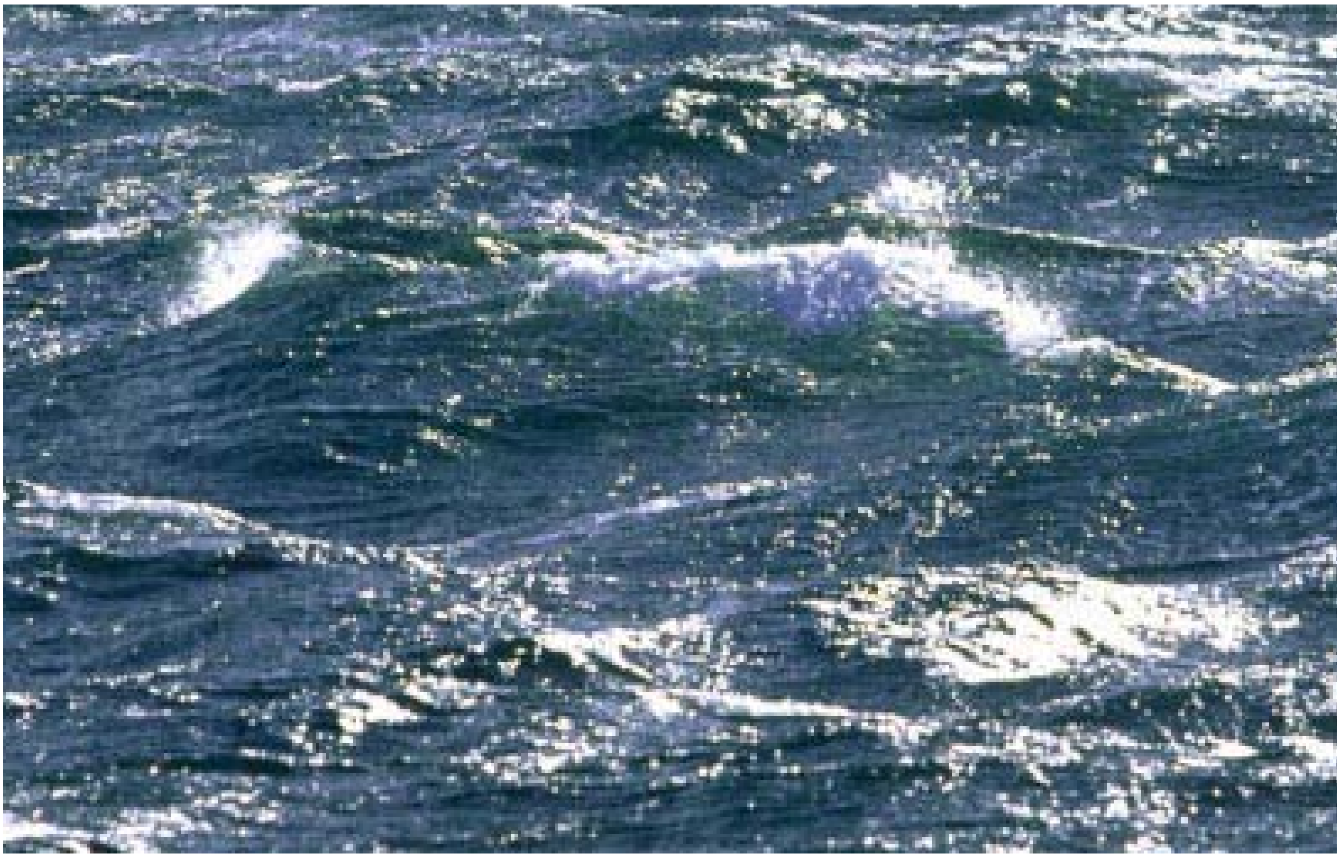
Waves often assume a direction of travel different from the wind you measure at the masthead. This is the result of many factors.

First, the wind close to the surface, which creates the waves, is blowing from a different direction from that which you measure at your masthead due to wind shear. This difference in direction can be as much as 20 to 30 degrees.

Next, the wind rarely blows from a constant direction. If the mean wind direction is 270, it will probably be shifting 15 or more degrees either side, creating waves traveling in different directions with each wind shift. Another factor is your location relative to the storm center. As you move away from your local area, the winds will typically be blowing from a different direction, creating wave trains moving along a different course than those locally produced.

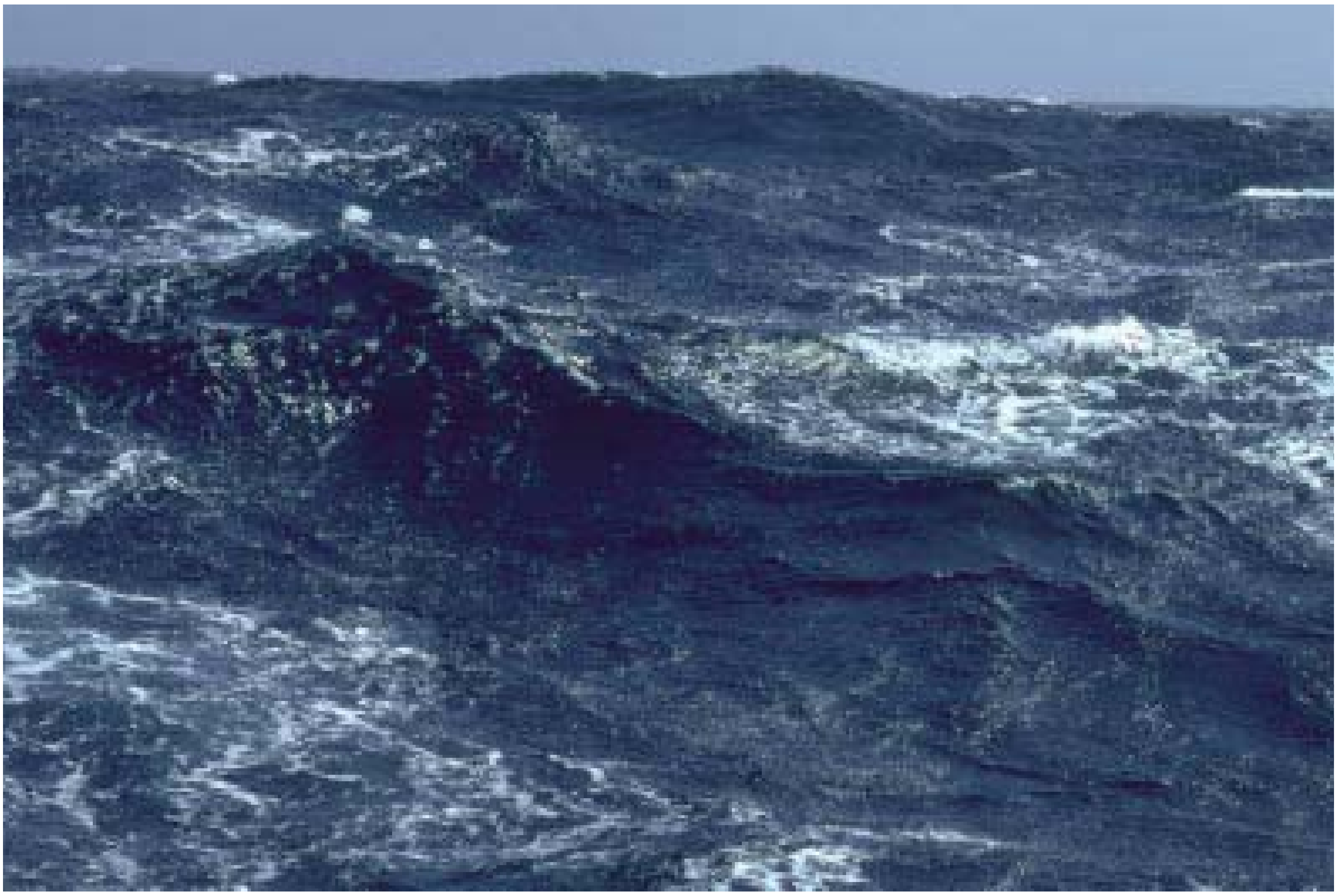


The way waves generate out from a low pressure system is extremely complex. The angles of radiation are constantly changing as the wind shifts and the storm moves. In this sketch we have a Northern Hemisphere hurricane. The solid arrows represent wind direction while the dashed arrows are wave direction. You can see that very quickly there would be all sorts of crossing seas.



By the time the wind is blowing a steady 30 knots (above), there will be consistent whitecaps. In the open ocean, without the influence of bottom shoaling or current, these waves do not have the power or shape to create safety problems for anything larger than a relatively small vessel.

Add another 5 knots of wind—to 35 knots (lower photo)—and the waves begin to peak up a bit more. The odd wave will now have some real power in its crest.

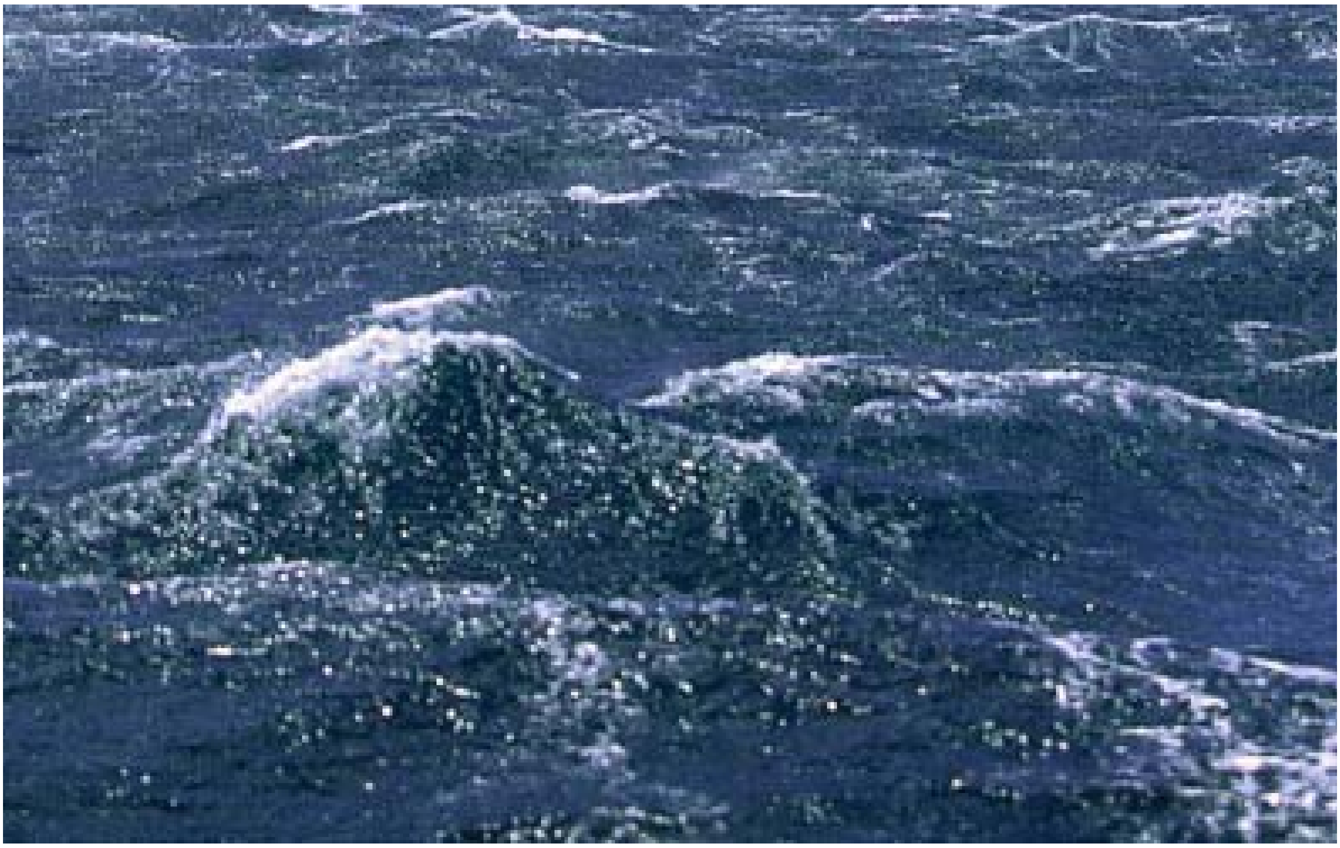


Both photos Stock Newport

In 35 to 40 knots of wind, the waves now have the power to give you some really good rides off the wind. In both of these photos there are crests about to break. These waves are in the 15- to 20-foot (4.6 to 6.1m) range, and typically the crests will have 3 feet (0.9m) or so of white water in them.

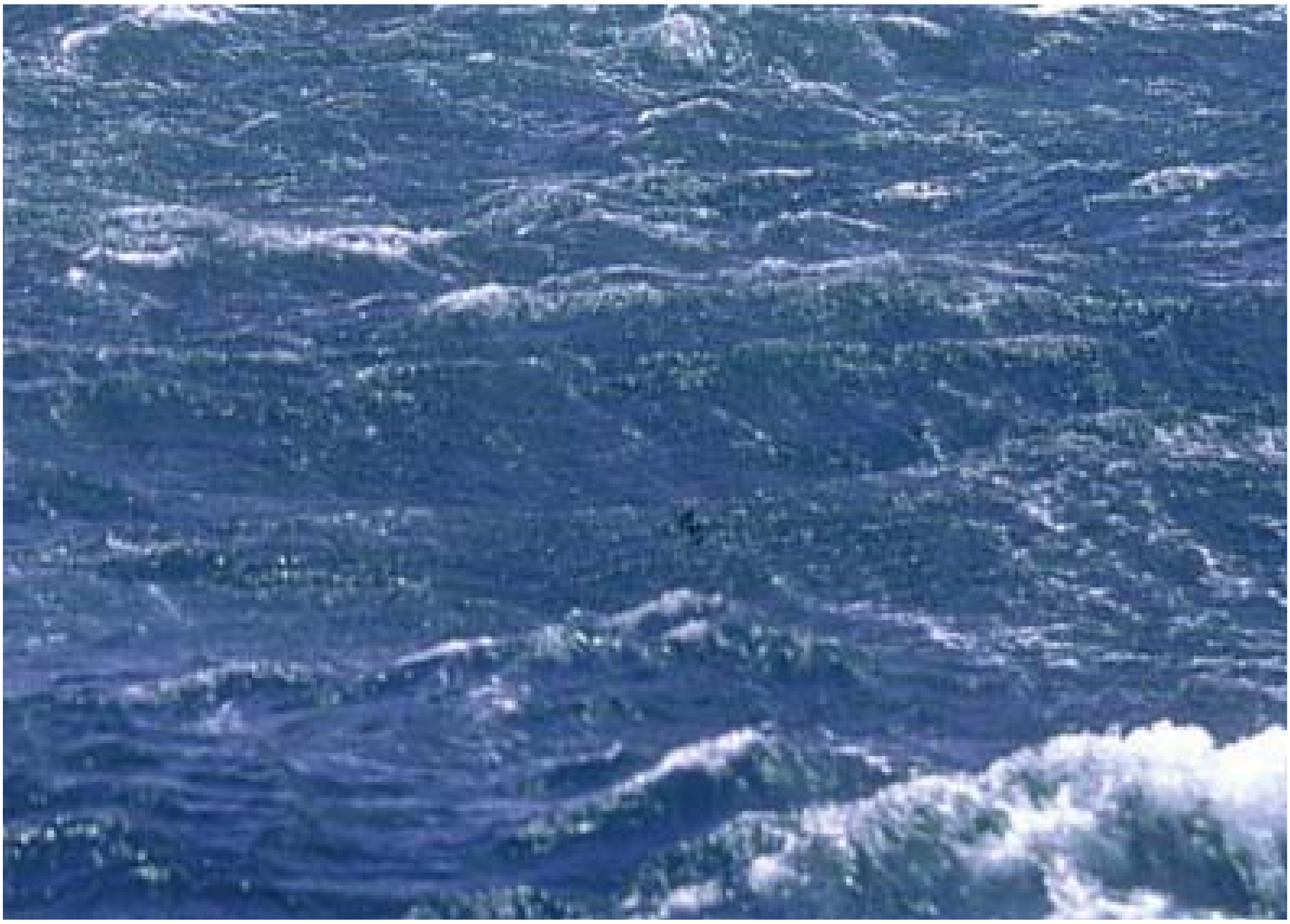
As long as the waves have this nice flat shape to them, there is little to fear. However, at this point there will be a wave every few hours which is several times larger—perhaps a 40-foot (12.2m) sea.

Both photos Stock Newport



Both photos Stock Newport

Forty knots of steady wind can raise quite a sea if it blows for long enough over a substantial amount of fetch. In the upper photo the wind has been blowing for about half a day. In the lower, it's been over 24 hours. Notice that the waves have more distance between the crests after time—and are bigger. However, the shape is actually easier to deal with as there is less of a break on the top.



When the Wind Drops

You will find that a sudden cessation of wind force after a prolonged period of strong winds often brings with it a chaotic sea state.

In fact, this is usually the most dangerous part of a storm from the seaman's perspective.

We have always assumed that a lack of wind pressure is what causes seas to become unstable. However, Professor Marshall Tulin who runs the wave research tank at the University of California at Santa Barbara has a very interesting theory on the subject.

Waves move at a speed relative to the wind that creates them. As we've already discussed, stronger winds create faster-moving waves.

When the windspeed suddenly drops, the waves in that area quickly slow down—but not those upwind where the wind has recently been blowing longer.

Those older waves follow the storm track and eventually overtake the vessel sitting where the wind has recently subsided. If they interact with the local, smaller seas, unstable breaking waves result.

Professor Tulin uses an example, with which we are all familiar to demonstrate the phenomenon. Say you are cruising along at full speed in your inflatable dinghy. If you cut the power suddenly, the following wake waves quickly catch up and break over the stern, wetting your bottoms and flooding the back end of the dinghy.

The same sort of thing happens to the ocean waves, created by the stronger winds, as they overtake your vessel and the more recently created slower-moving waves.

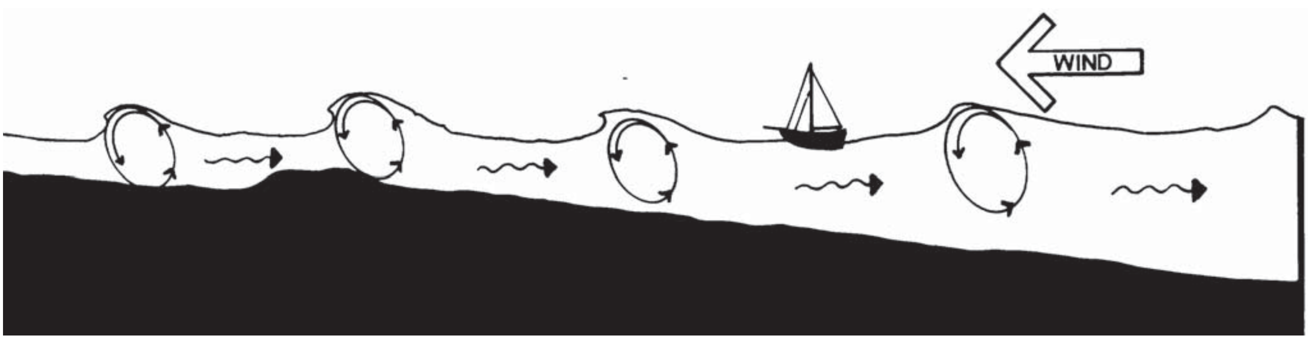
Sea Bottom Impact

Whereas in deep water wave speed is a function of wave period, in shallow water it's a function of water depth. The result is that as the wave begins to feel the bottom, it slows down. The energy remains the same so the speed energy is transferred, eventually turning the plane into a breaker.

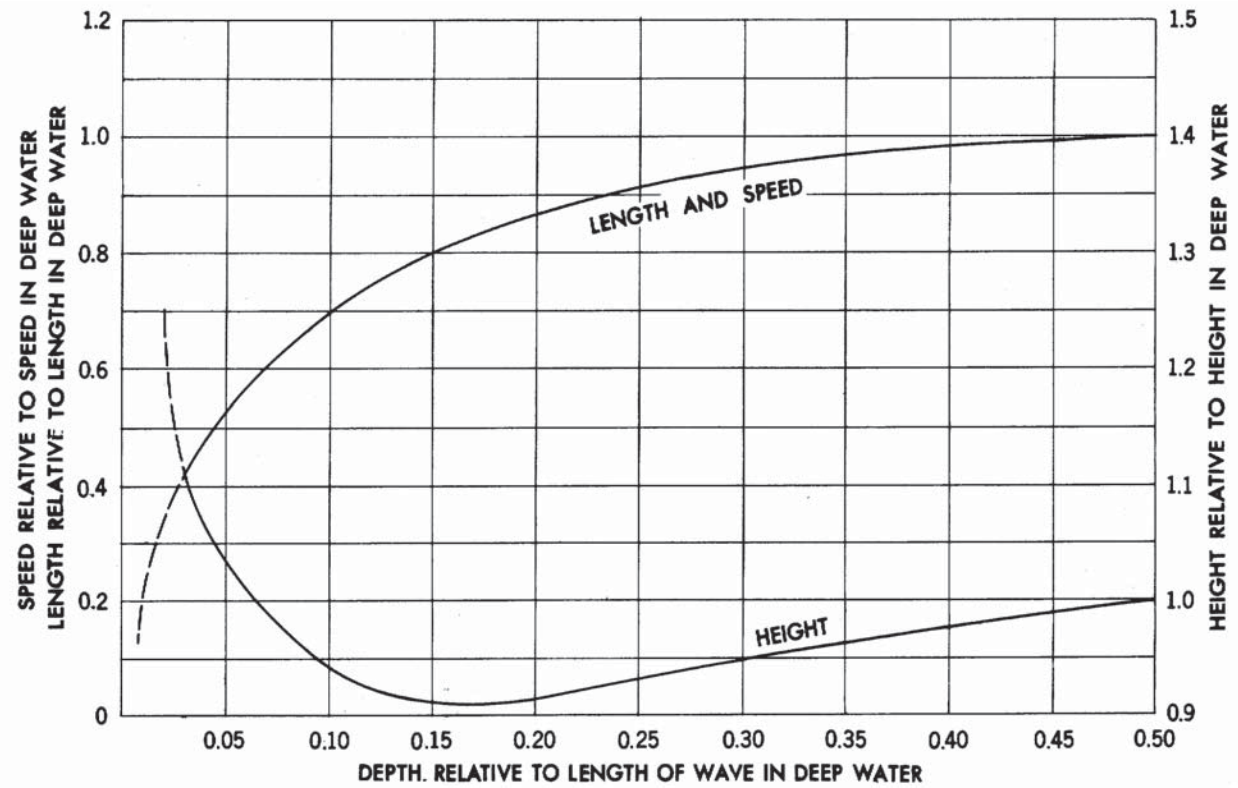
When waves approach a shoal area at an angle, friction on the bottom will have the wave refracted to the point where it is perpendicular to the shoal area. This friction also slows the bottom of the wave more than the top, again causing instability which eventually begins the breaking of the crest.

Continental shelves:

- ❑ Continental shelves are important from a wave-size perspective. If rapid shoaling occurs between the deep sea area and the continental shelf, it will affect the wave/swell systems as they come under the influence of the shelf.
- ❑ Unless there is a current, which you are trying to avoid with the shelf, it is better to give these areas a wide clearance, until it is time to make port.
- ❑ In some areas, such as along the South African coast, the continental shelf represents a haven from strong offshore currents.



The impact of shoaling on wave height varies with the shape of the bottom, the period of the wave, and any current present (there's often a countercurrent).



Bowditch

Here's a graph showing some of the relationship between waves and the sea bottom, when open ocean waves cross a shoal. The bottom row of numbers represent the depth of the water as it relates to the wave length in the open ocean. Thus, if we had a wave length of 400 feet and the depth were 0.05, this would be a depth of 20 feet. The numbers up the righthand side represent a multiplier for wave height. You can see that as the water depth shallows, to the right of the graph, wave height increases while speed and wave period (length) decrease. This represents a transfer of energy from the wave speed and period to height as it crosses the shoal.

On the lefthand side we have a multiplier for length and speed. On the righthand side it is for wave height. Using our water depth of 0.05 from the previous example you can see that wave length and speed would be roughly halved by a 20-foot shoal (for a wave with a length of 400 feet) while wave height would increase by about 15 percent. Indirectly this indicates that the waves would be much steeper (as their period has been halved) and that they would be breaking.

Slanting fetch affect:

- When the wind blows at an angle to a long coastline, the waves tend to align with and travel parallel to the coast.
- With a north/south coastline and a northwesterly wind, most of the waves will head due south, parallel to the coast.
- Some waves will run into shore, and then reflect back out to sea. These will typically be minor in magnitude as they do not have the wind blowing on them long enough to grow.

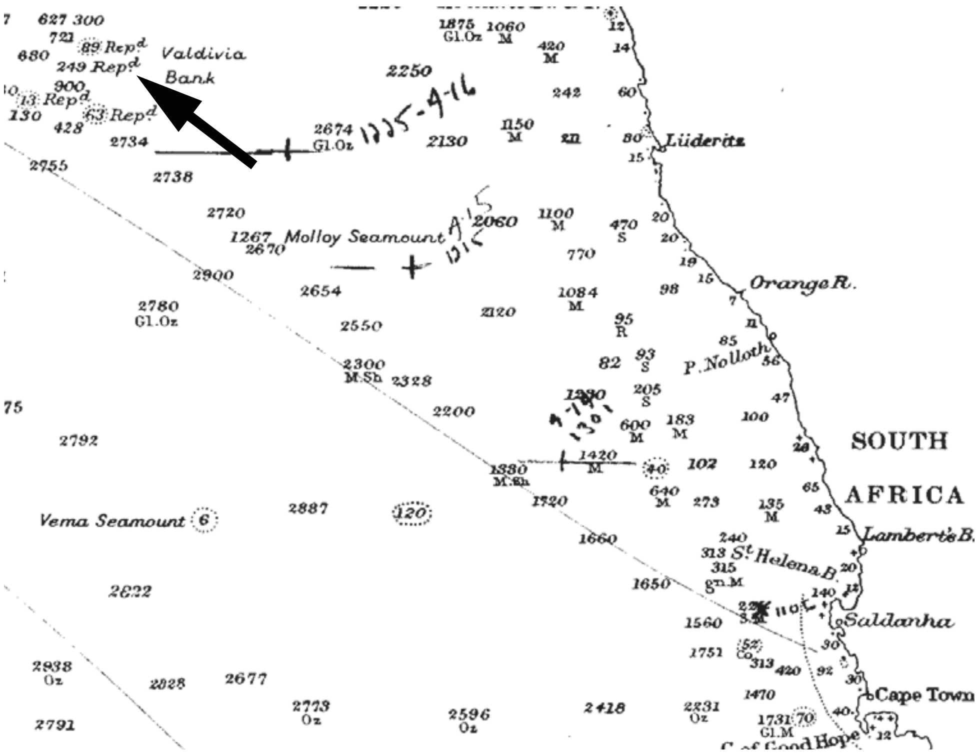
Undersea Features

Theoretically, if the water is deeper than half the wave length, the wave at the surface will feel no impact.

This appears to be true where the bottom contour is of constant depth and shape.

However, currents and/or waves can be deflected by seamounts, undersea cliffs, and areas of rapid shoaling, all of which can be hundreds of feet below the surface. This can have a big impact on the surface, much more than what some texts indicate is possible.

The anecdotal evidence for this from our own and other cruisers' experiences is overwhelming. The odds are that on most passages, there will be some opinions within the cruising fleet on areas to be avoided. This information, coupled with a thorough scan of the bottom contours of your charts, will indicate areas that you will want to steer clear of.



Here's a section of chart between Cape Town, South Africa and St. Helena Island. The lines of position are from our second passage along this route. The arrow points to Valdivia Bank, an area infamous for confused seas, even in moderate weather.

What is interesting is that this bank at its shallowest spot is over 249 fathoms—in theory much too deep to affect surface waves and swells.

Internal Waves

Another way in which surface waves are disturbed is by "internal waves"—waves which occur within water masses of different densities below the sea surface.

Water density increases with depth (from pressure), just as the atmosphere becomes more dense closer to the ground.

The difference is usually of small magnitude, and (at most) not more than 1 percent—unless there is a major change in salinity, in which case density variation will be greater.

Just as air masses of different characteristics do not mix, seawater of differing density and temperature tends to stay isolated. At the point where differing masses touch, a shear line similar to a weather front is created.

Because the densities are so close between these masses of water, it takes very little energy to create large long-amplitude internal waves.

These internal waves can, in some situations, affect the sea surface. When this occurs, surface conditions can become chaotic for no apparent reason.

There are some areas of the world where this phenomenon is well known, such as the Adaman Sea south of Burma.

A corollary of this effect is known as "dead" water. When you have freshwater sitting on top of the more dense saltwater (at river mouths, within fjords from glacial melt, or from the melting of sea ice) there is an obvious extreme stratification of densities.

If the vessel in question is of low power, and there is any current already against it, it becomes impossible to make progress.

This dead water phenomenon was quite common in the old days when low-powered vessels were the norm.

To be held back by dead water, you have to be traveling below a critical speed. Sometimes a very slight increase in velocity is all that is required to break free of the internal wave set up by the hull.

When the hull of a vessel moves through stratified fresh- and saltwater, at certain speed-length ratios significant internal waves are created beyond the normal bow and stern wave systems we are all accustomed to seeing.

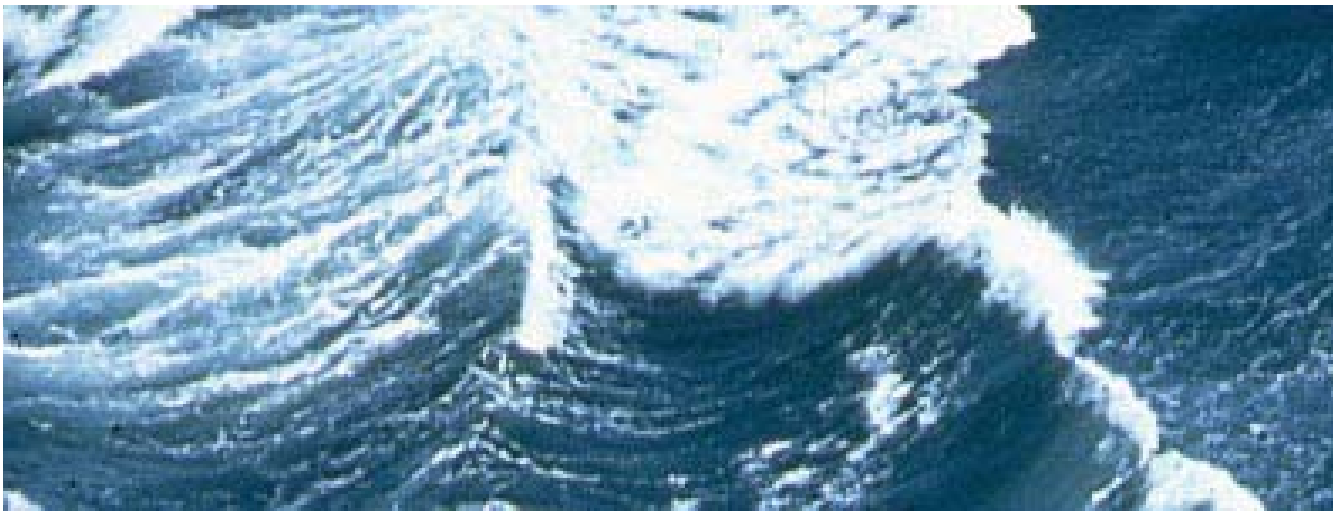
Current

A current flowing in the same direction as the waves increases wave length and decreases wave height. The opposite occurs with currents that oppose wave systems. Then the current tends to shorten the wave length and increase the wave height.

The effect of a modest amount of current can actually be quite significant. Just 1 knot of current against a 10-foot (3m) wave will take what would have been a nicely formed crest and cause it to grow and break. You can imagine what happens when there is 3 to 5 knots of current against the wave systems.

Strong currents running against wave sets will cause almost vertical waves and what are referred to as overfalls.

Any time you have current running against waves it stacks them up, making them steeper and causing the waves to break. The stronger the current, the steeper the seas. In areas where there are strong tidal streams, as around the coasts of Western Europe and the British Isles, the tidal streams can generate currents of as much as 10 knots. When these oppose the sea an almost vertical wave called an "overfall" is created. Overfalls are shown in the photos above and below.



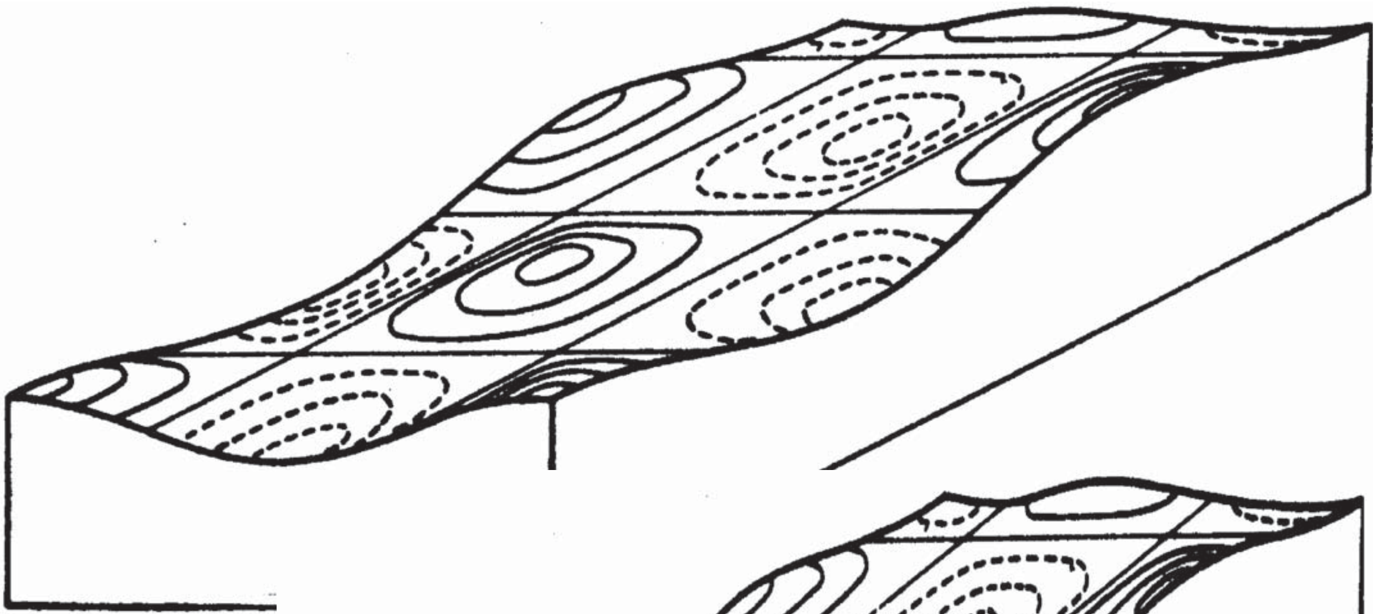
Both photos Stock Newport

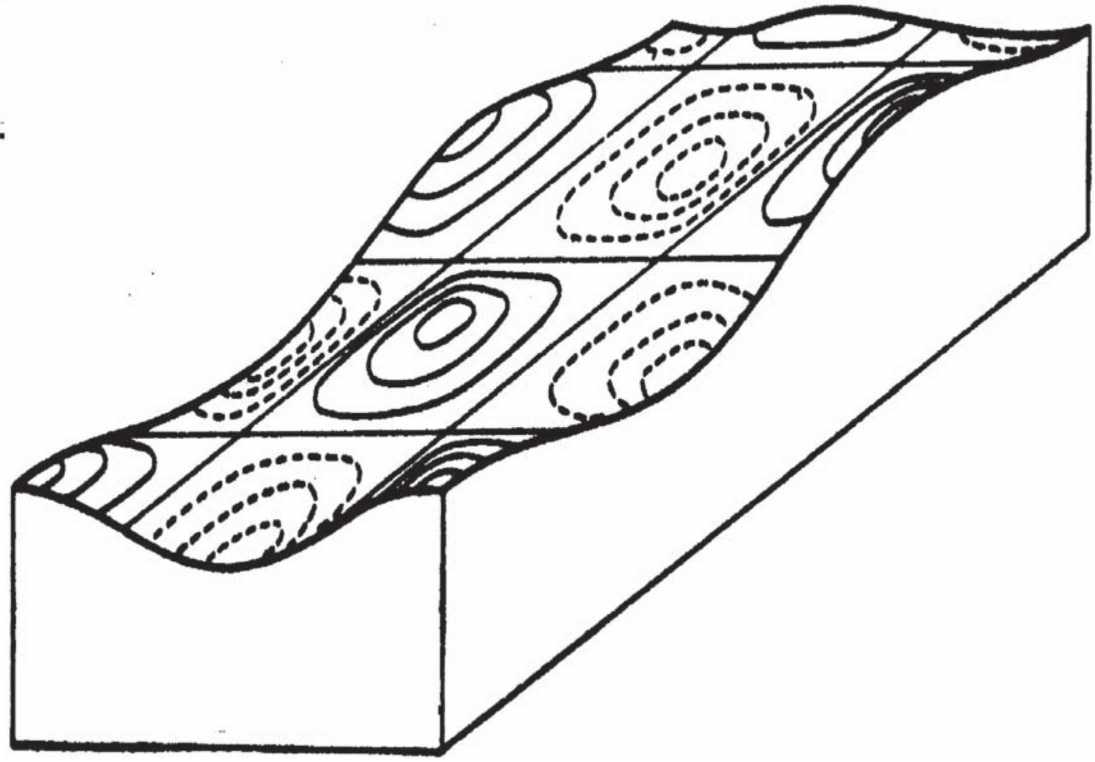
The impact of current also varies with the variations in speed. If there is a sharp vertical edge to the current (a shear), the seas in the vicinity of the shear, opposed by the current, will be far more tumultuous than those within the current itself and away from the shear edge.

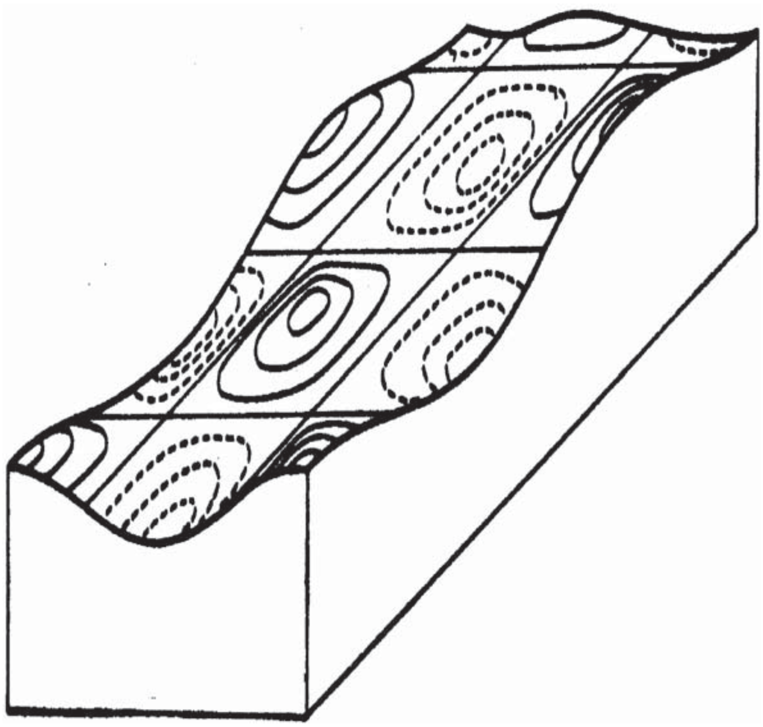
You also find clearly defined horizontal shears between layers of current and different water temperatures. These horizontal shears can affect waves in the same manner as a shoal or sea bottom, causing the waves to steepen and break.

Two more views of current against the waves. In the upper photo, it's blowing in the 40s, while in the bottom photo it's more like 30 to 35 knots. Notice how closely spaced these waves are. These are not yet large enough to damage a moderate-sized yacht. Given half a day or so, and several hundred miles of fetch combined with an adverse current, the situation would become extremely dangerous.

Both photos Stock Newport







Wave behavior is chaotic enough without adding the effects of current. If current were constant in depth and speed, the job would still be difficult. The fact that the depth of current and its speed varies within small areas makes the modeling job almost impossible.

The topographic maps pictured here are an attempt to show you differences in current influence. The top map is for a normal chaotic sea state, without current influence. The second (middle) map shows what would happen if there were two knots of current against the prevailing seas. The bottom map is for 4 knots of current. Note that these are crude representations! Solid lines represent peaks while dashed lines represent troughs.

It's very difficult to capture a series of breaking seas on film to demonstrate the effect of difference in current, so we've used the computer to modify two of these three images. The central photo is the original, and shows the effect of several knots of current against the prevailing sea. The larger wave faces are simply too steep to do anything but break.

The top image shows what these seas would look like without a current impact, while the bottom photo illustrates the effect of 3 knots or so of current against the waves.

In the real world, the bottom waves would have more of a crest as at the steepness shown they could not support the vertical faces.

You could deal with the first waves from a number of angles with room for error. But for the second and third photos, you would need perfect positioning and alignment to avoid a knockdown or roll.

John Neal

John Jordane

Both of these photos are taken in 50 to 60 knots of wind. The upper photo was taken off Cape Horn with a new wind, so the sea hasn't had time to really build. The lower image is also a high-latitude shot, but this time in the Southern Ocean where it's been blowing hard forever, and wind waves, and ever-present swell, combine for some really exciting conditions!

Breaking Crests

The shape of the breaking crest—the angle at which the water falls—is critical to the type of storm tactics being employed and the odds of a successful return.

Theory and tank test data indicate that waves become unstable at a slope ratio of 1 to 7 or steeper. However, observations in the real world indicate this figure is more like 1 to 10.

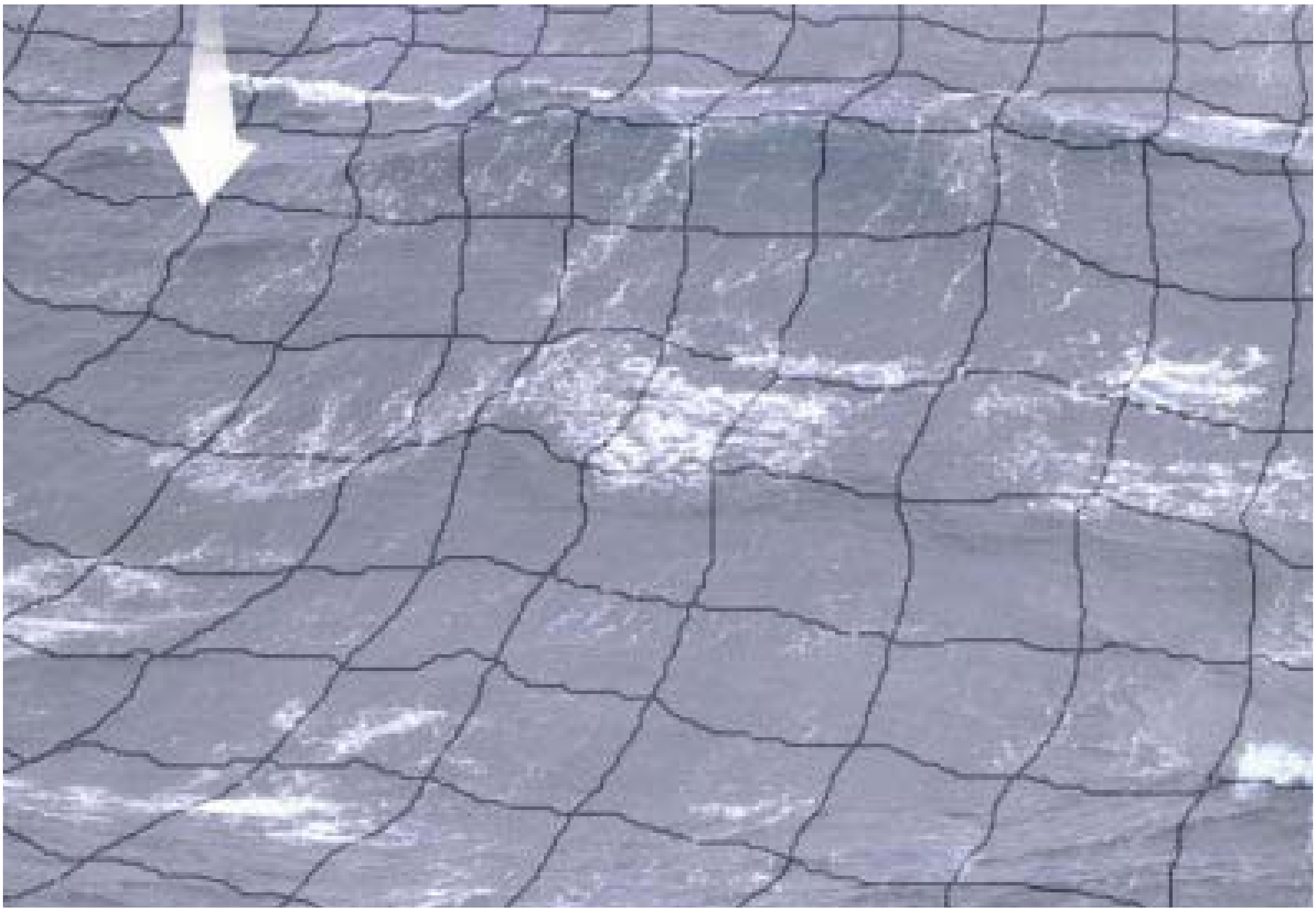
In the open ocean, with a large breaking crest that is the result of superimposed wave trains, you have a relatively flat jet of water cascading down the wave face.

This jet looks very much like the front of an avalanche of snow, or water dropping down a spillway of a dam.

Dag Pike

Two views of breaking crests. Above from boat level, this crest is in the 15- to 20-foot-range (4.7 to 6m). Note the "jet" in the upper lefthand corner. This is what does the damage. The wave below is probably a 50-plus-footer, photographed from the air. We are looking at the back side. Check out the trough immediately in front. This is a very steep, breaking face.

Richard Bennett



Two views of storm wind-force waves. Above is a primary wave system, without any cross chop. With a single system like this you will still have waves from plus or minus 20 to 30 degrees from the primary wind direction. This means as much as a 40- to 60-degree angle between waves at some times.

The photo below is a more chaotic sea state, typical of a mature depression where the storm center has been moving and is rotating about a central area, so that the primary waves caused by present wind will be crossed by waves from 90 degrees off axis.

Low-Pressure Waves

Dangerous wave systems are generally created by low-pressure weather systems—either tropical or extratropical. In most cases these systems are moving at high rates of speed relative to your vessel, so you can expect the storm system to pass you by at some point.

When the cold front passes, there is generally an abrupt change in wind direction (for more information see 196).

Let's say you're in the Northern Hemisphere and you've been experiencing a gale from the south or southwest. This probably indicates the track of the low center is to your north.

The primary wind waves and/or swells from this system will follow the wind direction. So right now you have waves from the south to southwest. When the cold front passes, the wind and sea direction will change to the west and then the northwest.

Eventually you are going to have waves running at right angles to each other.

Secondary Wave Systems

The waves from the west-to-northwest winds will not be as large as those from the more southerly quadrant, at least at first.

But they can cause significant problems with the boat's attitude. You will probably be basing your storm tactics on the primary wave system, but if a 90-degree off-heading wave slaps your stern, all of a sudden you are abeam of the primary seas—and if a breaker catches you in that pose, the situation could get serious.

Secondary wave systems, even though they are not large enough initially to do great harm on their own, can put you into a position where you are vulnerable to the primary waves.

Or, you may be lying to a parachute anchor or hove to on port tack, after a frontal passage, when you get nailed by a breaking sea from the southwest.

Compression Zone Waves

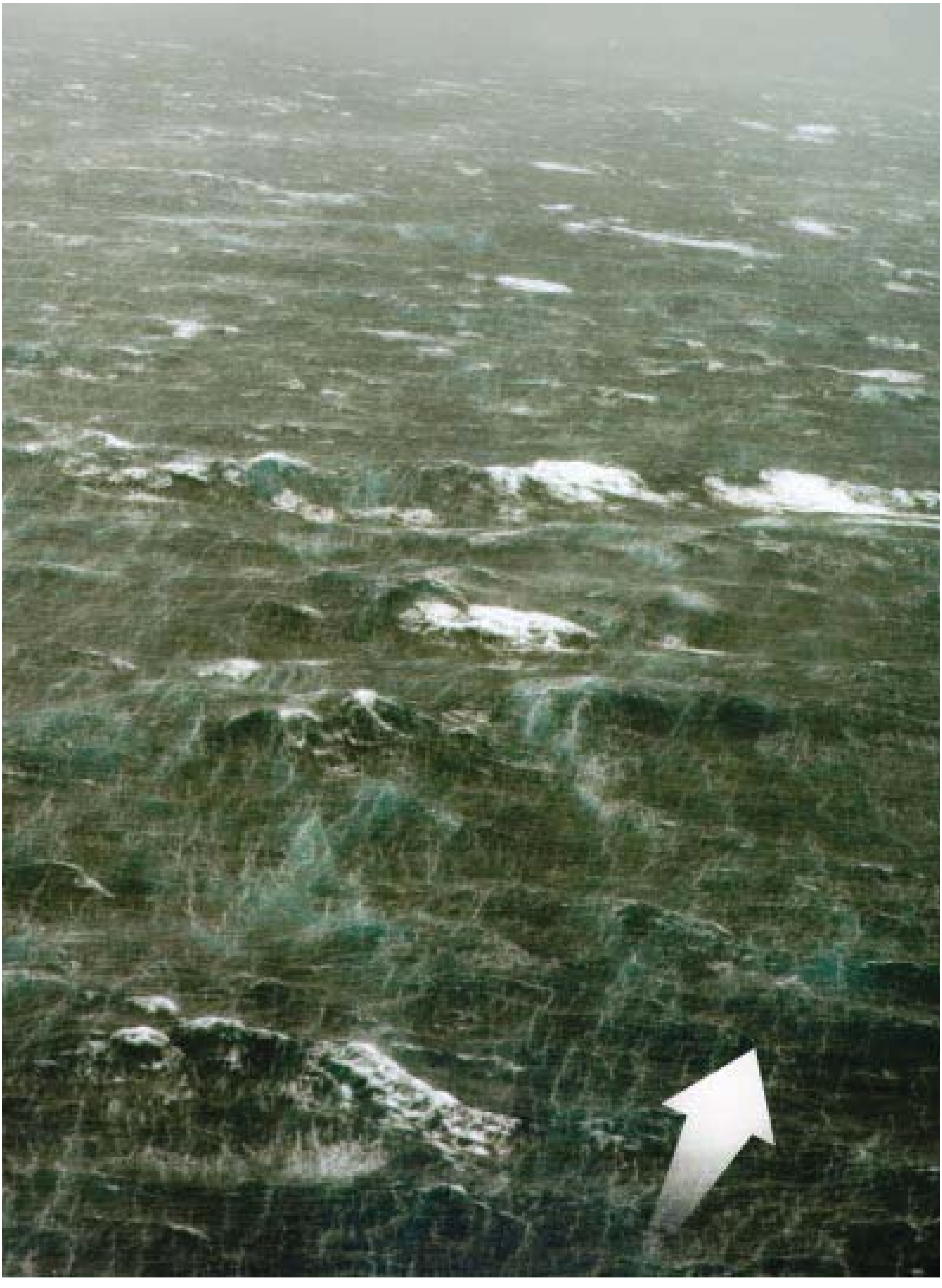
Compression zone waves are apt to be from a single general direction as compression zone keeps wind more or less aligned. However, as we've seen in the section on passaging to New Zealand, compression zone waves are still going to come at you plus or minus 20 to 30 degrees off the wind axis.

It doesn't sound like a lot of angle, but when you are trying to make your way against these seas, or hove to awaiting better conditions, the waves coming in from an angle are going to be a nuisance.

Often there will be more waves coming from one side than the other.

Generic wave rules:

- ❑ Wave height grows with fetch (distance), time, and wind strength.
- ❑ If fetch is limited, say by a windward shore, waves can only rise to a certain limited height regardless of how hard the wind blows.
- ❑ Wave speed increases with fetch.
- ❑ Wave heights typically do not exceed 0.8 times wind speed in knots—except in special circumstances (combination waves, current against waves, dynamic fetch, and so on).
- ❑ Wave speeds tend to be somewhat faster than wind speeds when the wind is less than 25 knots, and slower than wind speed when the wind is great.
- ❑ Wave speed appears to increase rapidly over time as the wind continues to blow.
- ❑ Wave steepness does not directly correspond to wind speed. It's related to the stage of the wave's development.



Richard Bennett

Sixty knots, gusting 80. This sea looks like it's coming from one direction, but there are crossing wind waves as well as a swell from almost right angles. It's when these crossing energy systems interact that you get the unusual peaking and breaking seas, often from a different direction than the primary seas. The rule is to always expect the unexpected from wave systems.

PREDICTING WAVE SIZE

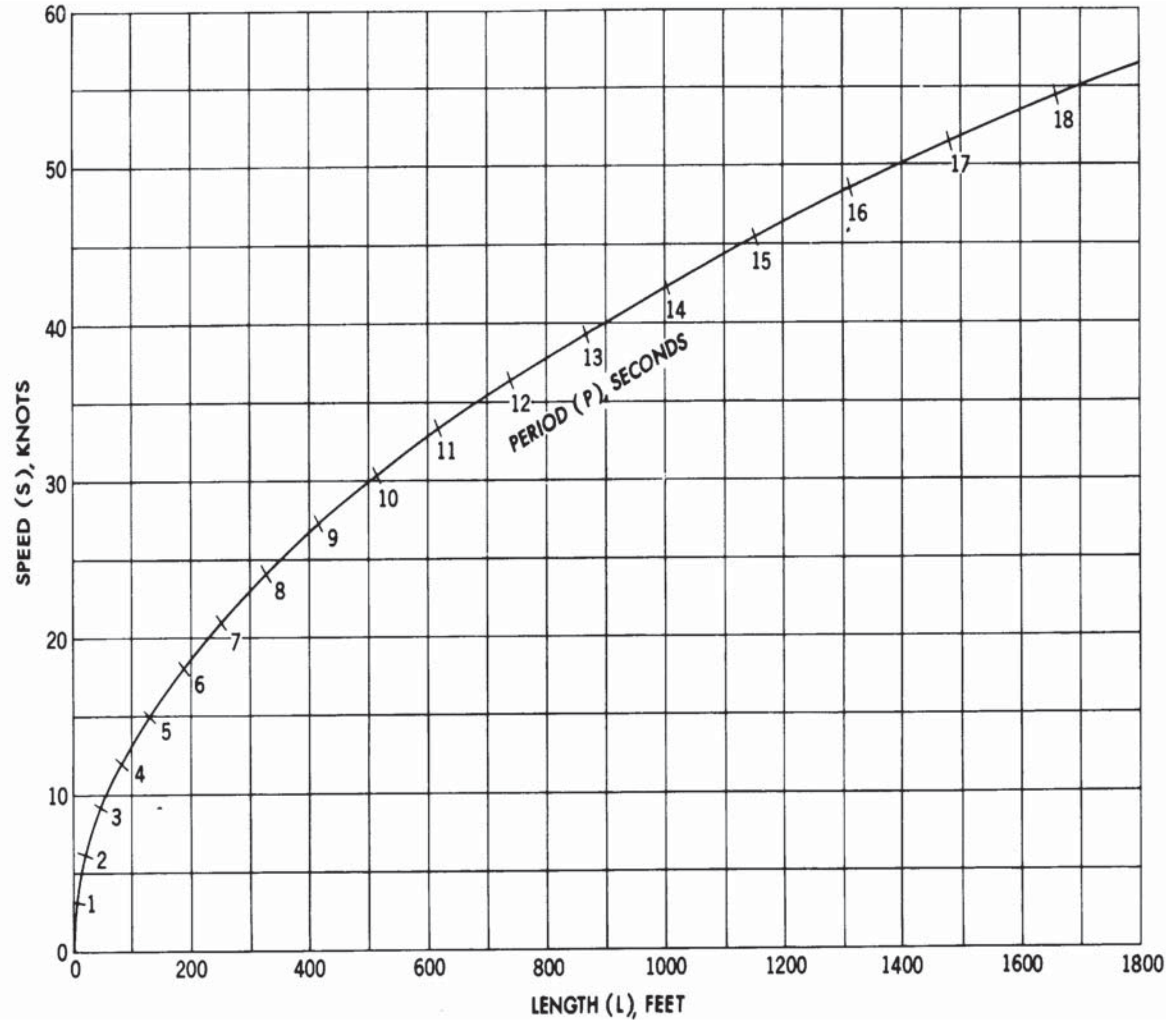
Predicting wave size is a tricky business. However, there are several charts available that indicate what to expect for the significant highest one-third of the waves expected from a given wind, blowing over a certain distance and time span.

Fetch

A critical element in this is the distance over which the wind blows, or fetch. Except in the case of dynamic fetch, discussed starting on page 246, if the wind blowing is limited in the area it covers, this also limits the size of the waves which can build.

The longer the fetch, the taller the wave. As an example, a Force 6 wind blowing over a 50-mile fetch will generate significant wave heights of about 10 feet (3m). Extend the distance to 200 miles and that wave will grow to 12.2 feet (3.7m).

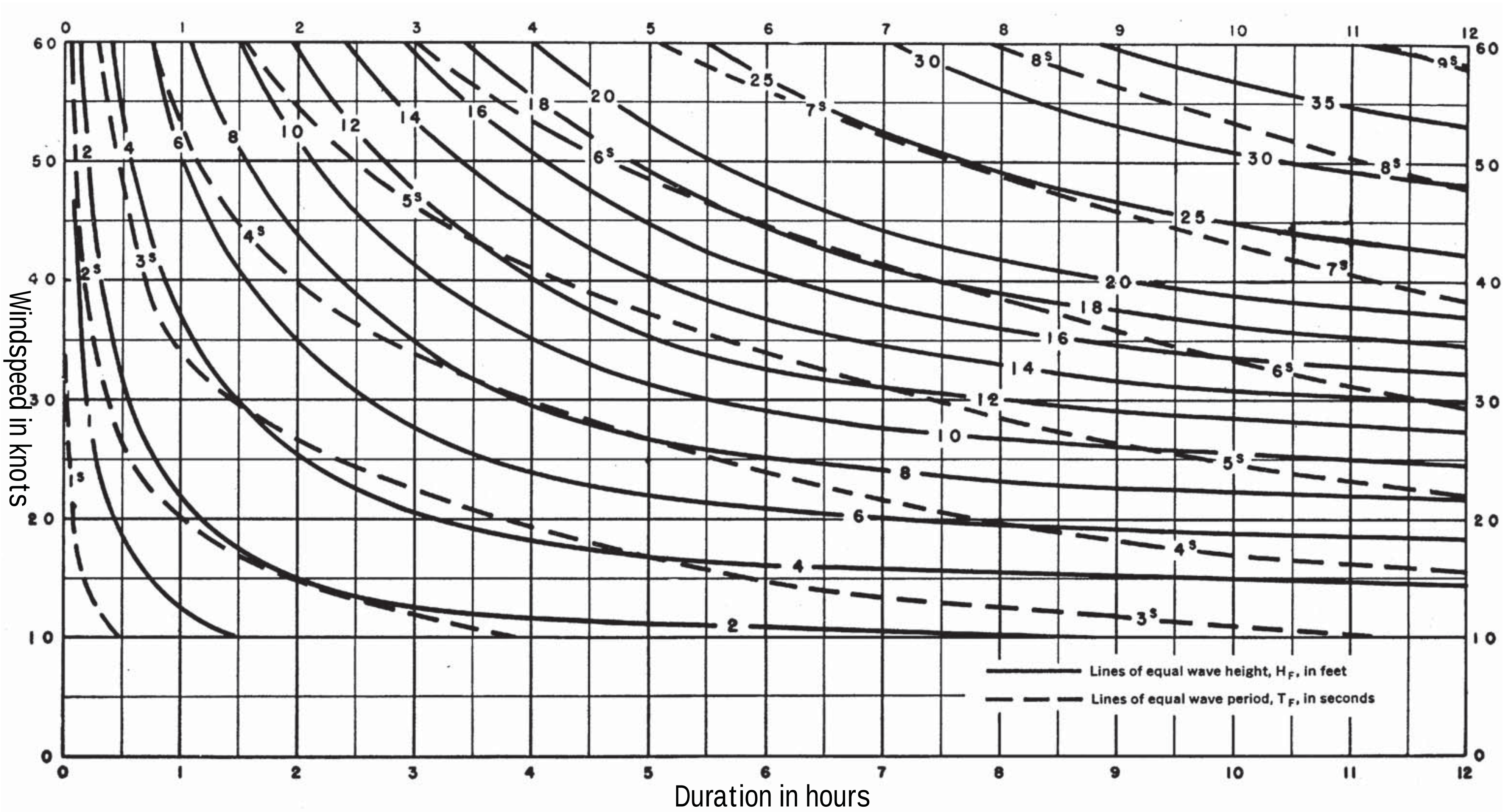
The series of tables on the following pages will give you a general idea of wave height, fetch, and time relationships. By wave height we mean "significant wave height"—the average of the highest one-third of the waves. As with any generalities about waves, this data has to be taken with a grain of salt. Still, it will give you an idea of what to expect.



In deep water, the relationship between the period of the waves, their speed, and length between crests is approximately shown by the graph (left). To use the graph, measure the time it takes a crest to pass you, then look up the timeframe on the curve. Look across to the left to find the wave speed and down to find the length in feet between the crests.

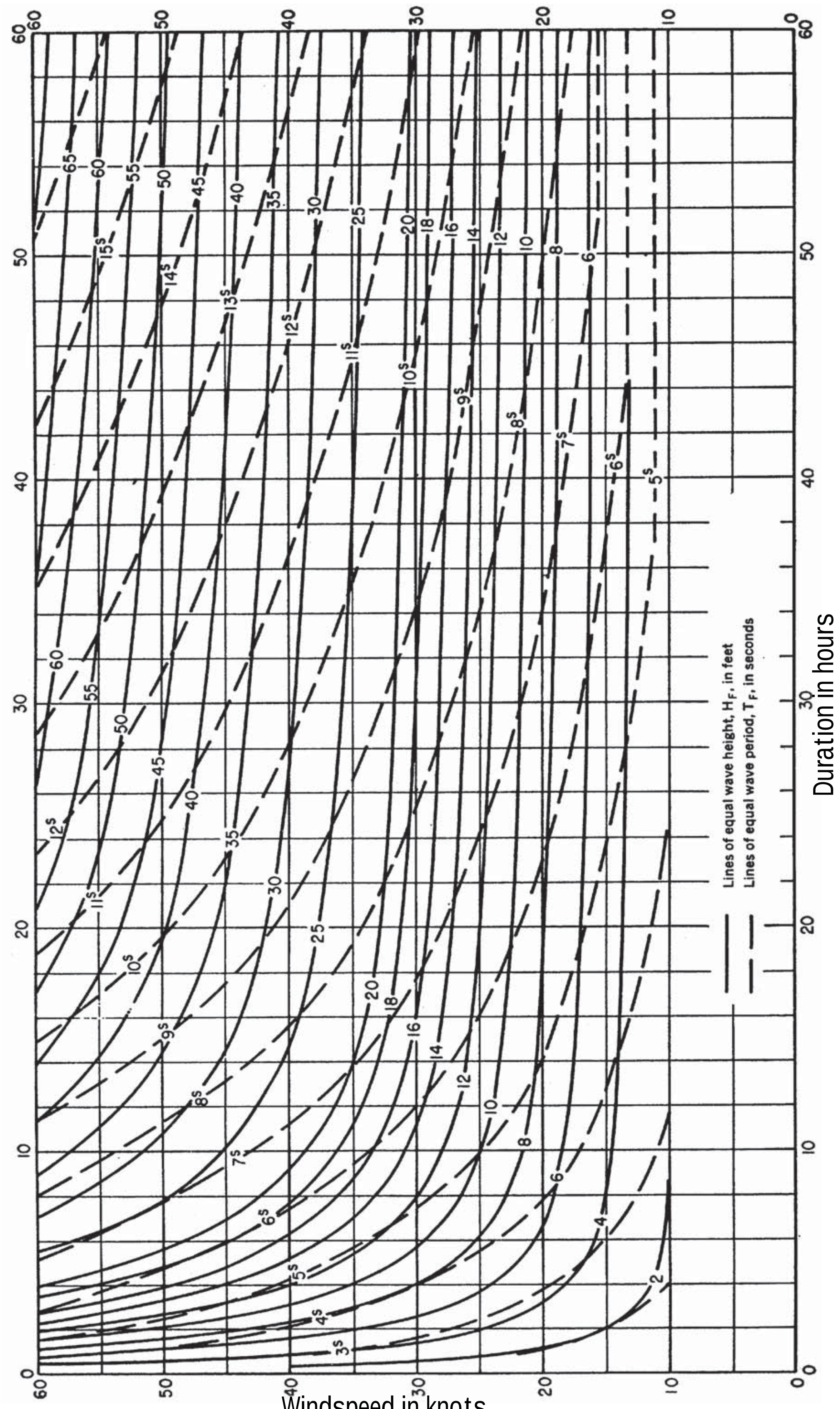
The chart on the next page gives the relationship between fetch, length of time the wind has been blowing, and the significant wave height. Keep in mind that this significant wave height refers to the largest one-third of the waves, and that occasionally waves can be significantly larger. To use the chart find the wind force across the top, then look across for the time (T), height of waves in feet (H), and wave period (P). Down each edge is the fetch distance required for the sea indicated to be created.

Fetch	BEAUFORT NUMBER																											Fetch
	3			4			5			6			7			8			9			10			11			
	T	H	P	T	H	P	T	H	P	T	H	P	T	H	P	T	H	P	T	H	P	T	H	P	T	H	P	
10	4.4	1.8	2.1	3.7	2.6	2.4	3.2	3.5	2.8	2.7	5.0	3.1	2.5	6.0	3.4	2.3	7.3	3.9	2.0	8.0	4.1	1.9	10.0	4.2	1.8	10.0	5.0	10
20	7.1	2.0	2.5	6.2	3.2	2.9	5.4	4.9	3.3	4.7	7.0	3.8	4.2	8.6	4.3	3.9	10.0	4.4	3.5	12.0	5.0	3.2	14.0	5.2	3.0	16.0	5.9	20
30	9.8	2.0	2.8	8.3	3.8	3.3	7.2	5.8	3.7	6.2	8.0	4.2	5.8	10.0	4.6	5.2	12.1	5.0	4.7	15.8	5.5	4.4	18.0	6.0	4.1	19.8	6.3	30
40	12.0	2.0	3.0	10.3	3.9	3.6	8.9	6.2	4.1	7.8	9.0	4.6	7.1	11.2	4.9	6.5	14.0	5.4	5.8	17.7	5.9	5.4	21.0	6.3	5.1	22.5	6.7	40
50	14.0	2.0	3.2	12.4	4.0	3.8	11.0	6.5	4.4	9.1	9.8	4.8	8.4	12.2	5.2	7.7	15.7	5.6	6.9	19.8	6.3	6.4	23.0	6.7	6.1	25.0	7.1	50
60	16.0	2.0	3.5	14.0	4.0	4.0	12.0	6.8	4.6	10.2	10.3	5.1	9.6	13.2	5.5	8.7	17.0	6.0	8.0	21.0	6.5	7.4	25.0	7.0	7.0	27.5	7.5	60
70	18.0	2.0	3.7	15.8	4.0	4.1	13.5	7.0	4.8	11.9	10.8	5.4	10.5	13.9	5.7	9.9	18.0	6.4	9.0	22.5	6.8	8.3	26.5	7.3	7.8	29.5	7.7	70
80	20.0	2.0	3.8	17.0	4.0	4.2	15.0	7.2	4.9	13.0	11.0	5.6	12.0	14.5	6.0	11.0	18.9	6.6	10.0	24.0	7.1	9.3	28.0	7.7	8.6	31.5	7.9	80
90	23.6	2.0	3.9	18.8	4.0	4.3	16.5	7.3	5.1	14.1	11.2	5.8	13.0	15.0	6.3	12.0	20.0	6.7	11.0	25.0	7.2	10.2	30.0	7.9	9.5	34.0	8.2	90
100	27.1	2.0	4.0	20.0	4.0	4.4	17.5	7.3	5.3	15.1	11.4	6.0	14.0	15.5	6.5	12.8	20.5	6.9	11.9	26.5	7.6	11.0	32.0	8.1	10.3	35.0	8.5	100
120	31.1	2.0	4.2	22.4	4.1	4.7	20.0	7.8	5.4	17.0	11.7	6.2	15.9	16.0	6.7	14.5	21.5	7.3	13.1	27.5	7.9	12.3	33.5	8.4	11.5	37.5	8.8	120
140	36.6	2.0	4.5	25.8	4.2	4.9	22.5	7.9	5.8	19.1	11.9	6.4	17.6	16.2	7.0	16.0	22.0	7.6	14.8	29.0	8.3	13.9	35.5	8.8	13.0	40.0	9.2	140
160	43.2	2.0	4.9	28.4	4.2	5.2	24.3	7.9	6.0	21.1	12.0	6.6	19.5	16.5	7.3	18.0	23.0	8.0	16.4	30.5	8.7	15.1	37.0	9.1	14.5	42.5	9.6	160
180	50.0	2.0	4.9	30.9	4.3	5.4	27.0	8.0	6.2	23.1	12.1	6.8	21.3	17.0	7.5	19.9	23.5	8.3	18.0	31.5	9.0	16.5	38.5	9.5	16.0	44.5	10.0	180
200				33.5	4.3	5.6	29.0	8.0	6.4	25.4	12.2	7.1	23.1	17.5	7.7	21.5	23.5	8.5	19.3	32.5	9.2	18.1	40.0	9.8	17.1	46.0	10.3	200
220				36.5	4.4	5.8	31.1	8.0	6.6	27.2	12.3	7.2	25.0	17.9	8.0	22.9	24.0	8.8	20.9	34.0	9.6	19.1	41.5	10.1	18.2	47.5	10.6	220
240				39.2	4.4	5.9	33.1	8.0	6.8	29.0	12.4	7.3	26.8	17.9	8.2	24.4	24.5	9.0	22.0	34.5	9.8	20.5	43.0	10.3	19.5	49.0	10.8	240
260				41.9	4.4	6.0	34.9	8.0	6.9	30.5	12.6	7.5	28.0	18.0	8.4	26.0	25.0	9.2	23.5	34.5	10.0	21.8	44.0	10.6	20.9	50.5	11.1	260
280				44.5	4.4	6.2	36.8	8.0	7.0	32.4	12.9	7.8	29.5	18.0	8.5	27.7	25.0	9.4	25.0	35.0	10.2	23.0	45.0	10.9	22.0	51.5	11.3	280
300				47.0	4.4	6.3	38.5	8.0	7.1	34.1	13.1	8.0	31.5	18.0	8.7	29.0	25.0	9.5	26.3	35.0	10.4	24.3	45.0	11.1	23.2	53.0	11.6	300
320							40.5	8.0	7.2	36.0	13.3	8.2	33.0	18.0	8.9	30.2	25.0	9.6	27.6	35.5	10.6	25.5	45.5	11.2	24.5	54.0	11.8	320
340							42.4	8.0	7.3	37.6	13.4	8.3	34.2	18.0	9.0	31.6	25.0	9.8	29.0	36.0	10.8	26.7	46.0	11.4	25.5	55.0	12.0	340
360							44.2	8.0	7.4	38.8	13.4	8.4	35.7	18.1	9.1	33.0	25.0	9.9	30.0	36.5	10.9	27.7	46.5	11.6	26.6	55.0	12.2	360
380							46.1	8.0	7.5	40.2	13.5	8.5	37.1	18.2	9.3	34.2	25.5	10.0	31.3	37.0	11.1	29.1	47.0	11.8	27.7	55.5	12.4	380
400							48.0	8.0	7.7	42.2	13.5	8.6	38.8	18.4	9.5	35.6	26.0	10.2	32.5	37.0	11.2	30.2	47.5	12.0	28.9	56.0	12.6	400
420							50.0	8.0	7.8	43.5	13.6	8.7	40.0	18.7	9.6	36.9	26.5	10.3	33.7	37.5	11.4	31.5	47.5	12.2	29.6	56.5	12.7	420
440							52.0	8.0	7.9	44.7	13.7	8.8	41.3	18.8	9.7	38.1	27.0	10.4	34.8	37.5	11.5	32.5	48.0	12.3	30.9	57.0	12.9	440
460							54.0	8.0	8.0	46.2	13.7	8.9	42.8	19.0	9.8	39.5	27.5	10.6	36.0	37.5	11.7	33.5	48.5	12.5	31.8	57.5	13.1	460
480							56.0	8.0	8.1	47.8	13.7	9.0	44.0	19.0	9.9	41.0	27.5	10.8	37.0	37.5	11.8	34.5	49.0	12.6	32.7	57.5	13.2	480
500							58.0	8.0	8.2	49.2	13.8	9.1	45.5	19.1	10.1	42.1	27.5	10.9	38.3	38.0	11.9	35.5	49.0	12.7	33.9	58.0	13.4	500
550										53.0	13.8	9.3	48.5	19.5	10.3	44.9	27.5	11.1	41.0	38.5	12.2	38.2	50.0	13.0	36.5	59.0	13.7	550
600										56.3	13.8	9.5	51.8	19.7	10.5	47.7	27.5	11.3	43.6	39.0	12.5	40.3	50.0	13.3	38.7	60.0	14.0	600
650													55.0	19.8	10.7	50.3	27.5	11.6	46.4	39.5	12.8	43.0	50.0	13.7	41.0	60.0	14.2	650
700													58.5	19.8	11.0	53.2	27.5	11.8	49.0	40.0	13.1	45.4	50.5	14.0	43.5	60.5	14.5	700
750																56.2	27.5	12.1	51.0	40.0	13.3	48.0	51.0	14.2	45.8	61.0	14.8	750
800																59.2	27.5	12.3	53.8	40.0	13.5	50.6	51.5	14.5	47.8	61.5	15.0	800
850																			56.2	40.0	13.8	52.5	52.0	14.6	50.0	62.0	15.2	850
900																			58.2	40.0	14.0	54.6	52.0	14.9	52.0	62.5	15.5	900
950																						57.2	52.0	15.1	54.0	63.0	15.7	950
1000																						59.3	52.0	15.3	56.3	63.0	16.0	1000



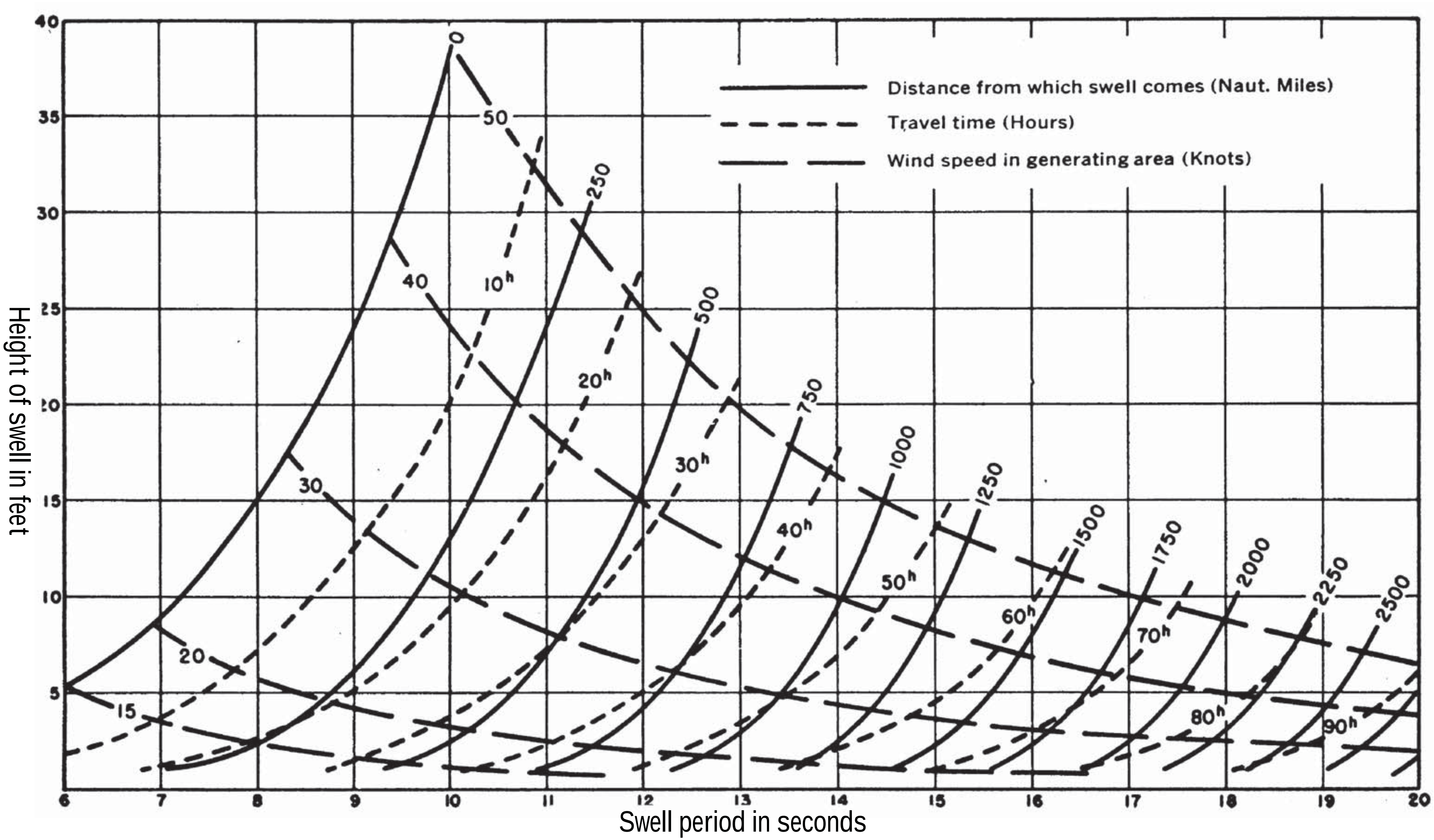
Short Duration Winds Wave Data

Enter windspeed on the left or right vertical column, and then run across to the correct time in hours. Find the solid curved line for wave height in feet (numbers within lines represent height of waves). Use dashed curves for swell period in seconds.



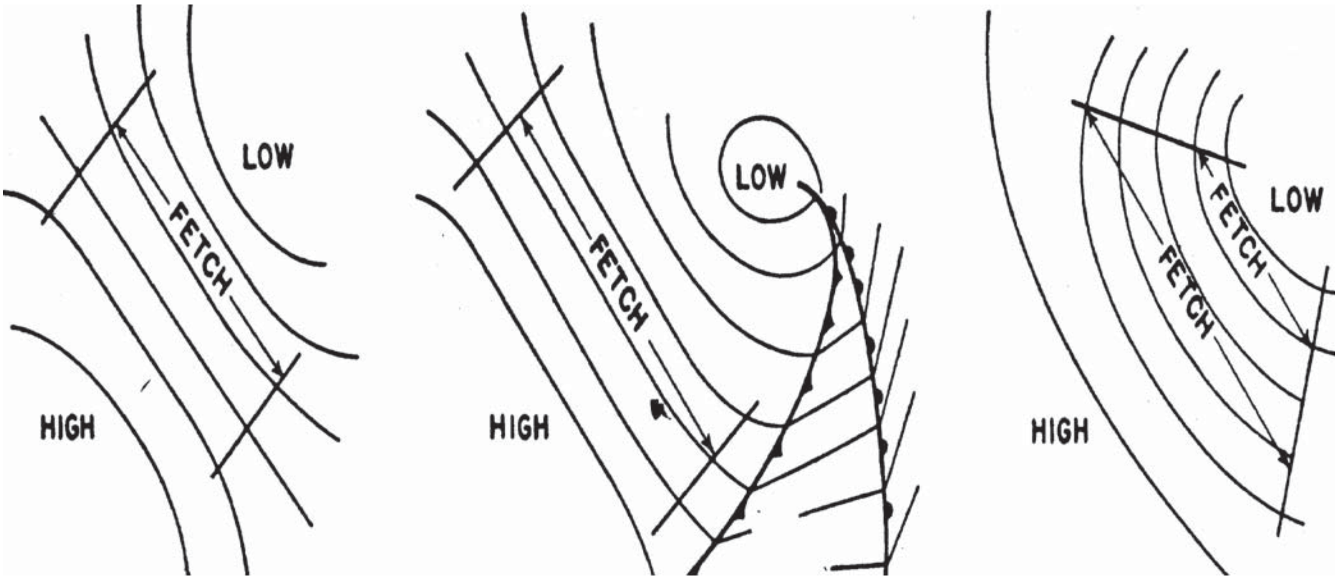
Long-Term Winds Wave Data

Find windspeed on side, run across for appropriate time, and then pick out wave height (solid curves) and period (dashed curves).



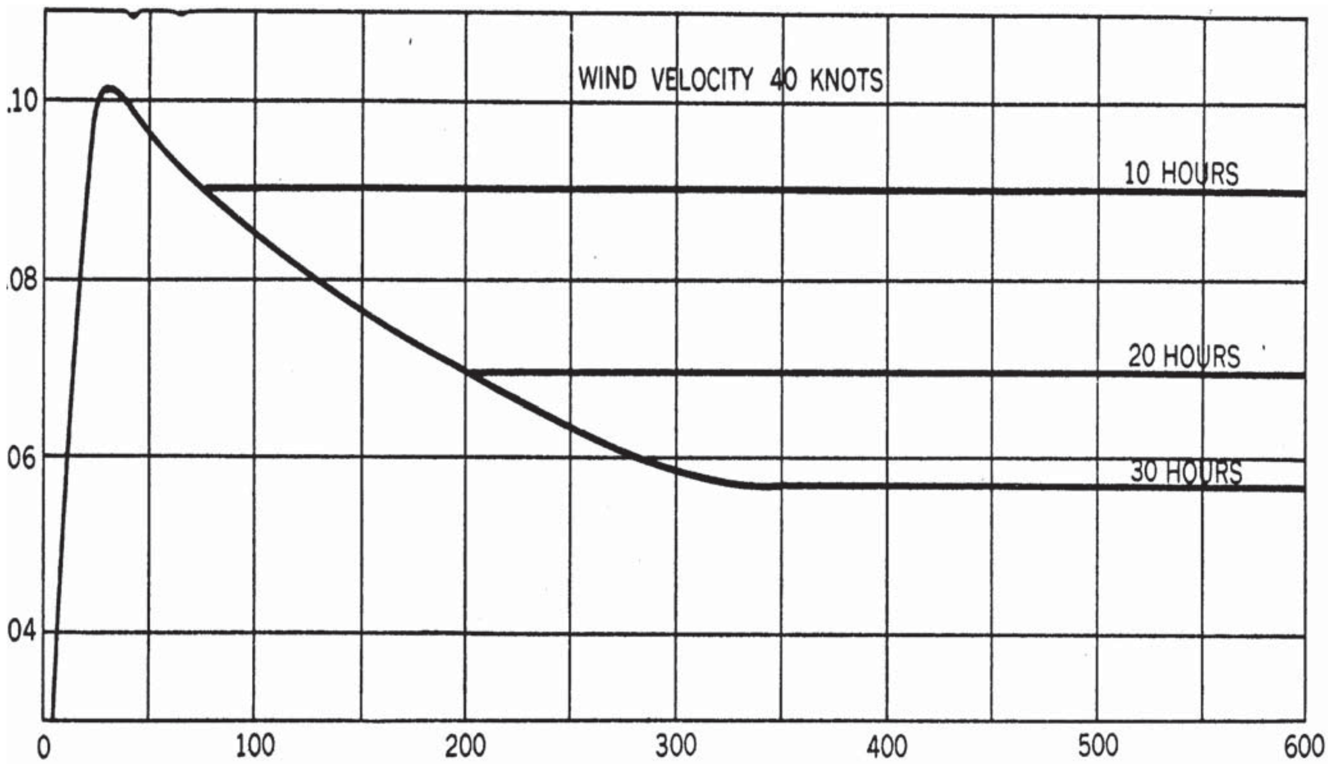
Calculating Swell Origin

This is a very useful table for roughly quantifying whence a swell has come, windspeed which has created the swell, and time it has traveled. If you are wondering what is coming at you and when it is going to arrive, this table will help. Enter the height of the the swell on the side, then come across to the swell period in seconds. Pick off the windspeed, travel time, or distance from the appropriate curves.



The concept of fetch within a weather system, where there are no blocking land masses, is shown in the drawing above. Fetch is defined by the area in which the winds are blowing more or less steadily from a given direction.

You can see from these example that a situation involving a compression zone between highs and lows often creates large areas of strong wind—the perfect fetch and wind situation to raise a large sea.



Here's a useful graph for gale-force winds—40 knots—and the relationship of time, fetch, and steepness. Fetch is read across the bottom (100 to 600 nautical miles) while the steepness ratio— wave height divided by wave length—is given across the left vertical edge (0.04 to 0.1). A steepness ratio of 0.1 or 1 in 10 would imply breaking seas.

The timeframe for the waves to travel the distance across the bottom is given in the heavy horizontal lines. Thus, after ten hours you would have a steepness ratio of 0.08 and the initial seas would have traveled 75 miles.

Royal New Zealand Navy

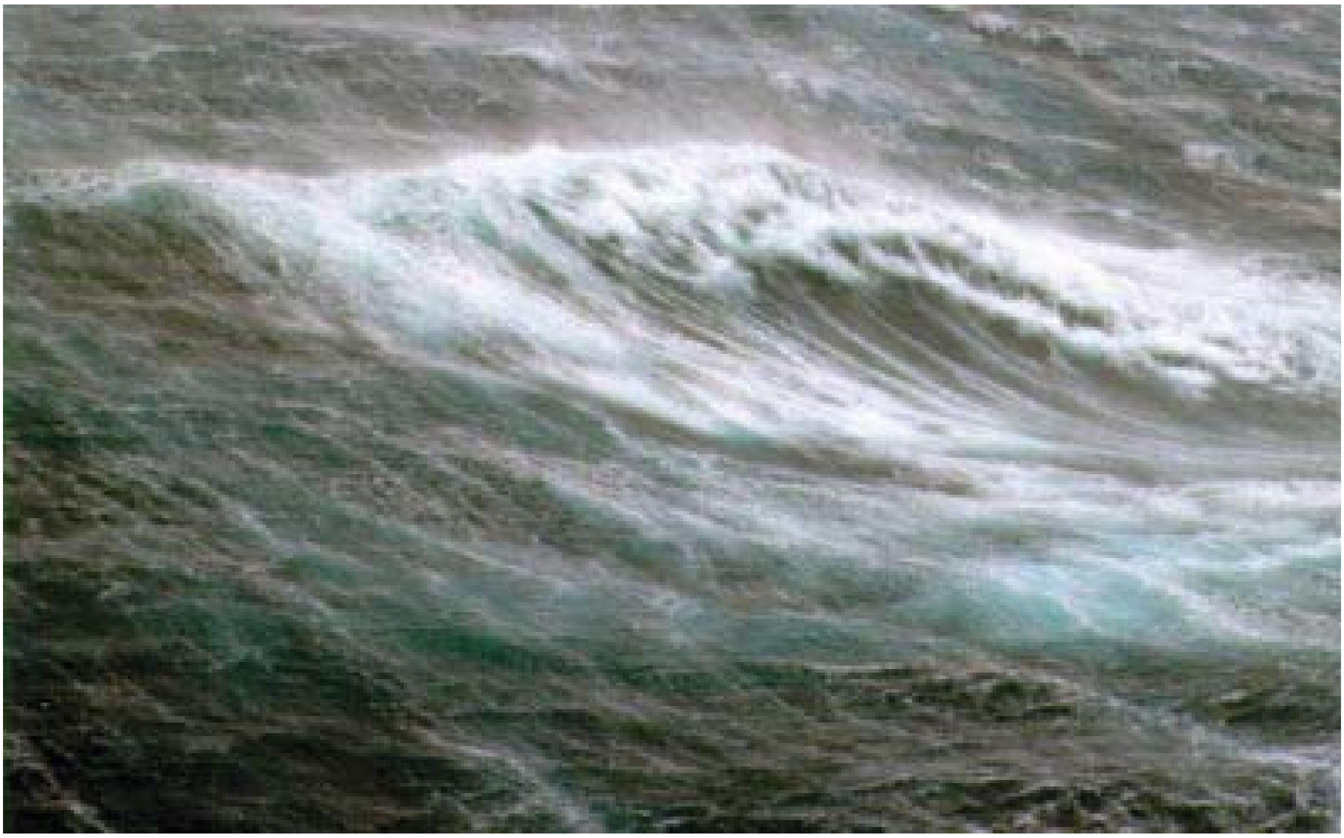
WAVE SIZE PROBABILITY

There really is no such thing as a rogue wave. These larger-than-normal seas are the result of two wave trains coinciding at just the right moment for their energy to combine.

When this happens the higher-than-normal crest is exposed to more wind force, and absorbs additional energy.

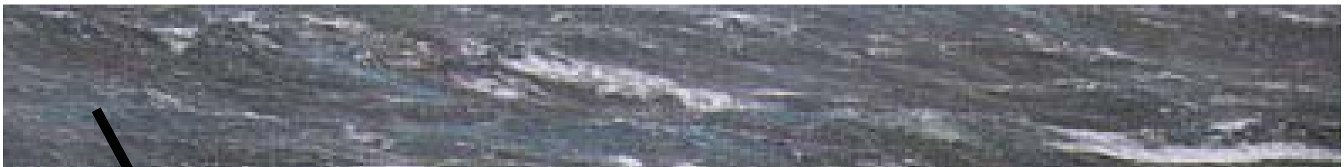
And if the wave happens to be unstable and breaks—because the rotating particles within the wave can no longer make it over the top—there will be a large mass of water falling downhill.

Monowai (above) during rescue operations in the Queen's Birthday storm in June, 1994. Seventy knots gusting higher. Seas are 25 to 40 feet (7.6 to 12.2m). Note the boat off the bow (arrow).



Huge breaking crests are transitory in nature. They occur only when several wave trains meet to reinforce each other in precisely the optimum way. Most of the time the wave trains actually counteract each other, often causing smaller waves, although they may be more chaotic in shape. Even when this huge crest does appear, it typically lasts for seconds—half a minute at the most. Afterwards they collapse in a welter of foam and white water.

Below is another view of a collapsed crest. This must have come from a huge wave because the front of the white water, almost half a wavelength away, is still enormous. Although this is intimidating, to say the least, you can take comfort from the fact that there is only one of these crests in a very large area of ocean covered by this photo.



Both photos Richard Bennett

Troughs

So far we've discussed the upper part of the wave—the crest. The bottom part of the wave system—the trough—is generally not thought of as a problem.

However, statistically speaking, for every giant wave crest there exists somewhere an abnormally deep trough.

These big holes in the ocean are more dangerous to large ships than are the crests.

From a small boat perspective the issues are somewhat different. If you are running off at speed on a high-performance light-displacement monohull or a fast-moving multihull, dropping over a wave top into a really steep trough can result in a severe bow burying and an abrupt stop—or worse, a pitchpole (for examples of this see pages **392** and **527**).

Significant Wave Height

Most forecasts discuss significant wave height. This refers to the *average* highest one-third waves that are expected in the forecast area. Anything smaller than this is not a worry, and statistically difficult to predict anyhow.

When the local meteorological service says expect significant waves of 20 feet (6m), it is possible to encounter waves substantially larger, although they will be rare. For example, you can assume that in a given forecast area, every two to three hours there may be a wave which is twice the predicted significant average wave height.

As we've discussed previously, this wave will be the result of different wave systems reinforcing each other. This means one wave climbing the back of another, or the combined energy of two waves. When this occurs, the speed of the waves and the distance between the crests remain more or less constant. The combination wave, twice as high as its neighbors, is also twice as steep—which is, of course, wherein the problem lies.

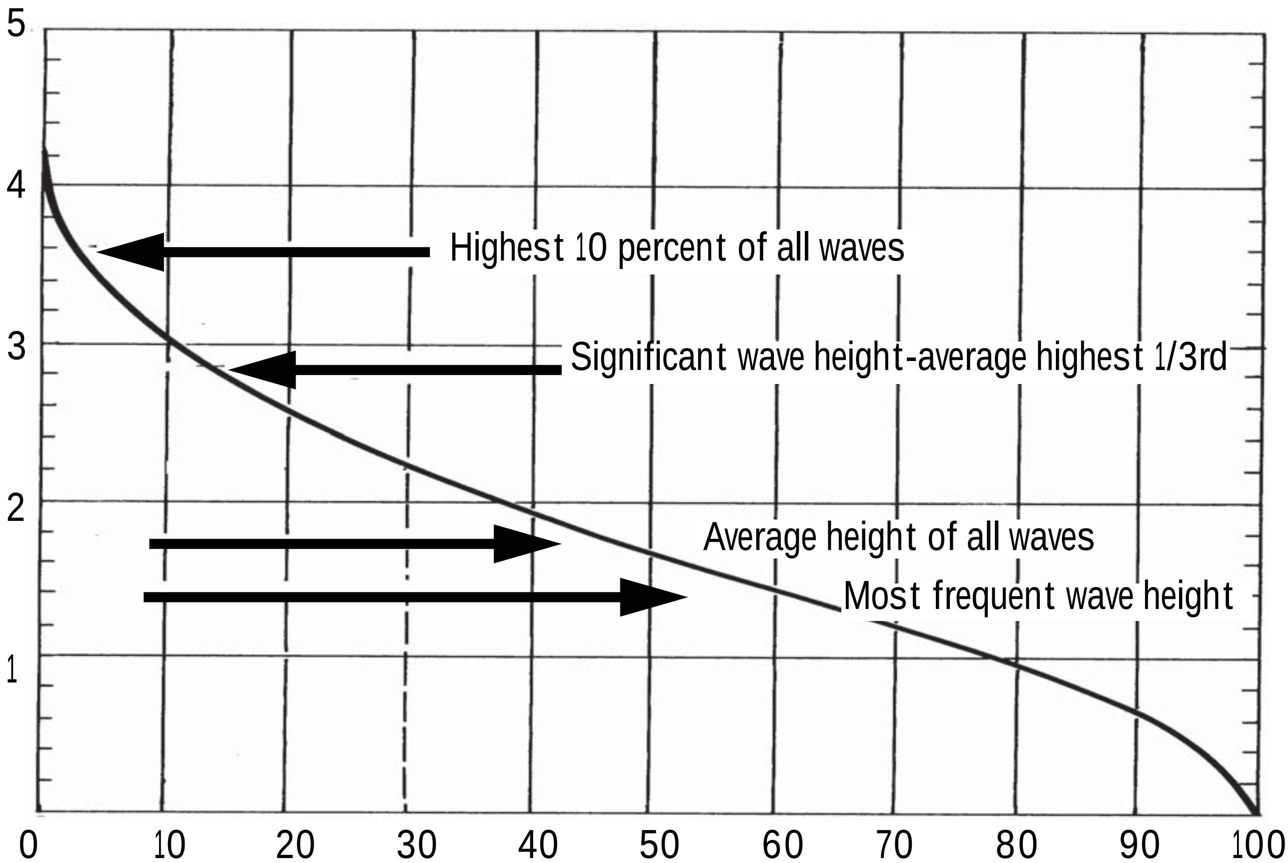
The time period in which these waves exists varies, but is generally not longer than two or three times the wave period. Typically it is thought these large waves last only a normal wave period then collapse.

What Are the Chances of Getting Caught?

What we are all really concerned with is the probability of waves that are a lot higher than the significant wave height just mentioned.

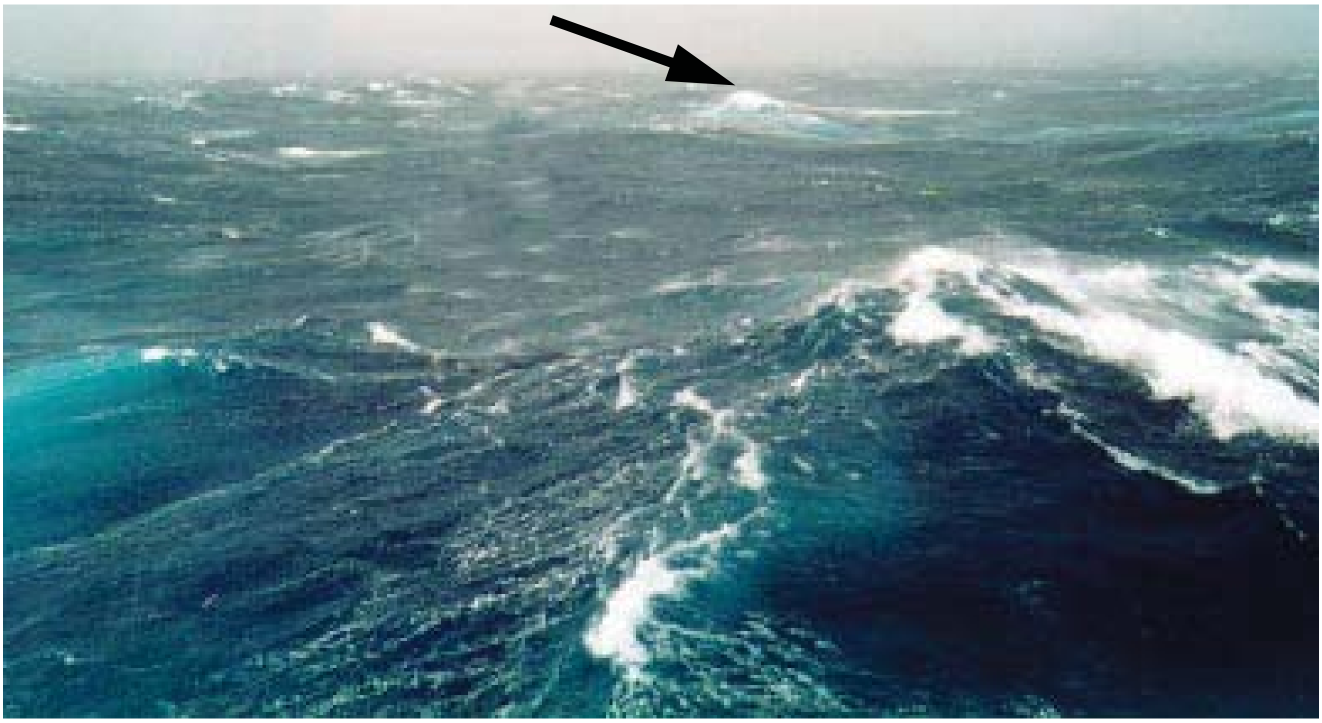
Oceanographers use statistical sampling methods to give us the probability of meeting a wave of a given size. One way of looking at this is to use the significant forecast wave size as a base, giving it a value of 1.00. This implies that the average wave height will be 0.64 of this value. The highest 10 percent of the waves will be 1.29 times as high, while the highest wave will be 1.87 times the significant wave height.

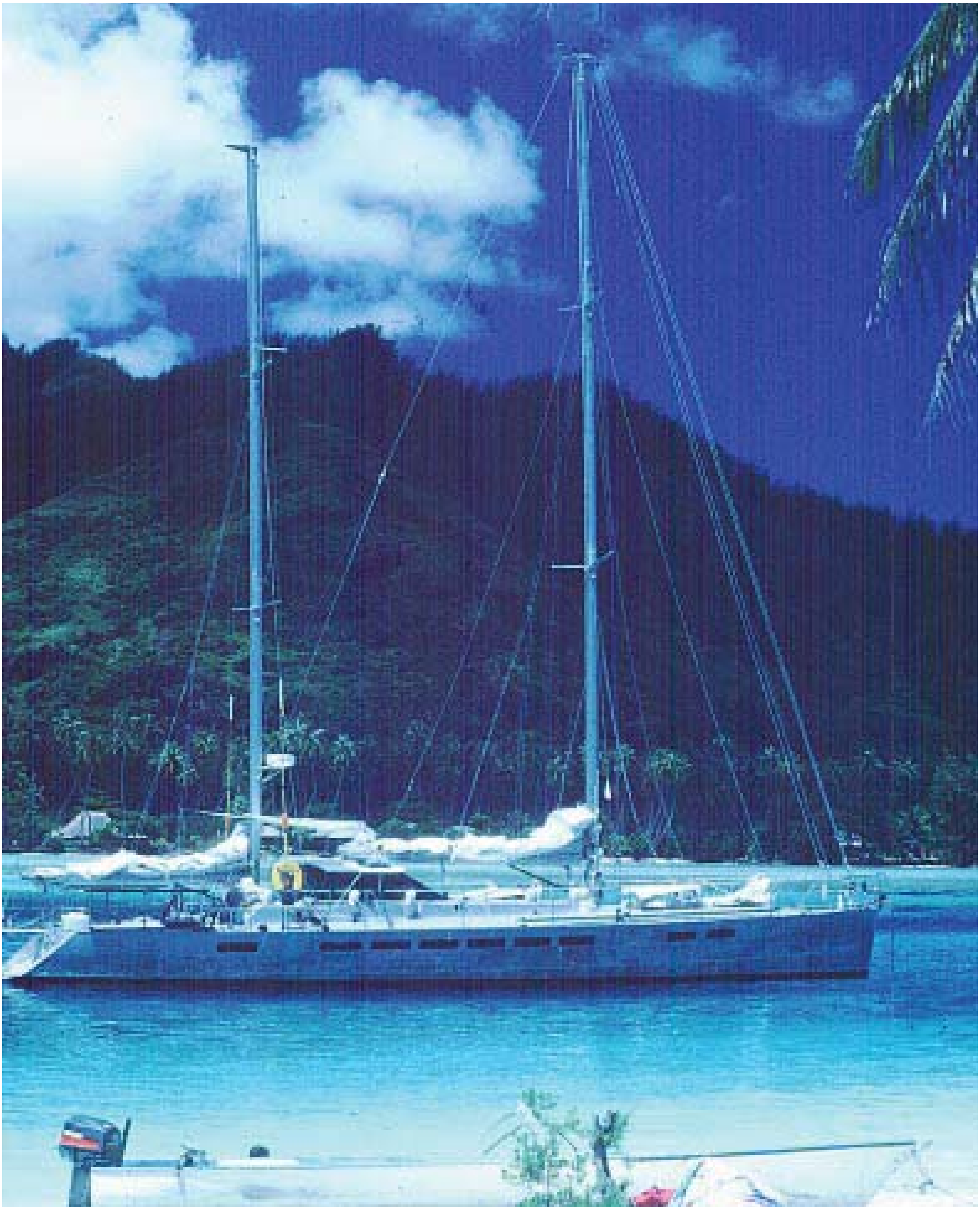
Another issue is how often we will encounter the significant waves. Looking at this statistically, the odds would predict that roughly 15 percent of the waves will reach the significant height. This implies one in seven waves. However, you can go for periods of time when waves will be moderate in size, and then have a series of significant wave heights.



Here's another way to look at wave probability. If you start at the bottom arrow you can read the wave height relative to the other waves on the left side and percentage of waves across the bottom. In this case, the most frequent average wave height will be roughly 1.4 times the base wave size and occur about 60 percent of the time. At the other end of the spectrum, you have the highest 10 percent of the waves, which are about 3.6 times the base wave height and occur 2 to 3 percent of the time. The significant wave height—the average of the highest one third of the waves—will be 2.8 times the base wave height and occur about 15 percent of the time.

Now, study the image below carefully. It is blowing 60 to 70, after a frontal passage. The wave in the foreground is one of the higher peaks in this region, as is the one in the background under the arrow. While these waves, which are multiples of the significant wave height, are rare, they do occur. With preparation, and careful tactics, they can be dealt with.





Time out for a reality check. Sundeer anchored in Moorea, French Polynesia. Forget all the huge wave photos we've been showing you. This is the reality of cruising 99 percent of the time—if you follow a few simple rules and watch your weather when passaging.

Dynamic Fetch

Leading indicators of dynamic fetch:

- ❑ Weather systems moving at the same speed and direction as the group speed and direction of the waves.
- ❑ Localized wind system which develops over—and blows along—an already established swell system.
- ❑ Rapidly accelerating weather systems such as tropical-to-extratropical transitions.
- ❑ Rapidly deepening lows (bombs).
- ❑ Longer-period swells interspersed with the background "noise" of the normal waves indicate a major blow somewhere upstream of the waves. (However, these can be difficult to decipher as they will be masked by the surrounding sea state.)

Seasonality:

- ❑ Data so far seems to indicate these are typically fall-through-spring events—October through April in the Northern Hemisphere and May through October in the Southern Hemisphere.

The data we have presented so far on waves attempts to make some sense of what is an extremely chaotic environment. For the most part, the various approaches to wave forecasting used by weather services make it possible for us to assess risk factors, so that we can make the appropriate decisions about when to slow down, heave to, lie to a sea anchor, or try as hard as possible to get out of a given area.

There is one problem, however. Anecdotal data indicates that under some conditions sea state can build rapidly, out of proportion to the existing winds.

At times a whole series of waves appear that are much larger and steeper than normal. They seem to hang around for a modest period of time—perhaps an hour or two—before things go back to "normal".

Until recently, most oceanographers ascribed this behavior to undersea shapes, currents, or long-period internal sea waves.

Scott Prosise is a forecaster working at the NOAA Marine Prediction Center. Back on March 26,1997, Scott was reviewing buoy data as a part of the normal forecast process. A storm was moving into the Gulf of Alaska, generating waves far beyond the norm for such a system. "It really got my attention," Scott told us.

"The way the waves developed at the buoys looked like a 'front' of waves. I'd never considered this before, but looking back you feel kind of dumb not to have thought of it before."

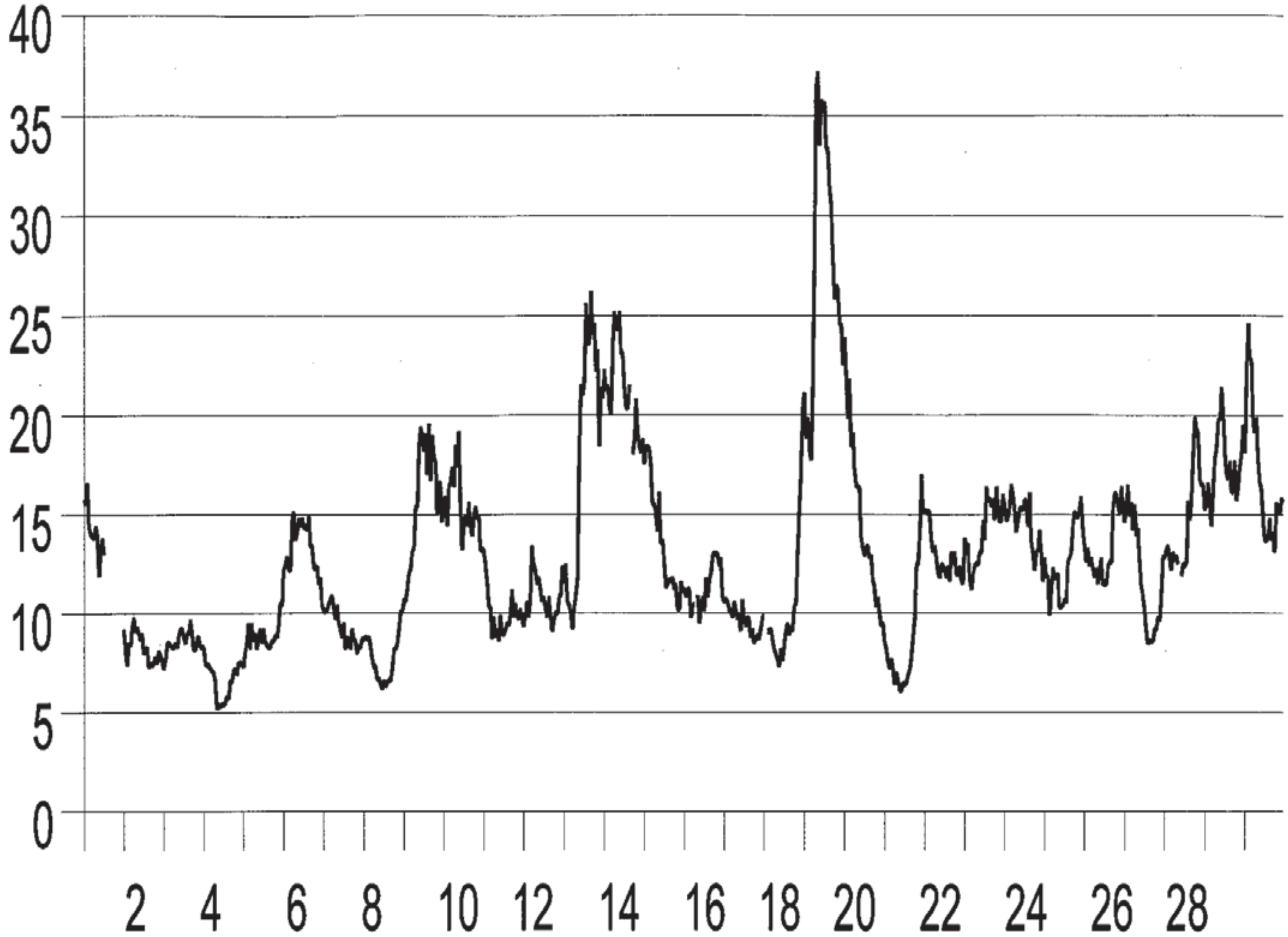
Scott went through all the buoy data for 1997 for the West Coast of North America, looking for other instances of rapidly building seas. He used a criteria of a 10-foot (3m) rise in seas within three hours. He found 10 instances for the year.

Scott goes on: "We can actually see this happening to some degree on our computer screens.There are times when, if we display significant wave height predictions side by side with wave models showing period and peak swell direction, there is the actual appearance of a front."

Reviewing this data and then working with NOAA scientist Hendrik Tolman, he gradually worked out a new concept of wave generation, based on a dynamic-fetch condition rather than the static fetch previously assumed to be all-encompassing. Henrik points out that "this has been discussed orally for three decades, but nobody had put any science into it."

As we've previously discussed with conventional wave generation, you have the wind blowing over a specific area—the fetch—for a certain length of time and at a particular force. The resulting waves are a function of all three factors. An important component in how this works is the fact that the waves are propagating away from the wind force in a variety of periods and sizes. These eventually group to form wave trains travelling at a group velocity (half the speed of individual waves).

Larger waves are periodically created when different systems combine for a short period of time.



Here is a graph from November 1997 of wave heights for buoy 46002 located at 47 N, 130 W, in the Gulf of Alaska. The lefthand column represents wave height in feet. At the bottom of the graph are the days of the month.

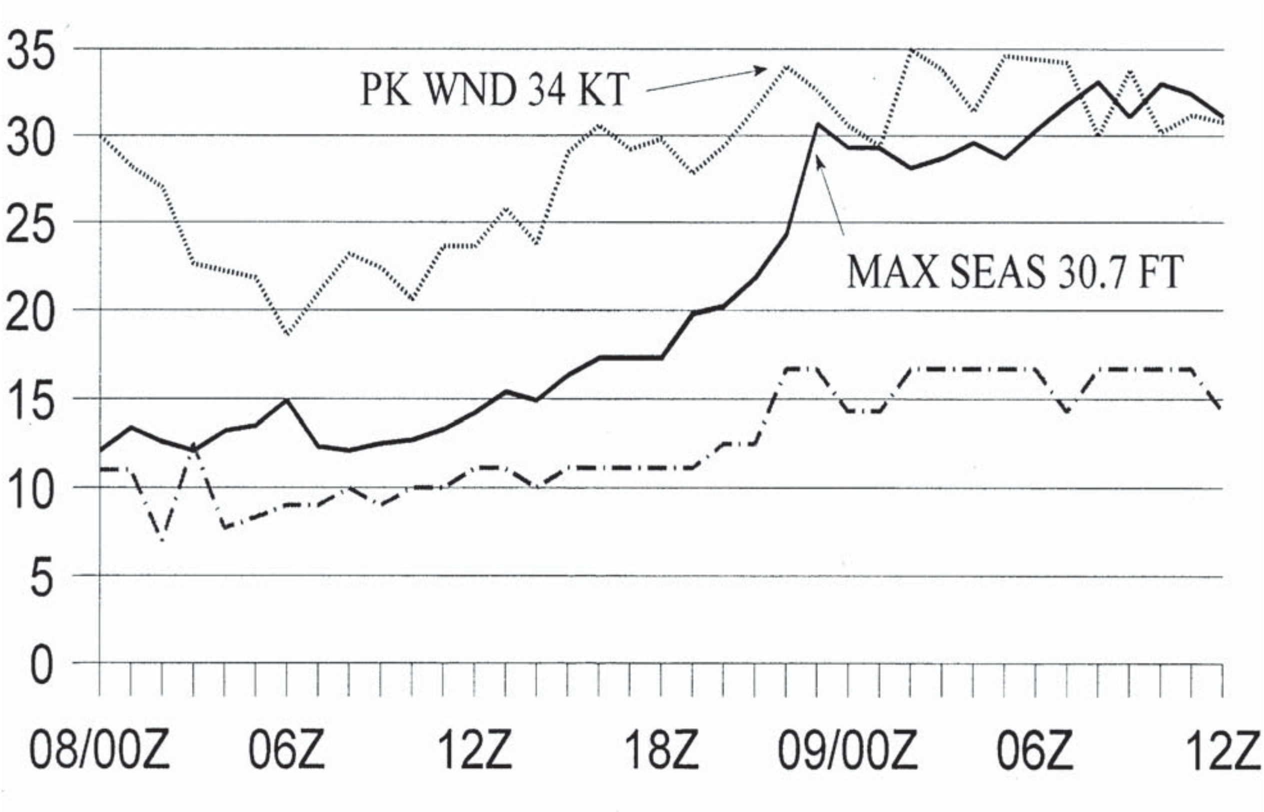
What we have here are mostly typical wave heights for an equinoctial gale season. You can see the weather fronts marching through by the waves they generate, every four days in the first two weeks of the month. For the most part, these wave heights are within an expected range. Then take a look at the peak—37 feet (11.3m) on November 20. This is out of proportion to the rest of the fronts. You would think that this was caused by stronger winds. However, what actually happened is that a wave front came through, based on a rapidly accelerating storm system.

When windspeed builds rapidly, it sends out faster wave systems with the stronger winds than with the earlier lighter winds. These faster-moving waves eventually overtake the slower seas. If they coincide at the right time, a wave front is formed with larger-than-normal waves, sometimes in the absence of significant windspeed in the area of the wave front.

Rapidly Accelerating Storm Systems

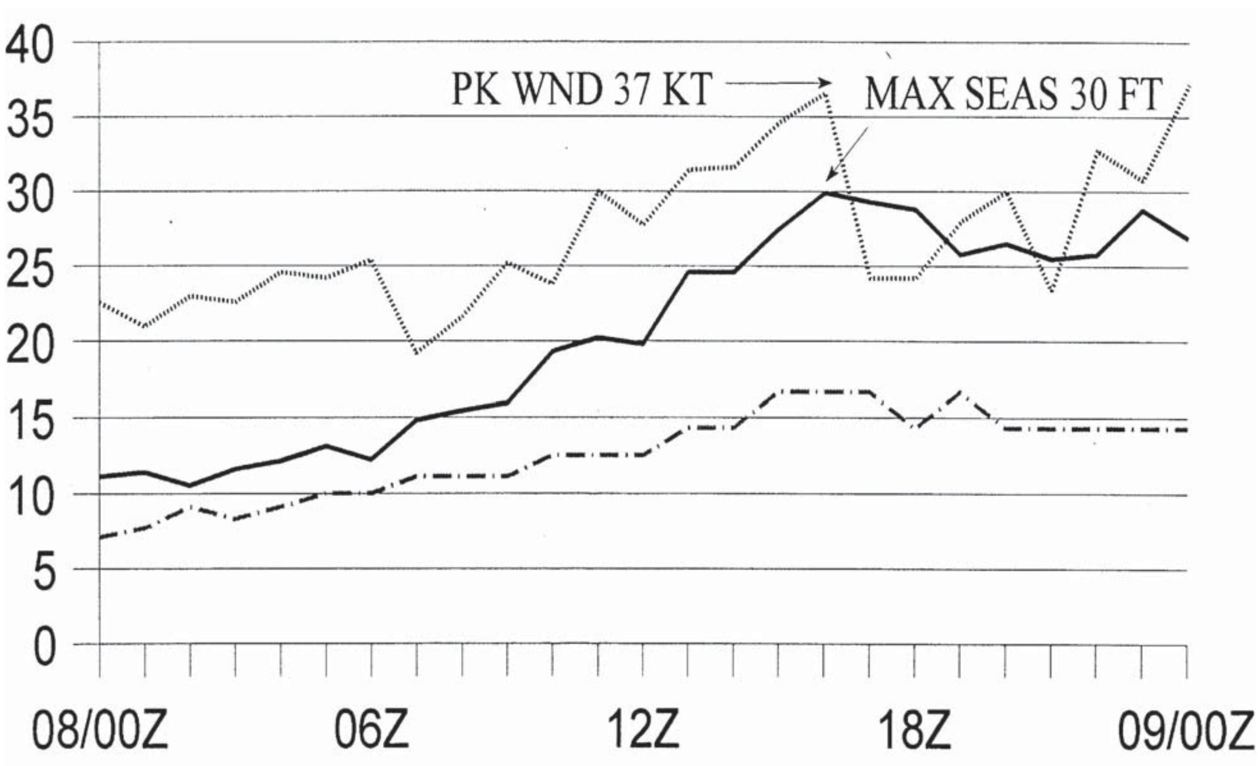
If a weather system is rapidly accelerating, and if the speed of this weather system matches the group wave velocity, then the wind force is effectively blowing over the same waves the whole time. This means the wind can impart far greater energy to the waves in a shorter period of time than when the waves move quickly out from under the greatest wind forces.

When the storm system and group wave speed are matched, the effect is the same as the wind blowing for a longer time over a greater area.



Here are the buoy data reports for two different locations on October 8 and 9, 1997. The upper buoy is number 46002 (located at 47 N, 130 W) and the lower is 46005 (located at 46 N, 131 W).

The dotted (upper) line represents peak windspeed, the solid (middle line) is for maximum sea height, and the dashed (bottom) line is wave period in seconds. Across the bottom you can read the timeframe over which the data was recorded—0000Z on October 8 through 0000Z on the October 9—only 24 hours.



Wave Fronts

Now, consider a situation where the manner in which the wind builds up and the speed, at which the storm moves, combine in some manner to create waves moving at group velocity that are steadily increasing in speed.

This means that the waves generated early in the blow—which have the longest period to travel and therefore are farthest from the storm system—will eventually be overtaken by the newer, faster moving waves.

If this results in an efficient combination of wave groups with differing energy, you can suddenly have a significant region of much larger and steeper-than-normal waves.

This area of combined energy is referred to as a wave front. The sea state encountered in the 1998 Sydney-Hobart Race discussed in the next section may have in large part been caused by a wave front.

Here's an example of how this works. Let's assume initial conditions of a 20-knot wind, a 4-foot (1.2m) wave, with a 4.5-second wave period. (The wave is moving at 13.5 knots.) Six hours later the wind is up to 30 knots, seas are 12 feet (3.7m), wave period is now 8 seconds and it's moving at 24 knots. The initial wave moving at 13.5 knots has traveled 80 nautical miles.

At the 12-hour point, the wind is blowing 40 knots, seas are 22 feet (6.7m), the period has lengthened to 11 seconds, and the waves are moving at 33 knots. The first set of waves have now traveled 160 nautical miles (13.5 knots for 12 hours) while the second group has gone 144 miles (24 knots for 6 hours).

At the 18-hour mark, the first group of waves has now gone 240 nautical miles, the second group 288, and the third 198 miles (33 knots for 6 hours).

The second and third set of waves will at some point overtake the first group. When this happens, and the waves of the three different groups get into phase, the result will be very steep, large seas.

Timeframe: What the buoy studies seem to indicate so far is that these events do not last for long periods of time—typically on the order of 12 to 18 hours.

Scale: These are generally thought to be small-scale events. The wave fronts do not cover huge expanses of ocean. Rather, they are concentrated along a narrow band, much like a weather system front—often just a couple hundred miles in length.

The most interesting aspect of both these graphs is how large a sea is built up by what appears to be a very modest wind force. In each case, we have 30-foot (9m) waves from winds in the 34- to 37-knot range. A conventional formula in an oceanography textbook would not support this size wave from such a modest amount of wind in this timeframe—yet here they are.

Note in both cases how quickly the sea state grows. For the upper buoy, the wave height goes from roughly 15 feet (4.6m) to over 30 feet (9m) in 4 hours. Wave period goes from 12 to 16 seconds. Since the period is not lengthening as fast as the wave is growing, this indicates a significant increase in wave steepness, so you can assume most of the larger waves would be breaking.

In the bottom graph, the growth of the height of the seas is less dramatic. Fifteen feet (4.6m) to 30 feet (9m) takes 10 hours—still a rapid build-up. (Data from the NOAA Marine Prediction Center).

500mb warnings: We asked Scott Prosise about warnings on the 500mb fax charts. He pointed out that "watching for a high-speed jet downwind (to the east) of a vigorous trough is a good indicator of depressions which may deepen rapidly and accelerate their movement. Meridional flow transitioning to zonal flow is another indicator of surface weather which may quickly accelerate."

Weatherfax Warnings

Several weather phenomena have been associated with dynamic fetch events. With the ability to receive weatherfax data, you can analyze your risk factors.

Watch for a pattern of rapidly developing low pressure systems (bombs) where the escalating winds push ever-faster-moving waves out from the storm center, eventually leading to a wave front as previously discussed.

In another potential scenario, you have a weather system where the movement is rapidly accelerating, like a tropical storm system transitioning to extratropical status (see page 471 in *Mariner's Weather Handbook*). Such a system was responsible for waves over 90 feet (27.6m) measured at two Canadian offshore buoys during Hurricane Lois in 1995. Similar data was recorded near one of the buoys by the *Queen Elizabeth II*.

Another tropical-to-extratropical example (explored in more detail later in this chapter) was found during Hurricane Danielle in 1998. In this case offshore buoys recorded a wave height increase of from 6 to 56 feet (1.8 to 17.2m) in a matter of 6 hours.

When you look at the 1998 Sydney-Hobart Race data, and consider the sailors' comments on waves as well as the photos starting on page **273**, bear in mind that this blow had all the factors we've been discussing including rapidly building wind strength and accelerating motion of the storm center.

Leading Indicators

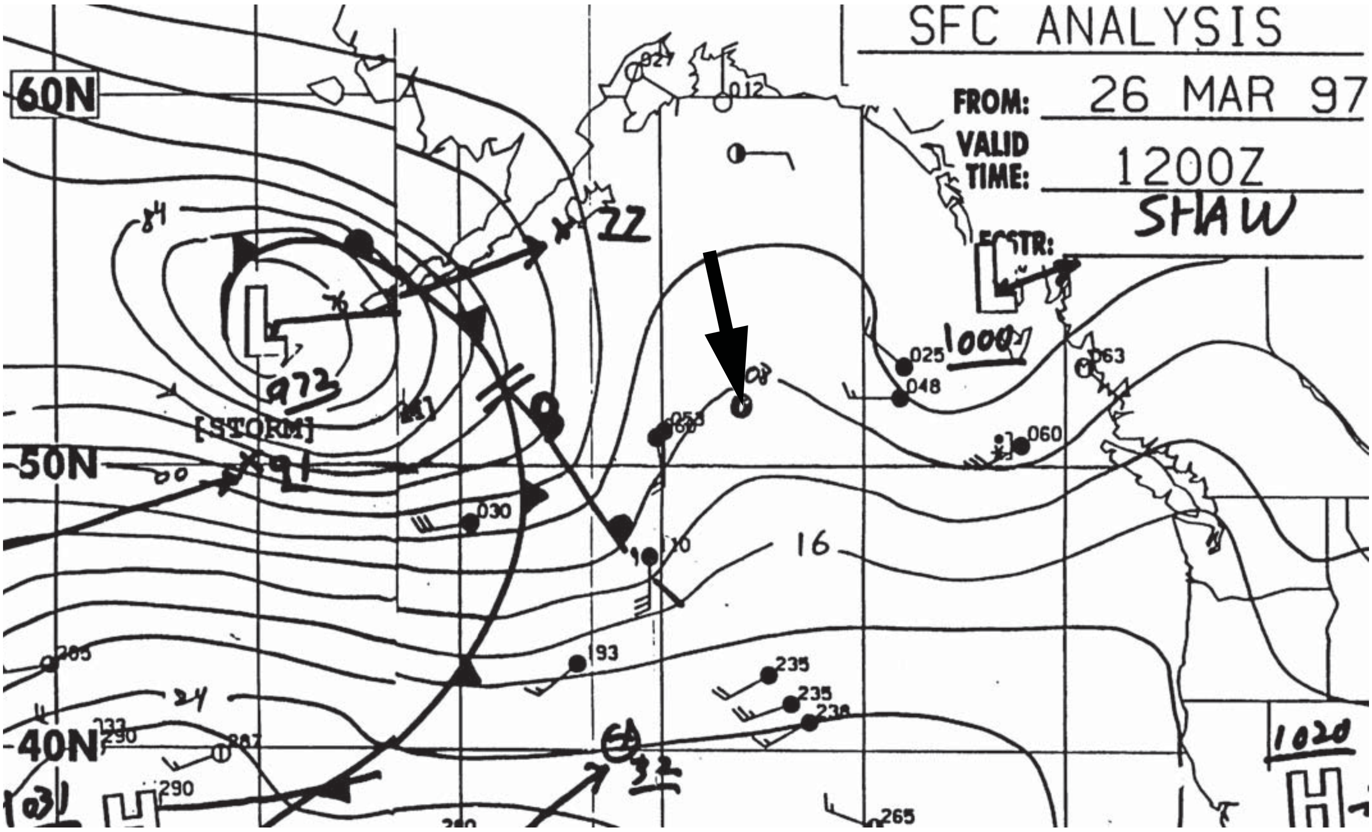
One of the problems with dynamic fetch is that there are few physical signs that you're about to be visited by one of these abnormal events. In the absence of a weatherfax, there are not many dependable warning signs.

However, one factor telling you something may be amiss is pointed out by Lee Chesneau, a Senior Meteorologist with the Marine Prediction Center. Lee explains that, "A good leading indicator is when wave period and wave height both increase rapidly over the short term. A wave height and period increase of 50 percent in an hour is a certain danger signal."

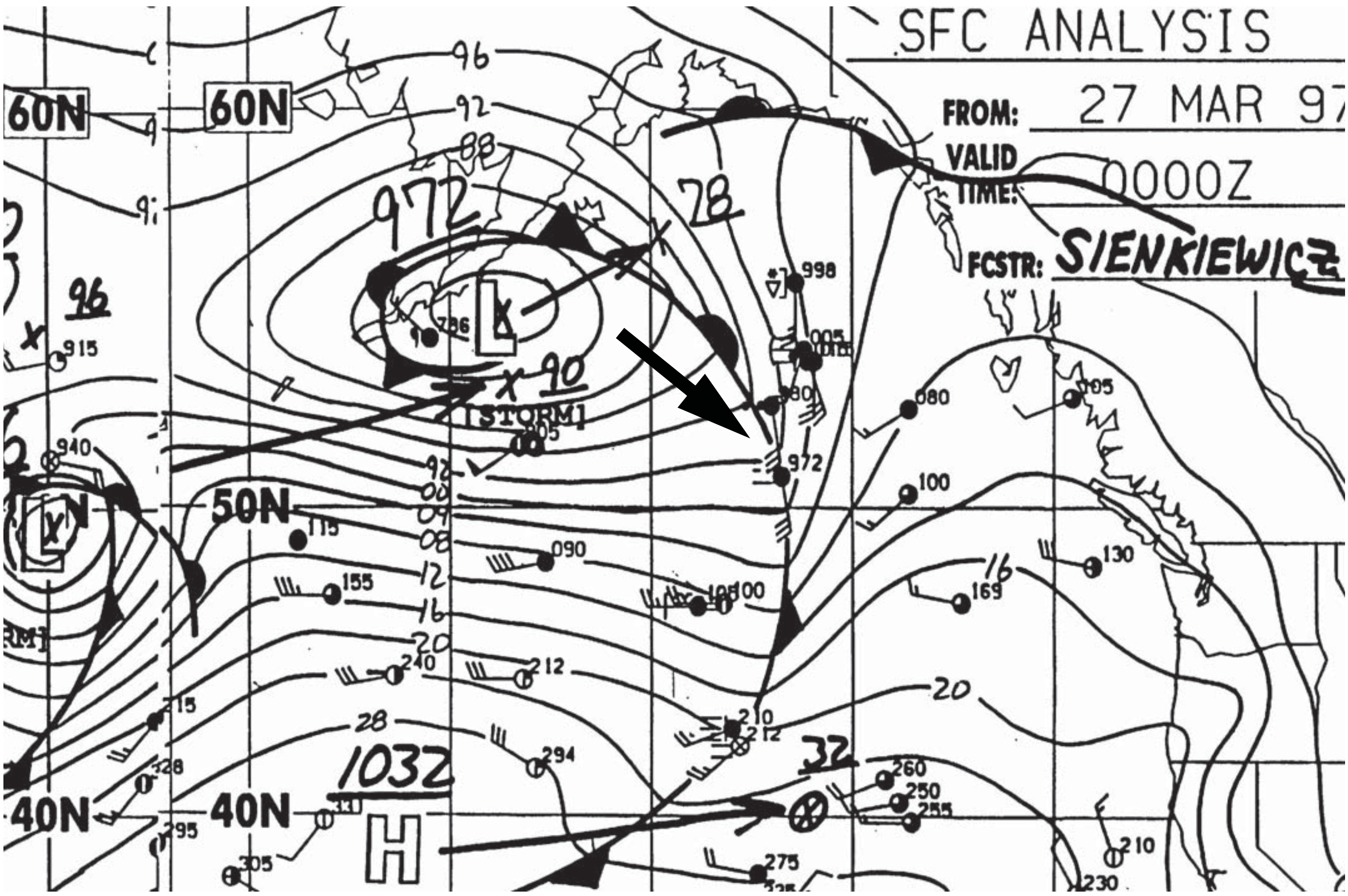
Scott Prosise suggests another warning sign: if the wave period (measured in seconds) lengthens considerably just before the onset of the wave front. For example, a typical 8-second period that suddenly lengthens to 11 seconds.

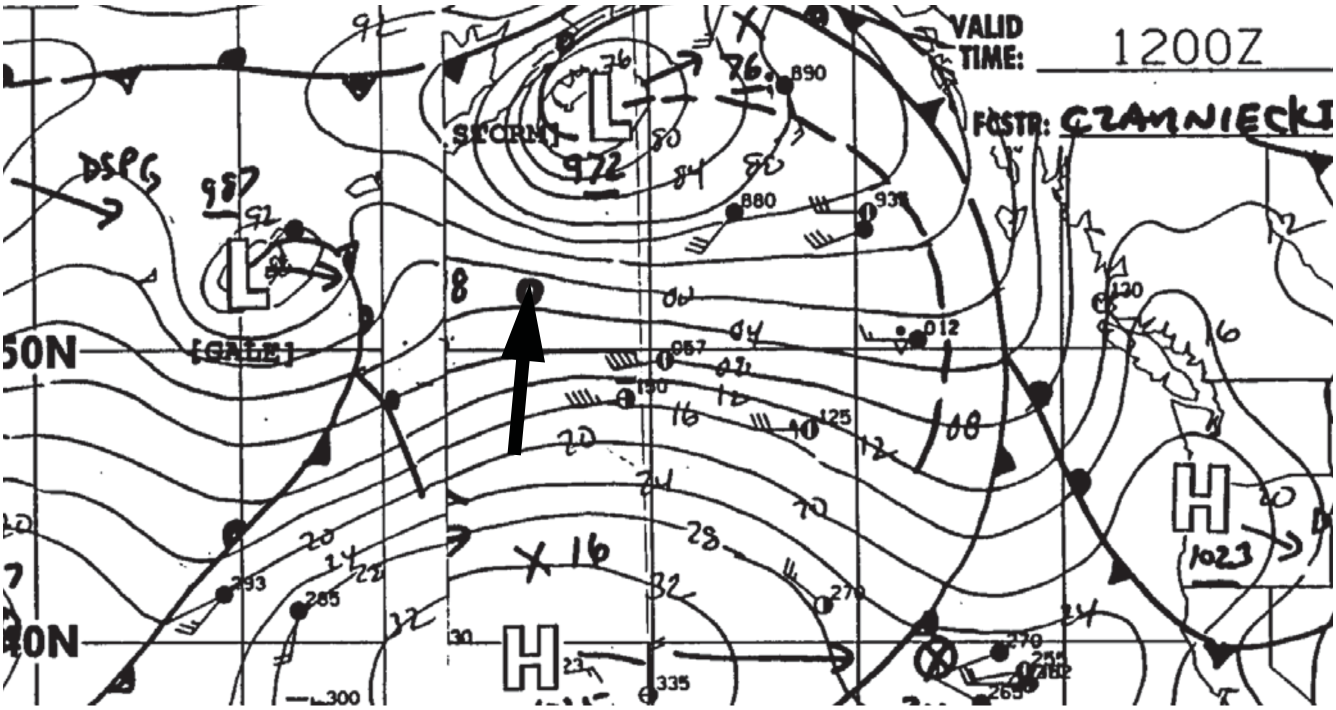
With few other physical signs, these characteristics could at least provide time to get the boat secured for the potential of stronger winds and large seas.

In most instances a change in wave period probably simply indicates a swell system from some far-off weather system, but it is best to keep a weather eye peeled.



We start with the 1200Z analysis for the Eastern Pacific for March 26, 1997(above). There is a rapidly developing 972mb low just off the Aleutian Islands. Twelve hours later (below) and the low center has moved east roughly 200 nautical miles at a speed of 17 knots. The central pressure remains the same, and a compression zone with the 1032mb high to the south has formed, accelerating winds between the two systems. The heavy black arrow is the position of the buoy from which the data on the following page was taken.



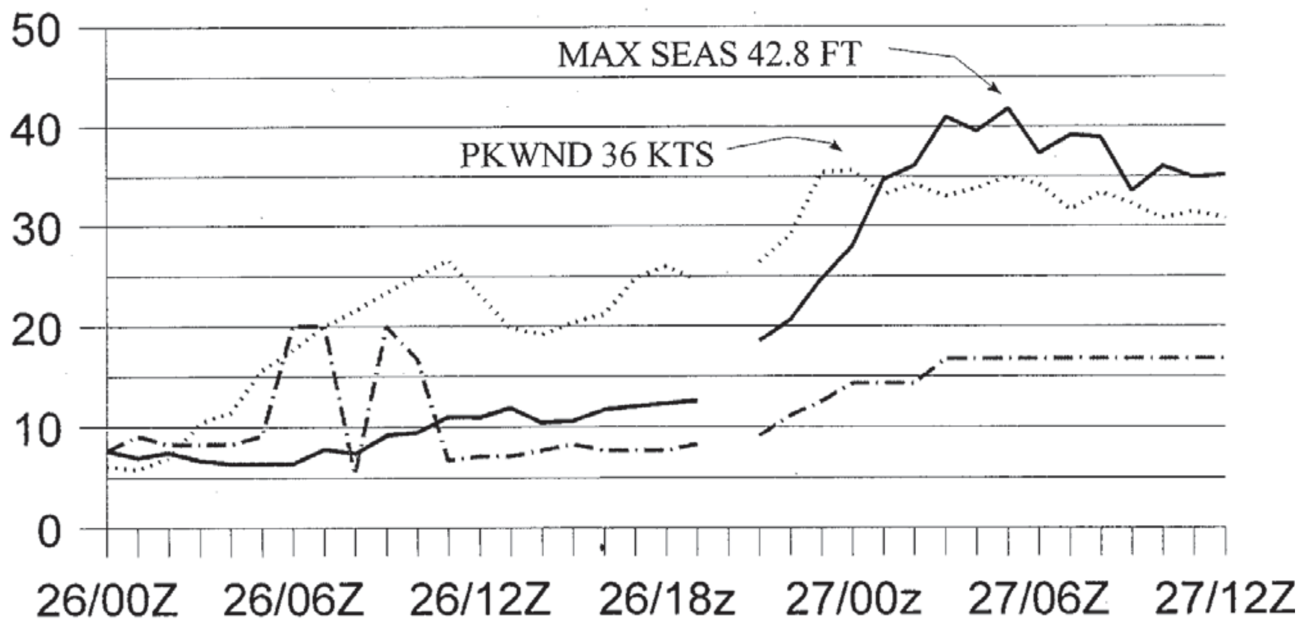


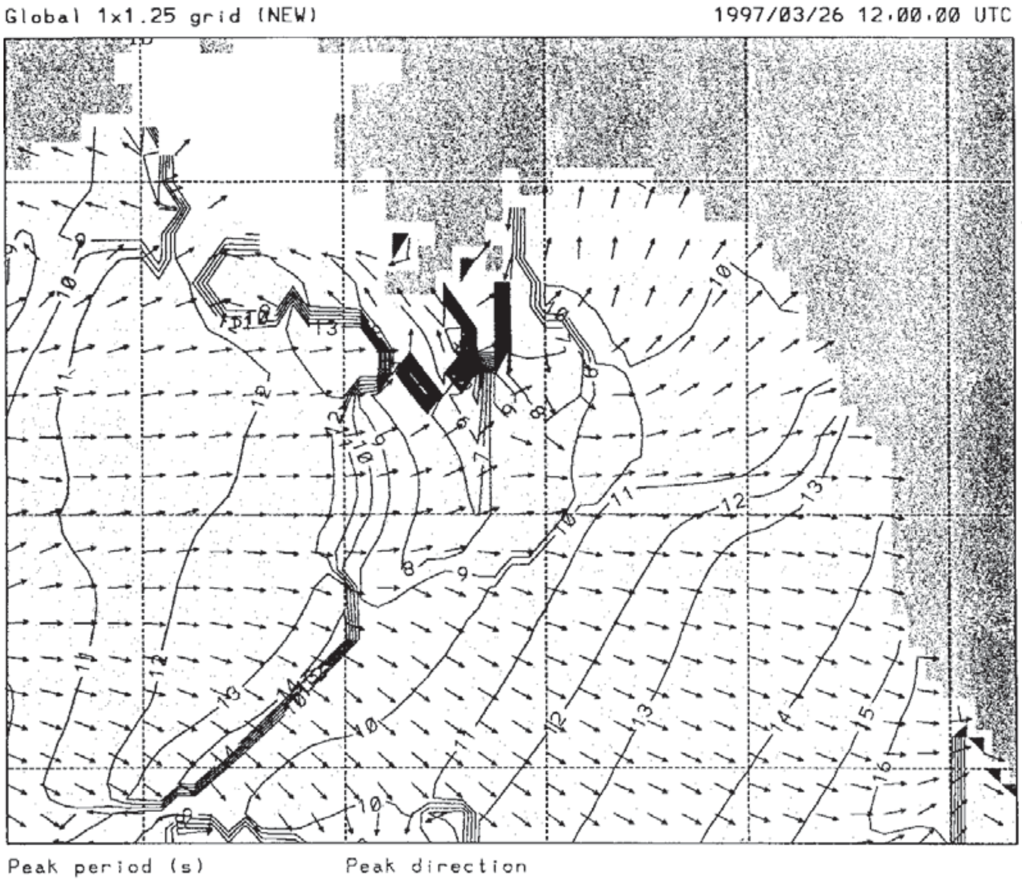
1200Z on March 27 (above) and speed of movement has continued in the 16-to-17 knot range. The compression zone is still well established, keeping wind direction and speeds stable and higher than they would otherwise be. Keep in mind that the entire timeframe of these three surface fax charts is just 24 hours.

Now let's look at buoy 46003 (located at 52 N, 156 W, pointed out by the heavy black arrow) for the same timeframe. As you can see below, the wind picks up from the 8-knot range at 0000Z on the 26th to 27 knots 12 hours later. It drops off to 20 knots before starting a gradual climb back to the 25- to 27-knot range 18 hours after the beginning of this track.

Starting about 2100Z on March 26, the windspeed begins to accelerate and in a 4-hour period hits a peak windspeed of 36 knots, before tapering off over 14 hours to 30 knots.

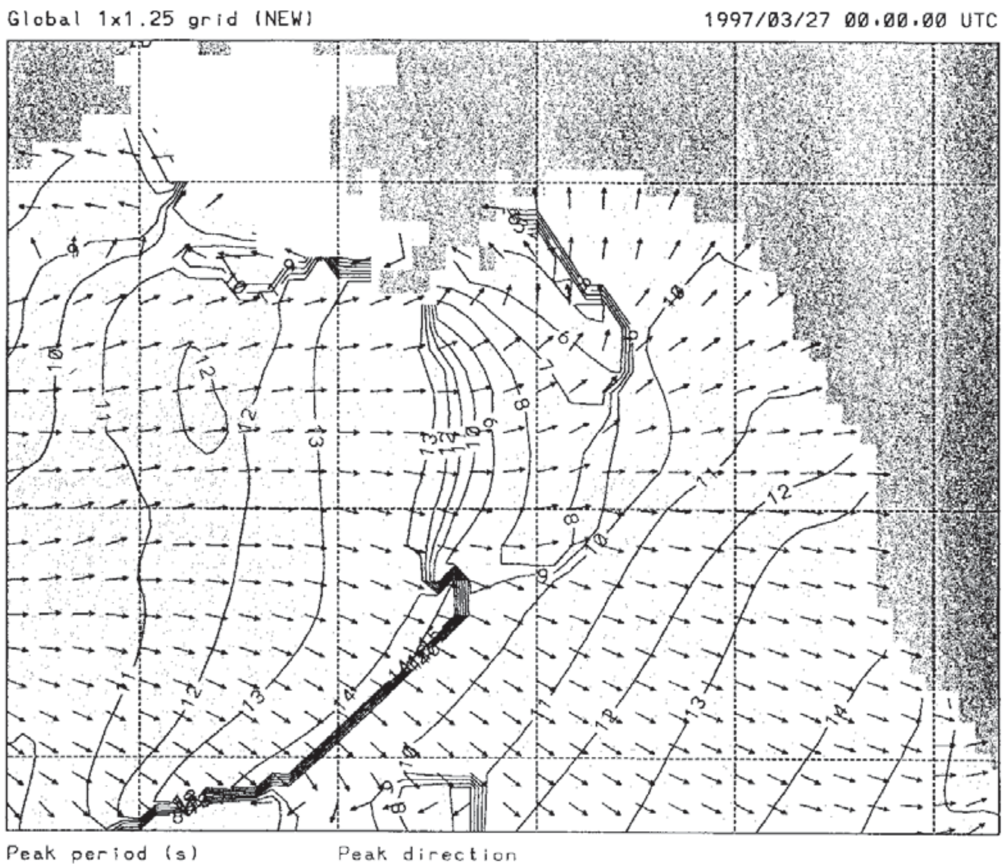
The waves start to build at around 1900Z on the 26th. At 0000Z on the 27th, 3 hours after peak windspeed, the waves have built to 35 feet (10.7m). By 0300Z wave height is up to 40 feet (12.3m), with a 14-to-16-second period. A wave of this period implies a distance between crests of 1,000 to 1,300 feet (307 to 399m), so we are looking at a wave slope of 1 in 25—not normally considered steep enough to break. Nonetheless, while the averages shown on this graph do not suggest breaking seas, you can be sure that plenty of seas will be passing through that are dangerous to small vessels.



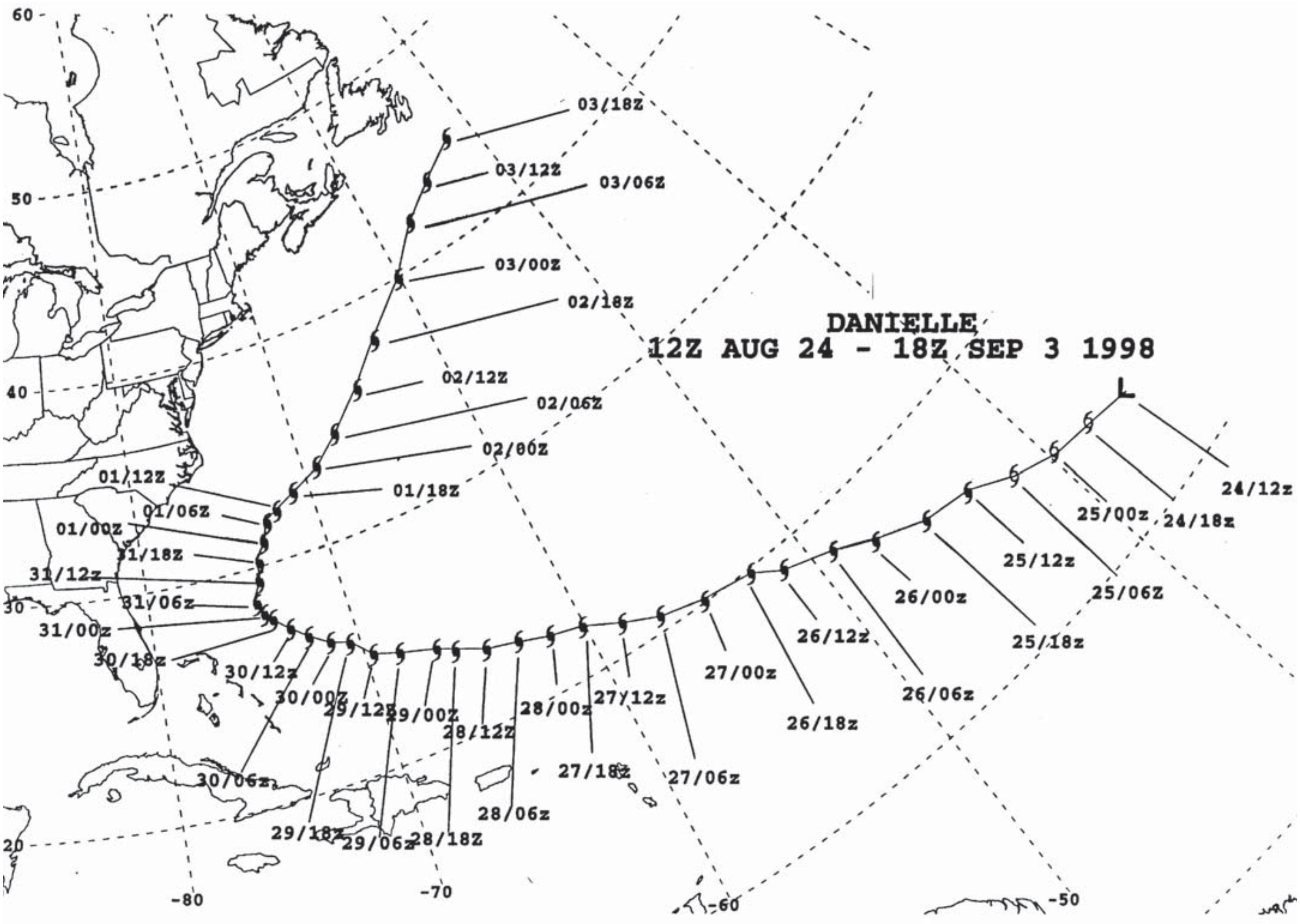


These two charts, produced by Hendrik Tolman at the Ocean Modeling Branch of NCEP, are "hind-casts," meaning data derived from history then used to explain what we think happened. The upper chart shows 1200Z on March 26, 1997, and the bottom chart shows the same area a day later. This time-frame coincides with the data in the faxes and graph on the previous two pages.

The lines represent wave periods. The arrows show direction of travel of the waves emanating from the low pressure zone to the north, and from the compression zone between it and the high to the south. Note how the areas of similar wave period are spread out well away from the front, then come together in the immediate vicinity of the front. This is the wave front about which we've been speaking. On the southern part of the chart is another wave front in the area of strongest compression between the two systems.



In the lower chart (opposite), 24 hours later, both wave fronts have moved to the east. The southern wave front has remained pretty much intact and simply moved along towards the coast. In the Gulf of Alaska the wave front is much more organized and has also moved more towards the east.



The track above is for Hurricane Danielle. This hurricane started in an easterly wave from Africa, as is normal for these systems. It then re-curved to the northeast paralleling the eastern seaboard as it followed the flow around the Atlantic high.

Hurricane Danielle

Now let's investigate a North Atlantic hurricane during September 1998. (The meteorology of this storm is covered in detail in *Mariner's Weather Handbook*, starting on page 475.) Danielle began as a typical summer hurricane in the Caribbean, then worked its way around the circulation of the Atlantic high until it was heading northeast from the tropics, parallel with the Eastern Seaboard of North America.

As the storm transitioned from a tropical to an extratropical structure, and as it came under the strong influence of upper level troughing, its speed accelerated.

In the slow-moving hurricane phase, the waves close to the center will be large and steep; but because the waves move out from the storm center faster than the storm itself is moving, they are under the influence of the storm-force winds for a relatively short period of time.

When the hurricane accelerates, this situation changes, and the waves in the "dangerous quadrant," where you add windspeed to speed of motion, are now being influenced for much longer periods of time. If the storm's speed of movement matches wave group speed, as occurred towards the end of Danielle's trip up the coast, it produces a dynamic fetch situation.

Avoidance Tactics

One of the difficulties in avoiding wave fronts is that they do not give traditional warning signs of oncoming weather.

The norm is to have a long-period swell moving ahead of a given storm system. When you see and feel that swell, you know something is on the way. Combine this with signs in the sky and barometer, and you can deduce what is going to happen and what you should do about it.

But the very concept of dynamic fetch is based on the storm system moving at the same speed as the waves, so any swells pushing out ahead are going to be few and far between, as well as difficult to pick out in the noise of the background sea state. It is not impossible, however, so keep your eyes open.

Here is a larger-scale chart showing Danielle's position and speed of movement for the September 1 through 3, 1998. Note how Danielle is accelerating. By mid-day on September 2,the storm system was moving at 25 or more knots. Buoy 44141, next to the circle off Nova Scotia, is the Canadian sea buoy from which the wave and wind data in the next chart are derived.

The lower graph is from buoy 44141 for September 3, 1998. The time (UCT) is shown across the bottom. Period in seconds (upper trace/circles) and height in meters (lower tracks/squares) is shown in the left-hand column. The gusts measured at the buoy are indicated across the top. The most interesting data in this group is the time period, in which the waves grow. At 0300 we have 5-foot (1.5m) waves. Six hours later at 0900 the seas have grown to 52 feet (16m). This buoy is located in deep water, so bottom shoaling is not a factor.

Hendrik Tolman points out an even better approach: "The best tactic is to try and get away from the area of the wave front. As these are typically small in area, usually not more than 100 to 200 miles in length, early avoidance of the storm center is key—as long as it means you don't have to put yourself in harm's way first."

Here we return to the importance of understanding the basics of meteorology. From the wave height-period forecasts broadcast over the SSB fax, *In the drawing below, the depression is moving in the same direction—to the northeast—as the winds ahead of the warm front sector are blowing.*

The area with the greatest chance of waves induced by dynamic fetch is shown by the shading. The danger increases as you get closer to the center of the depression where winds are strongest, but then tapers off abruptly as soon as you cross in front of the storm to its pole side.

This drawing would be typical for a Northern Hemisphere situation, where the winds circulate counterclockwise about the center. In the Southern Hemisphere, with clockwise circulation around the depression center, you would have a mirror image of this situation—the safest side of the storm would generally be on the South Pole side, while the most perilous would be on the equator side.

you can get a handle on the projected wave period. By converting the period to knots, then halving this for group wave velocity, you find the first part of the equation.

The next step is to examine the various forecasts for weather development and make note of the projected speed of movement. If that speed of movement coincides with group wave velocity, then you can expect a potential for a wave front.

Dangerous Storm Sector

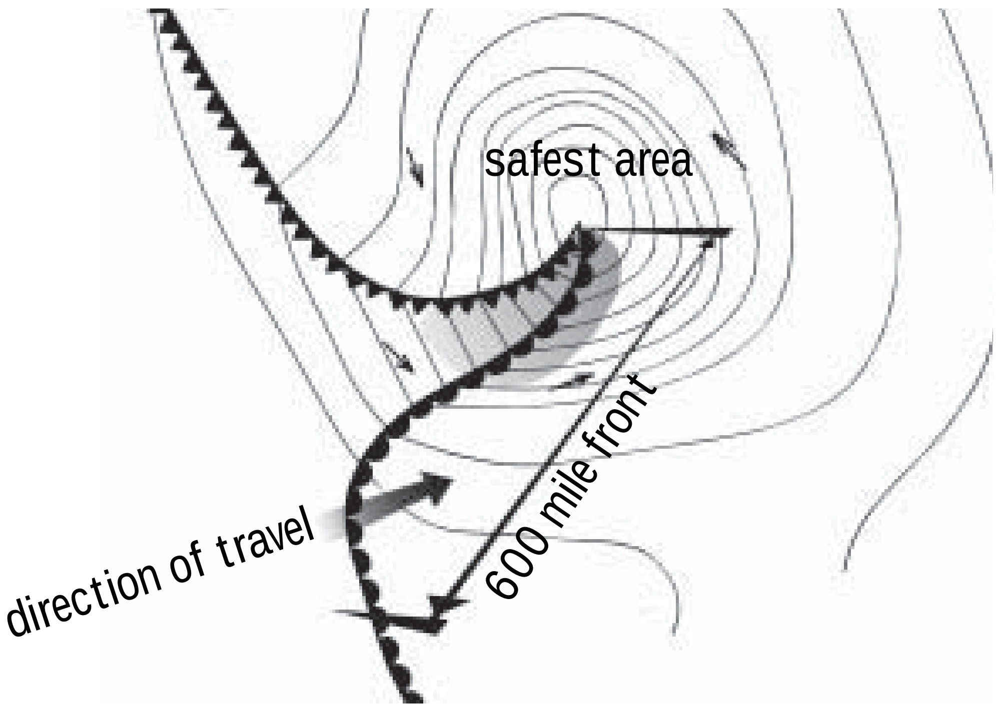
We need to come back now to the concept of the navigable and dangerous sides of the storm. As we've discussed previously (see page 195), the part of the storm system that is blowing in the same direction the storm is moving has the strongest winds.

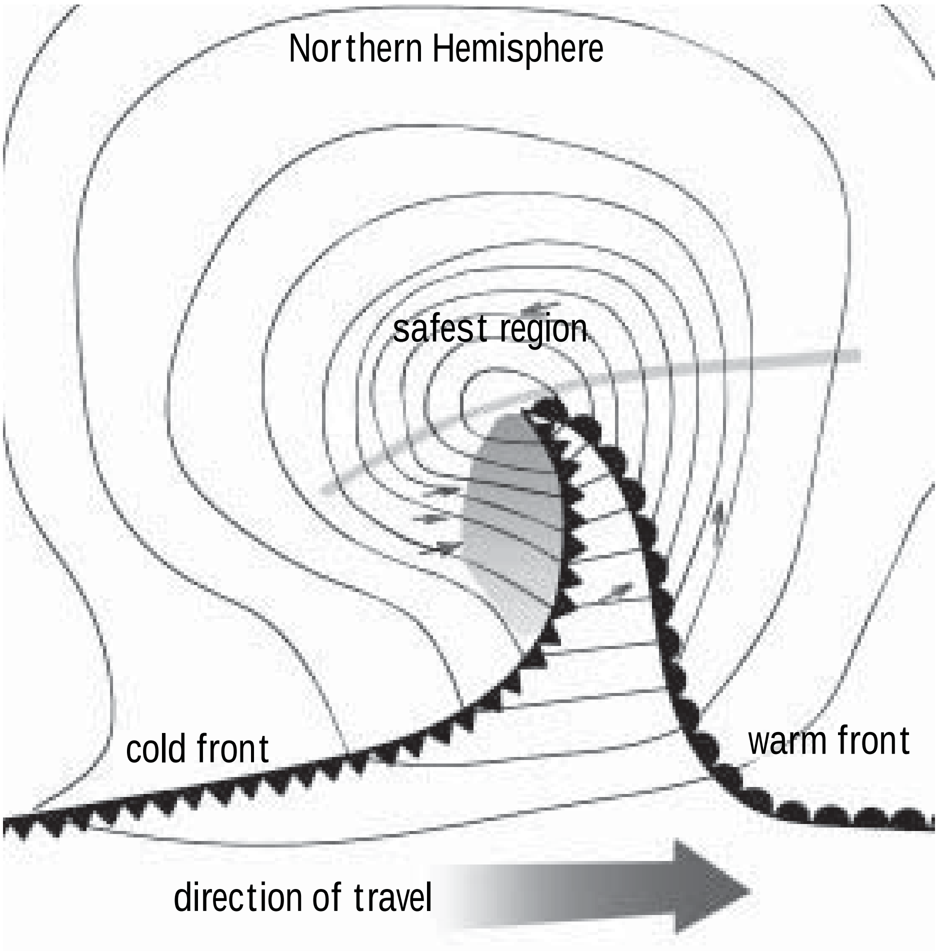
The area of the storm where the wave front is potentially created is this same region—i.e., where the wind is blowing in the same direction as the storm's movement. This manifests one of the crucial dynamic fetch conditions.

So, if you avoid this area of the storm system—typically on the equator side of the depression center—you will not have a problem with dynamic fetch.

Scott Prosise explains that the area of high waves drops off precipitously the moment you cross to the navigable quadrant on the poleward side of the storm. Moving towards the equator, the drop-off is much slower. However, crossing the storm track and center of the system does entail the chance of meeting what are potentially the highest winds and biggest seas just to the equator side of the storm center.

The timeframe over which these events happen is usually short. Scott's data attests to a rapid increase in wave height over a period of 4 to 6 hours, after which things begin to level off. If the storm system rapidly accelerating away from you, then the waves will drop off quickly. As Scott says, "once you've reached the peak wave size, the worst is behind you."



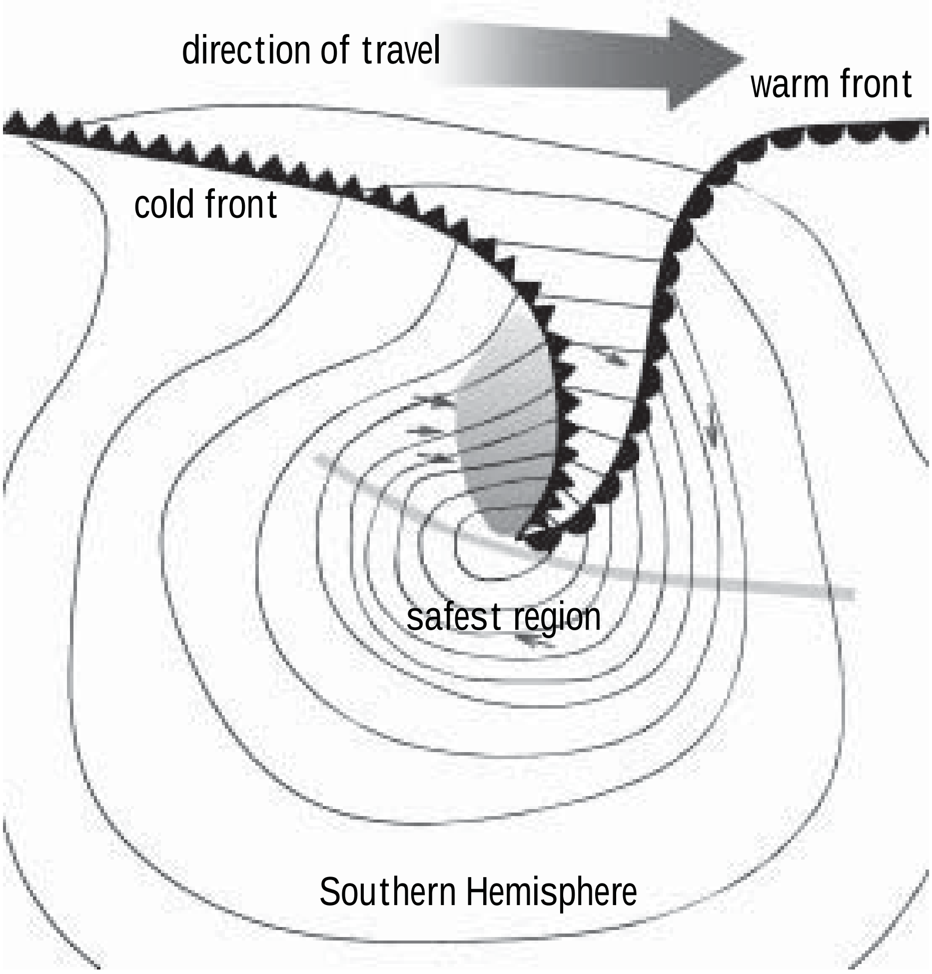


There are several approaches to avoidance tactics. One is to make sure you are on the pole side of the system, away from the dangerous sector. If you can make this happen, wave fronts will not be a problem as the winds are blowing opposite the direction of storm movement and seas will actually be calmed by the same forces that create the large seas on the other side of the storm.

If you are on the equator side of the system, the decision is more difficult. One approach is to cross to the opposite, less windy side of the storm track before it arrives.

However, this carries the risk of taking you closer to the worst area of wind and seas, if you do not make it across before the system arrives in your locale.

The alternate approach is to run off towards the equator. The strength of the wave front is thought to dissipate rapidly with distance from the storm center.



In these drawings, we have the depression moving more or less parallel to the equator, in the same direction as the winds from behind the cold front. The top drawing is for the Northern Hemisphere while the bottom shows the Southern.

As shown here, the wave front will be moving in an easterly direction.

Once again the safest area of the storm is the pole side, away from the equator, where the winds are blowing opposite the direction of travel.

This is also the area of lowest wind strength.

The shaded area on the drawing represents where the risks of a dynamic fetch event are greatest. The closer you get to the center of the depression, the more danger you face.

Richard Bennett

Beating to weather in 60 knots, gusting to 80, this yacht is working the waves carefully. She has just busted through the crest of a breaking sea, then pulled her head off to leeward to soften the imminent slam as the forefoot hits the back side of the wave. The next step in this dance is to feather the boat back close on the wind, ready for the next crest. Notice how the rudder is hard over to leeward—the crew doesn't want to waste any time getting back on the wind in these conditions.

TACTICS

The subject of storm tactics evokes passionate debate among seamen. Some say you must run at speed before a storm; others advocate heaving to or using a sea anchor.

From our perspective, however, no single tactic will work for all boats in all conditions. There are just too many variables.

Tactics need to be evaluated in the context of the existing weather scenario, and how it's expected to evolve. The sea state, now and in the future, will have a major impact on your approach.

These are the variables. The absolutes include the capability of your vessel, the skill level and strength (mental and physical) of the crew, and the navigational situation.

When you mix all these together, factor in some practice and real world experience, out will come the proper approach for the situation.

Throughout the book you have read the stories of different vessels. They and their crews vary in preparation and capability. Yet all contain lessons from which we can learn. The powerboat operator can learn from the sailor and the multihull aficionado from the leadmine driver.

Heavy-weather tactics are applicable to all sorts of weather situations. The same techniques that get you to windward safely in storm-force winds in the open ocean will help you pick your way to windward on an afternoon sail in 20 knots of breeze.

Heaving to, which might be used in a survival storm for some boats, can also be an efficient way of stopping to cook a meal, or awaiting daylight before entering a new anchorage.

All these techniques can be practiced in moderate weather, and we strongly urge you to do so. Start out in 25 or 30 knots of wind, then move up the scale when you get into your first gale. This way, if you ever end up in a serious blow you can spend your energy on weather and sea state analysis, while the boat handling remains routine.

We want to start this section of the book with an analysis of the 1998 Sydney-Hobart Race. The extreme weather encountered and the variety of tactics utilized provide an excellent database for us to study.

Sydney-Hobart Race

The Sydney-Hobart Race is perhaps the ultimate heavy weather laboratory. Running a 630-mile route from Sydney south to the Tasmanian port of Hobart, the majority of the race is sailed in the warm, swift-moving Southeastern Australia current (which typically opposes the post-frontal passage winds).

Add cold weather systems, sweeping into the area from the Southern Ocean, and you have a real potential for breeze with steep, breaking seas.

This event makes for an excellent transition between the theory of wave creation, which we've been discussing in the previous section, and the reality of how breaking seas impact tactics, which is the topic of the next section in the book.

The race starts on Boxing Day, December 26, and is one of the biggest sporting events in the Southern Hemisphere. It garners participants from around the world, its start is broadcast live in Australia, and it's the subject of intense media coverage throughout.

The sailors who take part expect to get hammered at least once en route to Tasmania. The norm is for one short stiff blow to hit the fleet. This is typically in the 50-knot range, frequently against the current, lasting 8 to 16 hours.

It is not uncommon for sailors in this part of the world to spend the first few weeks after the race wondering why they ever did it in the first place, and then the rest of the year waiting to go again.

Pre-Race Weather Analysis

Let's start with a look at the 1998 weather issues that would have faced the skipper and navigator as they prepared for the start.

Australia has excellent weather resources available to their sailors. Fax on demand, radio and phone forecasts, and facsimile broadcasts are available on a regular basis. They broadcast 500mb charts, an essential forecasting tool in this part of the world.

Competitive navigators and cruisers looking to make the passage to Tasmania would have been watching the weather for several weeks ahead of the start, to get a feel for the rhythm of the 500mb troughs and surface features. However, a majority of the race participants relied for their weather data on a pre-race briefing given by the Australian Bureau of Meteorology (BOM).

The briefing took place on December 24, two days before the start. Because the forecast models were not in agreement with each other, the briefer essentially told the assembled sailors to wait for a more detailed analysis to be issued the morning of the race.

In addition, the briefer explained, one of the computer models had suggested a low forming to the west of the race course, and racers should keep an eye out for it.

Now let's take a look at the weatherfax data that was available. Remember this is the result of computer modeling, with the intervention of a forecaster to arbitrate the disagreements between various computer models.

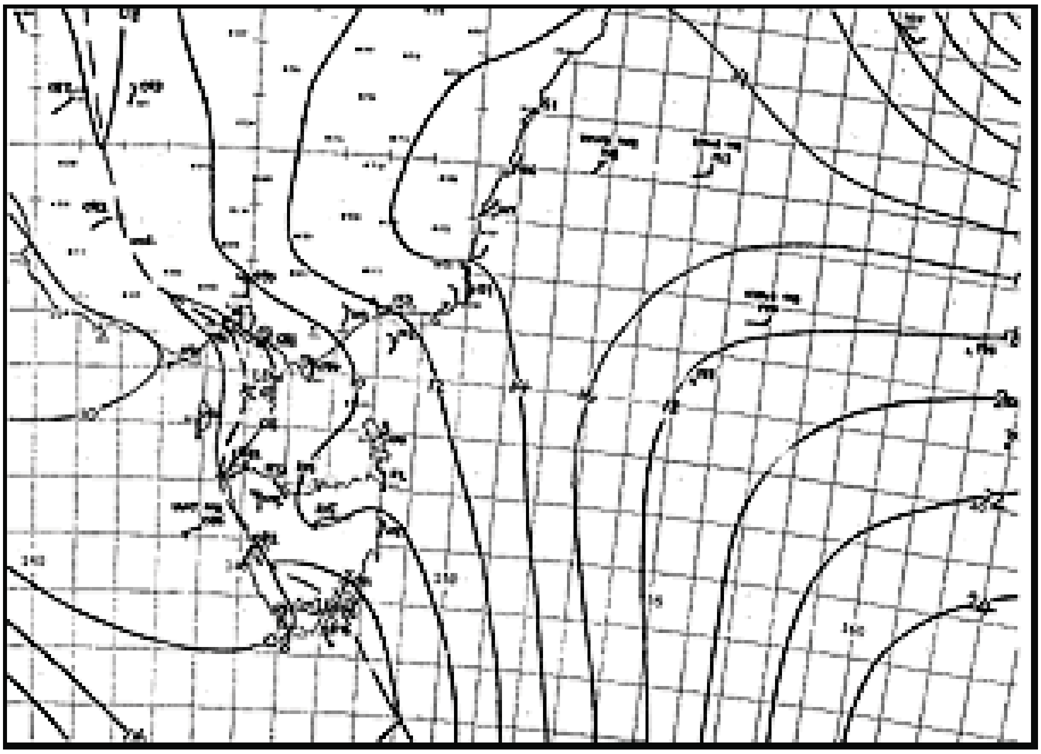
Surface Fax Charts

After your morning coffee and a quick check of the boat, the next thing you would probably do is have a look at the latest surface fax (below).

The first thing you would notice is the relationship of the subtropical low to the northeast, and the high pressure over New Zealand.

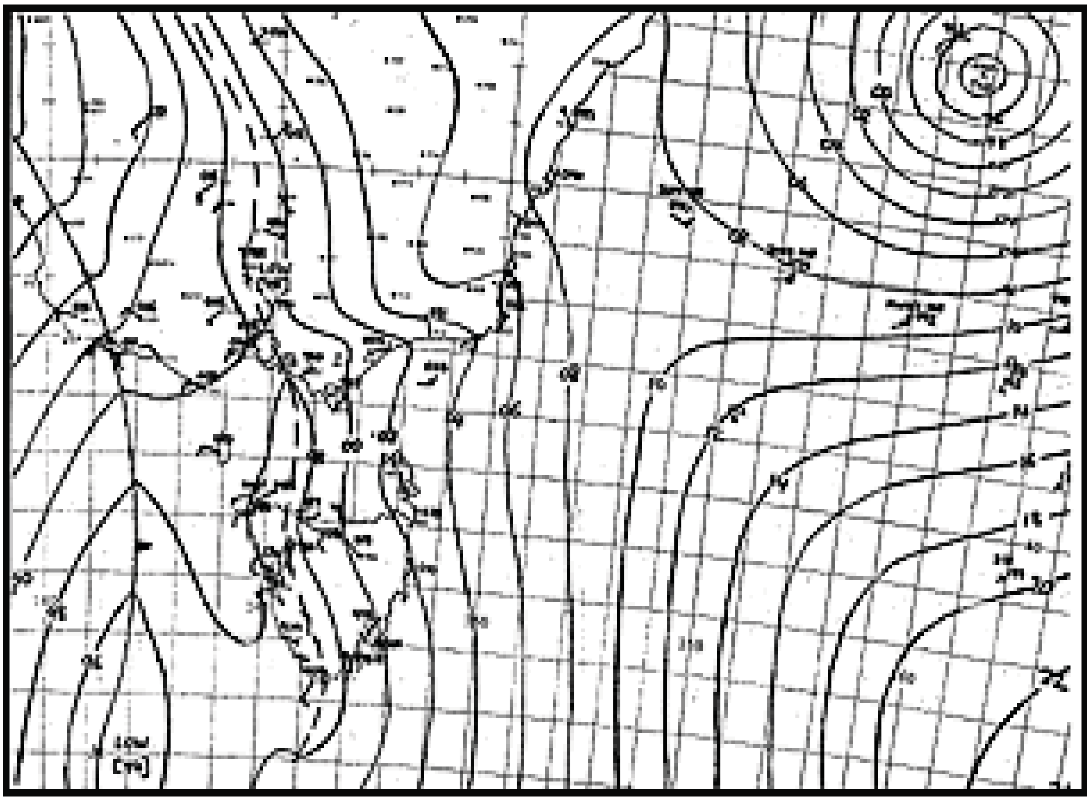
The high is expanding vigorously, blocking the low's normal path to the southeast. The low is now rotating around the counterclockwise circulation of the high pressure (remember, this is the Southern Hemisphere and weather rotates the reverse of the Northern).

Next, you'd have a look at the frontal line to the west. Nothing unusual there, but there's a chance for a compression zone between it and the high, and there's further fuel for an explosive weather scenario rotating down from the northeast.

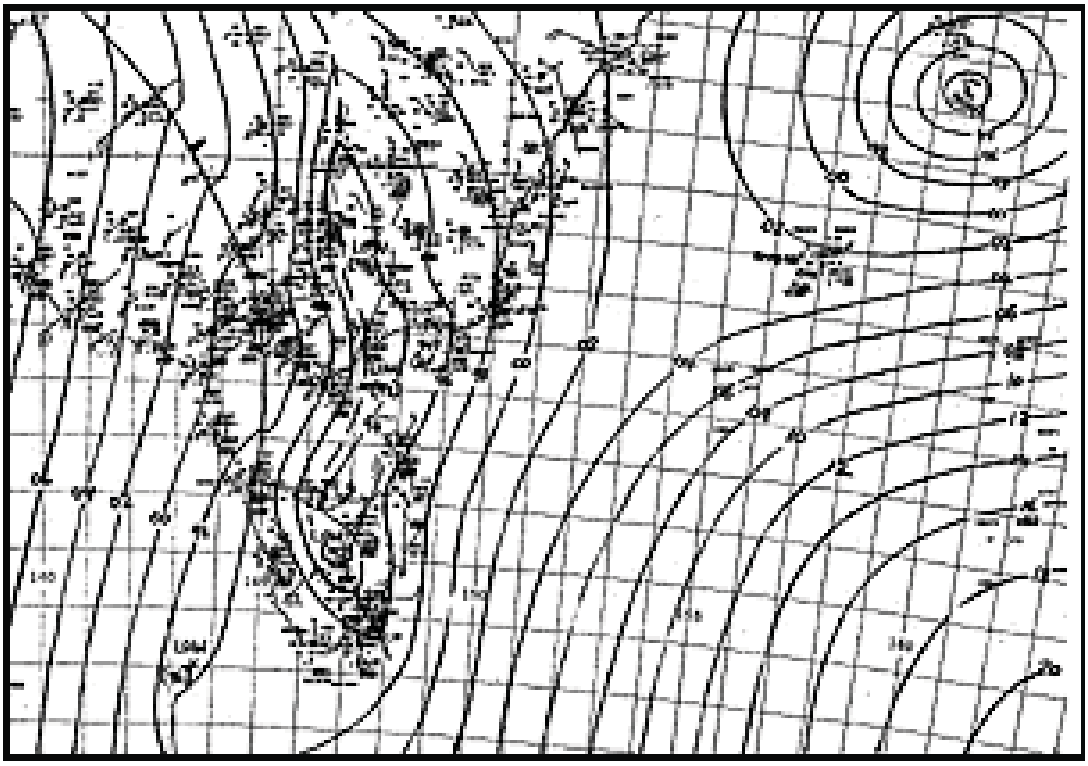


Note—isobars shown are spaced at 2mb (norm is 4mb spacing) at 0900 on the 25th. You can see a strong high pressure over New Zealand extending to the east of Australia. The subtropical low is off to the northeast.

Without looking at the 500mb chart you would not know the risks that exist in this surface analysis.



0900 on the 26th. The high pressure over New Zealand is expanding west; the subtropical depression to the northeast is rotating around the high towards the race course area. To the west we see a frontal boundary moving in a northeasterly direction. All the ingredients for a "bomb" are present on this chart.

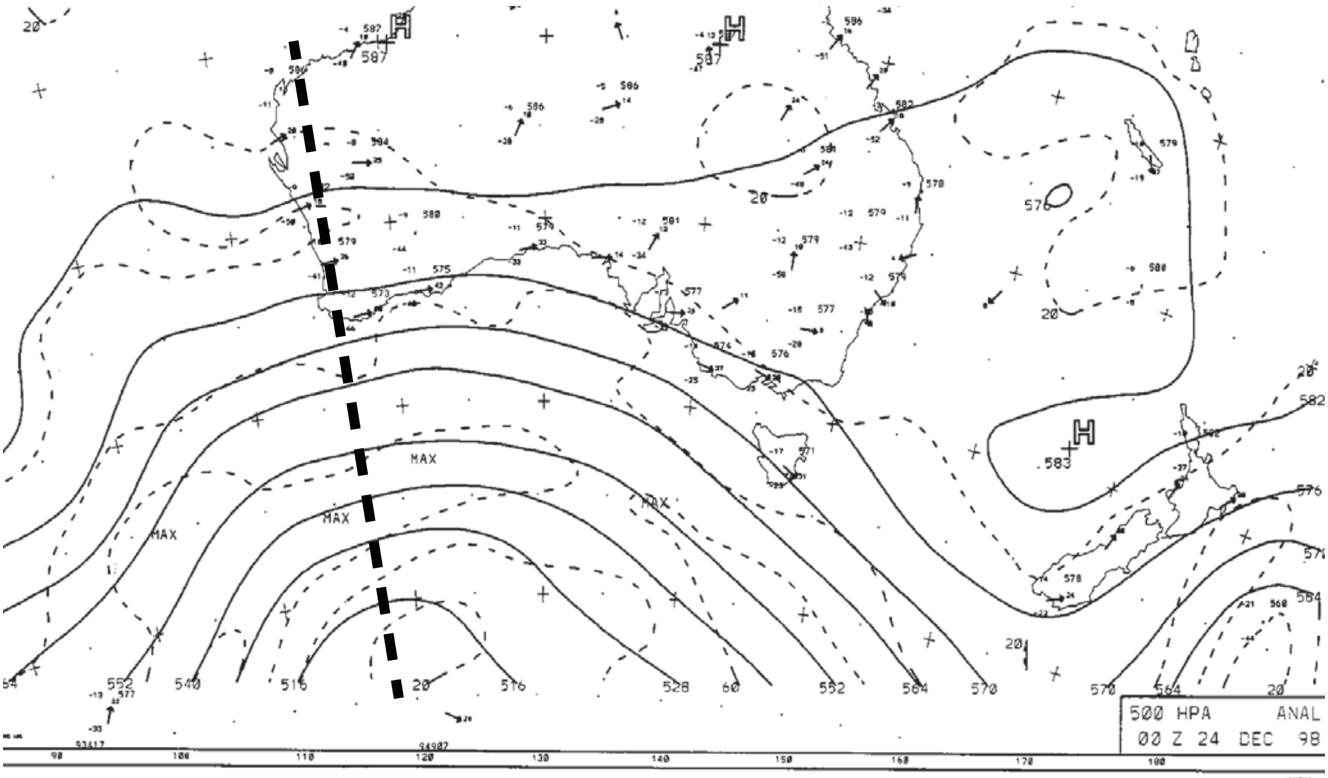


1500 on the 26th (bottom). This chart would have come in a couple of hours after the start of the race. All the elements from the AM fax are present, and going the wrong way. The high is getting stronger, as is the subtropical low. In the meantime the front from the west is more organized, now with a well-developed depression just to the west of the Bass Straits.

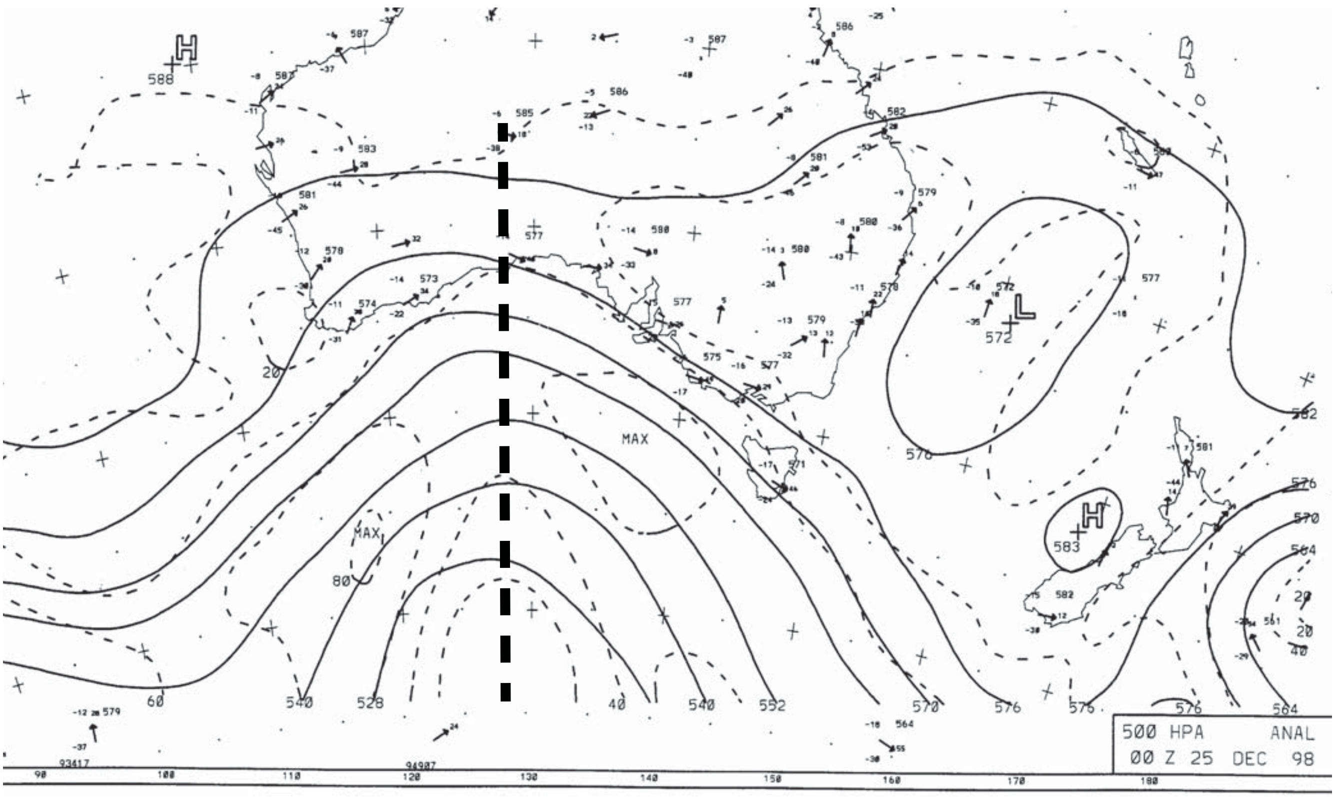
500mb Data

We'll start with the 500mb analysis (next page).

If you had been watching these 500mb charts for the past week or two you would have noticed a rhythm to their movement. There is nothing new in what we are seeing, except for the surface low to the northeast. And, it is safe to assume there will be a good blow resulting from this 500mb short wave trough.



This 500mb chart is for the morning of the 25th. Note the short wave trough to the west (heavy dashed line), a precursor of vigorous surface level activity. There's also a lobe to the northeast into the edge of the tropics which is related to a subtropical surface depression.



The short wave trough is rotating towards the race area and the lobe to the northeast has not closed, indicating the potential for a surface cutoff low. The circulation around the short wave trough is from the west, so you can infer that there will be cold, dry air coming up from the Antarctic. The clockwise circulation around the low to the northeast infers a source of warm, damp air that could come into contact with the colder high latitude air mass in the area of the race course.

Of course there is another way to look at this data. If the weather elements slow down, you are likely to have a fast ride to Hobart as the winds, at present, are from the north.

During the morning of Boxing Day, before the race commencement at 1300, the BOM maintains a weather briefing service outside the race headquarters. Competitors can avail themselves of the latest race weather and oceanographic information and have the opportunity to talk to BOM forecasters. Approximately 75 percent of competitors in the race availed themselves of this service, according to BOM data. Crews were handed the latest (0904) issue of the special race forecast, as well as a comprehensive briefing pack.

Imagine yourself as the skipper of one of the entries. You awake on December 26 with a long list of last-minute things to check, one of which is the current weather data.

You are obviously going to be excited. This is the day you and the crew have been training for, and you are probably anxious to get down to the boat and shove off.

The 0904 issue of the race forecast updated the 0429 forecast by including a gale warning for waters south from Broken Bay. The warning, based on computer model output, was forecasting south-to-southwest winds with mean speeds in the 30- to 35-knot range with stronger gusts. Competitors were told that the strong to gale-force southwest-to-west winds would persist south of Jervis Bay through Sunday and would start to moderate during Monday evening.

Looking at the latest 500mb and surface charts, the forecast seems about right. Of course the risk of something more severe happening is there.When the opposing current and the strong temperature gradient within the current (which can locally intensify the storm) is taken into account, a cautious sailor would have had to harbor some doubts.

Still, this is race day, your mates are eagerly waiting to set off, there is a fair wind, and nobody else is even considering waiting to see what develops.

When you add into this equation the fact that it is normal to encounter at least one gale during a Sydney-Hobart Race, the worries are probably well back in your mind by the time you get back aboard the boat.

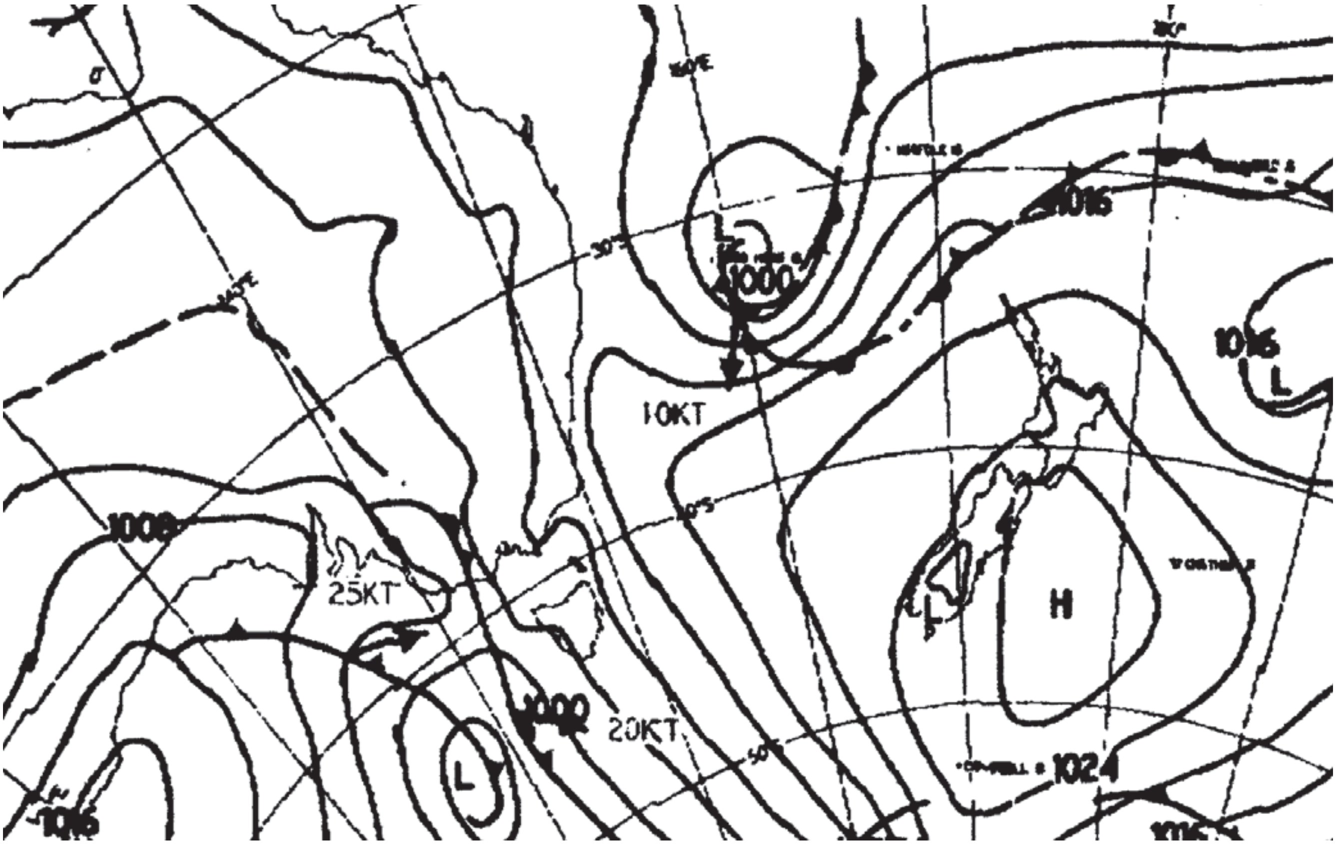
Cruising Considerations

If you were headed down the Australian coast towards Tasmania and had this data in hand, the decision on what to do would hinge on two factors:

The first was the speed of your vessel. The second, how quickly you could get into a secure anchorage in the event the weather "bombed."

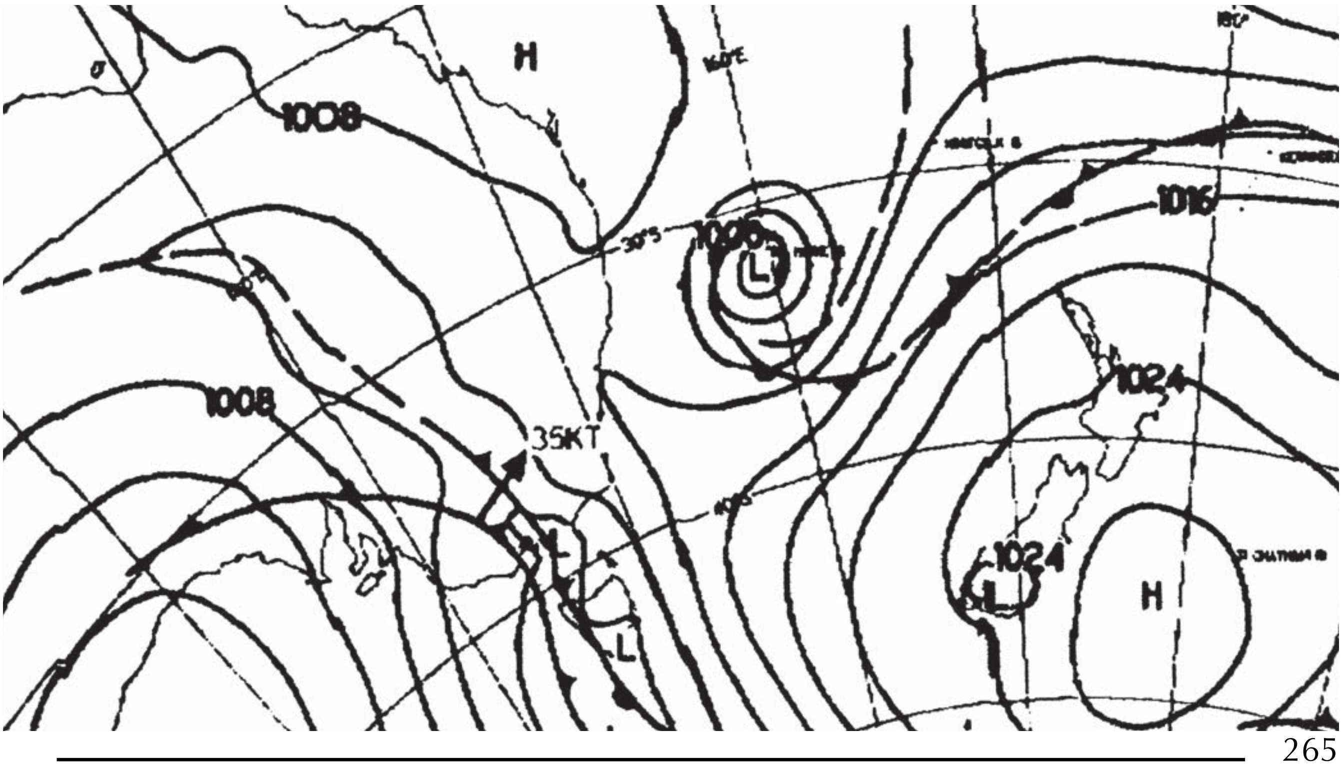
Even though the likelihood of a bomb occurring is not high, it is still a prospect which must be given respect.

Slower vessels would be better hanging out for another day or two in Sydney, awaiting the outcome of the various elements in place here.



In many parts of the world it's possible to receive fax charts from different countries and compare what the forecasters think is going to happen. These two charts are from the New Zealand Met Service, and if you had your fax receiver going the morning of the race, you could have picked up these along with the charts from Australia. They vary considerably—New Zealand tends to favor the Bracknell (UK) computer model.

The top chart is for early morning on the 26th. The bottom chart is for midday. They have the same warning signs that show up on the BOM charts—the expanding high pressure over New Zealand, the subtropical low pushing down the Tasman, and the extratropical low coming up towards the Bass Straits. If you had any doubts about what you saw on the BOM faxes, these would confirm significant potential for something interesting to develop. And if you were cruising, you would know to hang out a few days and let these elements play themselves out.



Bin Rouge

Anyone who grows up learning to sail on the Tasman Sea has a healthy respect for the ocean. If you can compete in sailboat racing locally in New Zealand, you are sailing against the best in the world. So the following account of the Sydney-Hobart Race by Mike Kalaugher should be read carefully.

Mike, a Kiwi, is sailing with a bunch of Aussie mates aboard a 31-foot (9.5m) Bruce Farr design, weighing only 2 1/2 tons.

Crew Background

I have wanted to do the Sydney-Hobart Race since I was knee-high to a grasshopper, and this year I got lucky. I arrived a week before the start and carefully examined the boat and her gear from stem to stern and from masthead to the bottom of the keel. Between the six of us, we had well over 100 years experience of coastal and offshore sailing.

Four of the six were familiar with racing the boat together, and it was to be skipper Chris Bowling's ninth Sydney-Hobart, and Ron Skinner's second, following a career of 25 years living overseas and accumulating more than 50,000 miles of ocean racing experience. The crew were looking for a good result in the race as they were currently lying in first place in the 1998 Tasman Performance Handicap Series and sixth IMS in the prestigious CYCA Blue Water Series. The Hobart Race would add double points.

Particulars

Bin Rouge is a five-year-old Farr 31 IMS design built by Franklyn Boats in Christchurch. She is owned by Darryl and Katherine Hodgkinson.

She has Bruce Farr-type foils, draws about 6 feet (1.8m), and the keel and rudder are high aspect but not extremely so. Her carbon-fiber-balanced spade rudder is large enough for her to respond well to her tiller. She is very maneuverable and quick in her movements, and has a narrow waterline with flared topsides amidships and aft. There is a very fine plumb bow, narrow foredeck and a very easily driven hull.

Daryl Hodgkinson

Bin Rouge wearing her trysail at the dock in front of the Cruising Yacht Club of Australia. This sail, from a smaller boat, measures just 10 feet (3m) on the luff, 8.5 feet (2.6m) on the foot, and 15 feet (4.3m) on the leech.

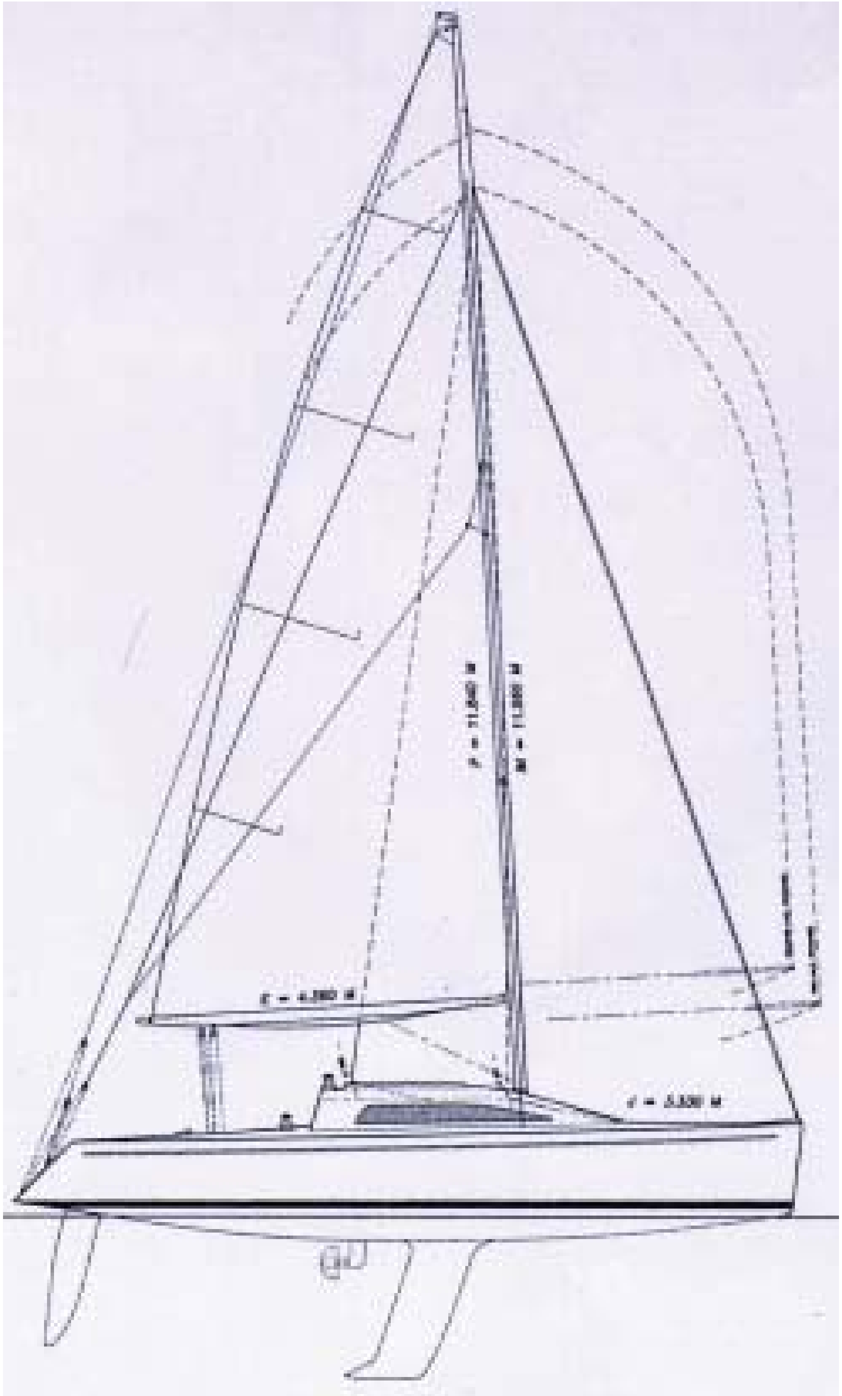
The cockpit is a shallow saucer type. Strong stainless steel bars in the cockpit are available to use as kicking straps as in a sailing dinghy. She has full instruments, including display of current and leeway direction and speed calculated from comparing GPS course over ground to compass and boatspeed.

Accommodations are bare essentials, racer style. Pipe berths had been added to give facilities for three off-watch crew to lie or sleep to windward, which because of the hull shape was very close to the center of gravity of the weight of sitting on the rail.

The berths are so close to the underside of the deck that you could only just roll into them. Once in, you would pull on a small block and tackle to accommodate the angle of heel of the boat, and this also made it harder to fall out. Cooking was on a primitive kerosene stove with kettle and one pot.

The boat has a strong aluminum mast (sturdier than the old IOR-type masts) with rod rigging and good deck and running gear. The safety regulations required that the boat carry bolt cutters; the mismatch is that they will not cut through rod rigging. The sails are generally pretty good. The rig is fractional and the mainsail has a large roach. The mainsail can be slab-reefed down heavily with the deepest reef point just above halfway up the mast.

Anything not race-related doesn't exist. For example: no bollard or cleat on the foredeck for an anchor, no cleats aft for mooring. The engine is an 18-horsepower two-cylinder diesel sail drive.



Bruce Farr & Associates

Bin Rouge is a middle-of-the road, light-displacement IMS-style race boat. She has minimum keel area, a large balanced rudder, and not much boat in the water. These attributes served her well in heavy going. The small keel large rudder combo gives good maneuverability. The light displacement and keel allow the boat to skid sideways when impacted by breaking seas.

The Start

26 December 1300. The start is a popular spectator event. Spectator boats are kept behind the lines, and it reminds me of a Whitbread start. The hard part for us is how to get a clean start in such a large fleet with so many big boats.

Our skipper decides to hang around just back from the committee boat and dive into the most opportune gap, even if that means starting half a minute late. Wind is nor'east about 15 knots.

The boats approaching the start line just ahead of us slow down. In doing so, the whole bunch drifts sideways to open a perfect gap inside the inner distance mark. Chris is straight into the hole, but then *Nokia* (formerly the Whitbread race boat *The Card*) heads into the wind on the start line and tacks onto port, colliding with the boat to windward. This squeezes up the boats that are ahead, closing our hole for us. We slow a bit and miss the leeward boat by approximately a foot (0.3m) and the inner distance mark by 3 inches (76mm).

It is about four miles or so on the wind, tack around the top mark, and lay the last harbor mark. After the last mark off South Head it is a broad reach down the coast. We hoist a 1.5-ounce reaching kite and settle down into a three-hour watch system.

Chris stays as radio operator, navigator, tactician, skipper, and cook. Ron and I are watch captains. David Whitfield is on Ron's watch. "Mac" McLean and "Dazza" Henson alternate at being on my watch and doing sail changes.

Romping Down the Coast

The afternoon and evening of Boxing Day gives us some great surfing. Wind 20 to 25 knots from the north. Ron and David get 14.8 knots of boatspeed on their watch from 1500 to 1800 hours. Mac and I have to try to beat that and/or the boat's record of 18.2. We quickly crack 14.8; our best surf is 17.3, and with 4 knots of current behind us, we are making good up to 22 knots over the ground.

Some good long surfing runs, but Chris wants us to sail quite low for the forecast southerly front and for the storm warning further down the track.

Sailing low (running downhill rather than broad reaching) means we can't really get her romping. The rhumbline is 190 degrees true, and we are heading slightly west of that.

2005 radio schedule and we've made good 75 miles (average 10.7 knots) and are 9 miles north of Jervis Bay at roughly 34.24 degrees S and 151.15 degrees E.

2100 hours, the end of my first watch, and the breeze comes more abeam from the east. After a bit of broaching, the kite shakes itself free from the guy, and in the resulting melee we lose two halyards.

I steer the boat as steadily as I can, trying not to let her roll too much, as Mac is hoisted halfway up the mast to retrieve the halyards (Mac was then re-christened "Moonwalker Mac" as his skywalking was done at night).

We settle into a two-sail reaching—mainsail and headsail. The breeze is easterly at 20 to 25 knots. We don't head very far out to sea as our instruments show we are already getting 2 to 4 knots of current with us.

A few hours later and the breeze swings to the nor'west. Ron jibes and heads more inshore. At midnight *Bin Rouge* is running flat with a poled-out headsail, good fun romping along. We are keeping an eye out for fronts. Chris is keeping us near enough to the coast of Australia so that we actually duck inside around the top of the southerly front.

December 27, 0305 radio sched, and we've made good 150 miles (still an average speed made good of 10.7 knots). We are 14th on IMS handicap. We are abeam of Montague Island. Approx Lat 36 degrees 15m Long 150 degrees 25m.

Our inshore position has allowed us to keep reaching while many boats are slogging into a hard southerly offshore.

A little later and Chris calls for sail changes after seeing signs of a westerly front. (With no barometer or weatherfax aboard our technology consists of listening to the forecasts and keeping our eyes open. The frontal band of cloud is thick and sloped higher at the northern end, looking lighter and clearer on the far side.)

Chris's timing is perfect so that we keep our speed high, but adapt just before the front hits us.

Since the start of the downhill sailing, we have been working our way through the fleet and are up with much bigger boats. We have a huge margin up our sleeve on the course record for boats under 31 feet (9.5m). We are about the 28th boat in distance made good, even though we are one of the smallest in the fleet. Our average speed since the morning sched has dropped to 7.6 knots because we have been reaching rather than running. We have made good 233 miles in 25 hours.

Chris Bowling, skipper of *Bin Rouge:*

"The northeast wind turned briefly to the east, then backed to the northwest as expected.

"With a storm warning ahead I wanted to stay within reach of shelter, not be blown to New Zealand.

"In the dark we were able to notice a classic roll cloud (announcing the arrival of the front).

"We got down to our very deep third reef and storm jib just at the right moment. Still no drama, just bouncy."

Ron Spinner, watch captain:

"In looking for cold fronts, we were watching for a rain bar and squalls, and an ominous sausage-shaped cloud.

"Also, of course, the immediate calm, which sometimes precedes the front by just a couple of minutes."

Just Your Average Sort of Storm

This means that at the 1400 radio sched We are running fourth on IMS in the fleet. Our position is 37-34 S, 150-26 E.

A storm warning over the SSB radio comes in for 45 to 55 knots, and the storm band is described as being a bit to the east of our course. Swells are forecast at 20 feet (6m).

Late in the sched, *Sword of Orion* radios in that they are actually getting gusts of 78 knots. I guesstimate that *Sword* is about 35 miles south or west-sou-west of us. The sched operator for the fleet asks them to repeat this so that the fleet can hear. The sched operator then reminds all competitors that the decision as to whether to continue racing is the responsibility of each skipper.

During the day, the breeze and the seas build as we enter the Bass Straits. The wind goes from west to west-sou-west so we are now on a tight reach. As soon as we are in open water, free of the Australian coast, the seas seem bigger than one would normally expect from the strength of the wind—and they just keep building up. The big rolling seas are running parallel to the Australian coast south of Gabo Island.

There is nothing in the clouds to make me think the wind will become stronger than forecast. During one headsail change with Chris steering, me in the cockpit and Mac in the bow, we do a very heavy crash landing.

Mac rips apart the palm of his hand, bruises his elbow and bends a stanchion. Chris is belted in his nose. I go flying across the cockpit and wrench my arm. At the same time below, one of the pipe berths collapses. After this we sail on without headsail.

Trysail

The wind increases and we change down to trysail only. Because the sail is so small and low down, we don't have a problem with weather helm.

It is my watch now, mid-day on the 27th. Water depth is 1,500 to 2,000 fathoms. The waves are coming from Melbourne through the shallower and narrower Bass Straits and must have steepened in the process. These waves with their east-setting current are meeting the strong warm current, of 2 to 4.5 knots, that sets south down the east coast of Australia. The waves seem larger than warranted by 50 knots of wind.

We are doing 6.5 knots straight at the mark and keeping *Bin Rouge* on her feet and unstressed.

The rig has two swept-back spreaders and the lower inner shrouds and lower spreader help to stabilize the mast low down. The lower part of the mast is sleeved and quite strong. We put some backstay tension on to help hold the rig firm, and tighten up the running backstays to stop the forestay pumping.

We are on a tight reach into the wind and waves. A few boats are pulling out, but we are going well. Two or three mountains to leeward is *Winston Churchill*, a wooden 52-footer. Her whole mast is disappearing for long periods behind the mountains. She has only a storm jib on, attached to her inner forestay. She is sailing a slightly lower course than us and eventually drawing out of sight to leeward.

Pippin, a Farr 37, is three miles behind us and north of Gabo Island. *Pippin* is managing to carry 3/4 main and a number-3 headsail. Ron and David come on at 1500 and I go below.

Let's Not Do Anything Stupid

We've gotten into "let's not do anything stupid" mode quite early. The pattern is definitely for the conditions to become more severe. Chris and/or the watch captains have called the sail changes quite conservatively and decisively. We've not waited until the boat is unmanageable to change down. No one suggests carrying more sail to try going faster.

It is fascinating to observe the variety of sail configurations on other boats and how they are handling the conditions. Some boats are running with bare poles, some have storm jibs on their forestays, some have storm jibs on their inner forestays, and some, like us, just have trysails. It is too windy to carry both a storm jib and a trysail.

From our observations of other boats, it seems to us that the carrying of a storm jib instead of a trysail means that the waves are being harder on a boat, and pushing the bow down to leeward and slightly farther down into the water.

Carrying a storm jib on an inner forestay means these effects are less pronounced. The yachts with storm jibs definitely heel over more than those with trysails.

Hurricane-Force Winds

By 1700 we have wind in the range of 60 to 85 knots and seas from 50 to 100 feet (15 to 30 m). It is getting harder to handle the boat.

The sheer size and power of the swells does not become apparent to us until, while still sailing south, yachts that have already turned back suddenly appear in front of us. We aren't able to see the tops of their masts above the swell.

One yacht, the 36-foot (11m) *Dixie Chicken* (we think), under bare poles on port tack, surfs past our starboard side heeled over so far that her mast is horizontal. From that image, it is apparent that the wave height is approximately three times the length of the yacht, which means a wave height of at least 90 feet.

At this stage, we notice our windspeed instrument has gone into denial and refuses to display over 30 knots. The Windex has been blown from the top of the mast. Getting the boat over the waves is getting harder in view of the breaking tops which push us considerably back.

On one wave, Ron can't get *Bin Rouge* to sail all the way up in one go, so he has to bear off halfway up to build speed and then continue climbing again.

Chris Bowling:

"We sailed into Bass Straits on a forecast of 45-55 knots, seas to 26 feet (8m). I know now, but did not know then, that this implies gusts to 80 knots and waves to 60 feet (18.4m).

"The forecast was strictly correct, but a warning of maximum wind strength and wave height would have made me and about 30 other skippers turn around. "

Ron Spinner:

"While we were screaming down the coast in a northwest gale, the boats which stayed out to sea got hit with a severe southerly.

"A lot retired the first night with damage or injury."

Steering Technique

Our basic approach to steering is to keep the boat sailing at from 4 to 7 knots to keep steerage, but not with so much speed that we broach or crash land too often or too heavily. We deliberately oversheet the trysail so that the helmsman can steer more widely, and to avoid flogging the sail when headed close to the wind.

We use the waves to control our speed, heading up to slow down and bearing away to build speed. We need to keep moving fast enough, so that when the boat slows from the impact of the crests she still has enough speed to continue slowly down the backs of the waves.

Heaving to isn't an option, as it is too windy to carry a jib and trysail. Sailing slowly gives us many of the benefits of heaving to. We can still choose an approximate course—towards shelter, or at least away from the track of the weather system, and pick the best spot to cross the wave crest.

I am impressed that when we get pushed sideways by breaking waves that *Bin Rouge* tends to slide but shows no sign of tripping over her keel. I think this is due to just carrying a trysail and no jib.

If we were carrying just a storm jib, then the gusts at the tops of the waves would tend to blow our bow off while the breaking waves would push us sideways. As it is, the higher wind near the crests tends to make us round up into the wind at the same time as the crest pushes against us. This allows us to take the crest more on the bow.

We are very particular in steering the bow high into the crests, so we have a situation where our trysail wants the boat to behave the same way as the helmsman.

Allowing a crest to catch us beam-on just one time could finish us. That we have a scrap of sail with such a low center of effort allows us to stay more upright in this critical part of the wave.

It doesn't feel as though we are having to fight the helm, and because we are not heeling excessively *Bin Rouge* shows no tendency to tack without the helmsman's consent.

Coming over the crest and down onto the back of the wave is the other critical part of the sailing. Keeping the yacht slow and on her feet, and not overpowered, seems to be the key.

Mike Kalaugher:

"We had played with heavily reefing down and trying on the storm jib and the trysail on the Sunday before the race, and we discussed sailing in storms with modern light racing yachts. It was quite obvious that the storm jib was way too big for a storm on such a light boat the luff length was okay but the foot was too long. So before the start, Chris grabbed the storm jib and trysail from a 26-footer (8m) for the race.

"Because the sail was so small, the loading on the sheets was small. The sheeting angle was wide enough that the sheet did not hook the foot of the sail and cause more heeling moment."

Watch System

We typically have two on deck: one helmsman, one crew. There is no discussion about how to steer; the weather, and having the companionway hatch closed, preclude much discussion. The level of concentration is high. We all consistently take care to keep the bow up when about to meet the impact of a crest, especially a breaking crest, and to bear away to start going down the backs.

Sailing on a tight reach seems to make this easier. It seems strange in a way to be steering so much from normal sailing habits and to find that it still works. It isn't that we have to steer in some different way because the conditions are extreme;

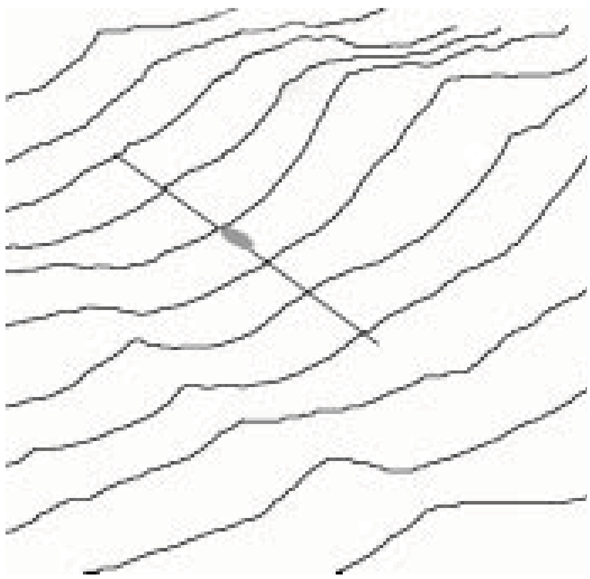
Richard Bennett

Lest you think that Mike or his mates are indulging in a bit of Aussie hyperbole when they speak of 80-foot (24.5m) waves, we invite your attention to the photo above. If you look carefully where the arrow is pointing, you will see the dismasted hull of VC Stand Aside, a 41-foot (12.5m) yacht. Now check out the wave bearing down on her and see how many multiples of her freeboard you can fit between the trough and crest of the wave. This vessel probably has an average of 4 feet (1.2m) of freeboard. The drawing in the lower right corner of this page will give you a better feel for the perspective.

it is just that the penalty for making a mistake is higher.

I think most people would experience some degree of fear in such conditions. But scared or not, one still needs to steer into a large breaking wave rather than turning away from it—to take the force on the strongest part of the boat and to take a lesser force because you are presenting a narrower profile to the wave.

Sometimes the crest is an anticlimax. At other times there is a dip of just a few feet and then another crest—as though two waves have joined together with a dimple on top.



Tacking for Shelter

Mike Kalaugher:

"*Sword of Orion* announced on radio to the fleet that they were getting 78 knots, and the crew of a Melbourne-based yacht, whom we met in Eden, said that they had noticed their windspeed instrument showing 84 knots at one stage.

"The nearest land-based weather station recorded 70 knots. Wind typically blows stronger at sea than it does over land—especially so when the center of the low pressure system is offshore.

"It was noticeable to me that for the part of the fleet we were in, the weather went from bad to terrible quite quickly."

At 1730 Chris calls for us to go north, to run for temporary cover to the port of Eden. We have come to the point where it is no longer a question of racing but one of survival.

We start the engine to ensure we have enough power to tack properly, to ensure we don't falter at the top of the wave.

The most difficult task is going to be the actual turn. To prepare for this one maneuver of tacking, Ron positions David on the leeward side in the helm position. Ron then points the boat to the top of the wave. Just before the peak and with the propeller turning, he drops the tiller to David who pulls away on the opposite tack, down the back of the wave. In this way the tack is completed just before David has to steer down the back of the wave.

One often feels that the boat will look after the people who sail in her but I no longer feel that. It feels like we have to look after the boat.

Bin Rouge's maneuverability is a real asset in sailing over big waves—one has some choice picking which part of the crest to go over.

Reaching Off

The sailing going north is more demanding because of the different angle to the waves. The trysail is still an excellent sail at the new angle because it does not try to dig our bow in to the water.

It is harder to describe the waves now as it is dark. We still follow the tactic of steering more along the troughs and bringing the bow up to meet the approaching crests, then bearing away quite sharply over the tops of the crests to resume our course for Eden.

We keep the engine going to maintain boatspeed in the troughs and when climbing some of the waves.

When I am below off-watch, I worry about the boat and all of us. I think that the conditions are really in excess of the boat's design. With the companionway closed in, I lose the direct experience of the conditions and cannot anticipate the yacht's next move. I think that death is a real possibility. I am also worried, and feel a bit selfish, that I am causing my wife to worry. Waiting to hear of your partner's fate can be tougher than being the one in danger. (Later she assures me that she would much prefer to worry a bit than exchange places!)

On watch, and especially while steering, I never feel the slightest bit scared. The fact that I have to concentrate so much to steer well in an adrenaline situation helps me focus. I am too busy to be scared. In some ways, I also relish the challenge and am quite in awe of the power of nature. These feelings are echoed by Ron and most of the crew.

As for David, I think the bastard is positively enjoying himself as he sings "You are my sunshine" while steering up and down the waves.

Mayday on the Radio

When you hear a Mayday call, every sailing instinct and all your respect for human life asks you to render assistance, and by now the calls are coming over the radio at a furious rate.

But we have no chance of being able to render any assistance to another yacht, or crew in a raft or in the water. To maneuver the boat in position to throw a line would be hard to do, as we are history if we let our speed fall below 4 knots.

Even trying to keep station near a raft to help helicopters find it would be extraordinarily difficult. Actually, even trying to find another boat would be pretty impossible.

While there are many boats in the area, they tend to appear and disappear quite suddenly because of the size of the seas. One moment no boats are about, and then one appears slewing sideways with bare poles halfway down a wave, or comes screaming straight down a wave under storm jib. It is quite spectacular stuff.

Chris calls the sched operator to offer assistance to boats giving Mayday calls. They tell us just to get ourselves back safely. We know they are right, and we don't like it at all.

Meanwhile, *AFR Midnight Rambler* keeps sailing south, partly because of the danger of turning around and partly because it's safer to sail into the seas. We have chosen to run for cover to shorten the time that we are in extreme conditions; we are nearer to Australia than to Tasmania.

By midnight, we get some shelter from the coast of Australia and are now on shorter watches, making our way to Eden.

Mike and the rest of the crew carried on to Eden, where you can bet they enjoyed the welcome calm of a protected anchorage.

Lessons Learned

By now you will probably agree with us that this is a remarkable story of what can be done with good seamanship in a small yacht.

If you had asked any number of experienced mariners what the chances were of *Bin Rouge* coming through unscathed, they would have told you something like zero.

Yet they did make it, without even a serious knockdown. Some part of this can probably be ascribed to not being in the wrong place at the wrong time—they did not meet the ultimate wave. However, there were plenty of other breaking crests out there, which they did deal with, and their active steering techniques allowed them to pick the best spot in any given wave crest.

We asked Mike if he felt that any other tactics would have worked, besides actively steering. He replied that:

Running under bare poles, or using a sea anchor, would have been dangerous in our boat in those conditions. Under bare poles one can't control speed well. Many yachts would easily do 10 or 12 knots with bare poles in that strong a wind. But they were not good wave shapes for high speed running. Without the steadying influence of sail, the boat is open to being rolled more easily.

Quite a few boats had gotten into trouble after they had turned

Chris Bowling:

"Our greatest fear was being pitchpoled backwards, and we came close a couple of times, but we did not get knocked down to more than 45 degrees.

"The thin keel and rudder gave us the maneuverability to get around the worst waves, instead of waiting for doom, like a sitting duck, and allowed us to ride over the ones that did catch us."

Ron Spinner:

"While I think we all steered well, the real point is that we were able to steer well, because we had the right sail up and sailed slowly. We quickly bore off on the crest of the wave so that we were running more along it rather than straight down it."

around—perhaps some of them tried to jibe instead of tacking, which would be suicidal for most.

To jibe would mean that at one point you would be running straight down a huge wave and the sudden change of the wind from one side to the other would tend to broach you at exactly the wrong time.

When you think of turning to run for cover, it is too easy to think that you should turn away and jibe rather than turn into the mountains.

For a sea anchor, we would have needed something like 500 to 1,000 feet (150 to 300m) of warp—and no other boats around to sail between us and the sea anchor.

The possibility of tripping or slingshotting at the end of a sea anchor dampened my enthusiasm for the idea.

Mike's comments on using the engine are also worth considering:

There are a number of dangers in having an engine going in such conditions. Firstly, the oil circulation system in diesel engines is not designed to handle the sort of movements a yacht makes in extreme conditions and you risk wrecking the motor. Secondly, diesel fumes encourage seasickness, which can incapacitate crew. Thirdly, if you roll with the engine in gear, a person or a line can get munched by the propeller. With hindsight, we should have used the engine sparingly, if at all, with those risks in mind. However the engine did seem to help control our speed, at worst it didn't create any direct problems other than the fumes.

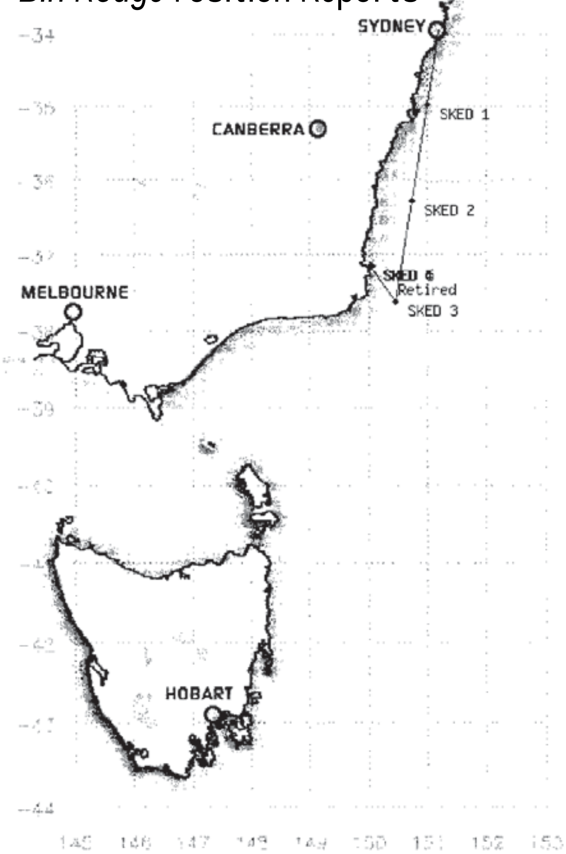
On the other hand, I was really happy to keep the engine going when broad reaching to insure against any wallowing in the troughs. Dealing with lesser wind in the valleys with big seas didn't seem a problem when we were close reaching into the wind. I suppose it is not a problem when close (tight) reaching because the apparent works in your favor.

Finally, we asked Mike if he thought they encountered any of the monster waves which created so many problems for other boats. His answer:

I think we did. However, we did try to avoid the big breakers as much as we could. As we were on a tight reach we could pick, to some extent, when we wanted to sail along the waves and when we wanted to go over the tops. So that reduced the number of times we got caught by crests.

The fact that we skidded sideways when caught by a breaker was what saved us. At the time I was thinking how glad I was that *Bin*

Bin Rouge Position Reports



Chris Bowling:

"When we turned for shelter we went where the winds and waves would let us.

"We turned from about 70 degrees off the wind on starboard tack to 70 degrees off the wind on port.

"We had to get north, or anywhere between northeast and northwest to get some protection from the land before dark, because we could not steer around the waves at night.

"We did not choose a course. We just weaved our way around the killer waves, going vaguely north.

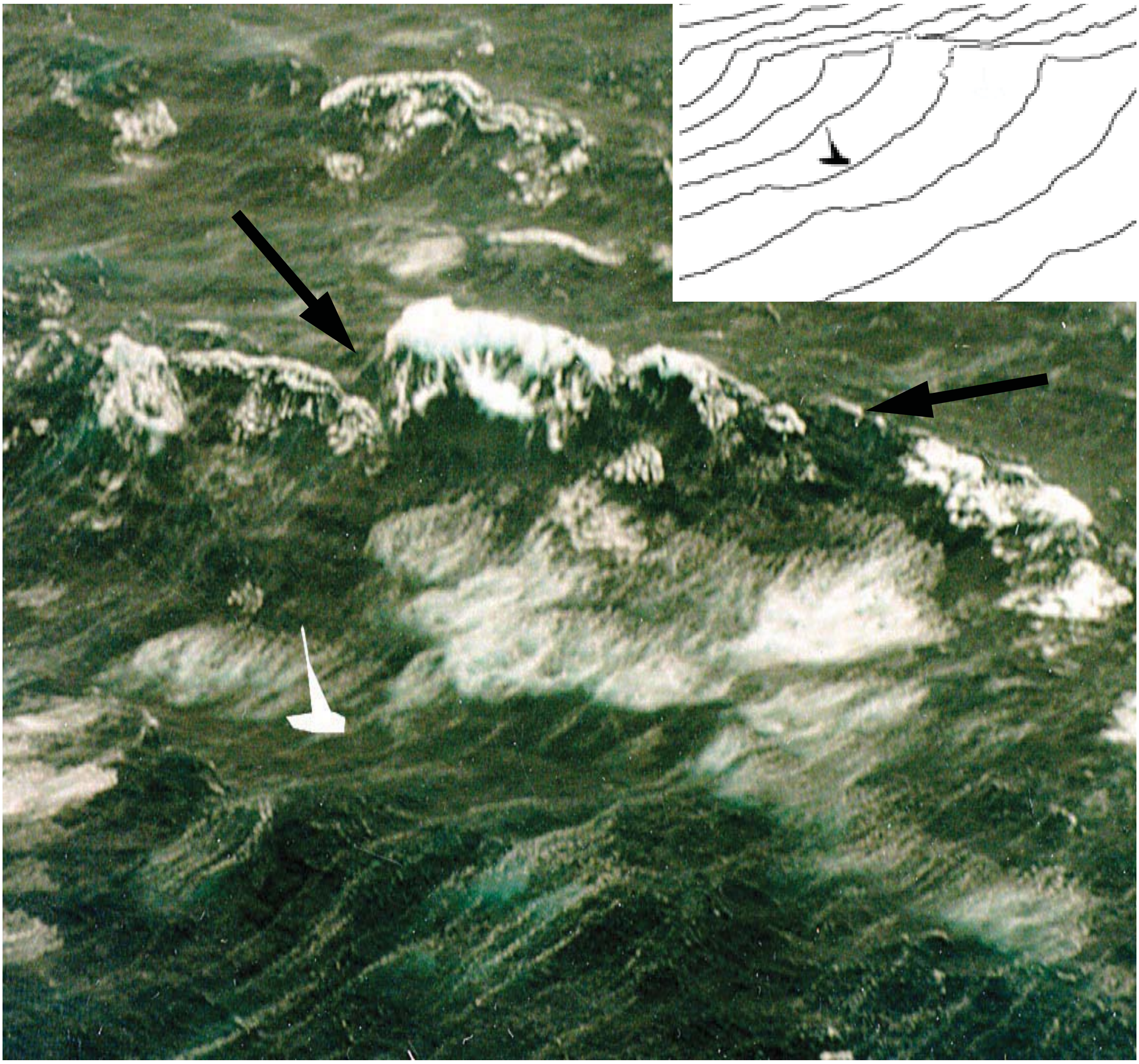
"Heaving to, lying ahull, putting out sea anchors and trailing warps are very good in your average gale, but not in a maximum storm.

"It is better to keep speed on and work through the waves.

"In particular, a sea anchor would have pulled our bow down through gigantic waves."

Rouge was doing this and trying to understand why. I had been apprehensive about our keel and rudder being of too high an aspect ratio. I haven't got a definitive answer to this but think that of first importance was having a small trysail because it would keep our bow up as we got the heavier winds and breaking crests together.

The yacht stayed at the right angle to the waves. It was the boats that got caught side-on that suffered. So the boat's response to the waves was okay because our bow stayed up, was held up by the trysail. As important was having enough boatspeed so that we didn't start going backwards when caught by a breaker. This has reinforced me to the view that no matter what else, "If you are on a sailboat, get the sails right." The sails are the key to it. Our fairly high-aspect foils didn't appear to be a problem so long as we kept our speed up.

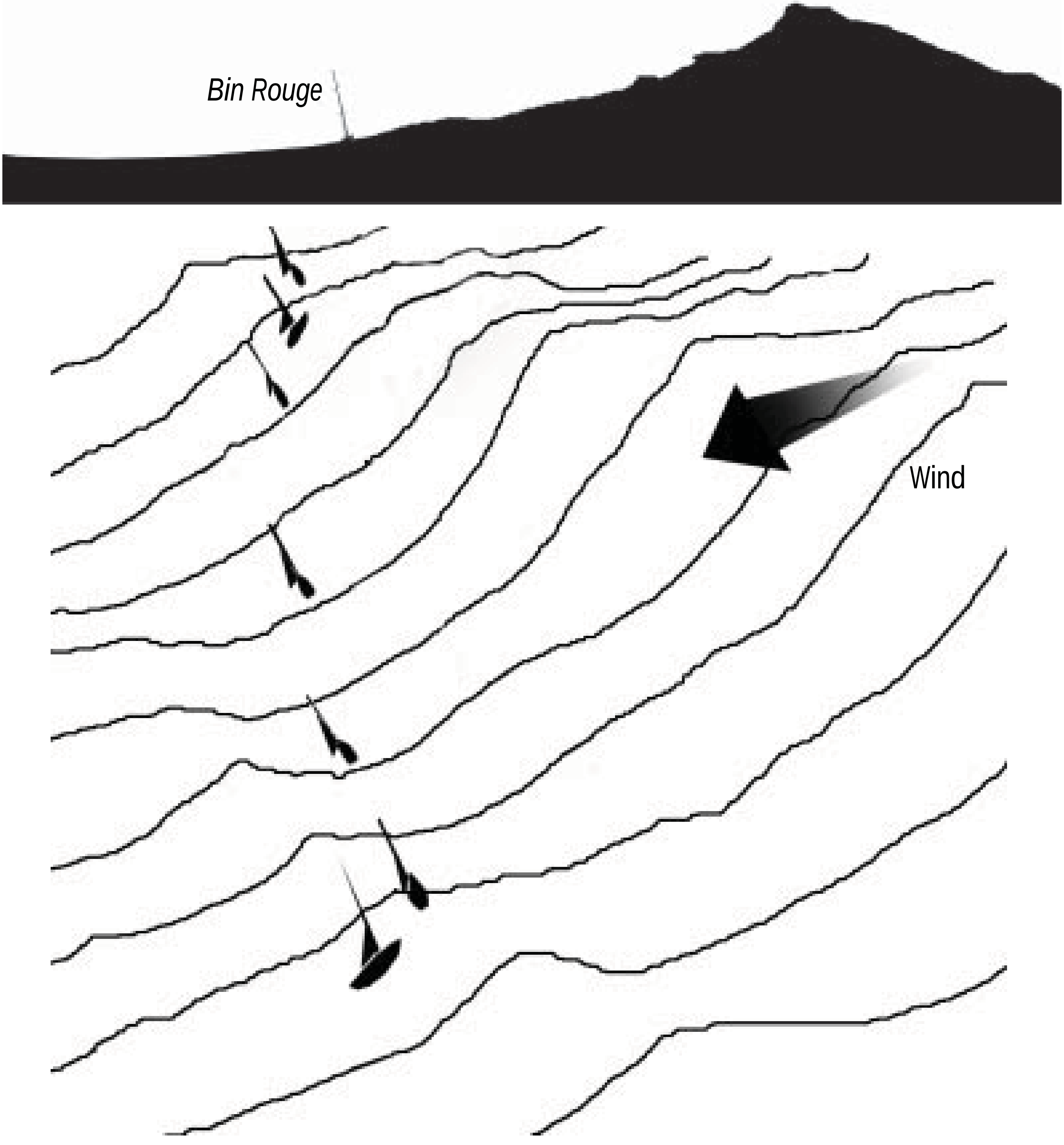


Richard Bennett

There really is no tactic to deal with a huge breaking crest like this one, except by avoiding it. You either have to cross the face before it collapses, or make sure you are to one side or the other of the crest where the wave is not so steep (arrows). This wave is an easy 70 feet (20m), maybe more, and there is at least 20 feet (6m) of break on top.

Mike Kalaugher: "When sailing towards Hobart we were on course 190 true, the underlying swell was about 245, and the wind and the wind waves which overlaid the swell was 260. So the wind was coming from the starboard side of the boat at an angle of about 70 degrees from the bow, which is about 20 degrees forward of abeam.

"The swell was large and rolling and was shaped much like a sine curve. In imagination, and with no wind or current, if you were in the trough of a swell and looking straight up at an oncoming wave top it would form an even line. The top of the swell would be rounded like a sine curve. However, because of the current and because the wind was blowing at about a 15-degree angle to the swell, the rounder rolling swell was overlaid and steepened at the tops. Instead of the crests forming an even line, the waves tended to have a more pyramid shape. A series of pyramids overlaid the rolling swell. This was overlaid again by the wind waves. The wind would blow the crests off making the water look white. There would sometimes be breaking crests of 2 to 15 feet (0.6 to 4.6m) on top of the waves, and these would tumble down like mini avalanches in long streaks. Some of these avalanche paths would be 300 yards (274.3m)long. At the bottom of the troughs the water would be quite flat and fairly even, then a slope of something like one in seven and a more irregular surface, then approaching the crest the gradient would steepen to perhaps one to three, or one to four, and there would often be a breaking crest. The breaking crests did not have a big curl like on a surf beach, but there was a moderate tendency at times towards this shape."



"We were sailing only slightly into the waves; we were sailing along them and climbing slowly up them. But on the steeper part of the wave approaching the crest we would turn the bow about 20 or 30 degrees more head—on to the waves and immediately at the top, just past any breaking parts, turn more side-on again to find our way down, and resume our course. As the long crests were like a string of pyramids, we would try to steer so that we went over the crests where the waves weren't so high and dangerous, but sometimes we didn't have as much choice.

"When a breaking crest caught us, the boat would get swept by water, over and above the usual driving spray. This would make her skid sideways, as well as continue to sail forward somewhat. The boat would heel more towards the crests as the wind was stronger. I am not clear at all on the angle she would heel when caught by a breaking crest and the higher wind, as a wild guess in the range of 30 to 60 degrees. When she started to skid this seemed to ease off the heeling pressures a bit."

Ron Spinner: "We did on one wave come close to pitchpoling backwards. I was trying to work my way over a big wave, (about 80 feet/25m) but being almost vertical near the top, it nearly stalled the boat, with about 10 feet (3m) of breaking water on top coming at us, I pulled away (to leeward) to gain speed quickly so I could then round up and drive through the breaking water over the top. If you see some of those surfing videos where the board is riding along the wave, weaving up and down and finally flipping over the top, that's what it was like, with the differences being that we took the wave on from the bottom rather than the top and of course we were travelling much slower. The big waves were travelling at about 30 knots I would imagine, so our drift rate must have been similar on occasion."

What Happened to the Weather?

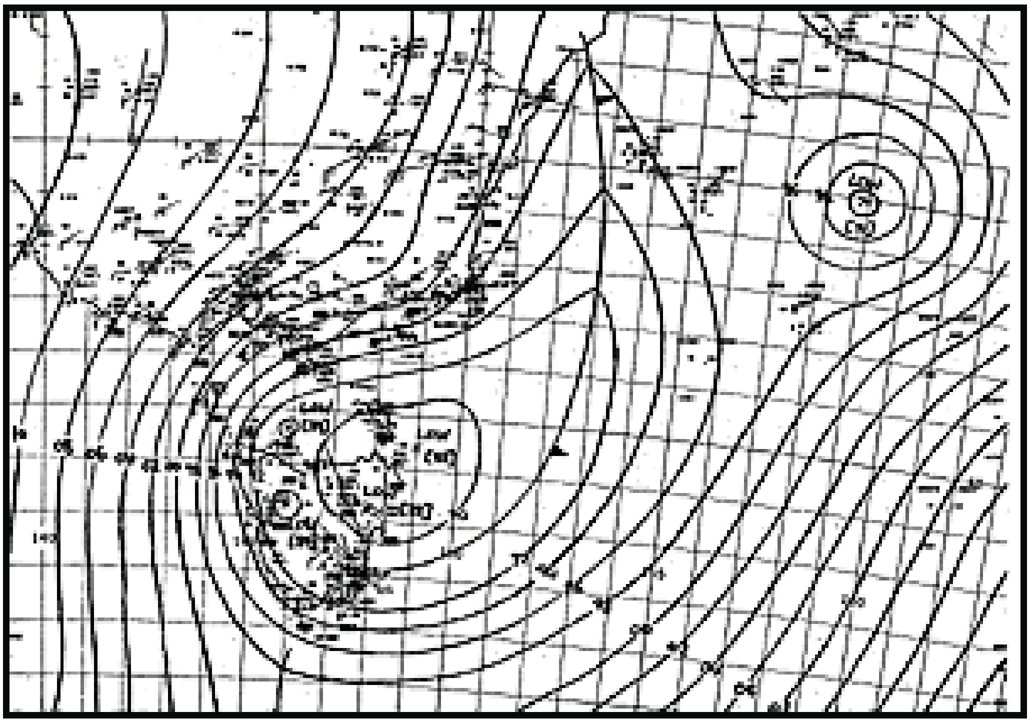
Having started this section of the book with the possibility of a "bomb" we are now faced with the reality of what transpired.

The data from *Bin Rouge* indicates several interesting things. First, they had an obvious frontal passage. You can infer this from both the roll cloud observed and the shift in wind. Second, they must have been very close to the center of the depression, on its west side. This is evident from the fact that they still had reaching winds on starboard tack.

This is not an isolated event in the forecasting business.

Mariners frequently misinterpret the data supplied by the local weather service.

Add this to the fact that it is impossible for a professional forecaster to call all the variables correctly more than part of the time.



This is the 0300 synoptic chart for the 27th. If you compare this to Bin Rouge's position, you will see that they were right on the frontal boundary. The isobar spacing is stacking up to the west of Tasmania with an extremely tight spacing (even though these are 2mb intervals as opposed to the normal 4). The low to the northeast is still organized, although by now most of its energy has been sucked south into the new low-pressure system.

If *Bin Rouge* would have had a weatherfax aboard, and had gotten a fax similar to that shown above, they would have known they were in for a pasting. But, if you take only this fax into account, there is nothing here to indicate sustained winds above 50 or so knots. And that's considered normal for this part of the world.

However, there are the same three very important and unpredictable factors at work here. First, we have the subtropical low to the northeast of the fleet still feeding energy to the extratropical low. There is no computer model around that will properly quantify the impact this may, or may not, have.

Second, the high pressure system over New Zealand is still around and has shown no sign of abating. Third, and potentially most dangerous, the extratropical low moving in from the southwest has been over a cold current which runs underneath Australia. It is now crossing over a very warm current. This temperature differential alone is enough to create a localized

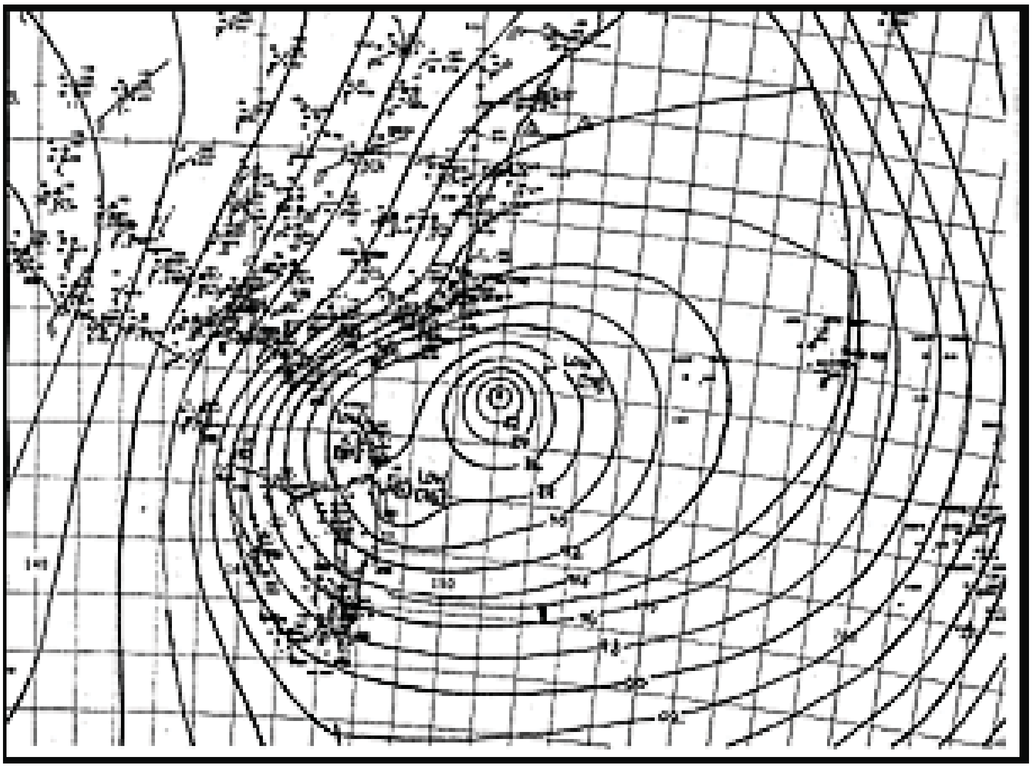
The BOM indicates that when they forecast a significant wave height (the average top third of the highest waves) they expect there will be occasional waves as much as 1.86 times the significant wave height. So, with a wave of 35 feet (11m) one can infer that there will be occasional waves as high as 65 feet (20m).

The development of the Tasman Sea low and the continued presence of the high-pressure system over New Zealand produced easterly winds resulting in a swell from the east to northeast over most of the area between Sydney and Hobart.

The westerly quadrant winds from the developing low to the southwest, which moved through the Bass Straits, then created a new, larger set of seas from the west to southwest.

During this period, the East Australian Current is thought to have been flowing southward at about 4 knots off the coast in the area of the race.

So we have a primary wave system with the new winds; a secondary wave system which had existed for several days; and a generally opposing current running at high speeds, with its typical sharp shear lines in water temperature and current speed.



1500 on the 27th. This is an hour after the 1400 "sched" on which Sword of Orion announces to the fleet that they have gusts to 78 knots. The isobar spacing has tightened further, indicating that winds are increasing. The subtropical low to the northeast has disappeared and the New Zealand high remains in place.

storm, and if the pressure gradient from the system moving in is tight, which this obviously is, then the temperature gradient could cause the system to bomb, in addition to the effect of the opposing current on the waves.

Compare the previous fax to the one above. In the 12 hours that have passed, the center of the system has only moved a small distance and is being blocked by the high to the east.

At the same time the isobar spacing has tightened, indicating that the storm is maturing, and the wind is increasing. Part of the storm is situated over cold water to the west and part over warm water to the east. You could not have a better situation for increasing wind strength and gust factors. The official forecast at this point is for winds of 45 to 55 knots, and that seems in keeping with the way most weather services would interpret this data.

Roger Badham Analysis

A region of cold upper air could be seen clearly on satellite images as it crossed the Bight on the days leading up to the 26th of December. The cold pool of air became cut off from the upper westerly flow when the system deepened to the surface during the early hours of Sunday 27th and it was this region of cold air that brought unseasonable snow to the high country of Victoria and New South Wales that day.

The computer models gave forecasters exceptionally good guidance on how this system was to develop. However, the exact location of the low pressure formation was not really certain until during Boxing Day.

The MRF (Medium Range Forecast—USA global model) picked up the development many days before while the other global models were less certain; there has been a fair amount of uncertainty in positioning the deepening process.

It is useful to gain an insight into how the forecasters (and you) might be lulled into false thinking. For much of December and certainly for the two weeks leading up to the Christmas period, the ECMWF (European global model) had been the preferred model on nearly every day. This model did not offer consistent guidance with this particular low-pressure development in the days leading up to the race.

Both GASP (Australia) and ECMWF models were not as bullish with this cold upper trough in forming a surface low. The MRF model has a slight tendency to spin up perhaps too many systems like this. So prior to the start of the race, the model guidance had been very useful, sufficiently convincing as to expect the development, but the exact position and intensity was not at all certain.

The upper low began deepening on the evening and night of the 26th as the yachts surfed their way south in strong north-northeast winds. By dawn on the 27th, the fleet already had west-southwest winds and the surface low was evident almost in the middle of Bass Strait, not far to the east of Wilson's Promontory.

During that day (the 27th) the low deepened and shifted east to cross the rhumbline of the race at around 1100 at latitude 39S. It continued to move east-southeast during the remainder of the day, before picking up speed and racing away to the southeast/south-southeast on the 28th.

As the low pressure deepened and shifted east on the 27th, the strongest winds were not near the center of the low, but rather on its western flank in the cyclonic circulation. From 0600 through to midday, the most severe winds lay in a narrow band across Bass Strait from the northwest tip of Tasmania to Wilson's Promontory.

This band of extreme winds generated the large seas that were to hit the fleet later that afternoon and evening. An average windspeed of 50 to 60 knots for a period of six to eight hours is capable of generating seas with a maximum wave height of 40 feet (12m) and an average wave height of 20 to 26 feet (6 to 8m). Until mid-afternoon, the low was west or close to the rhumbline and as such the nastiest winds and seas never hit the leading yachts. Those nastiest winds and seas appear to have reached the corner and the rhumbline from mid-afternoon and continued through the evening and night.

All the sailors knew there was a strong set running down the New South Wales coast, though it ran offshore around a cold eddy positioned at 38-5 S, 151 E. There appears to have been a strong set or push develop out of Bass Strait towards the east and northeast (with the extreme winds and sea), so that there must have been a meeting of these currents in the region where the nastiest seas were experienced.

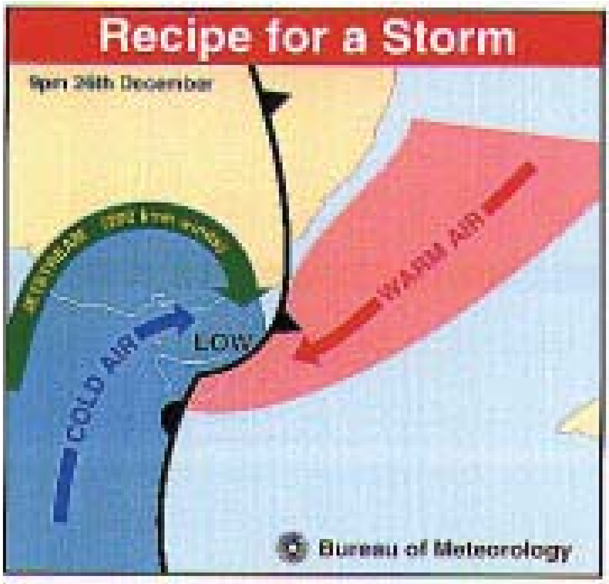
After midnight, the low pressure system began to pick up speed and pull away to the southeast/south-southeast and as a consequence the pressures rose rapidly and the winds gradually

Roger Badham is one of the premier marine meteorologists, in high demand with the top race boats. An Australian, he is involved with every Sydney-Hobart on a professional basis.

"This is a text book frontal low-pressure development and is quite common across the waters immediately south of Australia. The most common development with these low-pressure systems is for the low to deepen over the Bight waters and then travel southeast while remaining west of Tasmania.

"It is certainly unusual for such an intense and rapid development to take place over Bass Strait during December, so it was logical to expect that the actual location (of development) would be further to the south.

"The generation of extreme seas is sufficiently complicated in open ocean waters, but in Bass Strait and near the corner of Victoria/New South Wales there is the added complication of shallow depths and current."



abated. Undoubtedly the serious damage occurred on the evening and night of the 27th when a band of storm-force winds and extremely large waves with shallow backs moved in across the rhumbline coinciding with the bulk of the mid- to smaller-sized yachts heading out into Bass Strait.

At 0900, Wilson's Promontory reported an average wind of 79 knots from 250 degrees, gusting to 92 knots. The storm-force winds that swept the fleet were not that strong, but it does appear that a narrow band of 55 to 70 knot winds did operate for a time.

Let's switch back now the Australian Bureau of Meteorology. During the process of researching this section of the book, we talked to a number of helpful folks at the Australian Met Service. They were open with us and shared their thoughts while they were preparing their own internal investigation of the forecasting for this event.

While the BOM has come under criticism in some quarters, our feeling is that they presented the data necessary to see the potential for what was coming. But, you had to know enough about meteorology to read between the lines of the official forecast and analyze the risk factors.

Clare Richards

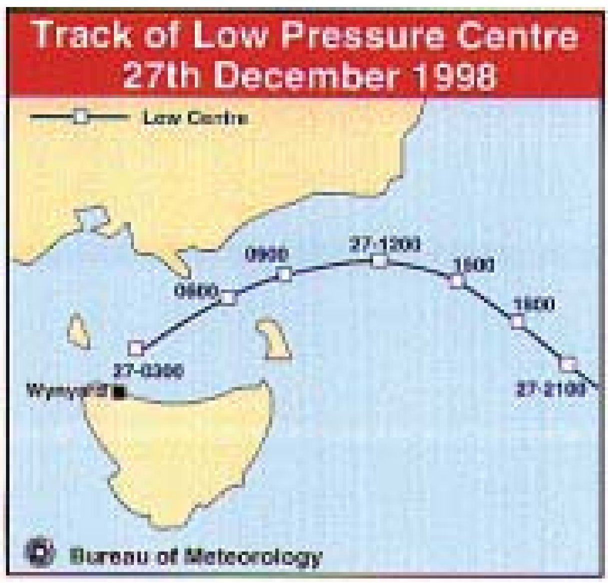
Clare Richards, from whom we heard in the first chapter of this section, has been kind enough to answer a few questions for us about their forecasting process:

Regarding the wind speeds, 45-55 knots is mean windspeed and does not include a gust factor. Our publications on Marine Weather suggest that a gust factor of 30 to 40 percent be assumed.

There was a trough lying over Southeastern Australia ahead of the frontal system. You can clearly see the associated thunderstorms (they started in Melbourne Christmas night) on the sat-

From the official BOM report:

"The storm-force winds and high seas experienced during the race were part of the circulation around a number of very intense mesoscale low-pressure systems, embedded within a parent low system which developed rapidly over the southeast corner of the continent during the 24-hour period beginning from 11pm, 26 December. These rapidly developing intense mesoscale systems within the parent low are a well-known phenomenon, although the development of this particular system was slightly unusual in that it occurred in Bass Strait rather than the more usual location further north along the East Coast."



ellite loop. Just prior to the front merging with the trough (Boxing Day), the thunderstorms crossed the southern New South Wales coast and headed out to sea.

In this case I am assuming that the sailors did see thunderstorms that were associated with the comma tail.

As to being a precursor to the development, while yes, it was definitely a baroclinic system (bent back warm front), and the thunderstorms we saw were probably part of that system, I will await the outcome of our research into the event before drawing such a conclusion. (There is a school of thought that would say the convection did contribute to the mesoscale development.)

There were several factors associated with the development of the system: it occurred at the boundary of the interacting very cold and warm air masses which, with the positioning of the curved jet stream in the upper atmosphere and a mobile upper level cut-off low, had become a favorable location for rapid intensification.

The satellite photograph taken at about 1500 (0400z) illustrates the very tight spiral structure of the low-pressure system.

Clare is indicating several key factors. First, this was a baroclinic (comma head, bent back warm front) type of storm structure. This accounts for some of the surface wind effects which have been reported, the fact that some of the boats reported sailing through what appeared to be a calm "eye" and for the unusual lightening displays reported.

Surface Wind Fields

It is important to remember that forecasts and windspeed reports are typically given for a wide area, and are based on mean windspeeds expected for periods of 10 minutes.

Gusts of fairly lengthy duration can exceed these figures by as much as 40 percent. Thus, a forecast 50 knots can have gusts up to 70 knots, and still be "accurate" from the perspective of the issuing weather service.

Add to this the fact that the norm is to forecast for 33 feet (10m) above sea level and that the winds above the altitude will be higher due to wind shear and surface friction, and you begin to see where the 78 knot gusts we've already discussed could come from.

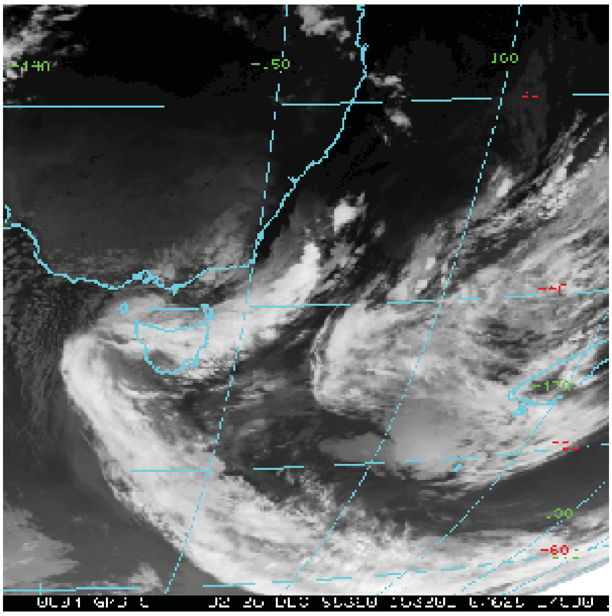
In addition, the forecasters are working with computer models which forecast for wide geographic areas. In any given storm system, there is a variety of local conditions. This can be influenced by external factors such as topography or water temperature—sometimes just a few degrees of temperature differential will trigger major increases in vorticity and wind strength—or its local difference may be based on a different mixing of the air masses in your area.

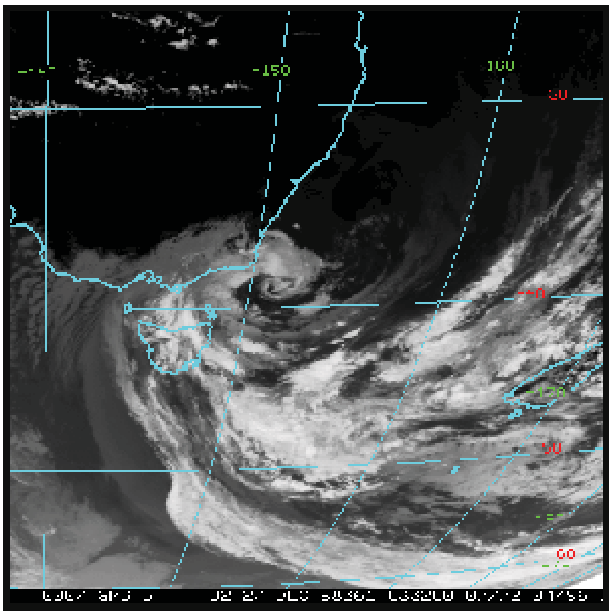
The point we are trying to make here is that you can never take the professional forecast at face value. Creating an accurate forecast for an insignificantly small geographic area is simply impossible.

From the BOM report:

"The preliminary re-analysis of the situation, taking account of all readily available information, including reports obtained to date from yacht crews, observations from the ESSO Kingfish B Platform in eastern Bass Strait, coastal station reports and information from the *Young Endeavour*, as well as the Bureau's normal observation network, strongly suggests that the highest mean winds over open waters in eastern Bass Strait and off the southern New South Wales coast were about 55 to 60 knots.

"Gusts and squalls of considerably higher windspeeds would almost certainly have been experienced by the yachts for short periods of time. Mean winds of this magnitude (55 to 60 knots) could be expected to produce gusts of 70 to 75 knots or more on a fairly regular basis."





The left image is 0300 on the 27th. The right image is for 1500. Note the development from an open frontal system to the tight spiral of a baroclinic or bent back warm front type of storm structure.

Satellite Imagery

Let's take a look at the satellite imagery now. Although the boats would not have been able to see these images unless they had satellite-direct gear aboard, they give us a pretty good idea of the structure of the storm (the following satellite images are processed by the BOM and originally obtained from the Goestationary Meteorological Satellite [GMS-5] of the Japan Meteorological Agency).

These images should be looked at in conjunction with the surface synoptic charts on pages **281** and **282**. They provide a classic view of how a bent back warm front depression develops.

You can see the cloud mass over Tasmania Sea moving northwards, while the cloud mass from the Tasman front to the northeast moves south.

The pronounced spiral shown in the 1500 image indicates that the low has probably "bombed"—developed rapidly. The warmth and humidity from the Tasman Sea low coming into contact with the colder, drier air from the southwest provide two of the key ingredients. The water-temperature shear line between the two current masses is the third ingredient.

Weather Lessons

This is a really tough situation to second guess. All of the signs for a significant blow were present on the morning of the race. As we've already said, if you were cruising, the decision was easy: Wait for the situation to clarify itself before heading out to sea.

But as skipper of a boat ready to go, the decision is far more difficult. There is no guarantee of a major blow—just a normal Sydney-Hobart Race gale, and everyone expects this. Would we have told our crew we were not going, on the chance (perhaps 1 in 20) that a really severe blow would overtake us? I think not.

So the real lesson to take from this event is, what would have been the best course of action, once you knew you were in for it?

Aside from getting to a port of refuge as quickly as possible, there are some interesting questions about the best direction to navigate. To learn more on this subject, let's go back to some of the other boats in the fleet.

Back in Bass Straits

The big boats at the front of the fleet were far enough across Bass Straits to avoid the worst of the storm. But as the low deepened, expanded, and moved in an easterly direction, it caught the mid- to small-sized boats right in its path.

Add to this the effects of an opposing current, and the dynamic fetch (caused by the storm moving in sync with the waves it was propagating), and you had a situation with an abnormal quantity of large breaking seas.

We feel that the overall results of this encounter between the yachts and nature at its worst speaks volumes about the quality of yacht design and construction today, and the ability of the sailors in this race to deal with the situation.

Of the 115 starters in the race, 44 finished. Considering the conditions, this is a very high percentage. There were five yachts rolled and dismasted, three of which were abandoned after suffering severe damage during knockdowns or rollovers. Another five yachts were severely knocked down, suffering some form of damage in the process. And, we are sorry to report that six crewmen lost their lives.

The IMS-style boats, with their balanced hulls, high aspect keels, and large spade rudders, allowed the crews to sail them upwind and pick their way through the waves, as the men aboard *Bin Rouge* did so well.

Structurally, if you leave out the yachts which were violently capsized, the fleet came through amazingly well, considering the very light (albeit strong and high-tech) construction represented. Only three of the yachts which were not rolled or severely knocked down sustained damage to the hull or deck.

The Cruising Yacht Club of Australia did an in-depth analysis of the race including detailed questionnaires filled out by the crews of almost all of the boats that retired and/or were damaged, and personal interviews with many crewmembers. If you are seriously interested in the subject of heavy weather, the entire report makes for an interesting read (and is included on the CD-Rom edition of this book).

The initial press reaction to this outcome was one of condemnation of the design and construction of the yachts. However, our opinion, after studying the debriefing reports; reviewing video, photos, and weather data; and talking at length with various participants is that the boats gave their crews the ability to maneuver them in such a way as to work their way through the waves.

If this weather had hit 20 years ago, with a fleet of IOR-style race boats, we feel the results would have been more serious than the 1979 Fastnet Race.

AFR Midnight Rambler

One of the most interesting stories to come out of this race is that of *AFR Midnight Rambler*. Just a day after the maxi yachts which had escaped the worst of the storm pulled into Hobart, *AFR* poked her bow across the finish line.

Considering she was a light-displacement 35-foot (10.7m) yacht, and had sailed the same course as the rest of the fleet, there are bound to be some interesting things to learn here.

She crossed the line in tenth place overall (out of a fleet of 110) taking overall handicap honors. Ed Psaltis, the skipper, was no newcomer to this race—it was his 17th running. He had purchased the boat along with partner Bob Thomas just four weeks before the race.

Psaltis was quoted as saying that reading John Rousmaniere's *Fastnet, Force 10* had mentally prepared him for the race.

In their post-race debriefing the crew reported that they were very pleased with their pre-race storm sail training. Without it, the end result might have been very different.

Over half the crew had been sailing together for the better part of a decade, so they knew what they could and could not do. The crew worked out, and were expected to be in top physical condition for the race—a major factor in not making mental errors.

By 0100 on the 27th they had jibed on the wind shift—they were sailing with jib and main at the time (the spinnaker having been removed several hours earlier).

In the early morning hours they were down to double-reefed mainsail and storm jib, with the wind blowing in the 40- to 45-knot range. By mid-morning the breeze had dropped a bit and the boat was under-canvassed. Psaltis decided to wait a bit before adding sail area to see how the weather worked itself out.

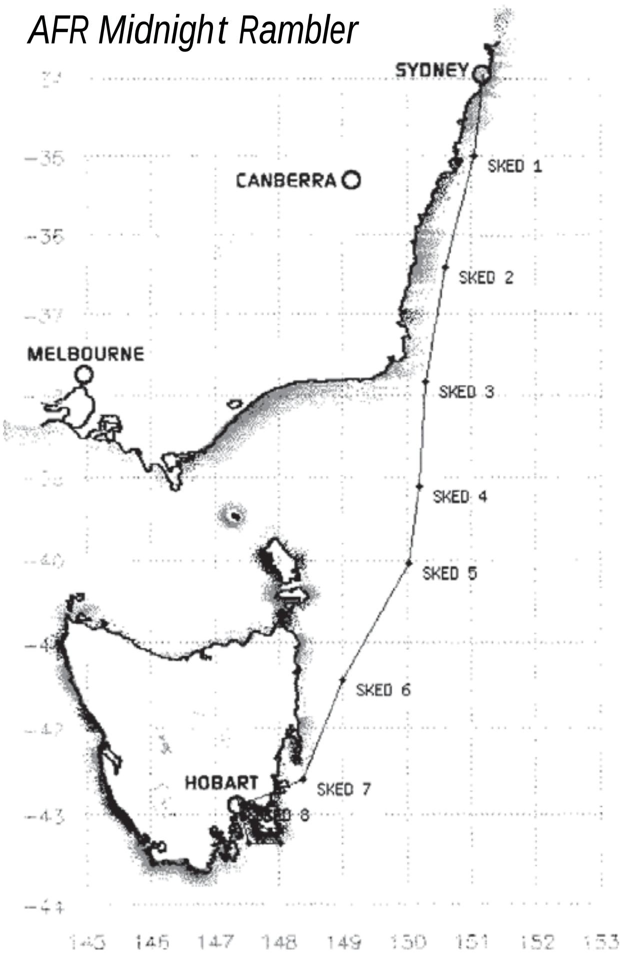
The following information is derived from the raw interview files of the post race analysis. We've left the material in almost original form to give you a feel for the interviewer's impressions.

Around noon the secondary depression hit, and winds increased to 45 knots with gusts to 60. The crew ran off downwind at 150 degrees apparent wind angle, removed the mainsail, and replaced it with the trysail.

When they headed back into the wind the boat was hard pressed with both sails set, so the crew removed the trysail and continued on under storm jib which was set on the headstay.

Around 1300 they were sailing into more wind and bigger seas as they crossed paths with the strongest part of the depression. They were now 50 miles south of Gabo Island and the subject of running for shelter was discussed. They had suffered a 90-degree knockdown, but were otherwise in good shape. While this discussion was taking place, another yacht in the race came flying past them on a downwind course, barely under control. This confirmed for the crew that they were better off continuing to beat into the storm, rather than running before it.

AFR Midnight Rambler



Later that afternoon they were caught by another wave and knocked down to horizontal. During both knockdowns, the helmsman was washed to the end of his safety-harness tether.

By early evening, the breeze was in the 35- to 45-knot range and the crew continued on to Hobart without further incident.

Both photos Richard Bennett

In the top photo AFR Midnight Rambler has just come through a crest. She will be bearing off now (see the next page) to gain speed again, while the crew looks for the smoothest spot ahead through which to guide the bow. Check out the seas directly to leeward—which they have avoided.

This is actually very much like a racing technique in more moderate conditions, although the penalties for making a mistake are more severe.

In the photo left you can see a close-up of the storm jib. The crew is allowing it to luff to depower the sail. It would be far more efficient if this sail were 30 to 50 percent smaller and could be trimmed properly. Even better would have been to fly a small trysail as did Bin Rouge.

Note how neatly the mainsail is furled around the boom. This sounds like a small thing, but the reduction in windage from a neat furl, as compared to a sloppy furl, makes a huge difference in how the boat handles.

Both photos Richard Bennett

Study this photo carefully and look at the choices facing the helmsman of AFR Midnight Rambler. He has just come through a rough patch and now has smooth going for a brief period—time to look ahead and pick the smoothest spot to get through the oncoming seas. Look at the seas ahead and to leeward—a large trough exists where a crest has just passed. A large breaking crest can be seen off to leeward (arrow).

AFR Midnight Rambler bearing away after climbing the wave crest. Note how the jib is filled now, and how there is a pause before the next crest arrives. In a situation like this, the crew needs to be on its toes and the helmsmen alert. This is where the physical condition of the crew pays big dividends.

Bright Morning Star

Richard Bennett

The crew, with the exception of Hugh and Ian Treharne, were new to the Sydney Hobart race, although most had experience with other long races aboard *Bright Morning Star*. Experience was gained on Lord Howe, Southport, Mooloolabah Races, as well as long cruises.

Both skipper and watch captain are as good as you get—very observant; great eye for detail; have been in all types of weather; and full-time sailors.

Since they don't have their crew together all the time, they talk through all procedures, such as man overboard, life raft, and safety. They do this by the book, step by step. They have a training day.

They regard the race as an adventure.

They try to change sails early to avoid pushing the boat to the limit, referring to this as the cautious way. Due to the make-up of the crew, they don't press with spinnaker, but instead wing out jibs.

They do not have personal EPIRBs. They carry personal strobe lights, harness and life jackets. Hugh Treharne is adamant that the correct way to pick up a man overboard is a figure-eight maneuver.

They sailed in the same manner as the other competitors and damaged their spinnaker. Jibed and set up for the expected southerly change in the wind. Two reefs and number-4. Stayed in that mode in moderate variable wind for three hours before the real blow.

During the Storm

Hugh's comments: "Wind strengthened and we reduced sail. We lowered main then sailed east, put in a deep reef but still overpowered even without jib. Boat overpowered and bow being pushed off.

"We did not have enough speed to sail through seas and this caused us to be pushed sideways with a huge wave, which laid her down with mast below surface of water. She recovered quickly, but it resulted in injuries to 3 crewmembers who suffered cracked ribs. We needed a trysail and storm jib for maneuverability and sailed at 60 degrees to the wind and at a safe and fast speed to enable us to luff through the seas; wind now 60 to 80 knots.

"From 1800 to 2359 on the 27th, wind never went below 60 knots. Our small sails are 60 percent of the area required by the rule (ORC regulations).

"Because of our inability to rig the boat properly for the conditions, and the crew injuries, we elected to retire and head for Eden under motor and bare poles, arriving in Eden the morning of the 28th. Because of commitments in Hobart, we stayed in Eden for 24 hours, cleaned up the boat, then headed for Hobart in a 46-knot westerly breeze. This moderated after a period, whereupon we motorsailed to Hobart. We found the fuel limit was more than needed."

Suggestions from the crew:

- ❑ Storm sails should not be too large.
- ❑ Serious injuries were sustained when yacht rolled down to just past horizontal.
- ❑ All yachts should have captive mainsail luff slides so as to control the lowered main, plus a separate track with captive slides for the trysail.
- ❑ Storm sails should be stopped strongly before hoisting, then sheeted in to break stops.

Sailing technique: run east, lower main, set the trysail and storm jib then sail at 60 degrees to the wind. This will give you a safe, fast speed to be able to luff through the big seas keep control of the boat.

VC OFFSHORE STAND ASIDE

The boat was prepared in Adelaide. Half the crew attempted delivery to Sydney, but as they experienced heavy weather and seasickness, the boat eventually had to be trucked. This left no time to do the Telsta Cup and lead-up races for final crew preparation.

Boat and crew performed well prior to storm, with boat well-positioned with vessels of similar size. Prior to weather

PPL

change, good run down the coast. When wind increased to 35 knots, changed to heavy 80-percent-size spinnaker, two reefs in main, boat generally running at 17 to 19 knots with no roundups or problems. Crew in safety gear (harnesses and wet weather gear).

On early Sunday morning the wind changed to the southwest and headed. The crew noticed bigger boats inshore. Observed change in sea state, changed to storm jib plus third reef in main. Wind then went light so changed to number-4 and back to two reefs in main at dawn. A number of crew were seasick and the watch system had broken down (eight crew were on deck). The boat was underpowered in light conditions and crew discussed alternatives.

During the Storm

Around mid-day Sunday, the wind shifted to the west with rapid increase in velocity and wave height. Removed all sails, running off under bare poles east. Yacht difficult to maneuver at 5 knots boatspeed. Lashed main to boom but did not lash boom to deck. Hoisted storm jib which blew out of headstay foil groove. Crew unable to recover so left sail as was (no inner forestay). Boat now in control heading 110 to 140 and comfortable. Thirty percent of crew off watch.

At approximately 1415, a large wave with top 23 feet (7m) completely vertical broke over the yacht. Yacht rolled 360 degrees, breaking mast at deck level, breaking the boom and imploding the deck. Windows shattered, storm boards missing. Deck damage could have been caused by broken mast and boom.

All eight crew on deck were washed overboard during the roll, seven tethered to yacht, one not tethered ended up 33 feet (10m) from the yacht. All overboard crew required the assistance of those who were below during the rollover. To get back on board the yacht took 15 minutes. Crew then cut rigging and mast away using boltcutters.They had an exceptionally large set of bolt cutters. Majority of crew suffered injuries during the rollover.

Emergency Procedures

Yacht engine and SSB radio not working. Launched both life rafts. No problems in launching life rafts from below as coachhouse destroyed and yacht 40 percent filled with water. One life raft failed to inflate, further tugs on the tether resulted in the tether breaking (probably at the weak link) and the life raft was lost. Second life raft deployed and tethered astern of yacht. Activated yacht EPIRB plus two personal EPIRBS. The crew were anxious and fearful.

Crew erected emergency radio antenna, SSB still not working. Deployed red parachute flare and two orange smoke flares. Handheld VHF connected to emergency antenna and Mayday call received by ABC Helicopter, which responded and was overhead within 15 minutes. Rescue helo arrived 20 minutes later, lifting eight crew from the yacht via the life raft. Second rescue helo lifted remaining four crew in a similar manner.

"Crew experience was considered reasonable.The safety inspector advised that the boat was the best prepared he had seen for a long race (with diagrams of safety equipment layout, briefing notes, radio notes plasticized and attached to bulkheads). New safety equipment including RFD life raft.

"Helo transfer of first crewmember took some time due to conditions and the yacht crew's lack of knowledge about procedures. (Note: some rescues were carried out with helo crew face to face with yacht crew; in other rescues, the rescuer held the survivor from behind. Found face to face easier. Snorkel, face mask and flippers used by one rescue crew considered an advantage.)"

Comments by crew and owners:

- ❑ Safety harnesses should have two tethers.
- ❑ Check clips on safety harnesses.
- ❑ Review personal flotation equipment. Suggested Musto type.
- ❑ Waterproof VHF.
- ❑ Life rafts to include EPIRB (406).
- ❑ GelCell battery for emergency communications.

Alice Bennett

VETO

Veto averages about 4,000 cruising miles per year and is set up for long distance cruising and passage making. Achieving Cat 1 (safety equipment) was easy. The boat was "over-equipped." Experienced cruising crew. Had done two or three Hobarts together on *Veto.*

As the crew had all sailed together extensively, the preparation for this race was not as complete as in previous years—just a few overnighters, mainly to check watches and equipment. No man-overboard drill was done, although this had been practiced in prior years with same crew.

One crew was ex-navy and had taken part in a number of search-and-rescue and life-raft survival courses. Another crew had completed helicopter SAR training in the North Sea. The crew had three experienced pilots on board.

Pre-race planning included race and weather strategy. Weather info was collected since early December. Finalized plan after weather briefing.

Had an uneventful first night. Heard storm warning (55 knots south) from Merimbula at 2000 sched on Dec 26. Understood 55 knots to mean average windspeed. Knew that gusting to plus or minus 10 to 15 percent was likely. Thought that the storm would miss *Veto* based on projected track.

Anticipating the Storm

Sailing with full main and genoa until hearing other boats in trouble between 1200 and 1400. Shortened sail in anticipation to two reefs and number-5. Wind was 35 knots by this time but noted color on horizon. Storm hit 1400 on the 27th. Wind went to 45 plus knots. Shortened down to trysail.

Removed dorade vents, tidied up cabin. Prepared for rough ride. Seas rough by average 10 feet (3m), no breaking tops. Boatspeed 6 to 7 knots. No dinner that night. Six of eight crew were sick. Seasickness lasted until mid-day the following day.

Engine died 1400 due to fuel blockage.

Tried to heave to at 2000 on the 28th. Did not try to make Eden—chose to stay at sea. Felt safer there than on lee shore. Winds now 50 plus knots. Concerned enough to "stop and ride it out" rather than to continue racing. Waves now breaking tops. Windage on roller-reefed headsail was making life uncomfortable.

Conditions uncomfortable through to midnight. Just prior to 0300 on the 29th seas started to increase quickly. Knocked down by larger-than-average wave at 0300. Boat rolled 90 degrees. Only two on deck, the watch system having been reshuffled due to seasickness.

Knockdown issues:

- ❑ Companionway was open to allow air to seasick crew belowdecks. This was later realized to be a mistake, as water came in through the companionway straight onto radios. Radios now dead. VHF thought to be in a waterproof bag (subsequently found to have a hole in it).
- ❑ Three crew on deck pretty tired due to seasickness and previous uncomfortable night.
- ❑ Fridges opened during knockdown, dumping food.
- ❑ Floorboards had moved despite being screwed in place.
- ❑ Noted that location of radios (immediately adjacent to companionway) was not the right spot.

During knockdown one crew was underwater for ten to fifteen seconds, harnessed on. (Note: the boat was not being sailed at this point. Was hove to instead. There was uncertainty about exactly what happened. It is surmised that they "fell off" an exceptionally steep wave.)

Electric bilgepump removed water quickly. After knockdown, boat was secured and damage assessed. Main was torn. Attempted to go head-to-wind with makeshift drogue (CQR anchor). Thought about trailing a sail as additional drag.

After knockdown used two tethers for each harness. There was no panic. Crew morale was high. Missed first radio sched at this point.

Seas too large to run with so remained head to wind until dawn 30th. Hoisted trysail. Commenced course to Ulladulla having made decision to retire. Engine eventually started.

Comments by *Veto*'s crew:

- Next year will have a pre-set plan for extreme weather sailing.
- Seasick crew are only capable of motor functions, not rational thought.
- Inflatable PFDs are a must.
- Will be putting crotch straps in harnesses as they came off in one instance.

B52

Boat well prepared with an experienced crew having extensive offshore experience. Majority of crew had done Lord Howe Races, Sydney-Maloolabah, Brisbane-Gladstone, Hamilton Island Regatta, Port Douglas Regatta and Cairns-Port Moresby Races, plus previous Sydney-Hobarts.

Boat and crew performed well prior to storm, with boat well positioned. Changed to number-4, one reef prior to wind increasing. As wind increased, changed to storm jib and trysail. All crew on watch and off watch in wet weather gear and safety gear when wind greater than 50 knots.

Boat overpowered, difficult to maneuver through waves as response to helm was sluggish, so removed trysail. Boat was easier to control under storm jib only. Prior to height of storm removed storm jib but could not control boat. Reset storm jib. Problems with storm jib and foil, twisted.

Secured deck gear, sheets and guys remained on deck, pole lashed to centerline of boat. Caused problem after rollover as could not exit forward hatch. Boat rigged with internal hand line running fore and aft as additional safety item. Two crew on deck, remainder below resting as best they could. Crew discussions re: weather—consensus and morale good.

Capsized

Seas were very confused. Northwest to southwest waves to 49 feet (15m). Boat picked up wave on quarter and capsized.

Boat remained inverted for four to five minutes. Water in cabin 32 inches (0.8m) high. Floorboards secured. Not


Richard Bennett

B52 Lessons:

- ❑ Split pins on stays not to be opened more than 30 degrees.
- ❑ Double tethers on personal harnesses. Review clips on harnesses. Localized man-overboard system.
- ❑ Waterproof handheld VHF. GelCell battery.
- ❑ More education re: rescue procedures.
- ❑ Reduce size of storm sails. Storm jib sheets to be sewn on permanently (no J-locks). Ensure sheets long enough to reach winches if flogging forward.
- ❑ Do not lash spinnaker pole across foredeck hatch.
- ❑ Review stowage of life rafts. Difficult to get from below if injured and minimal personnel available.

sure if mast broke above gooseneck during roll or while inverted. Two crew overboard, one forward, one aft. Thought they saw mast lying horizontal in water immediately after inversion. Crew in cabin discussing abandon-ship procedures, had difficulty in exiting main hatch due to buoyancy vests and flotsam. Crew could not exit forward hatch, spinnaker pole lashed to centerline of the boat prevented hatch being opened. Some confusion below.

Boat rolled upright. Overboard crew climbed onboard. First priority was to remove rig. Skipper split crew into two parties, one removing rig, the other bailing and securing integrity of the boat. Pulled split pins on stays, cut halyards etc. with hacksaw. Disposal of rig took 15 minutes, bailing of boat and stopping ingress of water into the cabin took two hours. *B52* had an additional manual bilge pump installed below. Triggered vessel 406 EPIRB confirmed by Australian SAR. Triggered personal GME 121 EPIRB but antenna would not extend.

Sighted aircraft and released red parachute flare (2050 hours). First flare failed to ignite. This was a new flare, recently purchased. Aircraft circled and then departed. Unable to communicate with aircraft as all radios and batteries dead. Approximately 1.5 hours later a helicopter was sighted and a red smoke flare deployed. Helicopter overhead.

Assembled crew on deck and advised helo of status by head count and indicated head injury to one crewmember. Communications with helo crew not understood. Helo had problem with winch wire (snapped) and deployed a note in a plastic bag which was recovered on *B52*. Note was on plain paper and completely illegible and in 50 plus pieces due to water damage. Wanted to get injured crewmember to helo to advise of current status, unsure whether to turn off EPIRB. Helo departed. Crew morale fair. Secured boat and managed to start engine. Crew changed into dry clothes, ate and got a watch rotation system in place. Proceeded towards Eden, arriving p.m. the following day.

Midnight Special

Boat well prepared. Considered crew experience sufficient for any conditions. Boat and crew performed well prior to storm, with boat well positioned with vessels of similar size.

When wind increased and headed changed to number-3 headsail plus full main, then storm jib plus two reefs in main. Crew in harnesses and life jackets. As wind increased to more than 50 knots removed main. Yacht was overpowered but handled conditions fairly well when reaching. (Some think they should have gone to trysail to assist yacht response).

Following weather report at 1500 on 27th, a large wave with breaking top (49 feet/15m) rolled the yacht 360 degrees to starboard, quickly breaking the mast above the gooseneck. Coachhouse stove in on port side 3-foot (1m) hole, windows displaced could not install washboards. Tiller was broken at the rudder stock and water had ingressed into the cabin, 1 foot (0.3m) deep. SSB and VHF radios unserviceable due to water damage.

Richard Bennett

Crew head count, activated the EPIRB (ME) plus personal EPIRB, deployed three red parachute flares, position twelve-man RFD life raft on deck, bailed cabin, damage control, plugged holes, released rig by removing rigging screws, plus hacksaw halyards. Noted that starboard side jackstay was broken. Lashed helm to mainsheet and started motor. Could maintain steerage way heading SW, exposing undamaged side of the yacht to the weather.

At approximately 0430 28th, an aircraft was heard overhead and two parachute flares deployed. Aircraft responded by flashing lights and then departed. At approximately 0500 28th, an aircraft was observed overhead and handheld flares deployed. Shortly after, the SouthCare helo arrived, three crew on deck, six below.

Hand communications with helo crew may have been misunderstood, as David Leslie jumped into water behind the yacht without a tether. Moved 330 plus feet (100m) away from yacht before helo rescue carried out.

As this rescue was being attempted, a wave rolled the yacht 180 degrees, where it remained for approximately one minute before righting.

The two crew in the cockpit could not release their harnesses. While inverted, a head count was carried out in the cabin, water depth was waist deep. One crewmember attempted to escape through the opening in the deckhead, but became fouled in cordage with his life vest and was unable to exit. A further wave righted the yacht, releasing two of the three fouled crewmembers.

The third fouled crewmember was trapped outside the lifelines under the boom and crew had to cut his harness free to release him, to retrieve him back on board with serious injuries. (Note: life vests in enclosed compartments, dangerous.)

Four additional crewmembers were rescued by the SouthCare helo before it suddenly departed site. As communications between the helo and the yacht did not exist, the crew became extremely fearful as the boat was taking water with every wave, and they had just watched their rescuers depart. Approximately 20 minutes later, the Victoria Police helo arrived and recovered the remaining crew.

Special points:

- ❑ Left forestay attached to rig and boat (helped to keep bow into the weather).
- ❑ Thought saw ship at approximately midnight, fired two flares with no response. Crew secured and watch system instigated to await daylight. During evening maintained damage control on yacht.
- ❑ Helo transfer of first crewmember took some time due to conditions and lack of knowledge on procedures by yacht crew.

Alice Bennett

NEW HORIZONS

New Horizons, a Cavalier 37, was well founded, well sailed and used extensively prior to the 1998 Sydney-Hobart Race. The crew of eight showed extensive years of sailing and racing including a few previous Sydney-Hobarts. The core group of this vessel has been sailing together for up to ten years. They have a strict safety policy and the placement of equipment on the boat does not vary from year to year.This crew did not feel they were highly competitive and were going to Hobart for the adventure.

New Horizons was getting the weather from Penta Comstat and Telstra Control, and thus always aware of the oncoming storm. They believed they were totally prepared for storm conditions and expected 50 to 55 knots. They were not, however, expecting the survival conditions that ensued.

They set off on a course to establish them to the east of the rhumbline. As the weather forecast increased the duration of the storm from 12 to 15 hours, they elected to come to the west of the rhumbline. At around 0001 on 27 December the wind swung into the west-southwest and they went straight to a number-4 headsail and one-reef mainsail. By daybreak the wind was 30 to 35 knots and by 1400 hours the vessel was in good shape with the storm jib on. The boat was well balanced; had good forward speed; the mainsail was lashed tightly to the boom; there was no major seasickness; and a strict watch system of four on deck and four below was maintained. Crew on deck were harnessed at all times. They were taking plenty of fluids but no food. At the 1400 sched, which was a normal radio sched, they were still in good control.

At dusk they put a storm board in. Some of the crew had Musto-style buoyancy vests, no barometer, and traditional life vests were not worn.

Preparation:

- ❑ The skipper's policy was that all crew should have sailed on the vessel at night prior to a Sydney-Hobart Race.
- ❑ They had practiced putting up the storm sails.
- ❑ They had practiced man-overboard procedures.
- ❑ They had chart plotter as well as conventional charts.
- ❑ The boat did not carry any extra safety equipment— strobes or non-regulated EPIRBs.

Storm Center

A huge half-hour rainstorm occurred at 2200 hours, followed by a total calm with no wind. This lasted for about ten minutes and the on-deck crew was in awe of the stillness. The wind then increased to 60 to 65 knots and the vessel was, at times, overpressed with the storm jib. The watch change took place as routine and the vessel was generally in good order with minimal bilge water and no other obvious problems.

At 2330 the breeze increased to steadily over 65 knots and in the mid 70s. The waves were huge and rolling in a formed, orderly sense. The vessel attacked the wind and waves at about 60 degrees to 70 degrees apparent. At 0100 at latitude 38 degrees 10 minutes an unusually big set of waves rolled through the area and the vessel suffered the first full knockdown. As the crashing wave hit the boat, they believe it slid sideways and then spun head to wind. The spinnaker pole was dislodged and was found over the lifelines, the mainsail and boom were lashed to a stanchion base, and during the knockdown, the stanchion base was ripped from the boat and the main boom was crashing freely. The crew immediately started to run the motor and it ran until the next knockdown. The crew was amazed and perplexed, however there was no panic as their strength of character and sailing experience prevented those problems.

The breeze was a full 70 plus knots. They removed the storm jib and contacted Telstra Control with their position.

Second Knockdown

Following this first knockdown, the crew was reduced to two on deck. No drogues were used and the wheel was tied down to try to keep the bow up. At about 0230 the second hatch board was put in, and the radio was giving trouble, as it was wet. The crew was tired and weary but still maintained a strict watch system with belowdecks being fairly shipshape. During the dawn, with two crew in the cockpit, a huge wave was heard, white foam engulfed the boat, and it is believed the second knockdown took the boat to 120 degrees to the vertical. Both crew talked of solid green water totally engulfing them. As the boat started to right itself, the on-deck crew managed to clamber back over the lifelines. The crew belowdeck commented how quickly the vessel came upright. A cockpit locker which was not tied down spewed its contents, fresh fruit, everywhere. The fruit clogged the cockpit drains.

Five minutes after this knockdown, the engine stopped. There was minimal water below, barely over the floorboards, and the crew felt there was a strange calm over them, as they believe they had passed the panic stage. The boom had broken off at the gooseneck and broken in half, the wind instruments had been removed, and all but one winch handle had gone over the side.

The navigator posed the question to the skipper that they should turn back. His response was immediately, yes. They had no lights, no power, and the crew required major first aid with a head injury case.

Approximately one hour after turning around, the on-watch who were still harnessed with shortened tethers heard and saw a massive roller coming through. The helmsman put the helm hard down, swung the boat through some 90 degrees and met the wave about head on. By this stage the vessel was in the white water and, as he described, simply slid down the front of the wave. The boat was then engulfed with white and green water, rolled heavily and came out on the other side.

The weather was just as severe when they turned around, as they felt they were bucking some current off Gabo Island. They headed in a direction that seemed safe—about 000 degrees. By mid-day the breeze was moderating and some hours later swung into the south. The crew put the trysail up and sailed to Eden. It was at this time the crew endeavored to eat. Their fluid intake had been good throughout the ordeal. All crewmembers were wet and cold, the three injured crewmembers were in mild shock and the crew with the head injury was in and out of consciousness, suffering from hypothermia.

Extensive efforts were made to get the engine going, with the odd success, but this never lasted for more than a couple of minutes. On approach to Eden, the police launch offered to tow them in and they accepted.

"Four crewmembers were injured during this second knockdown, one with an injured knee, one a damaged shoulder, and one with a hurt elbow.

"The skipper had severely cut his head on a vein or artery, which was spewing blood everywhere. A pharmacist by trade, he jammed his finger in the hole and wrapped his head in what the crew amusingly says was a sterile tea towel.

"A fire extinguisher came loose, gear bags and loose gear were everywhere, and evidently lasagna was spread all over. Strangely, some items ended up in the bow.

"This technique of meeting the breaking sea head-on saved the *New Horizons* crew from another knockdown or rollover."


Richard Bennett

KINGURRA

Kingurra was designed by the owner/skipper. She was a strong yacht and heavily built with a history of competing in many races that encountered tough weather conditions.

The running conditions were not ideal for *Kingurra* compared to many other boats in the fleet that would be comparatively quicker in the northerly flow. Nonetheless, the crew drove the boat hard, with positive expectations about the southerly front, where they thought they would get strong headwinds that would help them pull back the "competition."

By 2200, *Kingurra* had removed spinnakers and could see lightning across the full southern horizon. With the storm imminent, they checked the boat out for loose items and had storm equipment and lashings ready in the cockpit for when needed. (They were prepared for setting the storm sails, having deployed them in Sydney Harbor with the full crew one hour before the race start.)

By 0700 the breeze was west-southwest at around 25 knots, and by the middle of the day the wind had "settled down" at around 35-40 knots. On board *Kingurra*, the crew assumed that this was all the wind they would get.

The crew also expected that the change would come through as a "Southerly Buster"—fast and furious, rather than the slow build they experienced.

Conditions Prior to the Storm

At the 1400 sched, they heard *Sword of Orion* advise of extreme winds. By their change of watch at 1600 were experiencing winds of 55 plus knots, and only 20 minutes later up to 60 knots. The crew described the boat as "riding beautifully," and felt confident and positive.

By this time, they had removed the mainsail and were under staysail only with the boom lashed to the deck between two winches. There was modest seasickness, but no one was incapacitated and all were standing watches. The engine was started to charge batteries.

The winds remained at 60 plus knots, and only the first storm board was in place. Those below were comfortable, dry and even sleeping. The crew was confident that their storm staysail was the right size. The seas were so large that the crew claim that, in the troughs, there was virtually no wind.

They had been sailing effectively in these conditions for some 2 1/2 hours with the occasional extra-big wave putting some water over the deck. In the daylight these could be seen coming and the call "wave" from the helmsman preceded the boat being hit, giving the crew ample time to hang on.

On *Kingurra* heavy weather technique was to keep the boat sailing into the waves and wind, feathering it a little. This was somewhat more uncomfortable, but provided good control and "left options open." Occasionally they would "flick off" the top of a wave. Their course for racing had become irrelevant, as they were now steering the best course for the seaway.

Man-Overboard Recovery Attempt

In his peripheral vision, the helmsman saw a wave about to strike them on the aft quarter, rather than on the bow quarter where the seas had been coming from. He called "wave" and attempted to bear away, but believes he only altered course some 10 degrees.

The *Kingurra* was hit by the wave and "tossed like a cork," knocked down on its beam ends to about 120-130 degrees, and then righted itself.

The helmsman (Snyder) was washed off the boat to the extent of his harness strop, on the port side with his strop clipped on the starboard across the backstay, effectively shortening the strop.

A second crewman, John Campbell, also clipped to the same point on starboard, was over the starboard side off the boat to the full extent of his strop.

The watch leader on deck called "two men overboard" immediately after the boat righted itself. He observed one man in the water face down, and the other attempting to climb back up, holding onto the pushpit rail. After several attempts, this man realized that he would not get back on board without assistance and decided to wait for help.

Meanwhile, the watch leader attempted to lift an unconscious Campbell on board, but he could not get him over the lifelines. (He noted here that if the lifeline terminals were Vectran cord and not stainless steel fittings he would have cut the terminals.) The harness strop was wrapped around the crewman's neck and the watch leader removed this, though he was still unconscious.

Campbell was wearing thermals and a new wet weather jacket with integrated harness. In the second attempt to lift him on board (still unconscious) the jacket and harness slipped over his head as his arms raised, and he drifted free off the harness/jacket and away from the boat. He was facedown, later to be diagnosed with a fractured jaw and cheek bone after hitting and smashing the binnacle compass.

Within the next couple of minutes, the crew recovered the helmsman from the water, and he was immediately designated the "spotter," to do nothing other than watch Campbell's position in the water. The crew adopted a strategy to keep *Kingurra* as close to Campbell as possible. Despite this, Campbell slowly drifted away from the boat.

They could see John easily at first, and at about 60 to 70 feet (18 to 21m) behind the boat, he put his head up and started waving. Crew grappled with the one remaining life ring—the other had been washed off during the knockdown, but found the cords holding the various attachments had become tangled and would not release. They were cut, but the device was not thrown as John was too far away and it was thought to be prudent to keep it for an opportunity if they got closer.

The skipper, badly injured, made a call advising rescuers that *Kingurra* had a man-overboard situation, but then had to be relieved within minutes. It was now 10-15 minutes after the knockdown, and the EPIRB was deployed.

There was no panic among the crew, as they went about the tasks at hand in workmanlike fashion. With the engine stopped, the realization that the hull was not breached enabled one or two crew to get appropriate clothing to go on deck and to get the injured skipper into a bunk.

In deploying the EPIRB, the retaining line became tangled, and it was dragged back on deck.

"Below deck a loud sudden bang ('like hitting a brick wall') was heard and crew below assumed that they had struck something. The bang turned out to be a mainsheet winch to which the boom was lashed, being ripped out of the deck (1-inch (25.4mm) ply, number-23 winch). Approximately 2 cubic meters of water had entered through the companionway, covered only by one of two storm boards. The skipper was tossed from his bunk, seriously injured and in shock, and another crewman was thrown to the deck."

Aboard *Kingurra:*

With water to their ankles, those below believed the boat was holed. This was reinforced by a spout of water "like a fire hydrant" gushing at the front of the engine. This turned out to be the flywheel on the engine picking up water, but they did not know this at the time. The water flooded the electrics, and ultimately rendered the engine unserviceable. The floorboards were gone, there was debris in the bilge, and the engine covers were dislodged. The crew engaged the engine-operated pump, but the hose was blocked so they reverted to bailing and hand-pumping. In any event, the engine soon stalled.

Chutzpah arrived in the vicinity, having heard the man-overboard call. (*Chutzpah* was only carrying a storm jib with the boom lashed on deck.) They sighted the life ring washed overboard earlier and sailed to it, but could not see Campbell.

At about this time a search-and-rescue chopper arrived and made for *Chutzpah*, assuming it to be *Kingurra*. *Kingurra* assumed that the chopper had not seen them and fired a red hand flare which the chopper saw, then diverted to *Kingurra* immediately.

Kingurra and the chopper communicated by VHF, and the chopper requested information on what Campbell was wearing to help in the search. The "spotter," still able to see Campbell for only two to three seconds each minute, was able to direct the chopper to him. The chopper went first to the dislodged horseshoe buoy. The chopper recovered Campbell within ten minutes and departed.

Kingurra's crew was jubilant, but they realized that they did not know if Campbell was dead or alive. They contacted the chopper again and were again overjoyed when advised that Campbell was okay.

The crew now faced the realization that they must get *Kingurra* to shore, and a discussion ensued on what to do. The GPS was functioning and the boat was sailing satisfactorily under bare poles, with the wind blowing directly from Eden.

They maintained a mostly northerly course overnight, under bare poles, but with barely enough speed to maneuver. By 1500 the next day, they hoisted the main and a number-4 and made a course for Eden, arriving at 0300 hours, never able to re-start the engine. There was no damage to the boat, apart from the winch/deck and wet engine and electronics.

Business Post Naiad

Richard Bennett

The *BPN* crew had sailed together for several years and competed in a large number of Bass Strait Races. They claim to have considerable experience in winds over 40 knots and up to 60 knots. Five of the 1998 Sydney-Hobart Race crew delivered the boat to Sydney.

The crew reported that the yacht had previously been in winds over 60 knots.

Conditions Prior to the Storm

The crew had a conservative start, and set a spinnaker for the run south of Botany Bay. As the day progressed, they set a heavier spinnaker (1.5 ounce) as the wind increased to 20-30 knots.

They continued their conservative approach and removed the spinnaker early, poling out a number-1. This kept the boat going fast, but under good control. They jibed around midnight, as the wind moved to the north and northwest. They could also see lightning ahead and to the west and east of their course.

At about 0400 on December 27th, they removed the number-1 and went to the number-4 and two reefs, setting up the third reeflines in readiness.

They had a strategy of staying in the East Australian Current, and by daylight were slightly wide in the rhumbline in good current on sprung sheets. The crew was in good condition, and while not looking forward to the forecast "blow," knew that their boat was well prepared and that they were experienced in the predicted conditions. Their interpretation of the forecast was that they did not expect the seas they experienced.

At 1100 hours they had 25 plus knots, west-southwest, and could see a cloud bank ahead. By 1300 hours this produced rain and hail, and the wind rapidly increased to 35-40 knots. Within the hour they removed the number-4 and sailed only with the triple-reefed main.

Conditions During the Storm

At around 1530 hours, an "all hands on deck" call was made to take the main off and lash it to the boom as a batten had pulled out the leech of the sail. The winds had increased to 65 knots. They put up the storm jib, and at 1600 hours the wind was still around 65 knots. They could see clear sky to the west and thought these gusts were the worst of the front, and that things would settle down.

The sea, however, was building, although the boat was under good control at 65 knots. By 1650 hours the wind had increased to 75 knots, and between 1700 and 1715 hours, recorded gusts between 80 and 85 knots.

Winds were continuing to build and waves were consistently raking the whole boat. The crew commented that "the jib was in control of us, not us in control of it." Skipper Bruce Guy made the decision to "try it under bare poles".

BPN continued to make 4 knots "about on course" under bare poles, but was continuously washed sideways. Seas were described as big and breaking at the top (40 to 50 feet/12-15m).

"The storm jib came out of the headfoil on three occasions, and was tied to the forestay as a result. The crew had a discussion about the best course of action in the extreme winds. It was reported that skipper Bruce Guy was concerned that the yacht was going too fast, being wiped out by the head and blown away as it crested waves, laying over at 45-50 degrees. Consideration was given to running before the storm, but they were convinced that the yacht would have pitchpoled in the waves. They thought about going to bare poles, but hesitated to remove the jib, as it would be difficult to head up without it."

Rollover

After some 15 to 30 minutes under bare poles, at around 1730 hours, *BPN* came beam-on to the seas and was a little sluggish to steer. A big wave with a big breaking crest slammed into the boat, and started it surfing sideways and rolling through 360 degrees. The yacht flipped quickly, rolled, and was back on its keel in about 10 seconds. *BPN* had been rolled sideways, dropped on its cabinsides and top. The mast was broken, most bulkheads sprung, one window was gone and the rest were cracked. There was a 2-foot (0.6m) fracture across the coachhouse and a hole in the top of the cabin. The sidedecks were cracked and the deck delaminated where the compass had been fixed.

Once righted, the water level inside was still below the floorboards, but the crew was concerned that *BPN* was taking on water, as it was observed streaming from the stern.

The rollover had emptied the contents of the freezer, and this along with much of the crew and boat gear was scattered throughout the boat. There was a smell of diesel fuel and concern that the fuel tank may be contaminated or breached.

The five crew on deck were all washed into the water on the starboard side (with the mast) and were able to scramble back on deck within one to two minutes.

The crew below came on deck to assist in clearing up the rig which was lashed on deck.

Seas continued to grow and the crew reported that it was noticeable that *BPN* was more prone to roll without the mast.

They adopted a two-on-deck system of short watches, as they motored at low revs on course. The propeller was reported by crew below to be cavitating a lot, but this could not be heard on deck.

BPN made a request for a chopper to take off three crew (injured and hypothermic) and for a boat to stand by.

The action of the yacht in the seas caused the crew to become increasingly concerned that BPN would be rolled again. They continued to be tossed by big waves. They had flares out and ready, life jackets on and the life rafts ready at the bottom of the companionway.

"The crew reported no panic, just a calm business-like approach to matters at hand. They were nonetheless anxious. They were also concerned about the cracks in the deck and broken bulkheads: 'The boat was a wreck.'

"They set up a spare VHF aerial and transmitted Maydays on VHF 16 and HF 4483, and activated their EPIRB which they placed in a sheet bag just inside the companionway so it would not be lost.

"After cleaning up the boat, the crew attempted to start the engine, which started on the third try. The GPS was working intermittently and they adopted a strategy of trying to get into the lee of the land, a course of 290-300 degrees. (Although steering this, they reported making north at about 2 knots.) However, as the GPS was intermittent and paper charts were destroyed, it was difficult to plot or know progress. They estimated their position to be about 10 nautical miles SSE of Gabo Island."

Second Roll

At 2255 hours (with two crew, Skeggs and Matthews on deck), *BPN* was rolled for the second time. They were harnessed on the port side with their backs to the weather, one calling out the compass reading to the other. White-out conditions made it impossible to steer the course they wanted, so they steered the safest course up into the waves by feel.

A breaking wave wiped the bow out quickly and bounced the boat sideways some 650 feet (200m). It fell upside-down, right at the end of the impact. The boat was surfing on its roof.

BPN remained inverted for four to five minutes. Within 30 seconds there was more than 3 feet (1m) of water inside. Batteries and electronics were gone and the motor stopped soon after the roll.

The two crew on deck were trapped under the cockpit. Matthews, trapped under the end of the cockpit at the end of his harness tether, became short of breath and was in fear of drowning. He had extreme difficulty unclipping his harness, but eventually did. He was able to pull himself forward and got to the mast (lashed to the deck). As the boat rolled back he was flipped into the cockpit, landing adjacent to his harness tether and re-clipped. He found crewmate Skeggs face-down in the cockpit and determined later that he had died.

Belowdeck, two crew were wearing bushwalking "head" lights (flashlights worn on the head with a headband) so they had plenty of light while inverted. The crew found the rafts and had them ready at the companionway.

When a second big wave rolled *BPN* back up, it was apparent that everything below was "trashed." The EPIRB was still in place but the aerial was broken. Anchor chain, floorboards, crew bags and miscellaneous gear were scattered throughout the boat.

Skipper Guy below deck slipped in the companionway as he prepared to go on deck and assist. The crew reported that he had a massive heart attack at this time, which caused his death.

On deck they were administering CPR to Skeggs, while the crew below were getting a life raft into the cockpit, as they were expecting the boat to sink. The raft was inflated and tethered astern, where it kept flipping over.

At around 0200 hours, the crew noticed that conditions had improved marginally, although seas were still breaking and raking the boat. The crew believed *BPN* was in imminent danger of sinking.

In preparing to put the second life raft on deck in order to be fully prepared, it inflated accidentally halfway through the companionway, creating difficulties. It was eventually brought on deck and tethered on the side. The crew sheltered below deck, leaving Skeggs lashed in the cockpit.

At approximately 0300 hours another big wave struck the boat and carried both rafts away. The crew had "some sleep," then discussed what actions could be taken if no help came i.e., jury rig, etc. They also sensed the weather continuing to improve slightly.

At around 0700 hours, a two-engine plane flew an estimated 3/4-mile ahead of *BPN* and the crew launched a parachute flare and two orange smoke flares. The plane acknowledged the sighting by flying overhead and staying overhead for approximately 15 minutes.

By 0800 hours, a helicopter arrived and the *BPN* crew signalled that they had seven on board who were okay and two who were not. One of the *BPN* crew had search-and-rescue training and, armed with the knowledge of what to do, the helicopter was able to pick up the *BPN* crew within 30 minutes.

A tracking beacon was lashed into *BPN* and the yacht was abandoned, with Guy and Skeggs on board. *BPN* was later found and towed into Eden, and the bodies of Guy and Skeggs were recovered.

"The crew deployed three parachute flares, which was an extremely difficult two-person job due to the grease and diesel that had been distributed throughout the yacht's interior. The storm jib was deployed over the bow as a sea anchor later, to be joined by a spinnaker to improve efficiency. The helm was lashed to keep the bow into the seas.

"The crew bailed water from the boat, but when 'half full' of water it felt less likely to roll again, so they concluded to leave it in this state after several hours of bailing, leaving around 20 inches (0.5m) of water. It was now about 2000 hours on December 27."

LOKI

This was the owner's first race. Preparation for the race commenced immediately after the Hamilton Island Race Week regatta. A consistent crew was maintained throughout the season with no changes from Hamilton to Hobart. The crew was very experienced and selected particularly for the Hobart. Most of the crew had at least one Hobart, with the navigator having experienced several Hobarts.

The storm gear was tried in 35 knots off Sydney Heads following an SOPS Race. Some errors were corrected as a result of this trial. The trysail was hoisted on a separate mast track, which allowed the sail to be hoisted without removing the mainsail.

A great deal of time and care went into specific preparation for the race. Most of the fittings were checked/overhauled. Specific attention was paid belowdecks to stowing gear and securing movable items.

Richard Bennett

A southerly hit approximately 0000-0100 on the first night. The boat was double-reefed when the storm hit. Between 0300 and 0400 the main was torn as the wind increased to 40 knots. They changed to trysail and number-4. This was the configuration at dawn.

Second Front

The wind abated at 0700 on December 27, and the number-4 was changed for a number-3. At 1230, in 40-45 knot winds, they heard the report from *Rager* (wind at 70 plus knots). Note: *Rager* initially gave an incorrect position—subsequently corrected—but may have been confusing to those who did not listen to the entire transmission. They were hit by another front at 1300, with wind at 55 plus knots. There were three crew on deck. In anticipation of this front, the sail had been reduced to a number-4. Sail was further reduced to storm jib and trysail. Note difficulties in extreme conditions when hoisting storm jib due to having to go bare-headed.

Dropped trysail sometime later. Course was 180 degrees with 20-degree leeway. Steering 190-210, was the "safest" and most "comfortable" course. The primary consideration was the safety of the boat and not the course to Hobart. Watch responsibilities were now two helm and one crew (for the watch of three). Helm was on hourly shifts. No major seasickness was encountered. Food was not a key issue.

At this point the boat was comfortable and handling the conditions well. The crew were looking forward to Hobart. Morale was high.

Knockdown

At 1730, on December 28, there was a knockdown by a rogue wave. This occurred toward the end of a helm watch. Fatigue may have been an issue here. Conditions were 60-knot winds, 33-foot (10m) seas. Poor visibility. Rogue wave (significantly larger than ambient waves) broke prior to reaching boat. Trysail was filled, turning the boat beam-on to the wave. The boat was then rolled to an angle approaching 100-140 degrees. Mast was NOT in the water at this point.

Boat then slid down wave face, landing on port side. Port window was breached—reason unknown (suggestion was twist and water force). The window was hardened glass. There were no hard fittings, poles, etc. nearby.

Entire contents of boat moved. These included the floorboards thought previously to be secured. Boat was rolled for 10-15 seconds. It did not go through 360 degrees—180 only. Deck crew were submerged for this duration. Held breath and "hung on." Two eventually floated out on their harnesses (boat still over).

Used manual bilgepump all night. Water ingress had killed electronics. Could not start engine.

After recovery, boat was jibed to recover course. Sailed bare poled (course 045) for approximately 60 minutes while situation was sorted out. Attempted to fix window using cushions, etc. Eventually strapped number-4 genoa (in bag) over opening.

Used a drogue to stop pitchpole, but forgot to deploy chain on drogue. Wanted to continue racing, but felt it unsafe with the open deck window. Could not sail on starboard tack. Made mental decision to retire but did not report it at this time. At 1900 they hoisted trysail. Bad plan, went back to bare poles and drogues.

Originally purchased drogue for emergency steering. Now know that two drogues are required to effect this. Took opportunity to "test" emergency steering. Drogue eventually failed due to swage in ingress ring wearing its way through drogue fabric.

Speed made good on course at this time was recorded at 7.3 knots. Apparent boatspeed was 8 to 10 knots down wave faces and 4 knots elsewhere.

At 1000 December 29, they hoisted trysail followed by storm jib. Had difficulties with lashings for storm jib. The lashings kept flogging out. The sail remained in the aluminum track. It was noted that a plastic hank would not have held the storm jib in.

Sailed through the day with this configuration—comfortably but in the wrong direction. Were hoping that the weather would abate to allow them to continue to Hobart.

The engine was eventually re-started the following morning. Power was always available to the radios and instruments. The water had only killed power to the starter which eventually dried out. Did not miss a sched.

Notes:

1. Harnessing was taken very seriously. One crew (very big) was required to wear two tethers at all times due to his size/weight. The helm was required to wear two tethers. There were "permanently" mounted tethers (two) in the cockpit so that crew clipped in/out when entering/leaving cabin. This eliminated the need for personal tethers and kept the boat tidy.

Richard Bennett

While Hobart may be a hell of a tough place to get to, once you arrive the cruising is spectacular and the people as friendly as any you will find on the planet. And if the trip is a bit of a challenge, (although usually not as tough as what we've been discussing!) the satisfaction of a passage well done is all the more pleasant. This is Port Davey on the southwestern coast of Tasmania.

John Neal

Roaring 40s in normal moderate gale conditions approaching Chile. The wind has been blowing in the high 30s to low 40s for several days and Mahina Tiare II, a 42-foot (12.9m) Halberg Rassey ketch has things well under control. Note the high-clewed storm jib flown on the end of a tack pennant. The main is well reefed down and the wind is just off the quarter. She's about to have a nice ride on the approaching wave crest.

Choosing the Right Tactics

In any given heavy-weather situation, there will be a variety of choices you can make, or not make.

In moderate gales those choices will typically be dictated by comfort and the need to maintain schedule—because there is worse weather on the way or for personal reasons.

As sea state deteriorates, safety becomes a prime concern. Now we are talking about not only the external forces of wind and wave, but also the skill level of the crew and capabilities of the boat.

With this in mind we are going to start this section of the book with a recap of the major factors that influence the heavy weather decision making process. All of these are important, and should be constantly re-evaluated as conditions change.

Understand Your Vessel

For every boat design there is a safe way and a more dangerous way of dealing with the sea. The goal is to reduce the risk of damage from a breaking sea as much as possible.

Equally important is understanding what the boat's likely reaction will be to a changed set of conditions. If the seas build and begin to break from a different direction will you be stable in your present attitude? What happens if there is a frontal passage and the wind and seas shift 90 degrees?

If you are running is there a windspeed beyond which you should heave to, head into the seas, or deploy a drogue? If you are lying to a parachute anchor, will you be all right with another 10 knots of wind?

Until conditions have moderated, the need to keep analyzing the possible changes and the best way to deal with them will remain ongoing.

Watch Weather Trends

A key factor in the tactics you adopt, and direction you head, is what you assume the weather system is going to do. In some cases, where conditions are potentially dangerous or could get that way, the best approach may be to adopt the course which gets you away from the worst of the wind and seas.

The answer may lie in beating to windward—as it did for many of the yachts in the Sydney-Hobart Race just discussed. Or, it may be better to heave to or head away from a developing compression zone as with some of the boats heading to New Zealand in November of 1998.

To make a reasonable stab at understanding the weather you need a good handle on the process of onboard weather forecasting. This can be surprisingly accurate using just wind trends and the barometer.

At the risk of repeating ourselves, one of the keys to this process is keeping a written log of the barometer, cloud development, wind strength, and wind direction. By analyzing this data you will probably know better what is happening than a government forecaster thousands of miles away.

Staying alert:

- Nothing is more important to safe heavy weather sailing than staying alert to the interplay of the various forces at work. This requires that the crew and skipper be as well rested as possible and not hypothermic or dehydrated (both of which contribute to mental lethargy).
- When you are belowdeck the wind noise is less, it is difficult to tell wind direction, and you cannot see the sea state.
- It is important to keep track of these external factors, and how the boat is dealing with them.
- This means a periodic inspection of conditions outside the cabin. It only takes 30 seconds with the companionway hatch open, but someone needs to check outside on a regular basis—preferably every 10 to 15 minutes.

Water Temperature

If you are passaging in areas with large currents or eddies of warmer or cooler water, keep a log of the temperatures. Small changes, sometimes as little as 3 or 4 degrees Fahrenheit (1 or 2 degrees Celsius), can have a major impact on the development of the weather around you.

Frontal Passages

When you are dealing with an extratropical depression and its associated front, there will be a major wind shift accompanying the passage from warm to cold sectors. The wind will probably increase for a while, and then die off, rapidly or gradually.

If the sea state is not threatening, the frontal passage is simply a sign that it's time to get some more sail on the boat and resume your course.

But if you are dealing with breaking waves, the passage of the front may bring on the most dangerous phase of the storm, where you now have to deal with crossing seas.

In this situation passive tactics—such as being hove to or lying to a sea anchor—may have to be changed to those which are more active, so you can maintain better wave alignment.

When the Wind Drops

Equally important is that point when the wind starts to drop. If the drop-off is gradual in nature, the waves will slowly reduce their size.

However, if the wind drops rapidly, as sometimes happens, the waves can become unstable and break just when you are heaving a sigh of relief.

Stay in tune with the wind strength, and then get the boat underway as soon as it begins to fall off (with either sails or engine) until the sea state has stabilized.

Changing Sea State

Obviously it is breaking seas which create the problems. And in most cases these will not be an issue. However, there are many factors which can change a benign sea condition to one which is threatening.

Current or tide running against the seas (as opposed to with them) is one factor. Another is bottom shoaling or undersea mounts and plateaus. We've already discussed rapid changes in wind strength and wind shifts.

You may find that the wind conditions are steady, but a crossing swell from a distant storm moves into your area. This may create an occasional breaking crest where you would not otherwise expect one.

Any of these factors, if they come into play, will require you to re-think your approach to heavy weather tactics.

Correct Tack

The wind frequently blows at a 15- to 20-degree angle to the primary sea. This means on one tack your bow or stern will be more aligned with the waves than on the other. Throughout the rest of this section on tactics and the following section on drogues and sea anchors, you will find numerous drawings, photos, and descriptions of picking the correct tack. Some of these take a little studying. However, if there is any single issue that most impacts your safety in severe weather, being on the correct tack to minimize wave risk is probably it.

Once again, you need to be alert to the changing conditions and adapt as required.

The Right Boatspeed

After all other factors are considered, we come down to one overriding question—what is the correct boatspeed for a given situation?

This is a function of wave shape and direction, and the speed necessary to control your boat.

In any given situation there is a speed which is too slow, without enough flow over the rudder to give you good control and maneuverability, and a speed which is too fast, beyond where you cannot control the boat.

The factors affecting this speed will be discussed in more detail in the section on heavy-weather design factors (starting on page 608). For now, we want you to understand that for every boat, in every situation, ideal speed will be different.

To have the safest and most comfortable passage, you will need to know this optimal speed. If you don't have data from past experience, it can best be gained by experimenting.

Remember the key factor is having enough speed so there is good control, but not so much that the boat can't be steered.

Knockdowns

Knockdowns, when the boat is heeled well past normal, are not a major problem on a well-prepared boat. You'll heel to 50 or 60 degrees, the heel angle will relieve wind pressure while stability of the keel exerts maximum force, and the boat will come back upright.

A knockdown can be caused by too much sail, a wave slap, or a combination of the two.

If your lockers stay shut and gear on shelves throughout the boat stays put, you'll reduce sail and be back on your way in no time.

Capsize

When the boat is sitting in the trough of a wave or riding up the crest, the fact that the wave is moving—as long as it is not breaking—has little effect on the boat. Because of the orbital motion of the wave particles, the boat sees little motion relative to the waves, even if the waves are moving at 25 or 30 knots.

With a breaking crest, on the other hand, you have wave energy, which has been released from the orbital path of the nonbreaking particles. These breaking crests have a speed similar to the wave.

Any object in the path of the crest is going to feel the dynamic impact of the falling water molecules, unlike the situation when you are rising and falling in orbital wave motion.

Whereas a nonbreaking wave has little impact, a breaking wave crest contains enormous energy, which can rapidly accelerate the boat into a knockdown, rollover, or pitchpole—or just toss the boat down into a trough.

Breaking waves can take many forms. Wave height and speed differ for each storm, as do the results of the combining wave and swell trains. What we are concerned with here is the front face of the wave and the momentum of the water in the breaking crest.

When the boat is beam to the seas, it has the least capsize resistance, which is why picking a tactic that prevents this possibility is so important. In this image, the boat in the foreground (lower) is about to be caught by a crest. When this occurs (top boat) a knockdown or inversion is likely to occur, unless the boat skids off to leeward with the crest, or has the inherent stability to resist the rolling motion imparted by the wave.

The steeper the face and the faster the downhill momentum, the more difficult the wave is to handle.

The force impacting the boat is a function of the weight of the water multiplied by its velocity squared. The impact energy escalates rapidly with wave speed—so faster moving seas, those with *longer* wave periods, are more dangerous.

If you study the photographs throughout this book of large ocean waves, many of which are breaking, you will see a marked difference between these shapes and what you find in a surf break at the beach.

This difference is the result of the differing mechanics that create the open ocean breaks as opposed to those found onshore.

As we said earlier, it is the wave feeling the bottom, slowing down from friction, and then converting its energy from speed into height, which causes the shore break.

This difference in shape—the overhanging circular shape of the beach versus the cascading breaking crest-creates the foundation for all approaches to storm tactics.

In offshore breaking wave situations, the size and shape of the breaker, the boat's attitude toward the crest, and the design characteristics of the boat determine if the boat will be capsized or simply knocked around a bit.

The worst-case scenario is to have the wave catch you at an angle in anything from 40 degrees to abeam, the boat has the least resistance to the wave's capsizing forces.

Contrast this to the situation when the boat is end-on to the wave, either bow or stern into the seas. In this case you have the full longitudinal stability of the boat resisting the crest.

The entire subject of storm tactics is simply an effort to find the safest attitude of the boat to the waves, and in this context, proper alignment is by far the most important ingredient.

Here's the opposite approach—keeping the boat aligned with the waves in a position of maximum stability relative to the direction of wave travel. In this scenario the boat in the foreground (bottom) is slapped by a small crest on the windward quarter. The boat begins to round up (middle position) and does not have time to fully straighten itself out before the large crest in the background catches it. This may result in a knockdown, but the odds of avoiding a rollover are much better than if the boat were beam to the seas.

John Neal

Heaving to is most often used to stop when you cannot make it into an unfamiliar anchorage with good visibility. In lighter winds, as in this photo, it is often possible to find equilibrium with just the jib set. However, the angle to the wind and waves will have to be narrower with breaking waves.

HEAVING TO

When the time comes to take a rest or just hold station, you'll want to consider heaving to. If you do so properly, your vessel will lie quietly with her head 40 to 50 degrees off the wind, rising and falling rhythmically as seas sweep under the hull. Drift, both forward and to leeward, will be minimal. If the seas are on the steep side, the slick that develops to windward of the hull can, under some circumstances, reduce the chances of waves breaking on board—although the presence of slick and its affect are much debated.

Heaving to is a useful technique when an approaching low and its associated cold front turn your passage into a beat. If you heave to and wait until the front has passed, you will have a substantial windshift that may change your beat to a reach.

If you need to delay your arrival at a new port because of poor visibility or low tide, it will probably be more comfortable to heave to than to slow down so much that you haven't enough speed to keep motion reasonable. Over the years, we have hove to frequently for dinner, a hot shower, or a good night's sleep when conditions were a bit bouncy. We have also hove to while undertaking difficult maintenance chores.

In heavy weather, heaving to can be a useful means of holding station while giving up a minimum amount of room to leeward. If you are beating or reaching and the wind and sea are making life difficult, you'll notice an amazing difference in motion when you stop forward progress.

Heaving to is also useful in advance of a storm you know you can't avoid. It will give you a chance to check your gear, to rig storm canvas, and most importantly, get a good rest.

Monitor approaching weather:

- ❑ Pay close attention to the storm's likely path if you are contemplating heaving to because of deteriorating weather.
- ❑ Maintaining speed may get you clear more quickly than staying in one place.
- ❑ In some cases moving on, and taking a temporary pounding in the process, may be the most conservative approach if it allows you to put distance on the dangerous area of the storm.

There are as many ways to balance a boat when hove to as there are yacht designs and sea conditions. What ultimately works for you will be best found by experimenting in different conditions. Often the main will need to be eased off a bit as shown here when it is used against a staysail or storm jib.

Balancing Hull and Rig

There are an infinite variety of ways to heave to. As sea and wind change, you'll have to modify the particular combination that is working now. This will take some experimentation, best carried out first in moderate conditions.

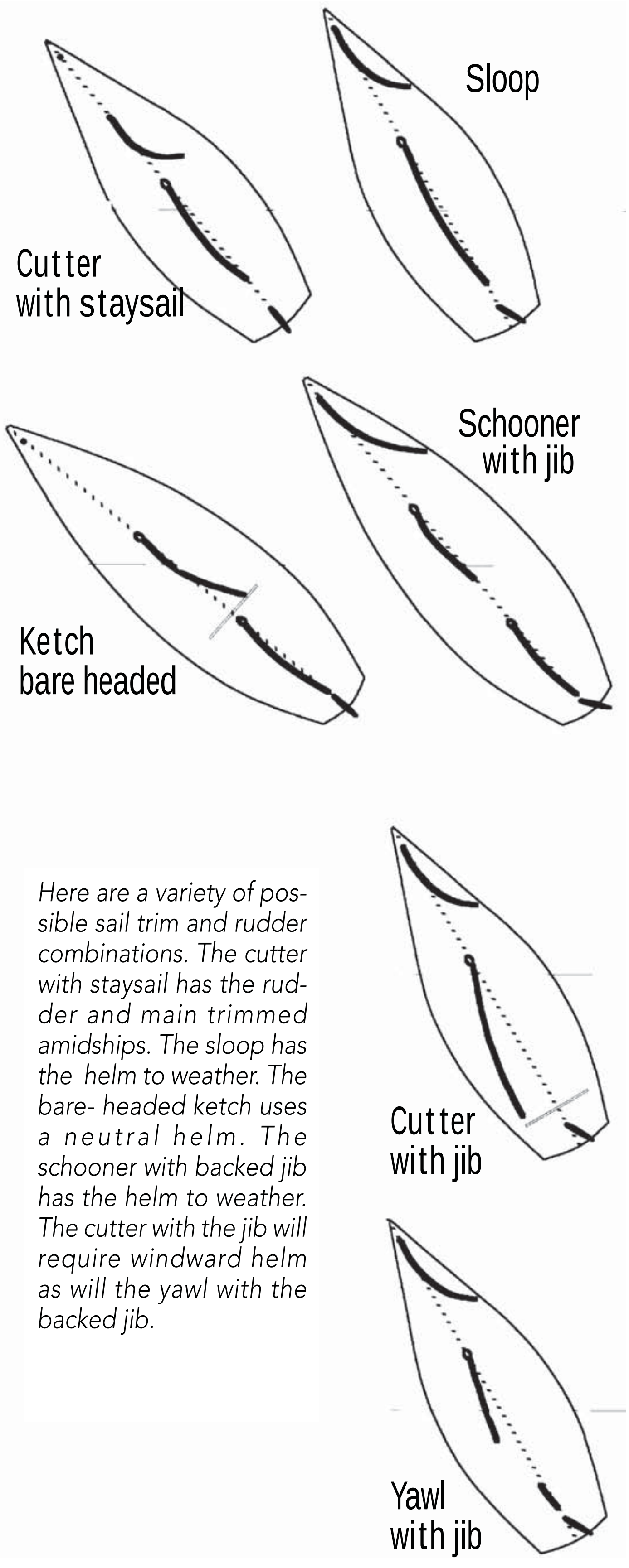
Reduced to the simplest components, heaving to is maintaining a balance among the forces generated by the sail plan, rudder, and wind.

By moving the balance or center of effort in the rig aft, reducing speed, and putting the helm over so the bow wants to head up, you effectively stop the boat.

The rudder is fighting the sail plan between the two and a form of equilibrium is reached.

If you are considering heaving to for more than a short period, you'll need to weigh several factors regarding navigation.

- ❑ If there is any current about, you will want to be relatively certain of the direction the current is traveling and know about any dangers that may exist in that direction.
- ❑ Remember, current will have more relative impact on your drift when you are moving slowly or not at all than when you are moving fast.
- ❑ Be certain to maintain a good watch if land or reefs are nearby. Even if you think you have enough offing, check the horizon periodically. Your last fix may not have been accurate, or your drift may be quicker than you think
- ❑ Because your electronics may quit when you least expect it, keep a plot on a paper chart.



Here are a variety of possible sail trim and rudder combinations. The cutter with staysail has the rudder and main trimmed amidships. The sloop has the helm to weather. The bare- headed ketch uses a neutral helm. The schooner with backed jib has the helm to weather. The cutter with the jib will require windward helm as will the yawl with the backed jib.

As you move the center of effort aft in any of these sail plans, so that the boat naturally wants to head more into the wind, the rudder will have to be eased toward neutral or even to leeward in some cases. Conversely, if the center of effort is moved forward, the helm will have to be trimmed more to windward.

Getting the balance right means the boat will not go through the eye of the wind, nor lie too far off the wind.

Hull shape, displacement, keel and rudder configuration, as well as the sail plan all have an impact on finding the right sail and rudder combination.

You may hear that modern fin-keel yachts will not heave to. This is not the case at all, as we know from much personal experience. But they do require different tactics and in heavy weather may give up more ground to leeward than heavier, longer keeled designs.

Proper Angle

If the seas are not breaking, the angle at which you end up lying to the waves is not critical. The main issues will be comfort and not giving up ground to leeward.

In breaking seas, you'll want to have the bow as close to the seas as possible.

Keep in mind that one tack usually keeps you closer to the wave angle than the other.

With a frontal passage, there will also be one tack favored over the other.

When the boat is properly situated, you will find it tends to oscillate back and forth within a certain range of angles. This oscillation is a function of the balance of sails and helm, wind strength, and seas knocking the hull one way and then another.

As wind and sea conditions change, you may have to adjust the amount of sail deployed and the rudder angle.

Leaving aside for the moment the concept of a slick to windward, the best angle in heavier weather is the closest angle to the seas. Some boats, especially those with sail area aft, will lie as close as 30 degrees to the wind, with oscillations down to 50 degrees.

Others may find a groove between 40 and 60 degrees.

Being Caught Aback

If your bow is too close to the wave angle and there is an oscillation in wind direction, or the sails and fins get out of balance, you may suddenly find yourself on the other tack.

This is not a problem in moderate conditions, but in breaking seas could quickly put you beam-on, a most dangerous situation.

A wave slap on one end of the boat or another (typically the stern) from a crossing sea can cause the same problem.

When these risks exist, heaving to must be set at a wider angle to the winds and waves, to have some margin for error.

Being caught aback when hove to is usually precipitated by a wave slap, typically on the stern quarter, where the boat tacks through the eye of the wind and then reaches off beam to the sea. This is only a problem if there are breaking seas and you become vulnerable beam-on. If this appears to be a risk, adjust your heading while hove to an angle further off the wind.

Picking the right spot to turn into the wind and heave to if you are running in strong conditions is a matter of patience. Watch the pattern the waves make. Periodically there will be a time when the sea calms down for a set or two of waves. When this occurs begin the turn into the wind on the back of a crest which is just passing under you. This gives you maximum time and distance in which to complete the turn and face into the next waves. Leave the jib on the weather side and trim the main as you feather up. Remember that the apparent wind is going to be much stronger heading up, so it may be prudent to reduce sail area before you make the turn—perhaps dousing the forward jib in the lee of the mainsail and then hoisting a storm jib or staysail on the inner stay will make the most sense.

If You've Been Running Off

If you've been running off, the conditions are getting marginal, and you want to heave to, carefully pick the moment to turn into the wind.

This is best accomplished by studying the wave and wind patterns. Look for a calm spot between seas to make your turn. If you watch carefully, you can usually find a relatively smooth spot coinciding with a lull in the wind.

Sail Plan

Having the right-sized sails for the wind strength is critical. In light to medium winds, single-stickers can make do with a full or reefed mainsail. In general, when wind forces increase, sail area has to be reduced proportionately, so that in heavy air you may be down to only a storm trysail or a trysail in combination with a storm jib set on a staysail stay.

Generally speaking, the center of effort in the rig should be moved aft. With split rigs—ketches, yawls, and schooners—this is easily accomplished as there is sail area on the stern to begin with.

Cutters, with the mainmast close to the center of the boat, also do well in moving the center of effort aft.

With these types of rigs it is often possible to get the boat to lie quietly hove to without a headsail. The aft sail area tries to head the boat into the wind, and the helm is put to leeward to counter this tendency.

There will be occasions when wind, sea state or balance require that a small amount of headsail be set with these rigs.

With the headsail backed you may be able to leave the helm in neutral, or a slight amount to windward or leeward may be required.

Sloops have a slightly more difficult time heaving to because of their large mainsails, and the fact that when these are reefed their center of effort moves forward. You may find that using the mainsail alone works best. Sometimes the traveler will have to be let down, or the sail sheeted in a reaching position, with the helm put up into the wind. The jib can be backed against the main, but will have to be very small in area.

If you find that your single-stick rig is difficult to heave to, the use of a backstaysail (riding sail) will often provide the sail area aft to balance out the mainsail.

If you are using a headsail while hove to for long periods of time it will be necessary to insure that the sail does not overlap any shrouds, or chafe will be a problem. Likewise, sheets should be lead inboard of the cap shrouds, so they do not bear and chafe on the shrouds (typically you can find a fair lead between the cap and lower shroud).

On *Intermezzo*, with her ketch rig, we often employed just the mizzen to hold us in position, although we found that as the wind increased we had to add a small headsail to balance it. In moderate-force winds a staysail with reefed main usually worked well. Both *Sundeer* and *Beowulf* hove to nicely with just mizzen (these sails were quite large). *Intermezzo II*'s cutter rig required that we use a staysail backed against some degree of mainsail.

Practicing

The easiest way to try heaving to initially is a simple tack, leaving the jib sheet cleated. As you come about with full main and jib backed, the bow will swing off the wind.

On many yachts you will find the bow down at 60 or more degrees. Next try bringing the helm to windward and see if that brings you closer to the wind.

If it doesn't do the job properly, this is a sign you need to reduce forward sail area.

Reduce the size of the headsail until the boat is lying at a closer angle to the wind—at a maximum of 40 to 60 degrees.

If the boat will not lie this close with a headsail, try heaving to bare headed, with just some mainsail or mizzen set.

On the other hand, if the boat heads too close to the wind and wants to tack, you will need to reduce sail area in the main or mizzen, or increase the sail area forward.

If your boat wants to round up, and won't stay quietly to leeward, try easing out the main boom.

Sometimes a backed headsail, working against a well eased main boom is all that is required for otherwise recalcitrant sloops.

Once you have a system established for this in light to moderate conditions, you can interpolate what refinements are required as the wind and seas increase. With a little practice you will quickly find the right combination of sails and helm to use as a starting point. It helps to make a log entry with this data, to which you can refer in the future.

John Neal

In lighter wind ranges you can adjust the roller-furling jib to optimize balance. However, once the wind is up to gale force it is usually best to set the proper size sail, preferably on a cutter stay.

When Do You Heave To?

If you use heaving to as a storm tactic, rather than to slow down or increase comfort level, you will have been sailing for some time prior in building winds.

If you are making good progress towards your destination, you might be reluctant to stop. This is especially true if you are broad reaching or running where wind and wave forces seem reduced by the drop in apparent speed.

Of course, the moment you head up into the wind, apparent wind and wave speeds escalate—and what was a boisterous sail downhill suddenly can look a lot more intimidating.

If the boat and crew are up to the steering requirements and the boat can be positioned properly in relation to waves, the best thing is probably to continue on course.

But if the boat is becoming hard to control, and shows a tendency to broach and/or round up, it may be time to pick that calm spot we discussed earlier, and heave to.

The less experience you have in heaving to, the earlier this should be done, before wind and sea state increase too much.

Getting turned around and stopped earlier, rather than later, allows you to sort out the proper balance of sails, helm, wind, and wave. Once the boat has settled down, you can study her reaction to the conditions and make a baseline in your mind against which any changes in the future can be measured.

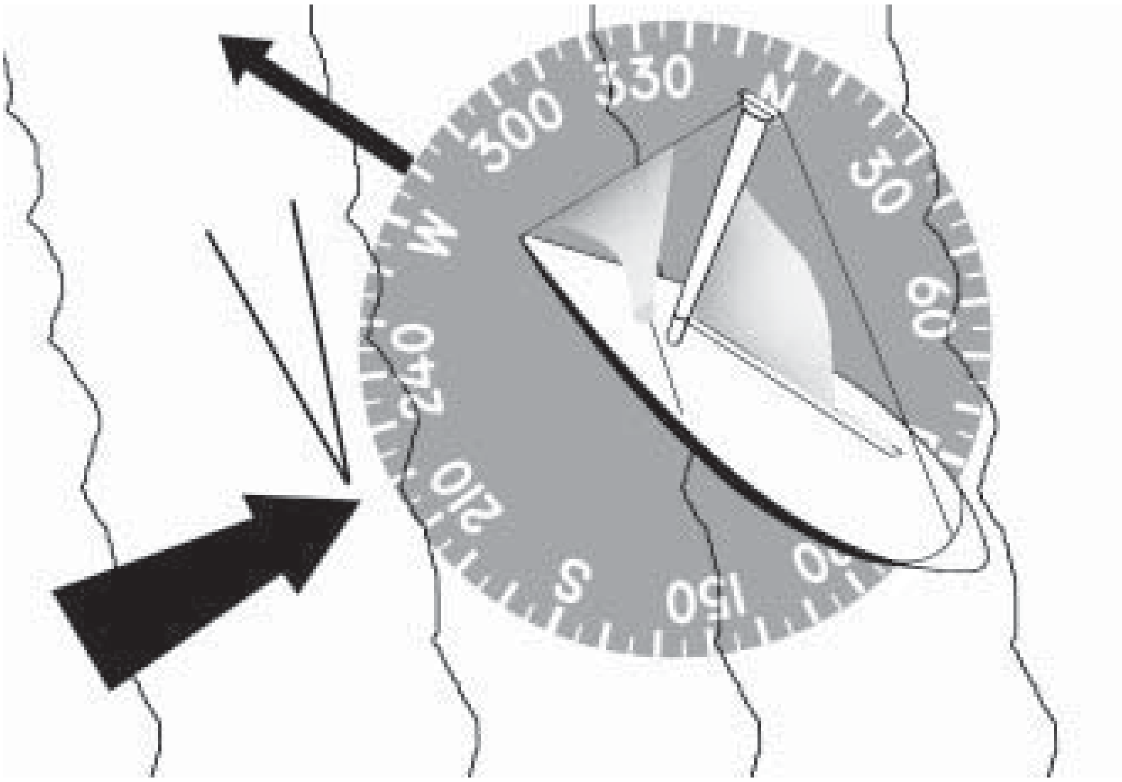
Checklist for heaving to if the bow falls off:

- ❑ Reduce sail area forward.
- ❑ Add sail area aft.
- ❑ Increase windward helm pressure.

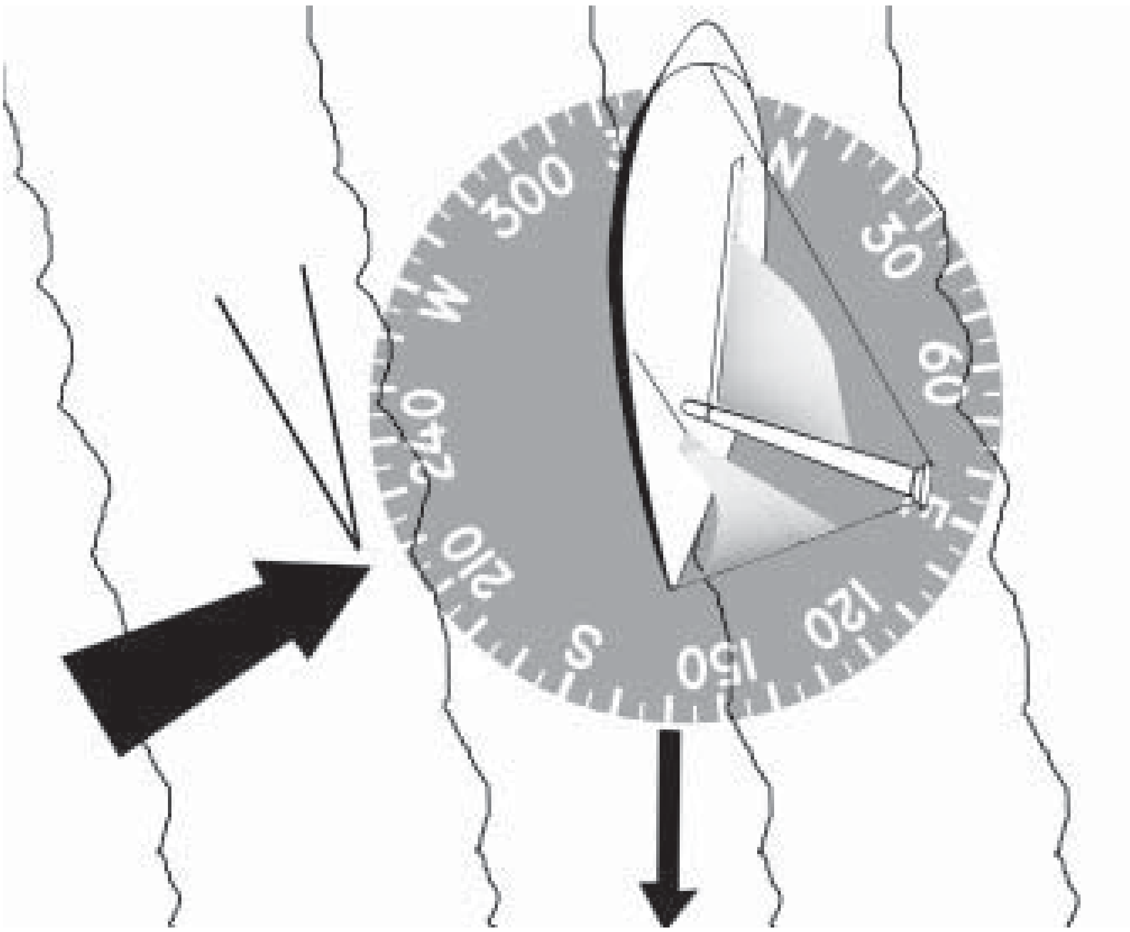
If the bow heads up:

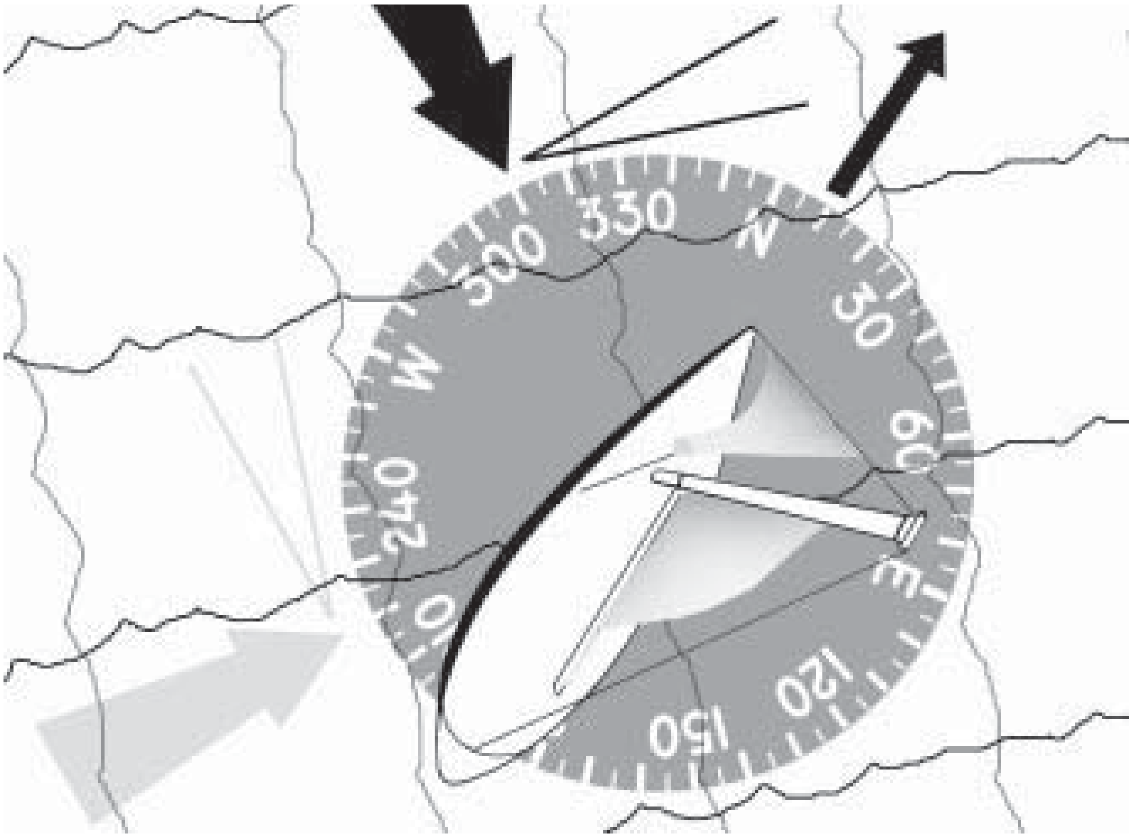
- ❑ Add sail area forward.
- ❑ Reduce sail area aft.
- ❑ Increase leeward helm.

If you have laminated sailcloth you will need to keep it off of shrouds and mast when hove to—or change sails as laminated sailcloth breaks down quickly when sails chafe.

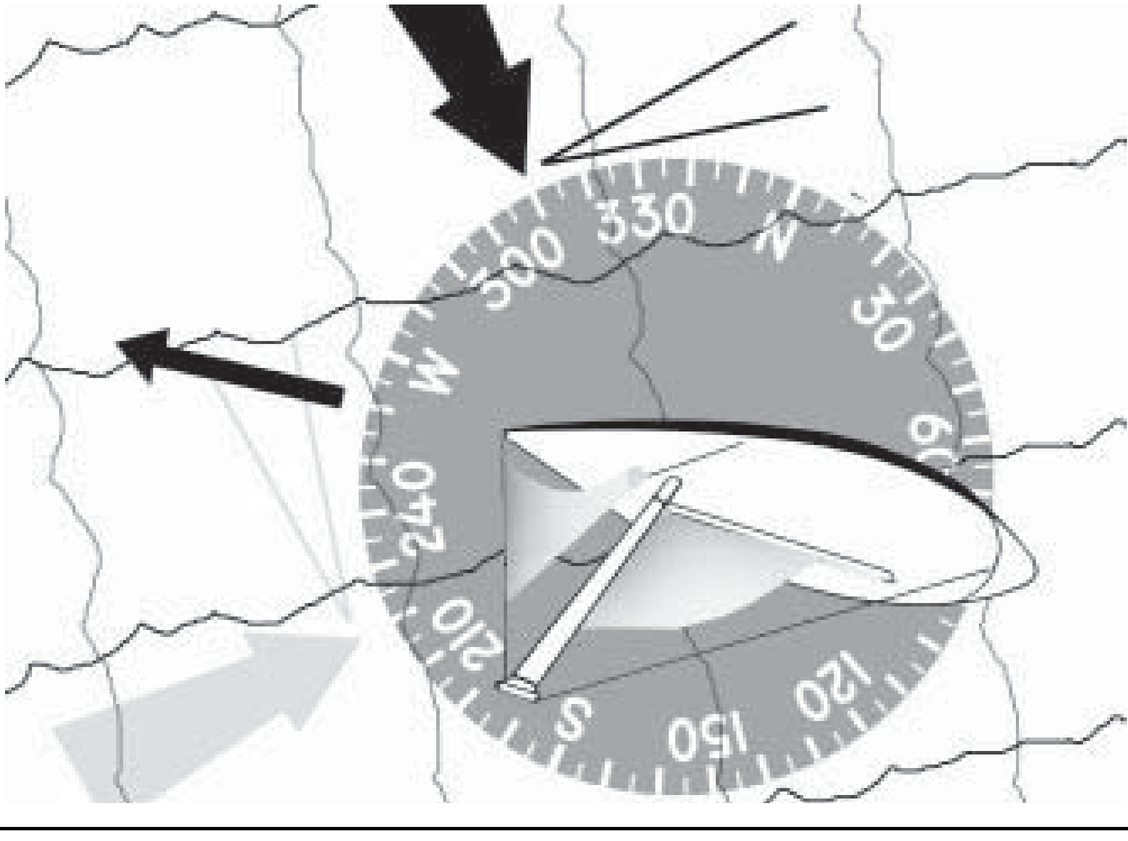


If the seas are not breaking, you can heave to on either tack. If there are no navigational or weather constraints, the tack with the seas most on the beam (below) will be the most comfortable. However, when the seas begin to break, you want the bow as close to the oncoming waves as possible (above). In both of these drawings the wind and seas are the same. The wind is from 220 degrees and the seas are veered about 20 degrees in a clockwise direction. Both tacks have the boats sitting 60 degrees off the wind. Notice the extreme difference in the angle to the waves. Above the waves are at a 40-degree angle. Below they are at an 80-degree angle.





After a frontal passage things get a little more complicated. Both of these drawings have the wind veered to the northwest (310 degrees), as is common in the Northern Hemisphere after the passage of a cold front. There are now two sets of waves to deal with—the new north-west-wind waves and the older waves and swell from the southwest wind. The waves are still veered 20 degrees or so from the wind angle. On port tack (above) the northwest wind waves are okay with the bow but the older southwest waves are now on the stern quarter. Combinations of the two wave systems will be on the beam. This is a decidedly risky tack. On starboard (below), the boat is splitting the difference between the wave sets, with combination waves right on the bow.



Most vessels could not heave to safely in these conditions. It is blowing 60 to 70 knots, gusting higher in squalls. Seas are running an easy 30 feet (9m), up to the occasional 50-foot (15m) wave.

The heavy-displacement, full-keel boat in the foreground might create a slick to windward if handled correctly. This slick off the keel theoretically calms the breaking waves. As you can see in this image, there are crests breaking off the bow and stern, but not amidships.

Very few (if any) modern yachts create a slick—or enough of one to be valuable in these conditions. If you cannot run, and don't have the crew to steer actively, heaving to and allowing the boat to slowly fore-reach sometimes makes sense. With the boat moving through the water, a moderate amount of dynamic stability is added. The boat can therefore sometimes move itself out of the way of a crest, before the crest breaks as shown with the upper boat.

Note how the boat is hit by the crest in the middle of its passage across the page. The wave knocks the boat 15 or 20 degrees off course, but then the rig brings her quickly back onto a closer heading to wind and waves.

When the seas start to break, it is critical to heave to on the tack which keeps your bow pointed closest to the most dangerous waves.

In the image above, the boat at bottom left is on starboard tack. Because the wind is backed 15 to 20 degrees to most of the seas, this tack has them almost abeam of the crests—a very dangerous position.

Contrast this angle to the upper boat in the same image, which is hove to on port tack. They have their bow almost directly into the waves, a much safer attitude.

The problem with a passive tactic like heaving to is that you lack the option of working around the dangerous waves. If you're at the wrong place at the wrong time, the odds of getting knocked down increase with any form of passivity. Look at the photo alongside (bottom left). This is a breaking wave under the black arrow in the top image. You could dodge this if you were steering.

Lady Be Good in more moderate conditions in the Mediterranean.

Lady Be Good

Mark Hoffman has been cruising in the Mediterranean aboard his 53-foot (16.25m) steel Van De Stadt ketch, *Lady Be Good*. She is a late-1970s design, with fin keel and skeg-mounted rudder, displacing 24 tons.

Mark and his crew of three went through a moderate gale in April of 1998 in the Tyrrhenian Sea between Sardinia, Sicily, and mainland Italy. His comments follow:

As anyone who has spent time in the Mediterranean can attest, the winds come up quickly, often unforecast, and create a sea that is short, steep, and uncomfortable. It's often necessary to slow down and hold station due to difficult landfalls, or just to ease the load on boat and crew.

Southwest wind 36-47 knots with higher gusts. We were on a passage from Elba, Italy, to Athens, Greece. Wind rose from 15 knots to gale-force fairly quickly, raising a typical short, nasty slab-sided Mediterranean gale sea. Every other one seemed to be breaking.

No warning from weatherfax or Italian voice forecast. The period between seas was very short. Both crew seasick but functional. They thought they had everything under control so didn't call me soon enough. Woke to overpowered condition.

Used engine at low revs to hold bow at slight angle to waves while crew secured main, dropped working jib and mizzen and readied storm trysail. Trysail was already hanked on to its own separate track and ready to go.

The hardest part was freeing the main halyard from the mainsail headboard and transferring to the trysail. Crew valiantly managed to get this done between bouts of vomiting. The head of the mainsail being out of reach meant one of the crew had to stand astride the mast at boom level as the yacht was rolling and pitching wildly. (Next time will have the main halyard off way before conditions get that serious.)

Raised trysail, sheeted in tight, and experimented with rudder position to get best hove to position. Found about 10 degrees of leeward rudder would hold the yacht about 40-45 degrees off the wind. There was a good slick to windward from the stalled keel and we began to drift slowly northeast towards Sardinia.

Had plenty of searoom so not too worried. Stayed hove to for about six hours until wind moderated. Vessel motion was very comfortable. Used lock function on hydraulic steering system to keep rudder angle constant. Next time will try using just reefed mizzen for heaving to. Used radar alarm function for traffic, and GPS chartplotter to track our drift.

Heavy Air Beating

Beating to windward, whether in protected waters or offshore fighting big seas, requires the maximum in boat efficiency and crew skills.

Small differences in vessel preparation, helming, sailing angles, and sheet positions can pay huge dividends.

Knowing how to make the best of the wind and sea when going upwind, will not only shorten an otherwise uncomfortable passage, but may have substantial safety benefits as well in extreme conditions.

In this chapter, we'll be discussing the various factors upon which you can work to improve your weatherliness, and how to pick the best course. We'll then go into the art of motorsailing to weather, an approach which may just provide the ultimate storm tactic in many situations.

But first, join us back aboard *Intermezzo*, while we finish our last leg across the Indian Ocean, from Mauritius to Durban, South Africa.

There are some weather scenarios in which beating provides the quickest relief from an oncoming storm system—if you are caught in the dangerous quadrant of a tropical storm, for example. You may be set down on a lee shore, and need room to weather to make it past a headland.

There are also extreme heavy-weather situations where beating may be the safest tactic. We've already seen a good example of this in the 1998 Sydney - Hobart race with *Bin Rouge*.

Mauritius to Durban

This 1,500-mile passage is probably one of the most difficult in an entire circumnavigation. Everybody gets hammered. You prepare for it the best you can, and then make the fastest trip possible.

Our passage began in the trade wind regions—Mauritius lies at the edge of the tropics. For the first few days we enjoyed typical tradewind sailing, albeit somewhat lighter than we'd experienced for most of the Indian Ocean. By the fourth day, as our latitude dropped, it began to turn chilly, and the trades gave way to variables.

We worked *Intermezzo* through every wind shift, keeping her moving as fast as possible. Up with the drifter, then back to twin headsails in the fresh breezes. When the wind was lighter and aft we'd fly the spinnaker and even mizzen staysail. We wanted this passage over as quickly as possible.

Southwesterly Gale

Early afternoon and the wind suddenly switches from northeast to south and then southwest, with virtually no change in the barometer. We shorten down to reefed main, staysail, and number-4 jib in the rising winds, expecting our first gale. However, the breeze tops out at 18 knots, and then backs off to 12 knots within a few hours—false alarm.

By the next morning the wind is in the northeast, blowing a steady 18 to 20 knots. We are back to drifter to leeward, jib on the pole, and full mainsail.

The fair winds continue and we make excellent time averaging close to 180 miles per day.

Two days later with the barometer slowly dropping from 30.21 to 30.09 the wind continues to be out of the northeast. However, sheet lightning to our south and the lower barometer indicate that we're in for a change in weather. The drifter is stowed, and we tuck a reef in the mainsail, leaving the number- 4 jib on the pole.

We give *Intermezzo* our usual daily inspection, tighten the lashings on the hard dinghy and life raft, and check out the rig. At the upper end of the port aft lower shroud on the main mast three broken wires are exposed at the swage terminal. These are replaced with some difficulty as the clevis pin has frozen in place, and it must be sawed in two for removal.

South African passage issues:

- ❏ You have to time seasons right. Leaving too late in the year, you are potentially exposed to the most vigorous cyclone area on the planet.
- ❏ Departing early, the equinoctial gales are a problem.
- ❏ Heading west puts you on a collision course with the weather systems as they sweep up from the Southern Ocean.
- ❏ The most direct course passes under the island of Madagascar, crossing shallow banks. If caught there during a blow, the odds of escaping breaking seas are not great. So you must dip south a couple hundred miles from the rhumbline.
- ❏ As you close with the South African coast, you face the south-flowing Aghulas current. Not only does this stack up the prevailing southerly-quadrant seas, but the warmth of the Aghulas provides extra power for depressions crossing its boundaries.

By the time the stay is back in place a line of frontal clouds is clear on the southern horizon. The gale hits in textbook fashion for this part of the world. One minute we're broad reaching in 25 knots of northeasterly breeze, then it is calm for a few minutes, and then wham, 30 knots from the southwest.

Within 30 minutes, it's blowing a steady 40, gusting higher.

We drop the number-4 jib and go to the heavy staysail, leaving the mainsail single reefed.

The sea state is confused, to say the least. With new southwesterly wind waves colliding with the northeasterly swell, *Intermezzo* is having a difficult time picking her way through the slop.

Our powerful Aries windvane is doing its usual excellent job of keeping us on course. The problem is picking the right course to be on through the chaotic sea state.

We try keeping the boat at speed, with the apparent wind at 50 to 60 degrees. She shoulders her way through the seas, throwing huge amounts of water around, more than a little of which finds its way below.

We then head up a few clicks on the Aries, so that apparent wind is at 25 to 30 degrees. Speed is down to 3 knots or so, and the waves are twisting us this way and that, but the boat is riding more comfortably.

The only problem with this strategy is the mainsail leech luffing violently. We worry it will damage itself, but think the gale will quickly ease off and the wind will free up for some reaching.

By 1635 the wind continues to blow a fresh gale, still on the nose and we're thinking about another reef. Just as we're getting into our foul weather gear and harnesses the main begins to tear—a repair made a few weeks previous has given out—and by the time the sail is secured, it has flogged itself to rags.

We hoist the mizzen and continue on under jib-and-jigger rig, making a respectable (and now quiet) 4 knots on course. The boat is standing up better than she was with the mainsail, and picks her way nicely through the seas. The rig has just the right amount of drive in it, coupled with a lower center of effort, so we have the power to push through the confused seas.

By early evening the breeze backs off, and we're faced with working the boat in light winds without our mainsail.

In the next couple of days the cycle of quick moving southwesterly gale repeats itself twice. We get used to the signs, and stow the big jib before the onset of the wind. Shortening down to heavy staysail and mizzen continues to work well for us.

In the Aghulas Current

By the evening of our ninth day at sea, the signs are in place for another gale. We are running hard before 30 knots of north wind, but the barometer has been dropping and the sky is black to the south. The wind drops, then suddenly shifts to the southwest and comes back at 35 to 40 knots. We tack from starboard to port, and harden up on the wind.

The sea state is far more confused than in the past. We've been in the Aghulas current now for half a day or so and when the northeast swells were predominant, it smoothed them out nicely.

Now the current is fighting the waves, which are extremely steep. Every second or third wave is breaking on top, and about once an hour a large crest catches us and breaks over the boat.

Throughout the evening and morning hours, the barometer rises while the wind stays steady in direction at gale strength. This indicates we're caught in a compression zone between high and low. It'll be interesting to see how long this lasts.

Driving slowly to windward, pointing as high into the wind and waves as we can while still maintaining steering control, *Intermezzo* shoulders her way through the breaking crests. She slows momentarily then, as she heads down the back side of the waves, accelerates again.

A shuddering crash announces another breaking sea. *Intermezzo* slows, heels further, and begins to free herself of the accumulating water on the side deck.

Linda, Elyse, and Sarah remain in pilot berths, secured by extra-high leeboards, while I peer out of inch-thick (25mm) doghouse windows at the huge seas marching endlessly across the horizon.

There's no sign of clearing in the sky to windward. Every few minutes another sea catches us at the wrong attitude and rumbles aboard. The preparations made before crossing the Indian Ocean are now paying dividends. The anchors, dive gear, and outboards moved from the deck to our bilges help stability and make it possible for our little ship to make forward progress while friends in this same blow are fleeing to leeward in their yachts.

Linda stirs in her bunk. She lifts the night shades from her eyes and sends me a questioning look. I sigh, shrug my shoulders and tell her the barometer is holding steady with no sign of imminent change for the better. Pretoria radio has not dignified our storm with so much as a comment in the most recent forecast to shipping.

"How about some lunch?" Linda asks.

Although not really hungry, I know I should eat. Linda slips a leg over the leeboard (on our next boat it will be leecloths with tackles, I vow for the hundredth time) and scrambles awkwardly out of her snug berth.

She works her way forward towards the head, moving carefully between handrails. How many times have we appreciated those few extra points to hold onto since we mounted them in California?

At the beginning of a gale, the waves will be moderate in size like these—in this case 6- to 8-footers (1.8 to 2.4m). The crests are quite close together as the gale has just started to blow. As the storm continues, the height will increase and distance between crests will lengthen. On a vessel like Intermezzo, you need to maintain a good turn of speed with these waves to keep flow over the relatively inefficient keel. Note the soft spot between crests. If you have a choice, this is the best place to put the bow as the crest rolls by.

Lunchtime

Linda reappears looking refreshed and ready to take on the world, or at least to brace herself in the galley. She moves aft using the lower-level handrails (she and the kids have a hard time in the middle of the boat reaching the higher handrails that work well for me). She enters the galley, takes a look through the windows, and fastens her safety strap."What would you like for lunch?" she asks.

"Surprise me." I reply.

She unlatches the freezer door latch and looks for a moment, "How about some of that chili I made before we left Mauritius, with fresh onions?"

Linda's habit of preparing a series of meals in advance of each passage is once again much appreciated by the crew. Turning to windward she lifts the external hook that keeps the locker door closed, even during a knockdown. She extracts a pot, lifting it over the 2-inch (50mm) shelf fiddle with one hand while holding down the pot's retaining shock cord with the other hand. In a few minutes, Linda announces lunch is ready.

In bare feet I move to the saloon table. Even with a damp cabinsole the nonskid walnut shell finish in the varnish gives me good footing. With one hand for bracing and the other for my bowl of steaming chili, I carefully seat myself behind the table. Fiddle rails around the table edge hold my bowl, while the extra fiddle rails in the center maintain onions, cheese, and drinks in position. Plates with high edges do an excellent job of keeping condiments from scattering at our 30-degree angle of heel.

Linda hands me a plastic bag filled with crackers. We've learned the hard way to put everything that needs to stay dry in heavy plastic. That goes for sheets, towels, clothes, and foodstuffs. There always seems to be a leak somewhere aboard. It doesn't have to be large, but opening a locker or drawer and finding soggy effects does take its toll on morale. So we prepare

When a crest slams into the bow, we are knocked off course to leeward. In a few seconds the Aries has us back on course. We would not want to be beam-on to these seas for very long.

At other times, we get hit on the stern. This tends to swing the bow into the wind, the staysail begins to luff violently, and we all hold our breath waiting to see if we'll be caught aback. It is not a comfortable feeling.

with plastic before every passage.

Periodically a breaking crest, perhaps twice as large as the others, rears up. We see them sometimes in the distance, and occasionally closer than we'd like. The smaller breaking crests, perhaps 5 feet (16m) of white water on top of a 25-foot (82m) wave do not seem to be a problem, as long as we continue beating.

The mizzen is reefed down to handkerchief size and balanced by the storm staysail, which is making it easy for the Aries windvane to keep us at the correct heading.

One of us is on watch at all times, in foul weather gear with harness attached. If we are caught aback we'll have to release the staysail sheet quickly to get the boat back on the wind. Otherwise, we'll end up beam-on.

The rest of the crew is confined to their pilot berths, leeboards in place—the safest place in case of a knockdown or worse.

Optimal Speed

There seems to be an ideal speed for *Intermezzo*. Right now we are making 3 knots through the water. This is just enough to give her large spade rudder some force, and coupled with the fast-reacting Aries seems to be perfect. If we slow down—if the wind drops, for example—we'll need to add sail area or the steering system will not be able to cope with the waves.

On the other hand, when we are moving faster, *Intermezzo* tends to fly off the back sides of the steep seas, landing with a crash—hard on the boat as well as the crew.

By late afternoon we've been in this blow twice as long as any of the previous gales. The seas are continuing to build.

We consider running off, but with a ripped mainsail we are loath to give up ground to leeward. Still, if it gets any worse...

Then it's time for our afternoon radio schedule with friends on other boats. It appears we are all caught in the same weather system. Jim and Cheryl Schmidt aboard the 70-foot (22m) *Win'Son* are motoring directly into the seas at 5 to 6 knots.

Dean Vincent aboard the 40-foot (12m) *Eos* has been knocked down, masts in the water while running with bare poles. He has added a storm jib to increase speed and has had no more problems.

South African friends, who left Mauritius two days ahead of us aboard *Senta*, a 43-foot (13m) sloop, have been lying ahull closer to the coast. They've been rolled and dismasted, but are making their way under power the last 60 miles into Durban.

The four of us are in an area approximately 100 miles long (east to west) by 50 miles wide (north to south), and all have similar barometric pressure and winds. The breeze is now blowing a steady 45 to 50, gusting into the low 60s.

We wonder among ourselves if the wind will ever drop off, or if the South African weather service will notice that it is blowing harder than the forecast 15 to 20 knots (they never do).

Like all gales, this one eventually passes into memory. Before long we are tied up to the quarantine buoy in Durban, awaiting the arrival of customs.

Lessons:

- ❑ As we sat in the cozy bar of the Durban Yacht Club discussing this last blow, it became apparent that the tactic of beating into breaking seas might in some cases be safer than running off.
- ❑ *Intermezzo* and *Win'Son* handled the seas on the bow with ease. In both cases, the occasional large breaking sea slowed the boat and put a lot of water on deck, but had no tendency to knock us down.
- ❑ Both of us could have handled running as long as we'd maintained enough speed for good steering control. *Eos* had no further problems with knockdowns once speed was increased by adding a storm jib. However, if the wind had picked up another 10 or 15 knots, in those steep, breaking seas beating would probably have been the safest tactic.

Rick Tomlinson

Nuclear Electric at the start of a wrong-way (westabout) voyage around the world. She is powered up with full main, number-5 jib and storm staysail. She will be able to reduce sail as the wind comes up by first reefing the main, then dropping the outer jib.

Upwind Sailing Technique

The difference in sailing to windward in a fresh breeze—say, 25 knots—and in a full gale is one of scale. The helming techniques and to some degree the way the boat is set up are similar.

The major differences are in fine-tuning sail trim and working the waves.

The best way to learn to sail upwind in heavy weather is to become proficient in moderate conditions. Then, practice when you get the chance in more boisterous weather.

Another approach is to practice in smaller boats. A day with 25 knots of wind and 3-foot (10m) seas to a 20-foot (6m) vessel is the same in scale as a 35-knot day and 8-foot (2.4m) seas in a 33-foot (11m) yacht.

Variables

There are a number of variables in this equation. The first is hull shape and keel/rudder combination.

The more fin there is below the canoe body (hull) and the higher the aspect ratio of that fin, the better you will be able to sail slowly uphill. (You will find a discussion of heavy weather design characteristics starting on page **608**.)

Shallow draft vessels as well as those with full keels and attached rudders are not going to be as efficient as those with fin keels and spade rudders.

The shape of the sails being used is a huge factor. If the sails have efficient shapes for the wind range—typically very flat—without hooked leeches, and if they maintain this shape as the wind increases, you are ahead of the game.

Go back and review Josh Porter's comments on his sail inventory (starting on page 25) to get a firsthand impression of how critical this is.

For a given boat there is little you can do about the hull shape or keel and rudder—but there is much that you can do about your sails.

Sail trim is another factor. In many cases, you will want to use outboard leads, and have the main traveler well eased as the winds increase—unless you are pinching into the wind and waves. The jib-sheet lead will also need to be adjusted so there is a nice twist-off in the upper portions of the head-sail.

In heavy air the fore-and-aft lead position on the jib sheet needs to be positioned so that the leach does not chatter. If the leach does chatter, move the lead forward until it stops or better yet, tighten the leech line.

Optimum sail trim is not something you can learn about in a book. It needs to be practiced, ideally with a similar boat alongside.

The condition of the bottom and prop is also a big factor. A clean bottom will be at least 10 percent faster to windward than one that has a bit of algae and grass on it.

Finally, the lower and more concentrated your moveable weights are, the stiffer and more comfortable the motion of the boat will be.

Hobby-Horsing

Yachts with narrow bow entries, short overhangs, efficient keels and rigs, and centralized rigs will seem to work their way through the waves with ease.

In the same conditions, boats with long overhangs, inefficient keels and rigs, and lots of weight in their ends will tend to bob up and down—hobby-horse—in one place.

Their keels are stalled, and they never seem to be able to make any progress.

In this situation, you need to somehow change the relationship between the boat's pitch period and the wave frequency.

One way is to head off more—sail at a wider angle. Another is to increase speed—often hobby-horsing is the product of not enough momentum to carry the boat through the waves.

Our first *Intermezzo*, for example, had only one speed to windward in most conditions—fast. The only way around this was to slow her down to the 3-knot range, which in some situations—if it was blowing hard and she was carrying small sails—was enough speed to keep her fins lifting.

Many modern designs like to go fast in short choppy seas, but can be slowed right down if required as the seas build. The difference is primarily one of overhang (or lack thereof in the new boats) and keels, which are much more efficient.


Stock Newport

This photo is taken as the boat is coming through a crest to windward (bottom left). The bow will be pulled off to leeward (to the right in the photo) as the boat comes through the wave. This helps to accelerate and maintain good steering control, in preparation for picking the spot to cross the next crest. These are relatively modest waves, from 25 knots of wind, just perfect for practicing your upwind techniques.

Sea Shape

In a heavy-weather context, the overriding issue is sea shape. If the wind has just come up, or you are sailing in gale-strength winds but with a land mass to weather blocking the waves, finding the right combination of sail and angle is easy.

The wider the sailing angle, the more time there is between wave crests. This effectively increases the wave period.

But once the waves develop, you need to help the boat pick its way through them. The steeper the waves, the more creative you will need to be in finding the right groove.

In smaller waves, and/or those that are not breaking, it's often possible to pinch up sharply as you go over the wave, then pull off gently on the backside. Pinching-up accomplishes two things: First, you trade speed for distance to windward. Second, with speed reduced, there is less chance of launching yourself over the crest and dropping into the trough with an uncomfortable and loud bang.

Falling off on the backside of the wave gets the boat moving again, and leaves more wave under the bow to cushion the drop.

The technique in larger waves is similar, except you have to be much more careful putting the bow into the waves to not slow down too far and/or be caught aback. If the waves are not breaking dangerously, then you may find that shortening sail, to slow down a bit, and sailing at a wider angle is actually faster and more comfortable.

Both photos Richard Bennett

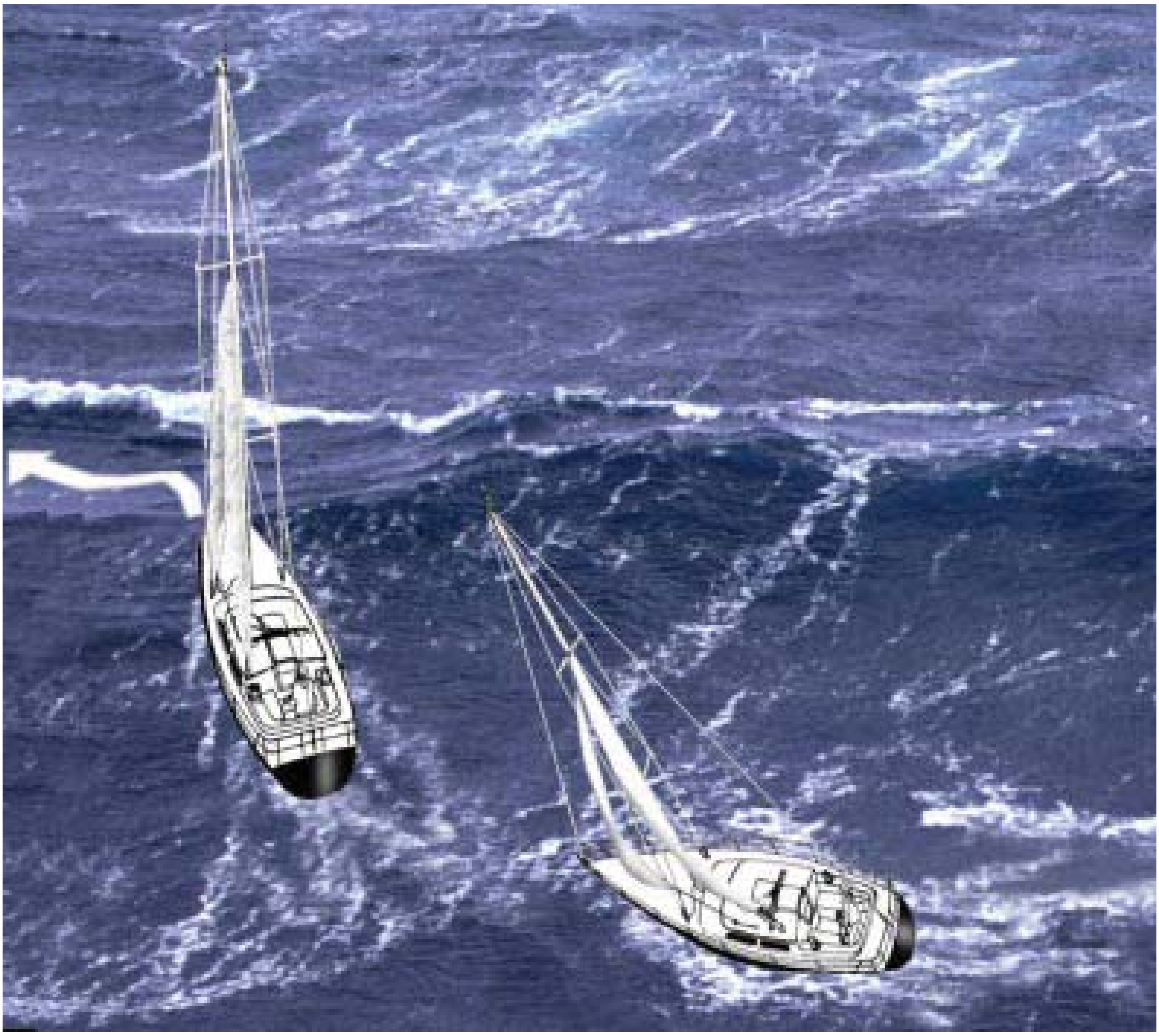
Beating in moderate gale conditions—30 knots, gusting higher. One reef in the main and a number-3 jib are too much sail area. Note how both sails are eased and twisted off to de-power them. They would be moving faster with another reef in the main and a smaller headsail, since both could then be efficiently trimmed.

In the upper photo note how the bow has dropped into the trough after they avoided the crest (arrow) immediately to windward. In the lower photo they were unable to avoid the crest as you can tell from all of the spray around the bow. The boat has been pulled off to leeward by the helmsman to build speed and soften the wave impact. Note the soft spot just to windward (arrow). Had they been able to cross there it would have been easier on boat and crew.

Here we are in a bit more wind—40 to 50 knots, gusting higher. There is some adverse current stacking up the waves as well. Note how steep the backs of the waves are. This boat is sailing with a moderately reefed main, all the way down on the traveler and well twisted off at the top, and a number-5 jib, also twisted off to de-power.

They approach the wave as close to straight-on as possible, and then pull the bow off on the back side. In the lower photo look how close the crest of the next wave is to their bow. Even allowing for foreshortening by the camera these are very steep seas!

Both photos Richard Bennett



Picking your way to windward around the waves requires that the helmsman or a crewmember watch the approaching wave crests. It is best to keep your eye peeled three waves to windward, so you have some time to plan where to head for the smoothest patches of water, avoiding the larger crests as much as possible.

The basic approach we've been discussing—heading up a bit as you come into the crest, and then down immediately as the crest passes—is shown here.

How Much Sail Do You Carry?

If we could count on the wind blowing at a sustained level the question of how much sail area to carry would be easy. You pick enough area to keep you moving, but not so much that you are overpowered in the gusts.

If the seas are not breaking, and we are talking about the most comfortable level of sail area, the norm is to set up for the gusts. This means you are somewhat underpowered during the average wind strengths, and extremely underpowered in the lulls.

However, if the seas are breaking, and speed is necessary for good steering response, (and perhaps for blasting through the crests), then you need to be carrying enough sail area to keep you moving in the lulls.

Arrangement of Sail Area

The steering balance of the boat is a function of many built in design factors, about which you can do nothing. However, you do have control over where the storm canvas is flown, and the center of effort of the sail plan.

In order to insure that there is adequate weather helm, the sail area will need to be moved towards the center or aft end of the boat.

What you want to avoid if possible is flying just a storm jib from the bow, with no balance from mainsail or trysail.

If a headsail is the only sail flown, it should be off a cutter stay.

In most cases, if you have to choose between going to weather with a trysail or storm jib or a deeply reefed main or storm jib, you will be better off with the trysail or deeply reefed main as either one generates more weather helm which makes it easier to feather into the crests.

If you are carrying too much sail what do you do when the puffs come through? The answer is to feather—in other words, head up a bit so the sails luff, thereby relieving load on the boat.

This luffing is going to be loud not to mention hard on the sails. The sails need to be in top shape, and well constructed to take the abuse that feathering entails. This is why storm sails should not be used or exposed to sunlight except in heavy weather.

More feathering will be required at the top of a wave, where the wind is strongest. This works in concert with the need to bring the bow into the crest.

Another factor to be considered is the wind in the troughs. In really large seas, small-boat rigs will be blanketed in the troughs, and speed will drop precipitously.

Using Weather Helm

Weather helm is an advantage, and you should be trimmed up so there is a modest amount.

When you feel weather helm on the rudder it means that the rudder is working. This means it's sharing lifting loads with the keel, which is efficient, as long as the rudder angle is not more than 5 to 8 degrees.

Secondly, when the time comes to feather up in the crests, weather helm automatically takes you into the wind, without having to exert much force on the helm.

On the other hand a neutral helm or a lee helm can be extremely dangerous. Aside from being inefficient, when you need to head up into a crest, you have to force the boat up and she may not respond quickly enough.

Sheeting Angles

In normal heavy-air beating, before feathering into breaking seas becomes a safety issue, it's generally best to have sheets on outer leads and the main down a bit on the traveler.

This reduces the angle of attack on the sails and allows them to generate their power without excessive healing when you are sailing at the wider apparent wind angles generally required to make the best progress through the seas.

However, when feathering through the breaking crests becomes a safety issue, you may want to consider oversheeting (having the main/trysail and/or jib sheeted further inboard than would normally be the case).

Oversheeting will reduce flogging.

Playing Frontal Wind Shifts

Unless you are in a compression zone between a high and low pressure system, the odds are that any strong breeze will have come to you via a low pressure and associated front.

When the front passes, there will be a major wind shift, typically 90 degrees or more. The key is to be on the favored tack, that which takes you towards the expected shift on the most direct route.

The alternative is to heave to, awaiting the passage of the front, after which you can start sailing again with a reaching breeze. (This subject is covered in great detail in *Mariner's Weather Handbook* starting on page 193, as well as on page **194** in the Weather Tactics section of this book.)

Tacking

Tacking is best done during lower wind levels and relatively calm sea states, as opposed to periods of big seas and heavier winds.

The main concern is to avoid being caught by a crest while tacking. Also make sure that nothing hangs up on the sheets which might cause you to be caught aback and then pushed broadside to the waves.

After the decision to tack is made, take your time and wait for the right conditions. It might be five or ten minutes but when the time comes, act decisively. Don't hesitate or slow down mid-way through the tack or you may be caught in irons or aback.

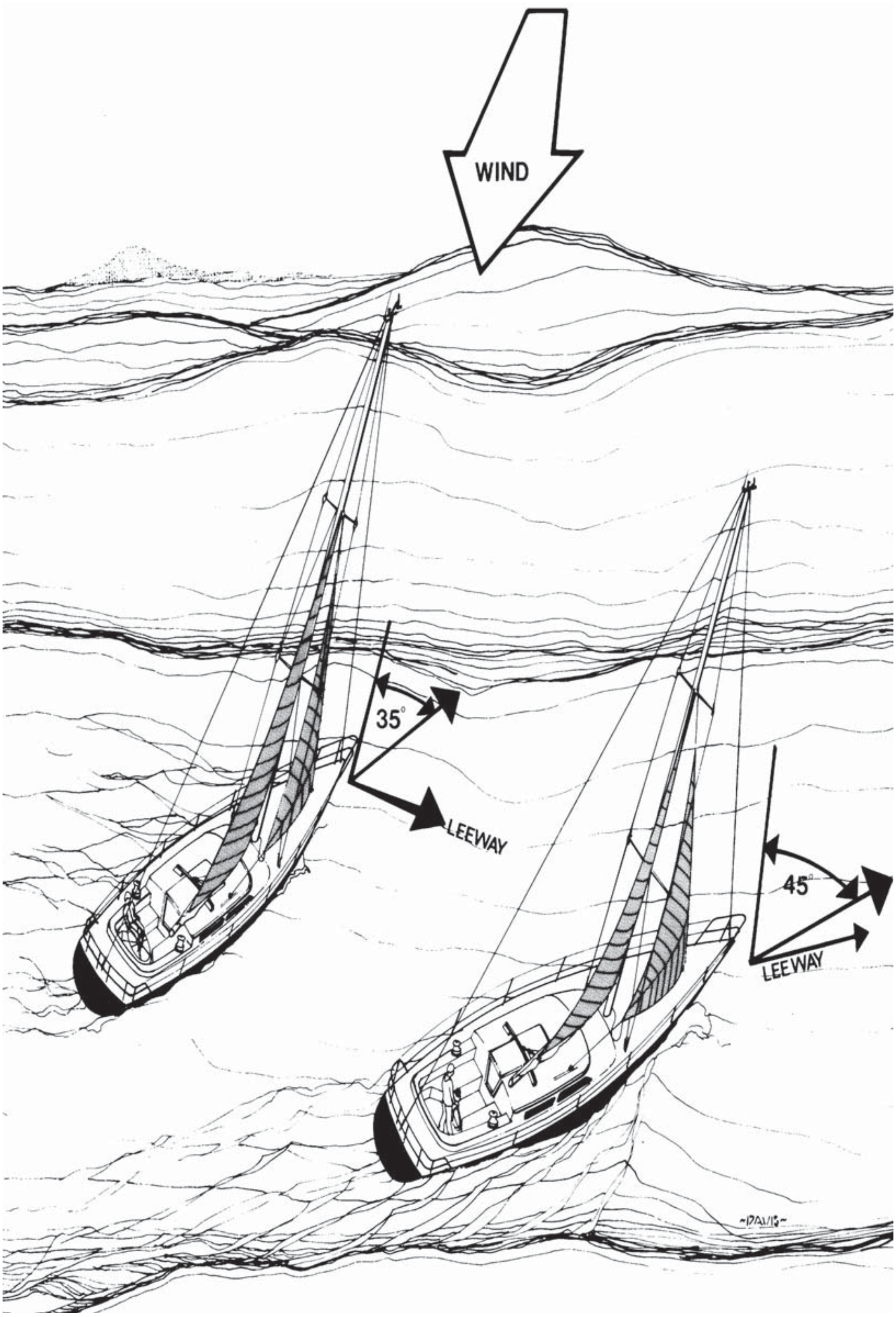
When tacking it pays to take your time, watch the waves, and wait for a smooth patch of sea which coincides with a lull in the wind. The boat should be put about just after you come through a crest, when you have full speed on (just used for punching through the wave crest). Put the helm over just as you pass through the crest (boat on far right).

Remember if a headsail is being used, when the sheet is eased, it will flog like mad as the sail comes through the eye of the wind until it is sheeted home.

If this flogging sheet wraps itself around a mast cleat, winch, or shroud, you will have to run off downwind to clear it.

If running off is required, it must be done expeditiously by easing the main or trysail sheet (which will otherwise hold you into the wind).

It is far better to make sure the sheets are handled quickly and cleanly in the tack, so that flogging is eliminated or at least minimized. To ensure a clean tack, practice with the sails you'll actually be using.



Keel efficiency and leeway become much bigger issues when sailing in large waves. The more the boat gets slowed down by the seas, the higher the keel loading will be and the more leeway you'll make.

Since the ability of the keel to generate lift is a function of boatspeed squared, small increases or decreases in speed have a huge impact on efficiency. Often you will find that when the seas start to hump up, you need to sail a somewhat wider angle, to maintain boatspeed and thus flow over the keel.

Sometimes heading 10 degrees off the wind will actually result in better progress dead to windward, since leeway is reduced.

There is always a tack which brings the waves more on the bow, and another which has them more on the beam. Often the angular difference to the waves is as much as 20 or 30 degrees.

In moderate conditions the wider wave angle will be more comfortable. However, this leaves you more vulnerable to breaking crests. With breaking crests the best tack will typically be the one which takes you most directly up the crest. With crossing seas, in breaking conditions you will need to choose the tack which allows you to adjust course into the cross sea if that is necessary.

Heel Effect

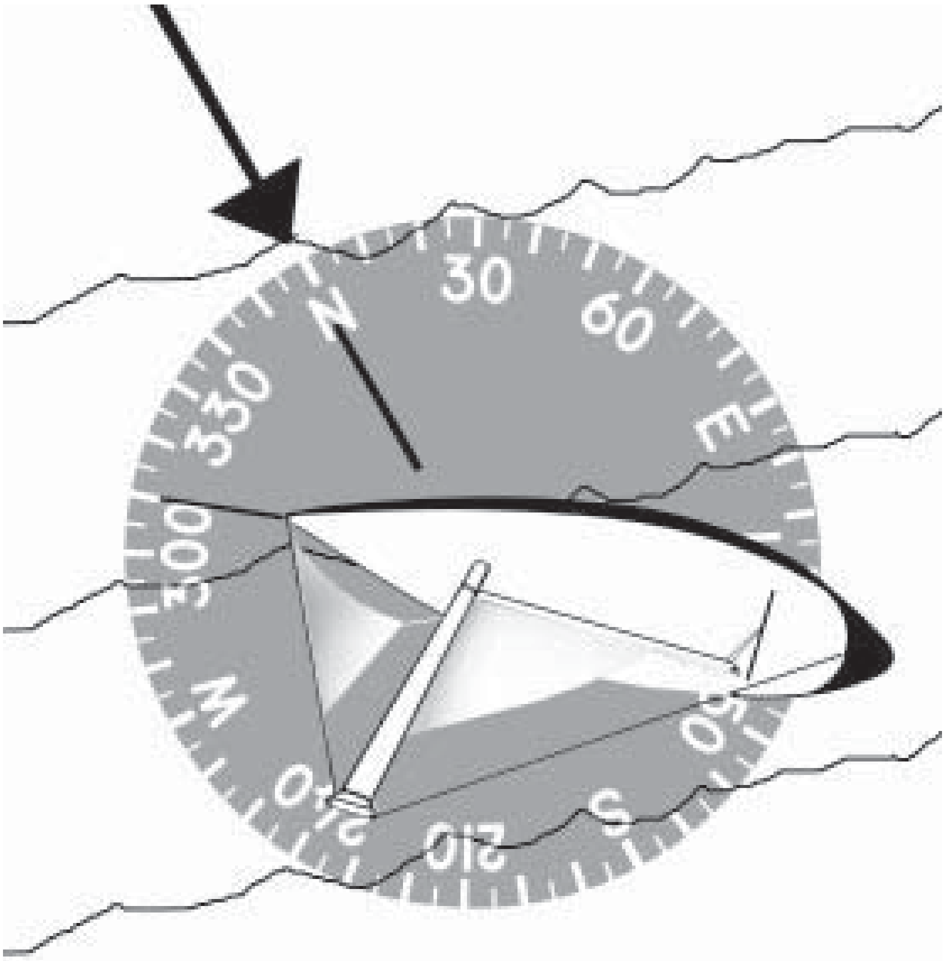
Heel works in different ways with different hull shapes. From a slamming and comfort standpoint, boats with flat bottoms forward need some heel angle.

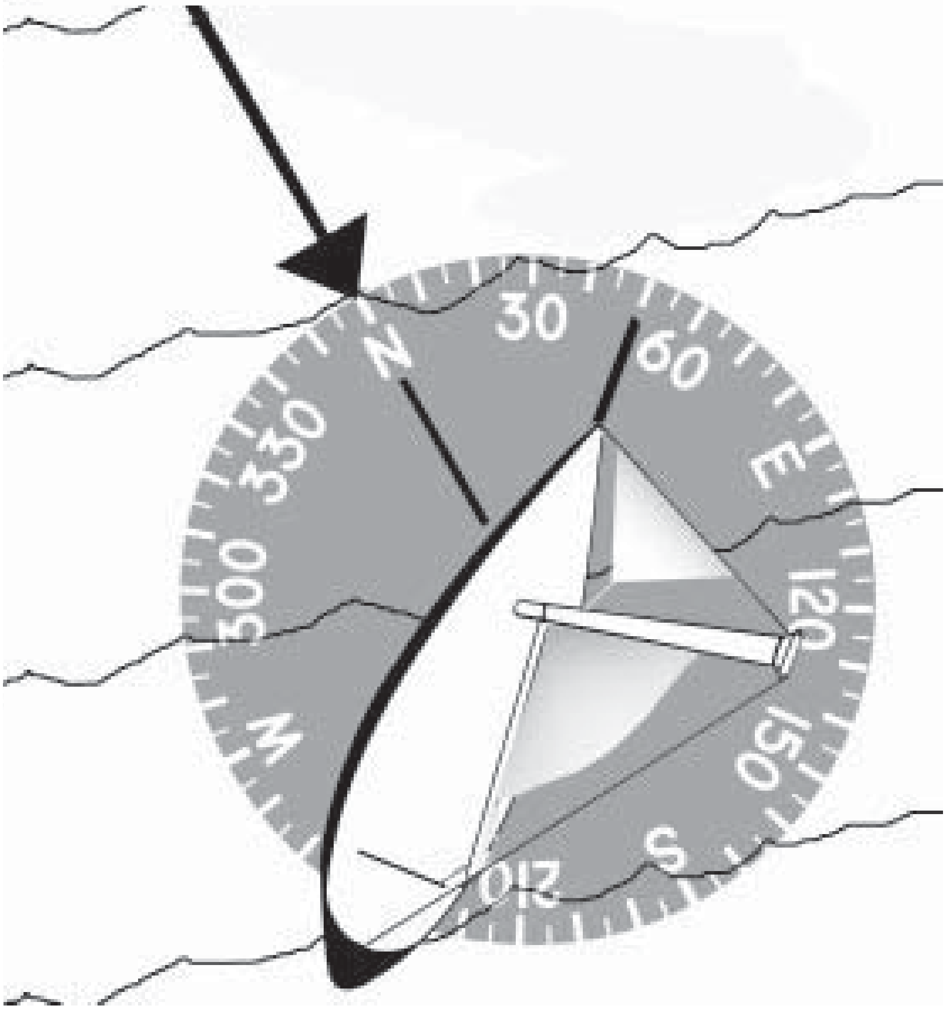
Hulls that have more deadrise and more V-shape forward will have a softer ride at a more upright angle.

On heavy boats with lots of deadrise angle forward, excessive heel leads to pounding on the flat of the topsides. For these designs it's usually better to sail with minimum heel.

We also have to consider keel efficiency in this equation. It's generally understood that keel efficiency drops off with something like the square of the increase in heel angle. So, for maximum fin efficiency, you want to sail as upright as possible.

How this works out in any given situation is a function of wave shape and boatspeed. The optimum combination of heel angle, wind angle, and boatspeed is always changing—so as conditions change, experiment.





Sail Trim

On the tack which is free of the wave angle (typically starboard tack in the Northern Hemisphere, port tack in the Southern) the boat should be set up for increased weather helm. As we've discussed before, this means more sail area aft and less forward.

You can also affect weather helm with sail trim. Powering up the mainsail, with less twist on the leach and a closer-to-center traveler position creates more rudder loading.

At the same time, easing the jib out a bit and allowing more twist decreases leeward helm.

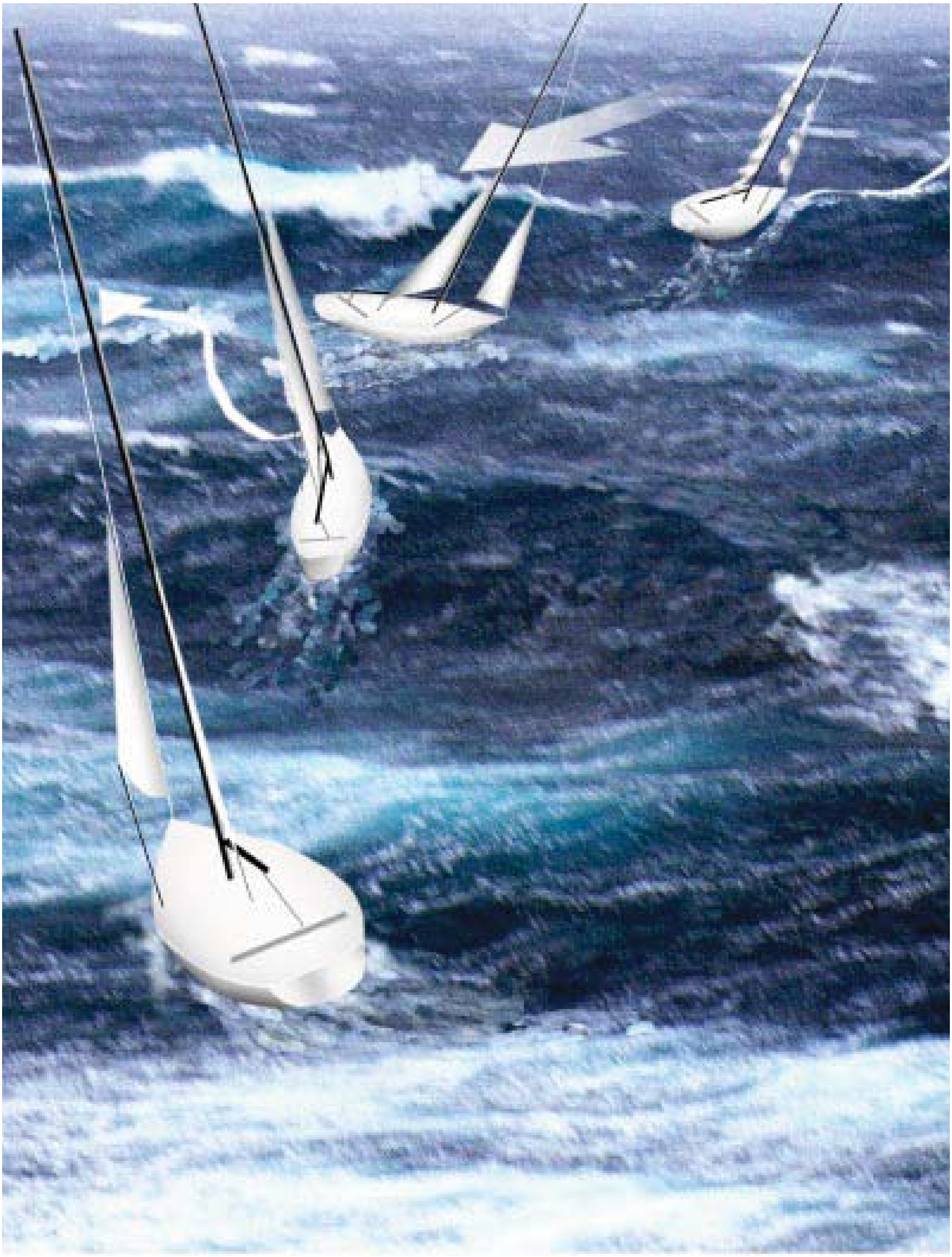
It's often fastest to have the main sheet traveler hiked up to windward, past the centerline on the favored wave tack.

On the opposite tack, where your nose is almost into the waves, less weather helm is desirable. In this case, the main traveler will be eased and the jib sheet will be trimmed a little harder.

Mainsail twist will be increased, and then if required, some twist can be taken out of the jib.

A nice day for a sail! Sixty knots steady, gusting 75 to 80 knots, current against the seas. The yacht shown is picking her way to windward carrying just a trysail, which is sheeted to the rail and eased a bit to de-power it. Look at the top photo and notice how much of the seascape has waves of a negotiable size. The really big crests occur occasionally, even in this much wind. In the upper photo they are climbing an intermediate-sized non-breaking wave—probably about 18 feet (5.5m). The bottom image shows the boat after having come through the edge of a breaking crest. If they had hit the peak of the crest (arrow) they would have slammed to an abrupt stop.

Both photos Richard Bennett



A cross sea from a frontal shift or another storm system some distance away complicates everything. You have to be concerned with combination waves, which can pyramid up and break unexpectedly, as well as breaking seas from the crossing angle.

Where the cross sea is the result of a wind shift as the front passes, it is typically best to be on starboard tack in the Northern Hemisphere (port in the Southern) as this keeps your bow into the combination waves, closest to the waves from the northwest wind (which is probably stronger than the previous southwester).

Richard Bennett

Force 12 conditions (65 knots and up) and hard on the wind. Flying a storm jib off the bow like this makes it hard to feather into the puffs. As you come up a large wave and are exposed to the full force of the wind at the top, there will be a tendency for the bow to blow off to leeward—exactly what you don't want, until you've passed through the top of the wave and are on your way down the backside. Note how sloppy the mainsail furl on the boom is. This extra windage will hurt both boatspeed and angle. In a knockdown, there is more surface for the wave to work against.

Patrick Roach

Nicely shortened down and sailing upright. In these moderate conditions, with a small amount of wave action, being under-powered like this offers a good compromise between comfort and progress.

However, if there were more seas running, they would need additional sail area and heel angle to build speed to penetrate the seas.

Note the shape of the roller-furled jib. This is a really baggy sail and will create huge amounts of drag. They would be much better off with a smaller, properly shaped sail on the headstay.

Beating in Survival Storms

Heavy air beating check-list:

- ❑ Correct sail balance for maximum steering control.
- ❑ Adequate speed for good steering.
- ❑ Proper tack to get out away from weather system—or;
- ❑ Proper tack for maneuverability with crossing seas.
- ❑ Save energy during early parts of the storm so you are at your best when called on to steer actively.
- ❑ Be alert to shifts in the wind and/or changes in sea state which require a different speed or course.

Before we leave this chapter on beating in heavy weather we'd like to revisit the issue of extreme weather, and what to do when the seas are breaking and becoming chaotic.

As we've seen in the 1998 Sydney-Hobart Race, given the correct sails, a good helmsmen or two, and a boat that is efficient to windward, there are many situations where beating to weather with just enough speed on for good steering control is the best survival tactic.

Your speed is under control; you can see the waves coming at you; and have a chance to adjust course in the troughs and in the early stages of the crests, so as to avoid the worst breaking parts of the wave. Go back and have another read of the *Bin Rouge* crew comments about their beating techniques (page 266). They got through horrendous conditions in a very small boat.

Along with the proper storm sails, you need to have the lowest possible center of gravity (which means keeping the decks clear and having anchors and other heavy gear stored in the bilge). As much weight as possible should be removed from the ends to reduce pitching moment. Roller- furling headsails should be stowed so windage is minimized. Just one roller-furled genoa will make it impossible to hold your head up going to windward in a survival storm.

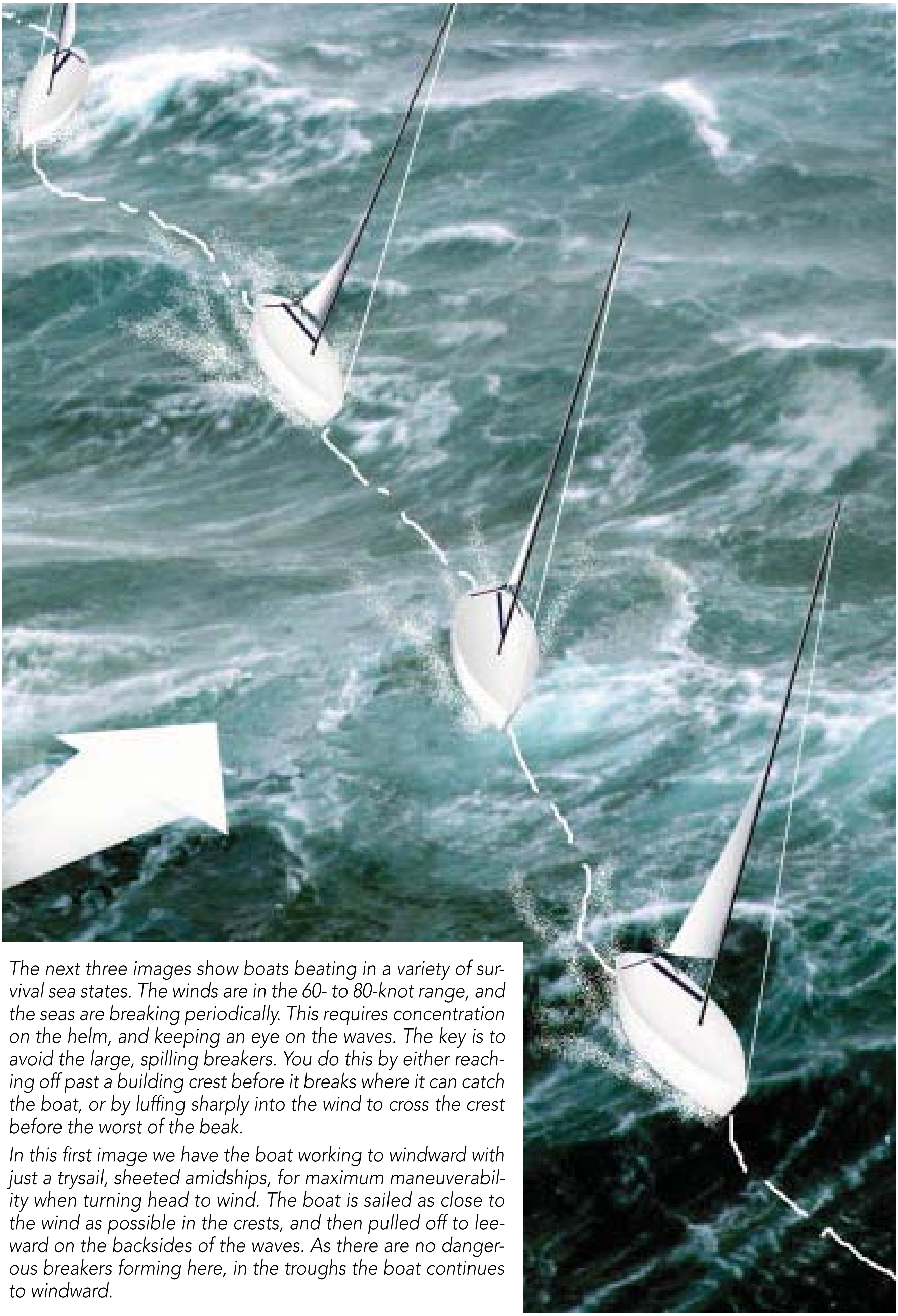
You will want to know in advance the best sail combinations to give you the correct speed and maneuverability—both of which are essential to weaving your way through the waves. This means practicing with different combinations of storm canvas when it's blowing a gale. This is not something that is pleasant to experiment with, but it might save your boat one day.

Most boats will work their way to weather quite efficiently on their own in strong gale- or storm-force conditions. A powerful pilot or windvane will augment the job, and in the period before the seas begin to break heavily, self-steering devices can be used to conserve the crew's energy.

To the extent possible, everything else should be done to husband your physical and mental strength. Staying warm, dry, rested, fed, and drinking lots of liquids will pay dividends when it comes time to actively steer around the breakers.

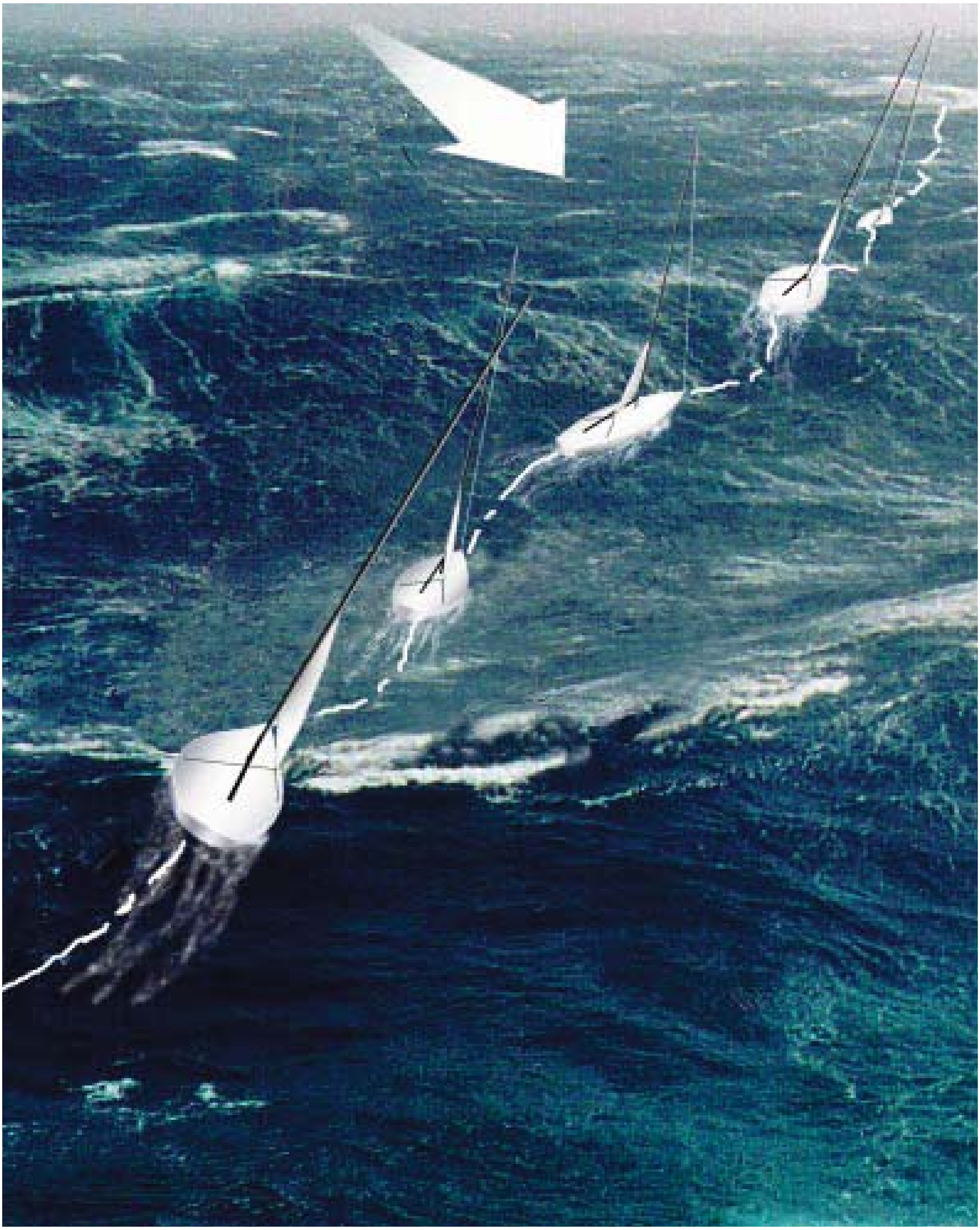
Which brings us to the final point on this subject: It takes a certain degree of skill on the helm to work your way through these waves. If you spend all of your time under vane or pilot, never take the helm, and have no small- boat-racing experience, you will find beating in a survival storm a difficult school.

It is far better to pick up some experience in advance. As we've said before, small-boat racing is an excellent way to learn how to navigate through waves on a beat. And then, when conditions are less than ideal on long passages, take the helm from time to time to see how the boat feels. Learn her response time, and how much you have to anticipate before a wave crest arrives. This will make you a faster and safer sailor.



The next three images show boats beating in a variety of survival sea states. The winds are in the 60- to 80-knot range, and the seas are breaking periodically. This requires concentration on the helm, and keeping an eye on the waves. The key is to avoid the large, spilling breakers. You do this by either reaching off past a building crest before it breaks where it can catch the boat, or by luffing sharply into the wind to cross the crest before the worst of the beak.

In this first image we have the boat working to windward with just a trysail, sheeted amidships, for maximum maneuverability when turning head to wind. The boat is sailed as close to the wind as possible in the crests, and then pulled off to leeward on the backsides of the waves. As there are no dangerous breakers forming here, in the troughs the boat continues to windward.

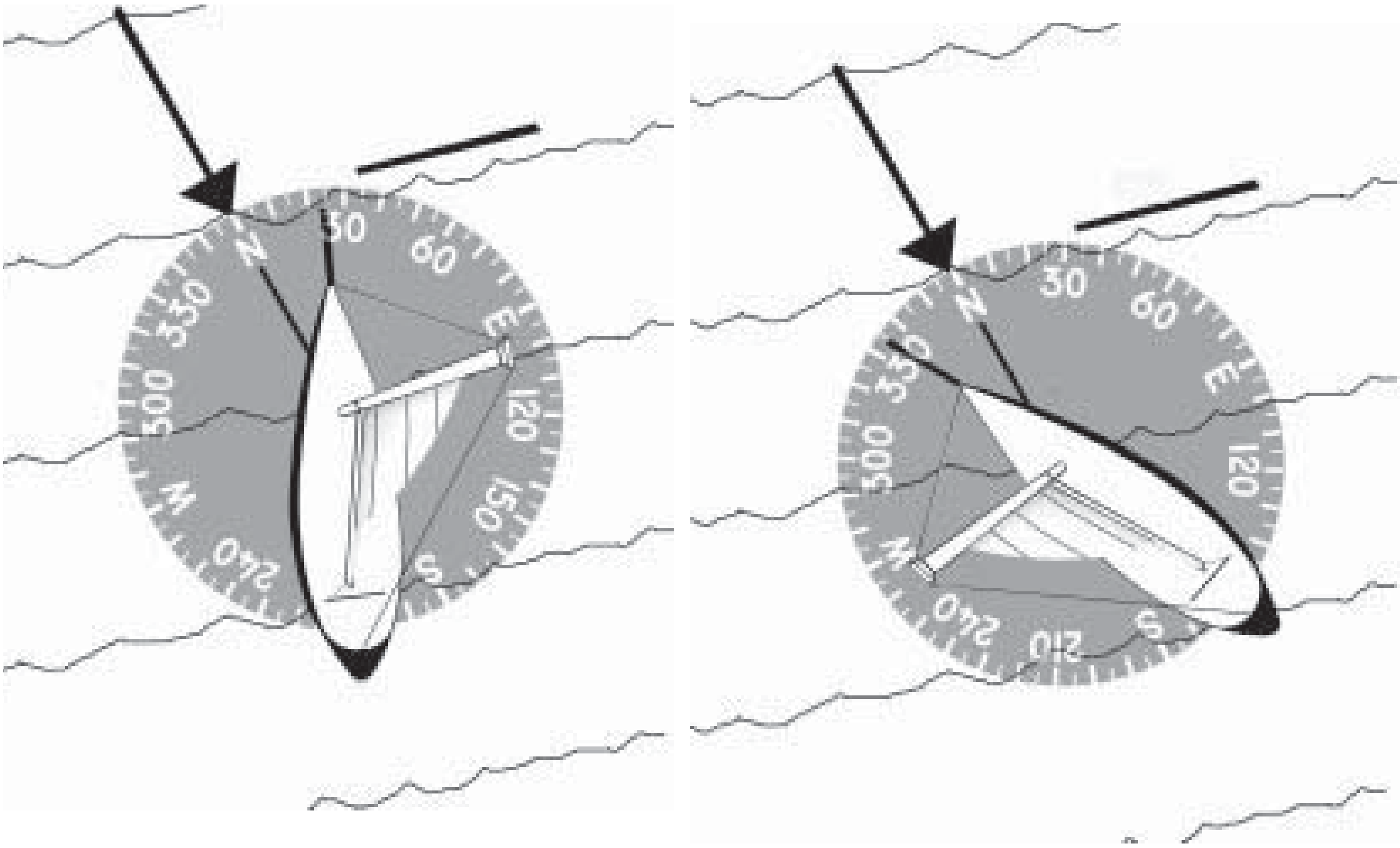


Here is a situation where the wind is almost square to the waves, with no cross seas present. Of course, you still need to keep an eye out for combination waves or those coming at you from an angle to the wind.

Periods like this are not unusual, even when most of the time the waves are more confused. In this case, we have the boat climbing the crest in the lower left corner, with its bow quite close to the wind. The crew will be watching carefully to make sure the wave doesn't begin to form a large breaker on top. On the back side of the wave the bow is pulled off to leeward. They close-reach across the trough, trying to put as much distance as possible between themselves and the large sea which is forming up in the upper left side. This could become a dangerous breaker, and by reaching off for speed they reduce the risks of being caught.

The port tack boat at the bottom of this image is working its way towards the looming wave crest. It is reaching off in an effort to cross before the wave breaks. The only alternative is to luff up quickly and put the bow through the crest at as straight an angle as possible.

The boat taking the upper track, on starboard tack, will be concerned with the building crest shown abeam of the second boat from the right. However, off to port is a patch of smoother-looking sea. They're reaching off in that direction, before heading up to cross just to windward of a wave that is beginning to peak at the third boat's position.



Just as there is a favored tack versus the waves for beating or heaving to, the same applies when motorsailing. In the left drawing, the boat is motorsailing at 20 degrees apparent wind. Because of the veer in the waves relative to the wind, this has them directly on the bow, the safest angle to take breaking crests. The opposite tack (right drawing) has the waves at a wider angle. If they are not breaking, this will be more comfortable and easier on the crew, as when angled like this the distance between crests is relatively longer.

Motorsailing to Weather

Using the engine to help you when beating in heavy weather can make sense in many conditions. Typically used in conjunction with storm sails, it provides the extra thrust that is occasionally required to get your bow through a breaking crest.

At the same time, if the prop is in reasonably close proximity to the rudder, the prop thrust will measurably improve slow speed steering response—a critical factor in breaking seas.

For vessels that are less efficient upwind due to hull design, fins or sails, the use of the engine can make beating a feasible tactic in conditions where it otherwise simply would not be possible.

Engine Considerations

You're asking the engine to work under extreme conditions. In order for it to do so, it needs clean fuel, adequate cooling, and a good supply of lubricating oil.

We've already discussed the issue of clean fuel (page 110) in the section on preparation. Ideally, your tanks will be cleaned periodically, and there will be large dual-size filters as any dirt on the sides or bottom of the fuel tanks will quickly be shaken loose.

Water flow is not typically a problem (except on some light-displacement designs) as long as the saltwater strainer isn't blocked.

Oil is a bit more of an issue. Diesel engines have an oil pickup above the bottom of the engine sump and most engines have an angle beyond which they will not be able to pump oil. This data is probably in your engine manual.

While a steady supply of oil is best, if the oil pressure is going up and down with heel changes, you are probably okay as long as there are not sustained periods of low pressure.

Sometimes adding an extra bit of oil to the engine, above the high mark on the dipstick, will solve this problem—check with a mechanic who is familiar with your engine.

Prop Type and Location

Prop efficiencies vary widely, as do their location. When beating in adverse conditions you may find that a combination of boat motion, air bubbles in the waves, and prop design cause occasional cavitation and overspeeding.

This is hard on the drive line, engine, and prop shaft supports. You will want to keep an eye on the prop strut connections and hull area, and make sure everything remains tight—without excessive flexing in the hull bottom.

In some cases it may be necessary to work the throttle to reduce RPMs when the prop is cavitating. There is typically a rhythm to this, and once you get a feel for it RPMs can be dropped before cavitation begins.

Safety Issues

As Mike Kalaugher pointed out in his comments about the Sydney-Hobart Race (page 276) using the engine in heavy going brings with it some safety issues.

On the inside of the boat, if the engine area is not isolated from living quarters there may be unwelcome heat, noise, and fumes—exacerbating any tendency towards seasickness.

If the boat is rolled or knocked down and a crew goes overboard, there is a risk of that person getting into the prop.

Any crew on deck will need to be harnessed in with dual and/or short tethers, so they cannot go far if the boat is knocked down.

Sheets that find their way overboard, perhaps being washed out of a deck locker by a boarding sea, may find their way into the prop. This means the engine is out of action until someone goes overboard to clear the prop. If the prop strut and/or shaft is not robust, it may also lead to a bent shaft or leakage at the hull to strut connection.

The best way to deal with this is to make sure all running rigging is made up in neat coils and secured so that even in a knockdown, it will stay put.

In many situations motorsailing may just be the ultimate storm tactic. Consider the advantages:

- ❑ Quickly variable speed control.
- ❑ Improved slow-speed rudder efficiency.
- ❑ The ability to take breaking crests at a tighter angle than is possible by sails alone.
- ❑ Possibility of eliminating the storm jib, which means you can sail closer to the wind without risk of getting caught aback.
- ❑ For vessels that are inefficient to windward it may be the only way to sail upwind in storm conditions.

Typically just the mainsail or trysail is flown when motorsailing to weather. The sail stabilizes the boat, reduces rolling, and provides extra power for punching through the crests while allowing you to sail closer to the wind without stalling the keel.

In the top drawing, we are flying a triple-reefed main. Note how the traveler is hiked to windward.

If you can't get enough angle on the traveler, try using a tackle from the end of the boom to the toerail.

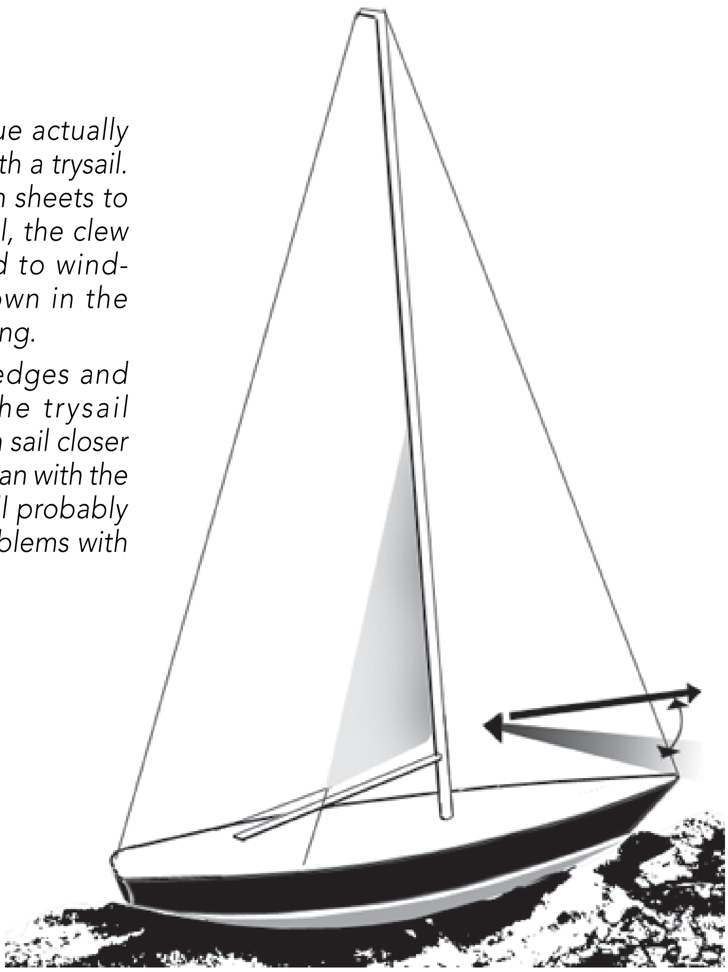
To flatten the mainsail to minimum draft, the halyard should be at max tension, the outhaul should be tight and the mast should be set up with as much bend as possible.

As with other storm sailing techniques, motorsailing to windward needs to be practiced in less severe conditions to learn the handling characteristics of your boat. Things to look for:

- ❑ Minimum controllable speeds in different wind and sea states.
- ❑ Correct sail combinations. Can you effectively use just trysail or deeply reefed main?
- ❑ Main/trysail sheeting position. How far to windward should the clew be for best results in the crests?
- ❑ Max heel angle before oil pressure drops to the potential damage range.
- ❑ Best steering techniques approaching a breaking sea, pushing through the crest, and then pulling off on the backside.
- ❑ How close can you sail to the eye of the wind without being caught aback?
- ❑ If you are caught aback, how quickly can you get back on to the proper tack?

This technique actually works best with a trysail. By using both sheets to bridle the sail, the clew can be hiked to windward, as shown in the bottom drawing.

The hollow edges and flat cut of the trysail mean you can sail closer to the wind than with the main, and will probably have less problems with flogging.



The best way to learn this technique is to practice active steering in moderate waves. What you learn this way will give you a head start in really severe conditions. In this image the boat is working its way through the crests, with trysail hiked to windward—on port tack. The bow takes the crests almost straight on, and then falls off on the back sides of the waves, and in the troughs between. Heading up on the crests accomplishes two objectives: one, it slows the boat down so it isn't "launched" into the air off the wave backs. Two, if there's a breaking crest, this is the safest attitude at which to take it.

Motorsailing checklist:

- ❑ Make sure engine is topped off with oil.
- ❑ Keep an eye on oil pressure.
- ❑ Use engine to help when pointing high in the crests.
- ❑ Back off on RPMs when off the wind to keep from accelerating too fast on the backsides of waves.
- ❑ Have mainsail or trysail tack hiked to windward if necessary to reduce luffing in crests.

Active Steering in Breaking Crests

The technique with the engine is similar to sailing, except the angles are tighter. With the thrust of the engine, you can luff up closer to the wind than would otherwise be possible.

Heading is determined by the need to balance wind and waves. Ideally, the sail will be just full enough to provide some drive while taking the seas sharply on the bow. By putting the bow as directly through the breaking crest as possible, more of the force of the wave can be dissipated before substantial heeling takes place.

Steering technique will vary with vessel design and sea conditions, but two basic tenets are constant: The first, as we've already mentioned, is choosing the right average speed and angle. Second, when a breaking crest of an extremely steep sea is spotted, head into it directly to minimize risk from the crest. Then, as the sea passes, pull the bow off to leeward to avoid dropping straight down into the trough on the backside.

It is even more important when using the engine not to get caught aback since you are sailing closer to the eye of the wind. Luffing up through the breaking wave must be done in such a way as to keep the jib, if you are flying one, from backwinding and blowing the bow off on the opposite tack.

Real World Examples

Like most cruisers, we've spent plenty of time motorsailing to weather when this was the most efficient way to get to our destination. However, we had never really considered this as a storm tactic until the winter of 1984 in Denmark. We were at the Walsted Boat Yard inspecting one of our designs under construction and were having dinner with a couple of cruisers, who happened to be hauled out there working on their yachts.

During the course of dinner, the subject wandered from self-steering systems, to electronics, through refrigeration, and eventually to heavy-weather tactics. We all told a few sea stories, most of which were pretty much the same. But then Pascual Grinberg began to tell us about a winter storm he had gone through in the Bay of Biscay while delivering a Swan 43.

They were "embayed" (trapped) in Biscay by a long-lasting 40- to 50-knot southwest gale. They did not have room to run off as the coast of France was to leeward, and they wanted to stay far to windward of the local currents, and shallow waters that produced huge breaking seas in these conditions.

Even though the Swan 43 was a powerful design with deep draft, they could not make progress to windward against the seas. Pascual decided to try the engine to help them sail closer to the wind, and do a better job of dealing with the seas. He found it worked extremely well, enabling them to sail at a 15- to 20-degree angle to the seas.

They were carrying just a trysail, and used the engine at low RPMs to keep their speed in the 2- to 3-knot range. The slow speed enabled them to avoid dropping into the troughs on the back side of the seas, yet provided enough steering control to allow them to feather through the crests.

The year after their experience, Pascual was most enthusiastic about this tactic's application in a survival storm. It was Pascual's feeling that as long as he could keep steering the boat, he would be safer working his way through the crests, rather than lying to a sea anchor or hove to.

Years later, sitting in an anchorage in the Sea of Cortez, we had a similar discussion with Doris and Ussi Aspialla. They'd used the same approach in a black southwester off the coast of Africa. Ussi felt that using the engine on their Swan 57 at the time gave them the most flexibility with the waves they found in the Aghulas current and got them into port much faster- and with less risk than would have been the case if they'd just been sailing.

POR VIDA

We want to leave this section on motorsailing in extreme conditions with some comments from Skip Elias, who went through the 1994 Queen's Birthday storm between New Zealand and Tonga. He and his wife Susan were aboard *Por Vida*, a Westsail 43 (13.1m).

They had owned *Por Vida* for six years, and when this event occurred they were on their second season in the South Pacific. Prior to this, they had raced and cruised extensively on both East and West Coasts of the US. However, their offshore experience was limited to time in the South Pacific.

Sea State and Wind Conditions

Skip picks up the story from here, starting with a description of the conditions in the height of the storm:

At the worst of it, windspeed meter hit 90 knots a few times, with the highest sustained winds of around 70 knots. Our instruments are Telcor 1976 vintage so I cannot vouch for their accuracy. We spoke to the Orion aircraft that was looking for *Destiny* and their estimates were similar. I don't know how to objectively describe the sea state. Average wave height of 40 to 50 feet(12.2 to 15.2m)would probably be accurate. We spent most of the time down below, but when I managed to look out, my mind was processing more adjectives than numbers.

Skip Elias

With so much data on unpleasant conditions it is worth remembering that most cruising takes place in moderate weather, and at the end of the passage, an anchorage like this one on Moorea awaits.

Por Vida is a ketch-rigged Westsail 43 with a displacement of around 18 tons (as compared to a design displacement of about 16 tons).

She is powered with a Perkins 4-236 turning a 3-to-1 reduction gear V-drive. The prop is a 22-inch (558mm) Max feathering prop, with 20 inches (508mm) of pitch.

They are over-propped and cannot not use the engine to its full RPM. However, for a Maxi prop this may actually be a good pitch ratio (see *Offshore Cruising Encyclopedia* page 753 for more data on the use of maxi feathering props). They generally power at 1,600-1,800 RPM.

Their autopilot consists of Cetrek controls, a Wagner PV140 pump with a Kobelt 30-cubic-inch hydraulic ram connected directly to the quadrant. The maximum design output was calculated around 1200 foot pounds.

My overall impression is that the seas were more regular than confused. Confused is not the word I would use to describe them. I remember the intense vertical motion. I remember having that feeling in my chest that you get on a roller coaster, with an occasional giant slam. In the eye of the storm the seas were quite confused.

It would probably be accurate to say that most of the time you could be hit from a direction of 45 degrees plus or minus from the general wind direction. Wave dynamics in open ocean and high winds is more a matter of statistical probabilities than an algebraic formula. Therein is the problem of defining fixed tactics to defend yourself.

Early Tactics

As the wind was building (we had no warning of what was to come) we started running with it at plus or minus 45 degrees to the general sea direction under reefed main, then went to the storm trysail. Next we put out a Shewman 54-inch (1.4m)drogue over the stern on roughly 150 feet (46m) of 3/4-inch (19mm) nylon braid.

The drogue had a very impressive effect on the motion of the boat. We slowed down to plus or minus 2 knots and were much more comfortable. We took a few hits over the stern but were doing okay. I think we started the engine to charge the batteries about this time, but not sure.

Unfortunately, we lost the drogue several hours later because of chafe (I think!). During this time, we also lost our second bow anchor. It was a 55-pound (25kg) Delta with 20 feet (6m) or so of chain and 300 feet (92m) of 3/4-inch (19mm) nylon braid. Which would have been no problem except it took the deck pipe with it so we had a 4-inch (102mm) open hole in the forward deck. Later in Fiji we discovered a knot of line around the prop and some damage to the rudder. Either one or both of the lines were caught in the prop and cut by the "spurs" on the shaft. Really happy I had them installed before we left.

After we lost the drogue (after 2 hours of use) we put the boat into the wind, off just enough to keep the centered trysail from luffing, and kept adjusting the course with the autopilot to maintain that attitude.So we went through the majority of the storm under motor. Using the engine was just an instinct to stay longways relative to the waves. In my mind, this was just basic physics.

Using the Engine

Skip ran the Perkins diesel at between 1,600 and 1,800 RPM. The throttle was not adjusted during the storm as they averaged 2 to 3 knots motorsailing into the waves. The autopilot was used the entire time for steering chores as Skip felt it was too dangerous to be on deck with the breaking seas. There was no problem with the oil pressure dropping due to heel angle as Skip indicated they did not heel that much. Fuel tank sediment was also not a problem.

We are fairly careful to filter and treat all fuel we take aboard. We also have a vacuum gauge on parallel Racor filters. Even using 2-micron primaries, we have had no problems.

We asked about the motion motorsailing this way, and Skip replied:

My memory is of being more uncomfortable from the vertical motion of going up and down 50 feet (15.2m) in what seemed like every few seconds than the horizontal motion. We have been in short choppy seas that caused more things to fly around the boat than in the storm.

When asked if he would change anything in terms of systems, Skip said:

The engine is getting on in years so we are considering a new one. Perhaps to an extent because of the storm we need the feeling that the engine is 100 percent dependable. The new one will be properly engineered with regard to prop size, reduction ratio, etc.

Final Thoughts

A significant (in strength) drogue off the stern is likely to be better than bow-on under power. In both cases, the smaller profile of the boat is presented but still the hit is going to be significant. A properly set-up drogue is more likely to hold the stern into the hit better that the relatively small horsepower that any motor can provide going bow-on. The boat is also going to be more stable being thrown forward than backward. The drogue, at least to an extent, is like feathers on an arrow. A boat is more stable going forward than backward. Given no proper drogue, I would go bow-on under motor, as we did. All one can do in this situation is improve the odds. The Shewman drogue has a design strength of about 5,000 pounds (2,270kg). A proper drogue would need to have a design strength of upwards of 20,000 pounds (9,080kg). It would also need to be functioning in quiet water. This means it should be maintained well under the surface (1/2 wavelength down would be ideal) or have multiple elements to reduce the chance if operating in an oncoming wave face.

DON'T RELY ON THE ENGINE

Having just spent a lot of pages discussing how to use the engine for beating in storm conditions, we'd like to close with a caution about engines.

This approach will work in many conditions where sailing by itself may not offer as much control. However, to totally rely on the engine for your safety is a mistake.

The engine itself could have a problem, the prop may cavitate excessively, or you may end up with a sheet wrapped around the prop.

At this point, without the engine, you still have your sails to help you work your way through the waves. If you have always relied in the past on the engine, you may not have the necessary sailing skills to make the most efficient use of wind and waves.

By all means, practice with the engine using these techniques. But don't neglect your pure sailing skills. Work on these as well, so that if the time comes where you are forced to sail to weather in breaking seas, you will know what to do.

Skip Elias's comments on rig and tactics:

"I don't think it would have made a difference (if we were a sloop instead of a ketch). The point was, with a centered, very flat sail, we could stay off the wind just enough to keep the boat heeled to one side for comfort.

"With our rig, we cannot reef the mizzen, so that was not an option. Another consideration is that, in such high winds, any sails used should be very heavy, very flat.

"The trysail was only used to stabilize us. We wanted to stay as close to the wind as possible.

"Keep a storm trysail on deck and rigged at all times. A main with two reefs is not of much use above 40 knots.

"We had a parachute anchor, but it was too rough to go on deck to deploy it.

"Any chafe-prone gear (drogue or parachute anchor) should be attached to the boat with chain or multiple (rope) elements.

"We needed bigger cockpit drains and will be better prepared below for the possibility of a roll (in the future)."

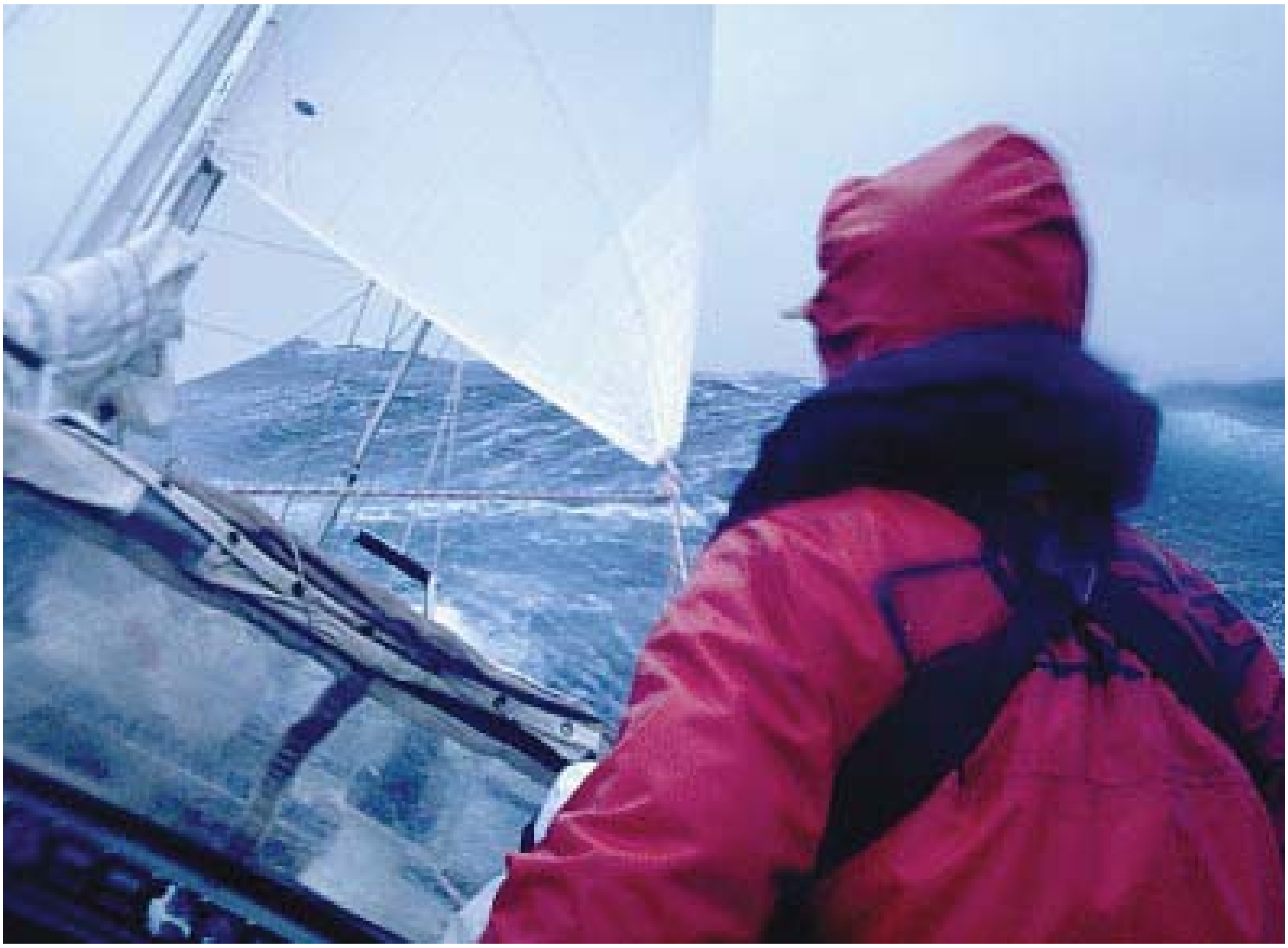
Richard Bennett

Picking the right speed to run is very much a function of boat design and sea conditions. Here we have 50 knots of wind, gusting higher, and a modern light-displacement boat sailing with boatspeed in the teens. You can see by their wake that they are actually sailing faster than the waves. Once you are close to wave speed, their negative effect on your progress and safety is much reduced.

Running Off

The traditional method of running off in heavy weather has meant going as slowly as possible, while towing some form of drogue to keep your stern to the seas. This method has the advantage of allowing the crew and vessel to assume a passive attitude. You are at the mercy of the elements and no direct action is required. The crew lie in their bunks, listening with apprehension as the big ones hiss by, theoretically safe from the tumult on deck.

The body of seagoing lore supporting this approach was based on the experience of heavy-displacement low-freeboard yachts with long keels and attached rudders. This type of vessel is difficult to steer downwind in heavy going, doesn't take kindly to surfing, and is at extreme risk in a broach. With such a design there is no choice but to adopt a slow-down approach to the elements.



Stock Newport

Sailing on a broad reach under trysail and storm jib. The trysail is a Hood radial panel sail rather than a cross-cut design. It is blowing in the 50-knot range, and seas are 20 to 30 feet (6 to 9m).

But the majority of today's cruisers sport moderate- to light-displacement hulls, detached rudders, high freeboard, and relatively low centers of gravity. As a result, they can tolerate more downwind speed, can be controlled better, and are not as subject to danger if they do broach. Thus on a modern-design vessel, it becomes possible for the crew to remain active participants in the downwind contest.

Picking the Correct Speed

Assuming you have sea room to leeward, running off at speed under control offers one of the safest ways of dealing with breaking seas. Within limits, higher speed can mean more, rather than less control, *and steering control is the secret to safety when running.*

With greater boatspeed, an overtaking wave will have less impact if it boards you. Boatspeed, as long as there is attendant maneuverability, means the helmsman can steer away from breaking crests and across dangerous troughs at the least risky attitude.

You will find that the faster you go, the less waves will overtake you and the less you have to deal with in terms of helming. Consider the situation with a wave train moving at 25 knots. If you are moving at 4 knots, running with bare poles or perhaps towing warps, the waves are closing with you at

The period immediately after the passing of a storm is potentially the most dangerous. The seas remain rough after the wind has gone; in fact, shorn of wind pressure, they quickly become unstable and more liable to break. Your boatspeed drops and the crew relaxes, happy the storm has passed. Now sail must quickly be set to keep up boatspeed. It will be several hours before the seas settle down.

a rate of 21 knots (the wave speed less your forward progress). This means you would have a wave crest to work roughly every 15 seconds. Cut loose the drogues or warps, hoist some sail area and accelerate to an average of 12 knots, and you will be working a crest roughly every 45 seconds. That's a huge reduction in the work for the helmsman, as long as the boat is controllable at the higher speeds.

The key is the physical ability of the crew to control the speed and direction of the vessel as they play on the wave faces. In deciding upon the right amount of speed, you first have to understand the handling characteristics of your boat in heavy-air downwind conditions.

Windspeed complicates decisions about what canvas to carry. If the wind were constant in angle and velocity, the boat could be trimmed for the chosen speed. But the wind is constantly changing, and it is the lulls that are the most dangerous.

Boatspeed drops, you lose steering control, and your ability to react ahead of a breaking sea—to steer out of the way of a crest—is compromised. As a result, in many situations it is safer to carry a bit too much sail than too little. Adequate speed must be maintained for good steering at all times.

Another issue in really big seas is the lull effect in the troughs. Enough speed needs to be maintained in the trough for steering control. Having the right amount of canvas in the trough will likely mean you are over-canvassed on the crest—but this is usually the lesser of the evils.

As the windspeed is going to vary throughout a given storm, the crew should remain alert to the sail area needs of the boat.

Sail Plan

The type of sail plan to be deployed and the ease with which it can be changed under adverse conditions will have a great impact on the success of your tactics. A low center of effort that is balanced in the same general area as the normal rig is required. Sails must be able to be set and led efficiently with good shape control. Carrying a storm jib far forward on the bow, for example, puts the hull-to-rig relationship out of balance, reducing maneuverability.

A storm staysail on its own or in combination with a deeply reefed main or trysail is ideal. Split rigs are usually safer this way as well, rather than with a jib and jigger setup.

One of the problems when running with a storm headsail is the difficulty of keeping the sail from collapsing in the lee of the mainsail. If the sail is alternately drawing and then collapsing, the shock loads on it will be tremendous.

There are three ways around this problem. One is to furl the storm headsail and run with the mainsail only. Many yachts will do just fine this way. Another approach is to head up 15 or 20 degrees so the headsail stays filled. The last thing you can do is lead the storm headsail sheet through a spinnaker pole reaching strut or the spinnaker pole itself.

Wave Characteristics

Within the context of the level of your crew's skill and your vessel's handling characteristics, wave shape and size are the most important considerations. The better your steering control—and this is speed-related—the easier it will be to deal with the seas.

A major factor that controls the application of these tactics is sea development. If you have been hove to, forereaching, or lying ahull, and the seas begin to break, you will have to consider running off. If only an occasional sea is breaking you will have more options in boatspeed and angle. During this period of a storm, carefully weigh the course to be steered while you still have some flexibility. Windshifts, lee shores, changing currents, and sea bottom contours that may cause wave changes all have to be considered.

You may want to work your way a bit upwind in the early parts of the storm to get into a more favorable area with less winds and/or smaller seas, or to gain some extra sea room relative to potential navigational hazards.

Four approaches to running off are shown here. Upper right, head up to around 150 degrees apparent wind angle so that the headsail and trysail will fill.

The upper left approach is to run with just a deeply reefed main, prevented to the bow.

The bottom left is to use a reaching strut as a whisker pole for the storm jib.

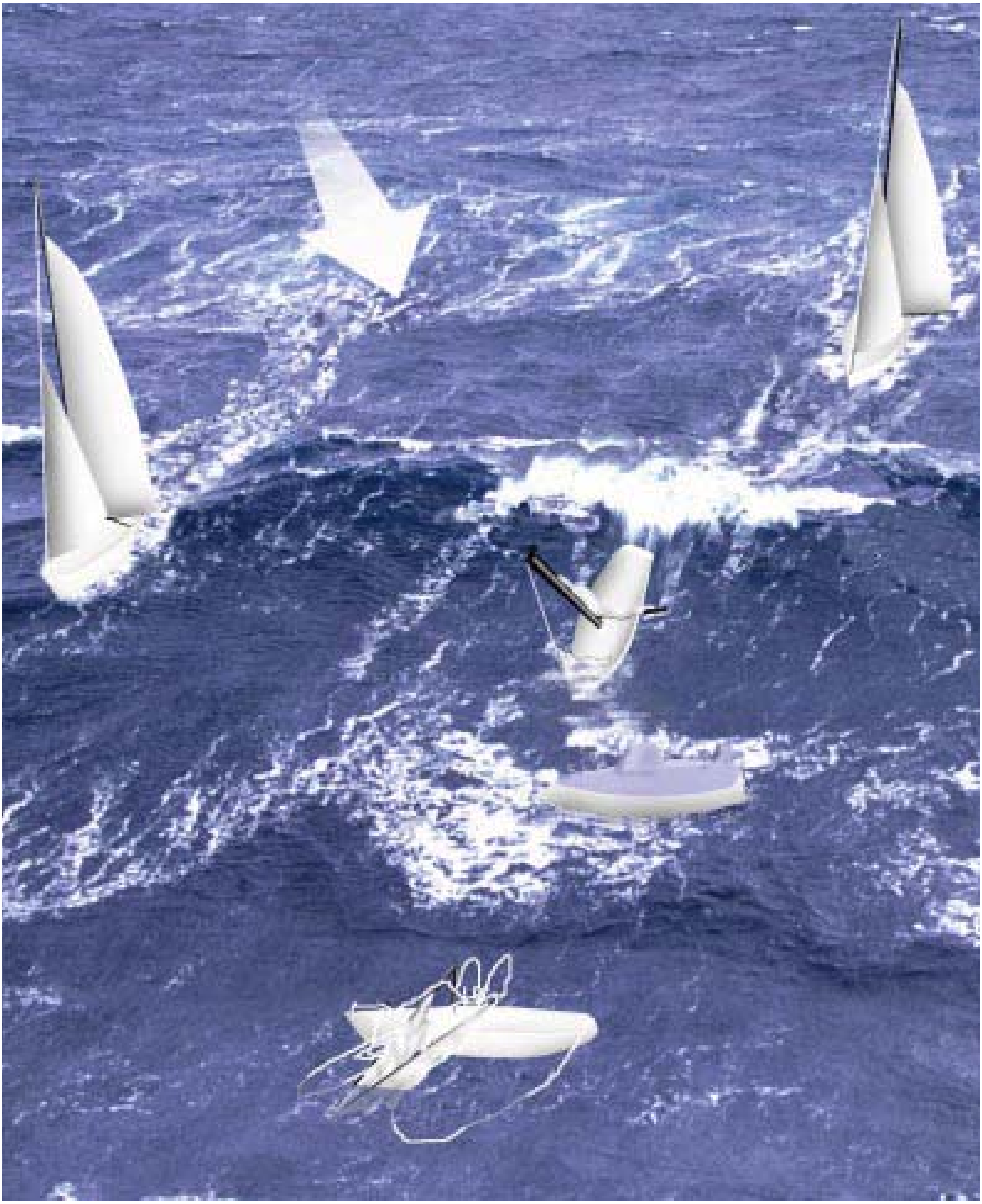
The bottom right has the storm jib hard amidships and running square before the wind.

Deep Troughs

It is worth repeating that for every large wave crest, somewhere there exists an extra-large trough. These are rarely discussed or photographed, but the odds are that the troughs do more damage to commercial vessels and maybe yachts, than do crests.

The issue when you are running downwind at speed is falling off the crest of the wave into one of these troughs. For multihulls and very high-speed monohulls, the risk is then one of a pitchpole or severe broach.

If you are worried about this issue the only practical solution is to slow down, while still maintaining enough speed for good steering control.



The images on this and the opposite page show different ways of dealing with deep troughs (and waves with very steep faces). The key factor is to maintain good steering control, and not accelerate too rapidly on the downhill side of the wave, until you know what is waiting for you. The boat on the left is going through a relatively calm spot on the wave, so they can tell from the backside of the wave that there won't be a surprise waiting for them as they come over the top. The boat on the right heads straight over a crest, accelerates down the wave face, and stuffs its bow. The crest coming along under the stern will then probably rotate the boat and knock it down, or complete the pitchpole. If caught in this situation the only option is usually to try and head up before stuffing the bow, and then pull the bow back downwind before the boat rotates too far into the wind.

Here is a different perspective on the wave, this time looking from the back side. If you are actively steering the boat, the biggest risks will be at night when it is more difficult to see the troughs. During the day, it is often possible to head up on the wave face before dropping into the "hole" and thus avoid stuffing the bow. In this image the boat is moving from right to left across the page. The middle boat is moving fast in the trough and heads up on the backside of the wave to slow down before dropping over the crest.

On some of the more aggressively sailed Whitbread boats, there is a technique of controlled broaching down the faces of big waves at night. By rolling the boat up on its side, and sliding down the wave face, the risk of sticking the bow into the bottom of a steep trough is reduced substantially. This procedure is not for the faint of heart.

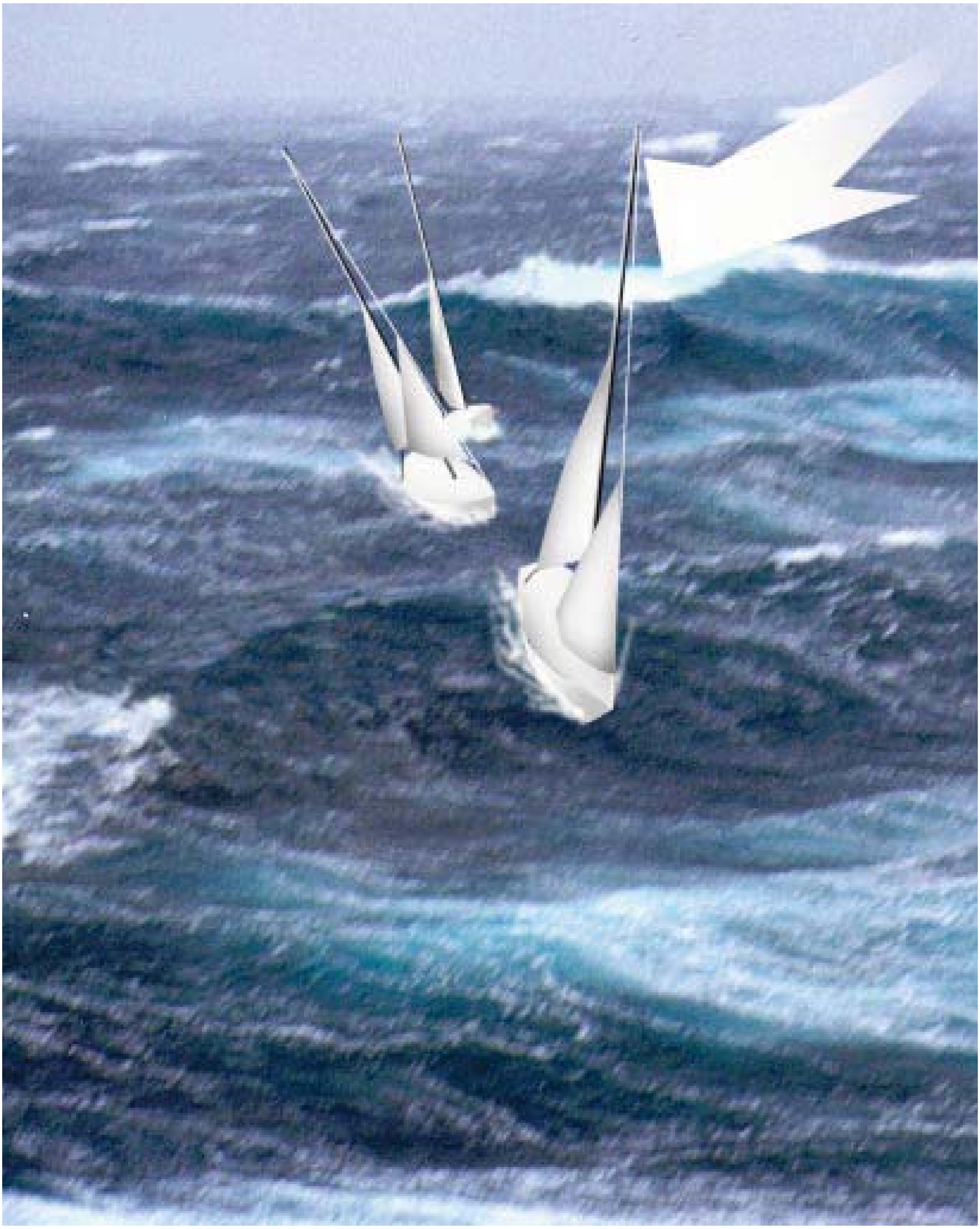
Rick Tomlinson

Sailors in the Whitbread Around-the-World Race have taken the art of downwind sailing at speed to never-before-seen levels. They routinely press these yachts with spinnakers in gale-force winds and big breaking seas—and sometimes they crash. It is usually the troughs that catch them. In the top shot the women on EF Language are about to overrun a wave crest. The interesting question is always, "What's on the other side?" Below, another Whitbread boat is smoking downhill. Check out the back of the crest ahead. They will have their nose deep into it unless the helmsman heads up 15 or 20 degrees. This will take fast action by the spinnaker trimmers, unless the sail is overtrimmed—but by this stage in the race, in the Southern Ocean, they are used to this.

Stock Newport

We don't want to over-do this issue of not going excessively fast down the wave faces, but it is an important concept. Here's a last look at this technique, with the boat moving from the top of the page towards the bottom. The top boat heads up as it climbs the crest to slow down. As it comes over the crest it then heads back off the wind, once the person steering is sure of the wave shape. The third and fourth positions show the boat heading back into the wind 30 degrees or so as it climbs the back of the wave—once again to slow forward progress.

Let's switch gears now and slow the boat down relative to the wave speed. These are heavier, slower boats, or boats towing some form of drogue device so that they are going much slower. The risk of broaching out of control on a steep wave face or into a deep trough is reduced. However, these boats have to worry about having enough steering control to maintain proper angle to the waves. The boat at the bottom of the image, in the foreground, is heading up 20 degrees or so to accelerate so it has enough boatspeed for good steering. This way, when the crest overtakes it, as shown with the top boat, the helmsman has the boat lined up square to the wave face. If they did not head up to start the process, the boat might be going too slow for positive steering, in which case they might end up at an angle to the overtaking crest.



Here is the same scenario, only this time the seas are much bigger and more of them are breaking. The waves are overtaking the boat at the bottom of the page. It has a small crest passing under the stern in the bottom position. It then heads up slightly to maintain enough speed in the trough (middle position). In the top position the helmsman sees, hears, or feels—or a crewmember calls the crest building beyond them (just under the wind arrow) and lines up the boat at right angles to it while still in the trough.

In survival conditions, the key point is having the boat's axis aligned at right angles to the wave. It reduces the chance of the wave grabbing the stern quarter and rotating it around, starting a broach or roll.

Picking the Best Course

You will often find that the boat will be much more easily controlled on one particular angle. Wave size, wind force, cross seas, and sail area will all affect this course.

For most boats the answer usually lies somewhere between a broad reach and a shy run.

In an ideal situation, you want to avoid running square to the waves. Having a 15- to 20-degree angle makes it easier to head up at the bottom of the wave if that is required, while reducing the apparent angle of the wave face (the same as taking waves at a wider angle going to windward).

However, there will come a point where the apparent windspeed and angle build up so rapidly that it makes steering difficult. If you are running comfortably under control at 165 degrees true wind angle, a heading change to 150 true may have you on the verge of an uncontrolled round-up.

The next factor is wave slaps. When the transom gets popped there is only so much course displacement your steering system will be able to handle.

Course needs to be chosen so that you have a margin of control left to deal with cross—and following—sea impact.

As the storm continues, the wind and wave relationship is going to change. As a result, the optimum course will change. The crew needs to be alert to the external conditions and stay ahead of the boat's requirements.

After the front passes the jibe that usually works best is the one that splits the difference between old and new wave systems. Hopefully, this will allow you the latitude to respond to breaking seas from both wave systems.

Let's say you are running off before a southwesterly gale. When the front passes and the wind shifts to the northwest (this is a Northern Hemisphere example) a major course change is going to be required. If you are on port jibe with the southwest wind as the wind clocks around to the northwest, you can fall off to starboard as required.

However, until the southwest wave regime has moderated, it may be better to harden up and broad reach with the new wind and waves, leaving your transom mainly exposed to the southwest seas.

Then, as the situation stabilizes, you can bear off to leeward, toward the southeast. This will keep the southwest swells on the leeward beam, and allow you to head up quickly if a breaker is spotted to leeward.

The alternative, being on starboard tack as the wind shifts, means you will immediately have the southwest wave system on the beam during the period when these seas are at their most dangerous.

Cross seas in troughs:

- ❑ It is not at all unusual to find a cross sea or swell from either the lee or weather side at the bottom of the wave.
- ❑ These cross seas can give you an uncomfortable smack, and send lots of water cascading down the deck. They can also spin the boat around at inopportune times.
- ❑ As the boat is steering down the wave face and into the trough, it's usually possible to avoid cross seas or take them at an angle to mitigate their impact—typically as close to straight-on as possible.
- ❑ If the sea is breaking, and behind or on the quarter, it generally works to align the boat temporarily with the cross sea. Then, once it has passed, resume steering for the primary breaking waves.

Here are two views of running off on opposite jibes in the same wave system. These are post-frontal waves, so there is a substantial cross sea. Wind strength is in the 60- to 75-knot range. The same rules apply here as when beating and heaving to. You need to pick the tack which puts you at the best angle to the most dangerous waves. Running off like this you want your stern to the worst waves and the other wave systems to leeward.

In the top image the boat is on starboard jibe, which means they must head up to avoid the breaking crest to the right. They will not have time to head off as too much change in course is required to get the wave onto the stern. The odds are that heading off would allow the wave to catch them on the quarter. The best course here would be to quickly luff to windward and try to take the crest on the bow quarter.

In the bottom image, the boat is on port jibe. There is more flexibility with this tack so that the breaking sea in the upper left can be taken on the stern by heading up, just a hair. The next issue will be the wave in the foreground, to the right. If this begins to break, the boat will have to bear off quickly downwind or luff up. However, this is a secondary sea. The other series crossing from the southwest are far more dangerous at this point in the storm.

If there are several experienced crew who can take the helm during adverse conditions, this opens up the possibility of being more aggressive in your tactics. If there is a shortage of capable helmsmen, then the less experienced crew should be on deck during the moderate parts of the storm, allowing those who will be needed later to conserve their energy.

Crew Capability

The pool of steering talent is important, and their collective strength must be rationed against the expected period of dangerous steering conditions. This applies to other heavy-weather tactics as well, of course. If you sail shorthanded, as most of us do, you will want to be sure that all your working crew can physically handle the steering loads.

Fortunately, it is not necessary to be caught offshore in a severe blow to learn how to steer off the wind under difficult conditions. The quickest way to become proficient is in a performance planing dinghy. The dinghy sailor's equivalent of a winter gale in the Gulf Stream won't even rate small-craft warnings in a 40-foot (12.2m) family cruiser.

Larger craft can find adequate testing grounds close to home where a strong breeze runs against a fast-flowing tide. If the water is shallow, so much the better. The short, steep waves—especially if you put up a larger than normal sail plan—will give you an idea of what may happen offshore with more wind, bigger waves, and storm canvas.

Lee Shores

If a lee shore is present (even far off) or if it may be created by a windshift, do everything possible to avoid giving up room to leeward. Maintaining sea room may mean broad reaching across the sea, in which case the helmsman will have to keep an eye out for the occasional breaking crest and head off downhill in front of it.

In the absence of the need to steer a specific course, the best downwind route is usually between a very broad reach and a dead run. Keeping the wind slightly on the quarter will be more comfortable. Boatspeed can be held in the moderate levels as the risk from going too slowly relates directly to the severity of the sea conditions.

When boats get into trouble running it is usually after a frontal passage.

- ❑ The wind shifts abruptly, and a new set of wind waves now crosses the older wave system at 90 degrees or more.
- ❑ Rather than having predictable waves to deal with from one direction, there are now random events where waves may combine into strange peaks, and come from acute angles to the boat's heading.
- ❑ Aside from the wind quitting suddenly, this is the most dangerous period in the storm—the point at which the crew needs to take the most care, and carry the right amount of sail area.

Broaching

Even a broach, properly prepared for, can be sloughed off. Heeling a well-found vessel to a 60-degree angle or more, when there is no second breaking wave, isn't a major cause for concern. If you stay dry below, have storm shutters in place, and have an easily managed rig, a little extra adrenaline may flow, but not much else.

Having examined your boat's design, checked out your crew, and practiced in moderate conditions, you must finally look to the condition of your yacht. All of the speed-reducing factors previously discussed are important when running at high speed. The less drag overall in your heavy weather configuration, the less sail area required to maintain an appropriate speed, and the easier the boat is to control.

Keeping Speed Up

As the seas steepen and more begin to break, it becomes safer to sail in the higher range of your controllable speed spectrum. Your steering has to be more adept, but you are less likely to be caught unawares by a crest and knocked down or spun around. With a windshift or secondary wave system imposed on the first, the situation becomes more complicated. The combination of two wave trains coming together at convergent angles will occasionally create unstable breaking seas. The normal wave-to-wave pattern will also be affected, and you may have to adopt a course change that keeps the most dangerous series of seas primarily aft of your stern quarter, while not letting the other system catch the bow and induce a broach.

During "normal" heavy-downwind steering your major moment-to-moment concern will be with quartering seas trying to slap the stern and spin you broadside to waves. You will hear and see these seas before they hit, which allows time to align your stern with them—or if you are late, correct course back downhill before being broached. Up to a point, the slower you move or the harder your vessel is to steer, the more you will have to anticipate the needed correction.

Even at night and with the sky heavily overcast, a breaking crest will usually be visible in enough time for you to take avoiding action. The mass of white water on the face of the wave is visible under the most inclement of night-time conditions. And of course, the sounds it makes don't change at night.

Using the engine for steering control:

- If steering is difficult, if it is hard to deal with the balance in sail area between lulls and gusts, or if the wind has suddenly dropped, it often makes sense to use the engine along with sails to maintain proper boatspeed.
- Prop thrust over the rudder also helps steering control at slower speeds.
- Obviously, the same safety factors discussed starting on page 351 apply here as well.

Using the engine to slow down: At some point you may find you have too much speed and need to slow down. Towing warps or drogues (discussed in detail starting on page 421) will reduce boatspeed but have the inherent problem of being relatively fixed.

It sometimes makes sense to run the engine in reverse as an overall means of slowing progress.

This gives you the ability to allow boatspeed to increase quickly when a lull threatens.

However, the coupling between the transmission and prop shaft must have a very positive connection. A tapered shaft coupling with a small key and a couple of pressure bolts may not be up to the task.

Split couplings, on the other hand, which can take the same load in forward or reverse, will do fine.

Richard Bennett

Choosing the correct speed at which to run is very much a yacht-specific issue. Many modern yachts steer so well at high speed that the faster you go (as long as there are not big troughs in which to fall), the safer you are, and the easier the boat is to handle. Other, heavier designs, must be kept at displacement speeds.

In the photo above it is blowing at least 50 knots, gusting higher. These sailors are having a wonderful ride, sailing square with the waves 4 to 6 knots faster than the waves are moving.

Yacht-Specific Considerations

Yachts at extreme ends of the design spectrum will require different handling. Extremely heavy vessels with attached rudders will be uncontrollable under the same conditions that will allow a more moderate design to be surfing gaily ahead of the waves. But design doesn't change the basic approach to dealing with extreme conditions. Less controllable yachts should still be run at the best speed commensurate with steering control within the context of their capabilities.

Extremely light, small yachts may accelerate too fast on a breaking sea to be controlled by any but the finest helmsman. They are caught in a design-induced conundrum: too fast and they may spin out and be rolled; too slow, and they will be caught by a breaking crest and smashed down in the trough. On the other hand, ultralights with balanced hulls and a low vertical center of gravity are so easily steered that they can be handled by less experienced crew with a higher degree of safety.

Stock Newport

The better steering control you have, the faster you can go; and the faster you go, the safer you will be in most situations (but not all). The ultimate expression of this approach is found in the BOC and Whitbread boats. These yachts are designed to sail faster than the waves under full control. This means that you have the option of picking where to steer, and what to avoid in terms of waves. It also means the waves have less chance to bang the aft sections of the hull, sending you into a broach. On the other hand, you have to take more care with cross seas. If they are a potential problem, or if the seas are extremely steep, the boat must be slowed down.

Steering Techniques at Higher Speeds

We've left the most interesting part of this subject for last. Unless you are in a survival storm, running off before big seas is an exhilarating situation. The interplay of boat, wind, and waves is wonderful to behold (and excellent practice).

Steering techniques, of course, vary with the boat and the situation. But there are some generalities.

The first is what to do at the beginning of a wave. You will sense—feel, see, or hear—the crest start to overtake the boat. It is during the first few seconds of the crest that the most important steering adjustments need to be made.

If you have good speed at your disposal, head up just a hair before the crest hits to accelerate the boat, and then pull the bow downwind before the crest actually impacts—so that you are aligned heading down the wave 15 or so degrees up from a right angle to the wave's direction of travel.

Richard Bennett

As you start coming up from a run towards a broad reach, steering becomes more difficult. The waves are pushing the stern to leeward as they pass, trying to round you up into a broach. As the boat heads closer into the wind, apparent wind goes forward and builds rapidly, which in turn heels the boat. The heel angle increases the tendency to round up. When you are on the edge, as with the yacht in this photo, it take very quick reflexes on the helm to react ahead of the sea and wind, so that the helm does not get a chance to load up. It would help here to reduce sail, or sail a lower course.

If the boat is more sluggish and prone to rounding up from the slap of a crest, the helmsman needs to anticipate the arrival of the crest and have the boat heading down well before the crest arrives.

The next steering decision is about the bottom of the wave's trough. If the wave isn't that steep, you can continue down the face on a straight course and then continue up the backside of the next sea, or wait to be overtaken by the crest.

In order to maintain speed at some point you may have to head up to build apparent wind.

If the wave you are on is steep, if there are cross seas in the trough, or if the backside of the next wave is especially steep, you will want to pull out and head up before the bottom of the trough is reached.

This will call for anywhere from a 15- to 30-degree course correction to windward.

Many modern designs will steer with fingertip control at surfing speeds. Older yachts and those with deep or V-shaped forward hulls tend to "lock in" at speed. If your vessel is of the latter variety, it will be necessary to anticipate the required angle to the wave before acceleration starts.

Working big waves at speed:

- ❑ Head up to accelerate in lulls or as crest approaches.
- ❑ Listen for the crest, or sense the lift of the stern at night when you cannot see the waves.
- ❑ Head off as the boat begins to accelerate.
- ❑ Before the bottom of the trough pull up 15 to 30 degrees to avoid burying the bow.

Richard Bennett

Take a close look at the sea state in this image. There is a significant cross sea coming from the left (arrow). These are going to make things wet, and occasionally uncomfortable, but in this level of sea—about 8 to 12 feet (2.5 to 4m)—there's little to worry about for a well-found vessel.

Steering at Slow Speeds

If you are steering at slow speeds, with the waves overtaking, the odds are you have less steering control and are perhaps on a heavier design, which is not happy when surfing.

There may be some warps or a drogue out to help align your stern. If this is the situation, then the major steering issue is keeping the boat from turning broadside to the seas.

The less responsive the boat is to her helm, the more you must anticipate needed steering corrections, and get the boat aligned with the wave before it has overtaken you.

Jibing

The basic premise for jibing in heavy weather is similar to that in more moderate conditions: The loads will be lightest when the boat is accelerated, as in a surf.

On the other hand, loads will be much higher if you've just completed a surf and are parked at the bottom of a wave with the apparent wind howling about your ears.

The tricky part of this maneuver is getting the sails across without something catching, or sails filling before you are squared away—in which case you could be quickly beam-on to the seas.

If you know a jibe is going to be necessary, because of an expected windshift, or navigational obstacle, it is always better to do this early before the wind and seas have really built up.

Jibing in heavy going is always an interesting experience. Success depends very much on picking the right point in the wave sequence. Ideally, you will have the boat well accelerated, going down a wave face as the main boom comes across. This reduces apparent wind loads, lessens the chances of breaking something, and provides extra time before you lose steering control. However, in some situations, it may be safer to head up and tack through the eye of the wind, rather than risk losing control and broaching.

Richard Bennett

This is the same vessel as shown two pages earlier. The camera angle is different, and the sea state is more readily apparent. Note the crossing crest (lower arrow) and the breaking crest behind it (upper arrow). Even though this yacht is shortened down to storm jib and triple-reefed main, she is still moving along at almost wave speed. With fin keel, spade rudder, and light displacement, she can surf off ahead of the waves with ease, as long as she doesn't get caught by a large cross sea or dropped into a trough.

If you are caught in severe conditions, it sometimes makes sense to pick a smooth spot, round up into the wind, and then tack rather than jibe.

But if you have to jibe, and are short-handed, you will want to have sheets neatly flaked and ready to run.

Our preference is to drop or roll away the jib, so we just have the main (and possibly mizzen) to deal with.

Our technique is as follows: steer up from a run 15 to 20 degrees. Start to crank in the main, typically about a third of the way. Rest for a couple of moments before resuming. The final period of cranking goes as fast as possible as the boat is much harder to control with the mainsail inboard.

With the boom in a reaching position, we start to steer dead downwind watching the leach for signs of a premature jibe. When the sail is amidships, we slowly put down the helm so that the leach starts to curl towards the new tack. As the boom starts to come across, we head back towards dead downwind, so there is less tendency for the boom to drive us into the wind.

We ease the sheet before it stops the boom, reducing shock loading. As quickly as possible we ease the boom to its former position and reset the preventer.

Here we have a medium-performance design that is capable of surfing the waves, but not running at wave speed without a kick from gravity on the wave faces. This type of design will accelerate more slowly than a light-displacement, higher-performance vessel. This means less risk of flying off into a trough if a steep crest isn't played correctly. However, it also typically means less maneuverability (and less ability to accelerate out of the way of danger), so more anticipation on the part of the crew is required.

The key feature in this image is the large crest in the lower left corner. There's a steep, overhanging face and a deep trough. If you go "over the falls," as surfers call it, a pitchpole or broach and roll may result. So the helmsman heads up on the back of the crest to bleed off some speed, allowing the crest to pass along under the boat and away (downwind) from them while it is breaking.

Here a much slower boat is being overtaken by the waves. The key issue is making sure to be properly aligned with the waves as they roll past—stern just off of a right angle. In the upper part of the image (second boat from the top) there is a crossing peaked crest. The boat will need to be headed momentarily upwind on a reach to bring this crest onto the stern. Because this boat is flying only a trysail, she will rotate much more quickly into the wind than with a storm jib forward.

Stock Newport

Reaching in Heavy Air

Reaching in heavy air with breaking seas is one of the most difficult courses to maintain safely. You're more or less beam-to the waves, which means if you're caught by a crest, you are likely to be knocked down.

Obviously, if there is a choice, heaving to, beating, or running off are better approaches. But sometimes you need to head abeam of the wind and sea to get away from the storm center, out of the current, or into the shelter of a windward shore or safe harbor.

Steering through Wave Crests

This technique has already been described in some detail in the *Bin Rouge* chapter (page 274). Once they decided to head for shelter, in the port of Eden, they had to maintain a course which was more or less abeam of the sea.

The issue here is one of speed and maneuverability. The more speed at your disposal, and the better the maneuverability, the greater chance you have of dealing with breaking waves.

There are typically two approaches: the first is to avoid the breaker entirely by accelerating off ahead of the crest. The risk here is that you won't be fast enough, or that more of the wave than you are expecting will begin to break.

The other approach, that adopted by *Bin Rouge* most of the time, is to head up into the crests, so you are putting the bow through, as when going to windward.

The main difference is that on the backside, once through the crest, you pull the bow off much more sharply to leeward, and then make as much distance reaching as possible before the next breaking crest is encountered.

Here are two views of a path through a series of breaking seas. The boats are shown starting from a position far away from the crests on the left side of the image, and then reaching down for speed to cross the area where the crest is likely to break. They both then head up across a relative smooth patch between crests, before resuming their reach down and across the backside of the waves just crossed.

Weighing the Odds

Before adopting this approach you need to weigh the odds of success. Does the advantage to be gained by reaching across the waves offset the risks to be taken?

This is very much a function of wave shape at the present time, the options you have for dealing with the waves, what you expect to occur with wind and waves in the future, and the capabilities of vessel and crew.

A boat that is not quick to turn on its axis, or that accelerates slowly, is taking more chances than a faster, more maneuverable vessel. The crew of the slower boat will have to anticipate so much more of what the sea is going to do.

The crew must be up to the steering demands as well—even more so than in the case of some of the other storm tactics we've been discussing. To reach across breaking seas demands quick reactions on the helm, plus a dose of good luck.

It is often less risky to adopt another strategy, maintaining your sea room and keeping bow or stern into the waves by running or beating.

Be aware of your situation:

The decision to reach off for the apparent shelter of shore or to get out of the weather or waves carries with it significant risks.

The decision will be based in large part on what you expect the weather to do. If you have an accurate feel for this, then the decision-making process becomes far easier.

If the odds favor significant deterioration in the local weather, then reaching off now, while it is still an option, may be the most conservative thing to do.

On the other hand, if the weather is stable and the boat is dealing with the seas, you are probably better off staying put.

All of this bespeaks the necessity for a good handle on the weather, so you can evaluate what the forecasts are saying and make an educated guess about what is to come.

Stock Newport

This schooner is shortened down, keeping her heel angle modest in this fresh gale. By reducing heel, you improve steering response.

This is a trickier situation, with two breaking crests to be dealt with (shown by the black arrows). There are three options. First, run off and present your stern to the waves, which is almost always difficult to accomplish from a reach as few boats have the ability to head downwind this fast, and the acceleration could end up causing you to stuff your bow. Second, reach off just a bit and try to get past the crest before you are caught. Third, which you see here, is heading into the crest to take it on the bow. If using this tactic, the sails should be set up to allow you to turn into the wind quickly. This means weather helm—more sail area in the main or trysail than in the storm jib, and the storm jib set aft on a cutter stay, not on the headstay.

Lying Ahull

If conditions are such that you feel lying ahull may be a safe compromise:

- ❑ Keep a wary eye out on the development of the storm and its seas.
- ❑ You will want to change tactics *before* waves start to break.
- ❑ If you wait until it seems dangerous, the same breakers that give you warning may also roll you over.

When wind strength increases to the point where there is simply too much wind force to heave to, lying ahull can be a convenient, albeit potentially dangerous, way of "playing possum" with the elements. Shorn of sail, with only natural windage, most yachts will lie head downwind in a beam- to broad-reach attitude.

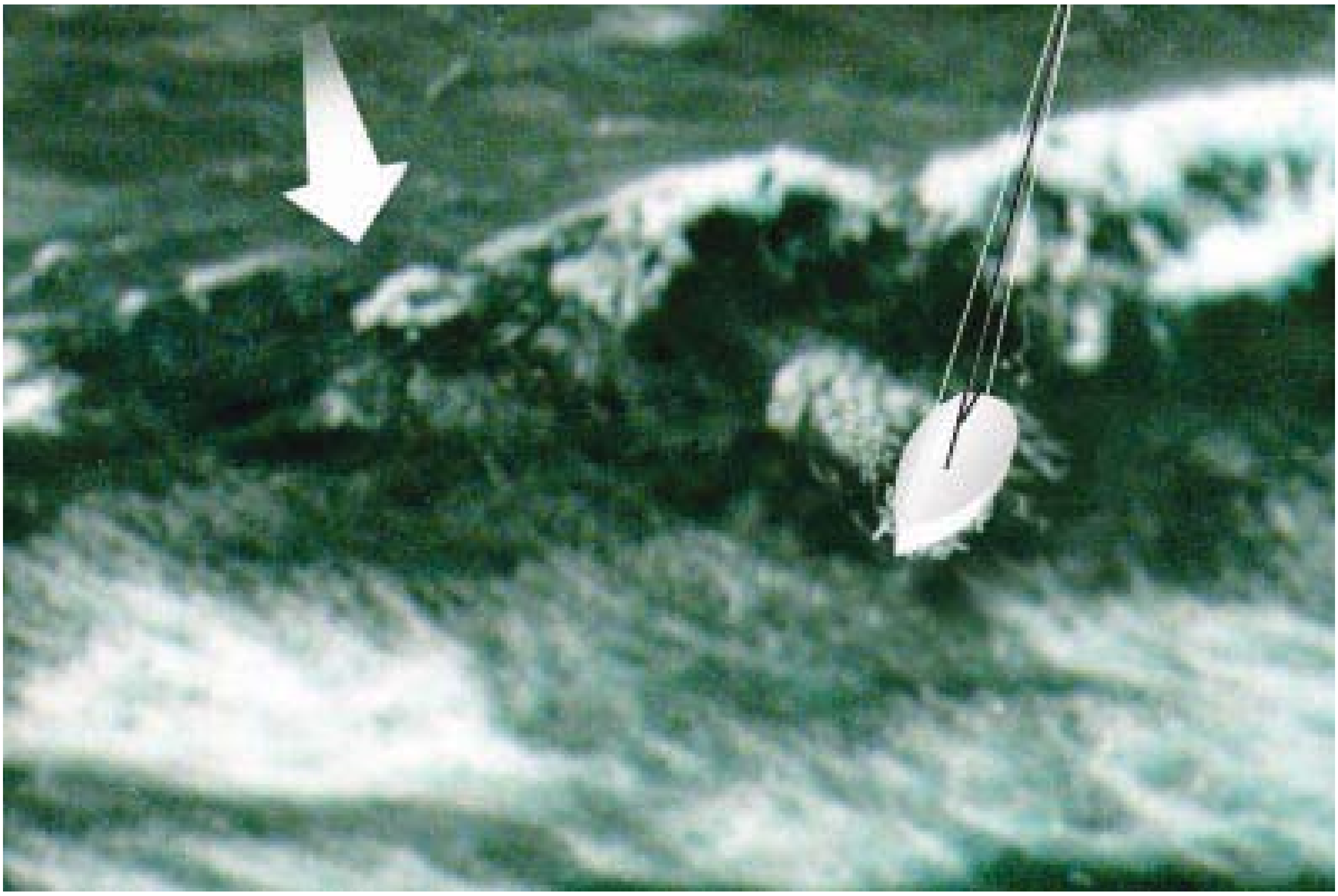
The Dangers

Lying ahull is only a temporary stop-gap tactic. While it has the advantage of allowing the crew to stay below, it also has shortcomings: First, it is very uncomfortable. Rolling motion will be extreme, and moving around the boat at all will be difficult. Second, drift to leeward will be rapid. Third, once the seas begin to break, you are at a very vulnerable angle to the waves, with no means to adequately steer clear of dangerous crests.

Under these conditions, lying ahull becomes the most dangerous of storm tactics. The majority of people who lie ahull in breaking seas end up capsized.

However, lying ahull can be useful for short-term squalls, where the wind comes up rapidly and the easiest thing to do is to strip sail off the boat and wait things out. This presupposes that the wind has not had time to build much of a sea, so there is no danger from the waves.

When you are thinking about lying ahull consider the breaking waves you have seen throughout this book. If the waves are not breaking, then lying ahull is fine. If they are breaking, monohulls are asking for a rollover.



Two more reasons why lying ahull in breaking seas is dangerous. Granted, these seas are huge, and it would be rare to find one this large sharing the same patch of ocean with you; but even a 10-foot (3m) breaking sea has the power to knock you down, if it catches you in the wrong attitude.

Multihulls in Heavy Weather

The entire subject of multihulls in heavy weather engenders heated debate. There are those who say multihulls are not safe offshore, and others who say they are the only way to go to sea.

The issue of appropriate storm tactics is also discussed with some passion, even among the multihull experts.

Although we have sailed multihulls extensively ourselves, and have been through a few moderate blows in them, we felt that the best approach to this subject was to check with some of the designers and sailors who have been racking up the miles. You will find their thoughts here, as well as in the section on professional sailors, starting on page 481.

Erik LeRouge

Erik has designed over 200 yachts, split evenly between monohulls and multihulls. Between 1976 and 1991, he sailed 5,000 to 10,000 miles a year. Now he spends more time with his family, but still goes offshore during sea trials to test his new designs.

Erik LeRouge

Erik LeRouge is one of the better-known racing and cruising multihull designers in Europe. Based in France, he is somewhat unique in that he has sailed his designs extensively offshore, spending a considerable amount of time in heavy weather.

The following account is of a race from Lorient on the coast of France to the Canary Islands. Erik is sailing aboard *Freydis*, one of his 46-foot (14m) long, 25-foot (7.6m) wide catamaran designs.

Lorient to Canary Islands

A southwest gale was forecast for the start of the Transat des Passionn's in Lorient. Rather unpleasant to start a 1,500-mile passage towards the Canaries. Unfortunately, weather charts were showing new lows on the Atlantic and there was not much hope to cross Biscay in November.

I decide to leave with the northwest windshift because if we have to ride a gale, let's do it off the wind—it is not so bad and at least we will sail fast!

The morning forecast is Force 9 with gusts. It is not an easy decision to make, but we leave harbor at noon. *Freydis* is a good 46-foot (14m) catamaran with an experienced crew and, after all, we are well-prepared to cross the Atlantic.

Under double-reefed main and half-rolled jib the coast is quickly out of sight, then wind and sea increase. Third reef in and jib rolled to storm jib size.

We overtake all the monohulls which had left in the morning, a beautiful sight. The course is set 60 miles offshore of Cape Finisterre to stay in deep water.

The night will be rough, and for the first time of my life, I decide to run under bare poles. The rotating mast is a big help to drop the mainsail and is angled 45 degrees, which is enough with the windage of the mast to act as a storm sail.

As usual in Biscay, we have short cross seas around 15 feet


Freydis in more pleasant sailing conditions.

Erik LeRouge

(4.6m) high. Westerly swell from the previous day and sea building up from the north with the windshift. Occasional 20-foot (6m) breaking waves. One of these takes us on the beam. I was crossing the saloon, then flew across it to land inside the hanging locker, which I thought was too small for me, at least on the plans! The helmsman bent the steering wheel before reaching the lifelines while the other crew on deck was wrapped around the mainsheet.

Apparent windspeed sometimes exceed 50 knots and a few surfs top 24 knots, averaging 12 knots—awful noise and the cross-sea shaking us terribly. The main thing in these conditions is to find the adequate speed for the slope of the swell: too fast and we dig into the waves which we overtake, too slow and we are pooped by the breaking waves. The jib roller is greatly used to increase speed between the squalls.

La Corona is left behind, and two days after the start the wind drops to 40 knots and the double-reefed mainsail is set. The maxi-yacht *Atlantic Privateer* confirms on VHF that it was gusting to 70 knots.

Life starts again—hot shower, proper meal, but a 27-knot surf reminds us that this end-of-gale sea is treacherous.

Moral: It is not very clever to seek a Force 10 storm in Biscay, but *Freydis* could take a lot more and this gave me a few ideas on what I will do if I am stupid enough to find myself in worse weather.

The third day is spent becalmed off Lisbon with a new southwest gale warning ahead. Fortunately, boatspeed allows us to round Cape St. Vincent before it becomes nasty. Our luck does not last, while a low deepens between Madeira and the Canaries to give us three more days of southwesterlies gusting to 48 knots with hail, thunder, and 15-foot (4.6m) short seas off the

Erik LeRouge:

- ❑ Never steer dead downwind. For best stability, steer with an angle to the waves. This lets you choose where the breakers are not so bad.
- ❑ I prefer to run as long as there is sea room.
- ❑ When sailing with an angle to the wind and waves, you can escape from a bad gust by bearing off with boatspeed.
- ❑ It is important to keep speed under control, so bear off when there is too much, and luff to keep it up.
- ❑ The danger when under bare poles is to be without wind at the bottom of the wave and get caught again by the wave.
- ❑ If you are going too slow there is a danger from broaching for the same reason.
- ❑ I would only consider a parachute anchor if there is no other choice due to lack of searoom. I would use it from one bow only to get maximum diagonal stability—the bridle could allow adjustment of the angle.

"I had plans in case things got a lot worse. Fix the mast so it's not rotated and run under bare poles. Pull all heavy weights back onto the aft beam. Tow warps. However, I felt we were not at the limit of *Freydis* and could cope with a lot more.

"It is essential to have a rig which allows you to reef the main downwind.

"I have never used a drogue and am skeptical. Safety comes from keeping the boat to the design weight and going fast.

"A Catana 44 with exhausted and panicked crew rigged a para anchor from the bows and forebeam with a bridle and 490 feet (150m) of rope and went inside. They reported 70-knot gusts. The boat was capsized backward, bow over stern, possibly due to lack of stern buoyancy. It was a bad storm and a 52-foot (16m) cold-molded (timber) monohull cruiser/racer was smashed by the waves and sank in minutes. Other monohulls were capsized or dismasted."

Morocco coast. I don't need to sail that far to enjoy this kind of sailing—the English channel is enough for me!

This time we cannot run. We have to either seek shelter in Morocco—which I do not recommend with dangerous coastline and unpleasant harbors—or beat our way against the wind.

Not as exhilarating as running, I am using a completely different technique while beating. The idea is to keep a comfortable speed—not too fast to avoid slamming, but fast enough to go somewhere—steady the boat and keep steerage. On *Freydis* this means around 8 knots. I keep a lot of mainsail (two reefs in these conditions) and reduce the jib to handkerchief size only to keep the balance. In gusts the mainsail is twisted to release the pressure, then sheeted back after the gust. Jib unrolled to keep the power only when the wind becomes too light before the next increase.

We constantly have to steer the boat through the waves, pointing high to keep the speed down. Bearing off is dangerous in these conditions with a dramatic increase of speed.

The last day, at least, pays for all our troubles. The mighty *Atlantic Privateer* is a few miles behind us at daybreak and stays there for the last 150 miles beat to the Canaries. Calm sea, Force 4, sunshine, just perfect.

Superb arrival in Tenerife. We see 12,000-foot (3,680m) high snow-covered Mount Teyde from 60 miles, fireworks on San Andreas, lighted Santa Cruz hills, and a party onboard *Atlantic Privateer*.

The next boat arrives two days later, the entire fleet being scattered in Spanish, Portugese, or Moroccan harbors for repairs or to wait for a break in this boring southwest wind.

Heavy Weather Suggestions

Control of speed is the main factor. It is important to sail nearly as fast as the waves to reduce their impact and have an efficient rudder, but it is essential not to overtake them because the speed increase downhill could be fatal. I could have further reduced speed by reducing mast angle and sheeting the boom and furled mainsail on the centerline.

Safety is increased if all heavy weights are moved aft.

If the boat is still going too fast, it is time to put the brakes on. A drogue can be improvised with all the ropes and chain carried on board. I think that at high speed, ropes must be weighted to have any effect. The drogue should be secured on various mooring cleats or winches to be able to modify the boat angle to the swell.

Choose, while it is still possible, to jibe or tack towards deep water.

Do not forget the crew. If possible, shift the best helmsmen before they get tired. Prepare easily reached energizing food. Try to drink hot fluids. Force the crew to lie on a bunk—one can rest, even scared to death. Crew on watch should wear harnesses; the others should shelter inside. Take pictures: It is beautiful and it boosts the morale!

Stock Newport

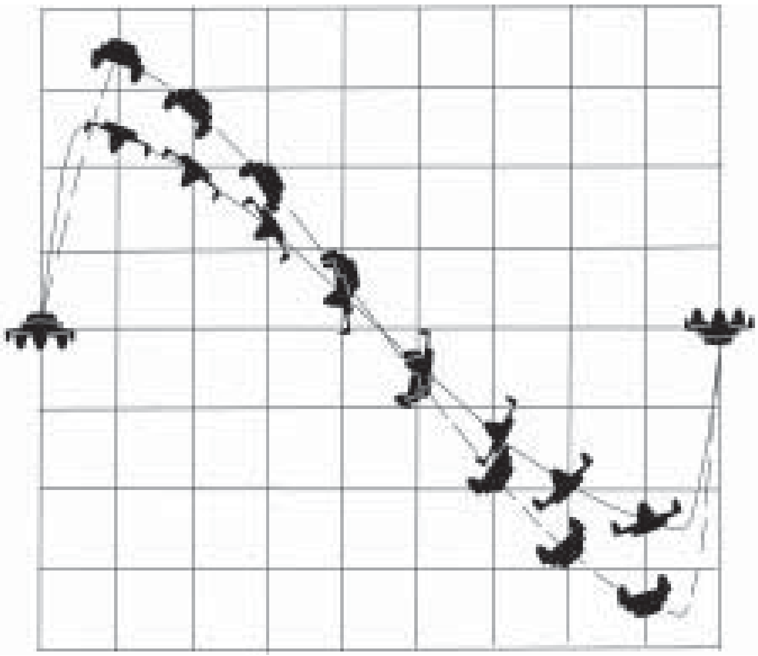
The 80-foot (24.5m) catamaran Enza at the finish of her circumnavigation. The winds are storm force and above, seas are short and breaking. This is a huge, powerful multihull, being sailed by some of the best seamen on the planet. Note the tiny storm jib set on the cutter stay. Enza is also towing all of the extra rope and chain they have aboard to try to slow progress.

MULTIHULL ISSUES

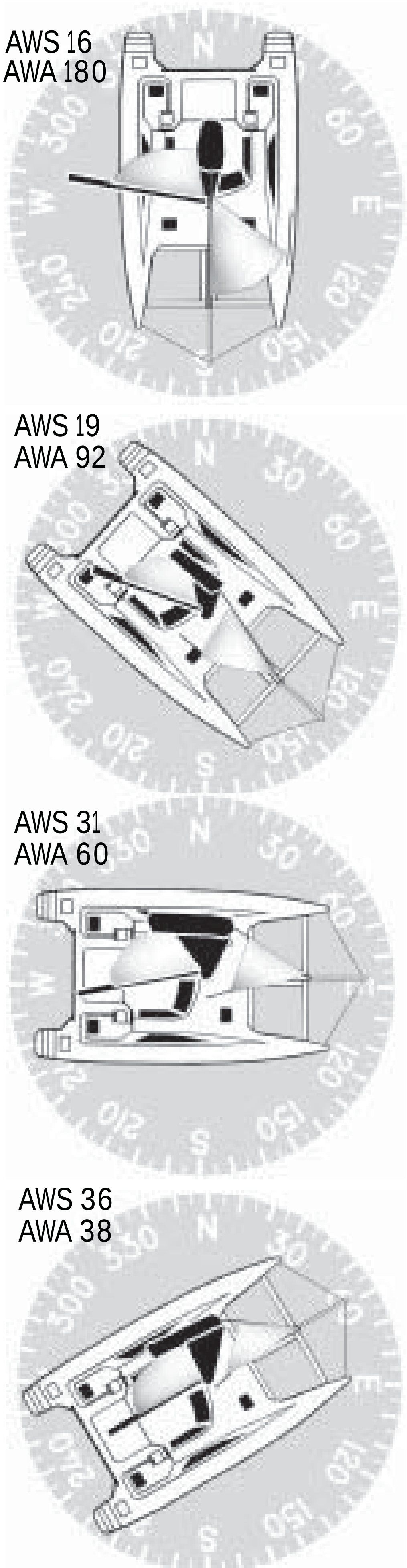
The big advantage that multihulls have is initial stability. That stability is greatest at zero angle of heel. Once the hull lifts, the stability drops continuously until, at around 65 or 70 degrees, the odds are the boat will capsize.

Since stability comes from the geometry of the multihull—wide beam and long hulls—the greatest stability to wind and wave will be on the diagonal—when the wind and sea are on the forward or stern quarter.

This point of maximum stability has a major impact on all storm tactics.



Multihulls have huge initial stability, but once heeled to past 70 degrees or so the stability begins to drop rapidly—which is why it is important to keep them sailing upright!



Apparent wind force builds rapidly as you turn from a run to a reach. Keep in mind that wind energy goes up with the square of velocity, so small increases in angle or windspeed generate huge increases in overturning force.

The sequence of numbers with each of these drawings is for 28 knots true windspeed. The apparent windspeed (AWS) and apparent wind angle (AWA) are shown with associated values. The compass rose indicates the heading relative to the wind for each boat. This data would be accurate for a high-performance cruising multihull.

Wind Risks

The risk of capsizing due to wind is easy to quantify and deal with. Either you reduce sail area so there is not enough area to overcome the initial stability, ease sheets, or change course.

In this context, it is important to understand the function of apparent wind in creating capsizing forces.

When you are running or broad reaching, apparent wind is less than true wind, and it is pretty much aligned with the attitude of maximum stability for a multihull.

However, when you begin to head up, apparent wind builds quickly, both from the change in angle, and because the boat is probably accelerating.

As the apparent wind angle comes closer to beam-on, it is reaching its point of maximum force just as the multihull is reaching its angle of minimum stability. This is responsible for what is called the "death zone" among multihull racers.

If you are beating or close reaching, the sheets are cleated and you begin to be overpowered, head into the wind. This reduces rig forces while increasing stability relative to the wind angle.

If you head off with a puff when close reaching, wind forces build while stability drops—and the result is often a capsize.

The opposite holds true when broad reaching. Head off with the puffs to reduce wind force and increase stability.

And if you are reaching either side of beam to the wind? Be very careful with sail area and be ready to release the sheets, as nothing can be done on the helm to improve the situation.

Sail Area

One of the first things to learn is how much wind is required to lift a hull at various true wind angles. From this data you can then establish some wind levels, beyond which you automatically reduce sail.

For example, if, when close reaching, you begin to lift a hull at 35 knots apparent windspeed, you might wish to begin reducing sail at 24 knots, roughly a 50 percent factor of safety. (Remember, wind force increases with the square of velocity.)

It is also necessary to maintain helm balance as you reduce sail area. If the area is all taken out of the headsail, leaving a full main, and you are broad reaching, it will be difficult to head down in the puffs as the mainsail will tend to force you into the wind.

If sailing free of the wind (righthand boat), you will want to head down in the puffs of wind or when a wave lifts a hull. Carrying more sail on the bow and less aft makes it easy to turn in this direction. From a reach, however, you will want to head up in the puffs (left boat)—in this case carrying more sail aft and less forward works best.

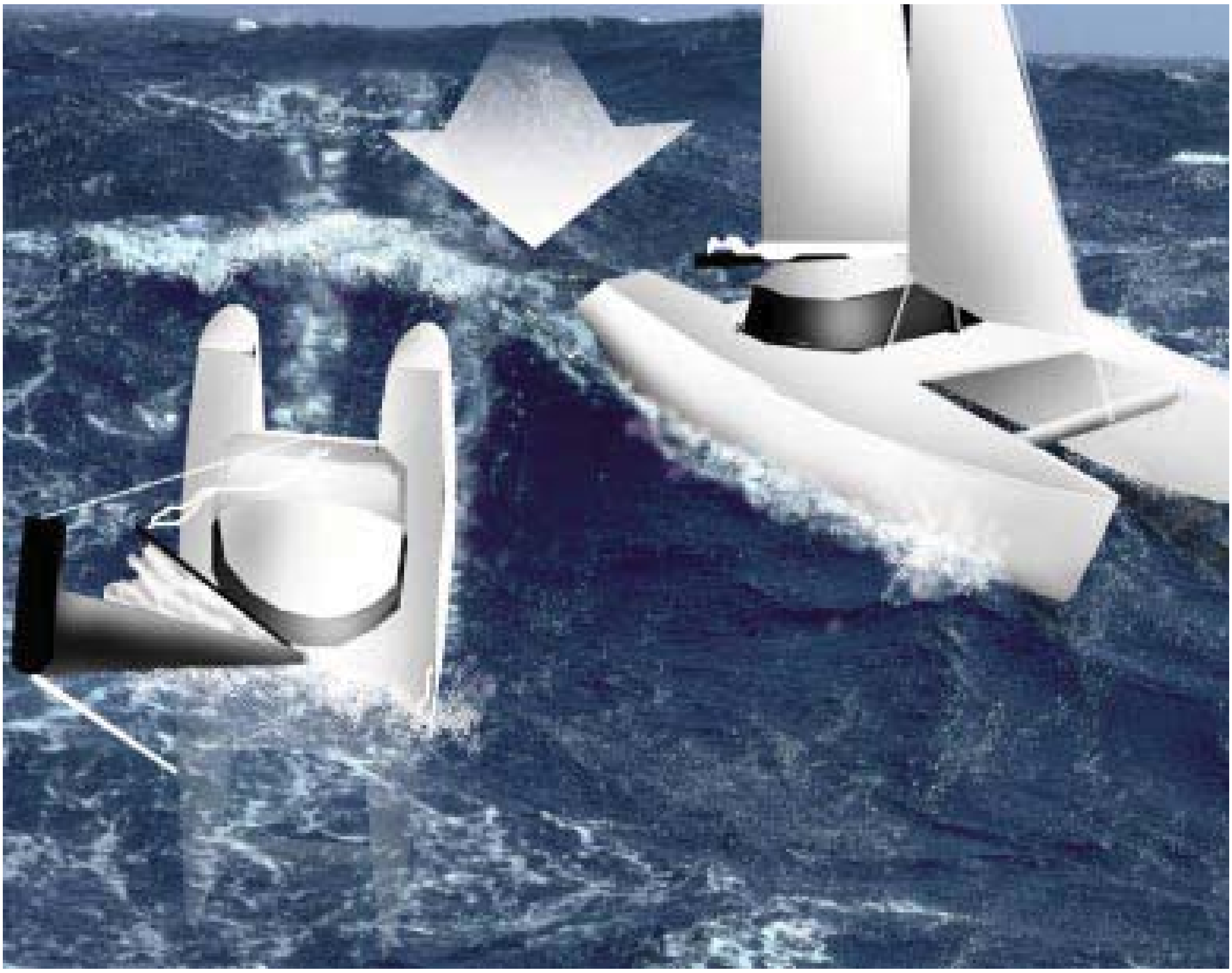
The opposite is true when reaching. Take all the area out of the mainsail, and the jib will make it difficult to feather into the wind in the puffs.

Wave Shape

While you have lots of discretion with wind to ease heeling pressures, if a wave catches you and begins a capsize, there is little that the crew can do to prevent the capsize.

Since waves are random and chaotic, it's never possible to know exactly what you are setting the boat up to handle. If you end up in the wrong place at the wrong time, there is not going to be much of a second chance—once you're at the start of a wave-induced capsize.

Whether you run off at speed, heave to, beat slowly, or lie to a drogue or parachute will depend on many design issues. But the underlying factor driving everything else is wave shape. In this respect, multihull heavy-weather tactics are much like those for monohulls.



Going straight down a wave fast in a monohull can lead to a broach and maybe a knockdown—even though stuffing the bow and pitchpoling is a very rare event. However, the relative fineness of multihull bows, combined with the speed at which they can accelerate, makes the risk of stuffing the bow and pitchpoling or rotating into a capsize is much higher. Thus more care should be taken in maintaining the appropriate angle at which to descend the wave face. As shown here, the wind and/or wave should be on the diagonal, across the hulls so stability is at a maximum, and you have steering options left if the situation begins to get out of hand.

The issue is one of wave shape and the position of the boat on the wave. As with monohulls, anything that hints of beam-on to a breaking sea is dangerous. Not only are you in an attitude to absorb maximum wave impact, but the boat has an initial heel on the wave face, reducing stability. And of course, beam-on is the narrowest, least stable dimension.

So waves must be taken on the bow or stern quarters where stability is at a maximum.

The second issue is acceleration down the wave—high-speed surfing. This is exhilarating, but can be dangerous if it leads to stuffing the bows, pitchpoling, or broaching so that you rotate beam-on to the crest you just surfed.

You do not have to have big breaking seas to create a problem with excessive speed. A moderate wave in 30 knots of wind can get some boats moving so fast that if they stop or pivot at the bottom, the combined wind and wave forces are enough to start a capsize.

In this image we have a trimaran picking its way downwind: Heading up a bit on the crests to slow down, and then sailing at a lower, faster angle in the troughs (unless speed was required for maneuverability, in which case you would head up to a very broad reach to accelerate). As the boat comes over the crest, it heads up to keep the wind and waves on the diagonal, as you can see with the boat in the foreground.

Speed and Angle Downwind

Picking the right speed is much the same as with monohulls. You want to go fast enough for fingertip response to steering, and no more. This varies with boat types, steering systems, and, of course, sea state.

When running in marginal conditions, it often makes sense to bring the wind and seas on the quarter. Here stability relative to wind and wave is greatest; and you can escape by heading straight down the wave if the boat begins to be overpowered and lifts a hull.

Stock Newport

Two more images of Enza. In the first photo on page ***389*** *conditions didn't look that bad. But check out the sea she has just dug her nose into (top photo). If she was up to even moderate speeds (by her standards) in these conditions—20 knots—she'd be in big trouble here.*

If you look closely at the lower photo, you can just make out one of the warps being towed in a bight between the two transoms (arrows).

Optimal Beating Angles

Beating involves different trade-offs. One of these is wing-slamming. Although this is a problem off the wind as well, it can really tire the crew sailing upwind, leading to mental errors.

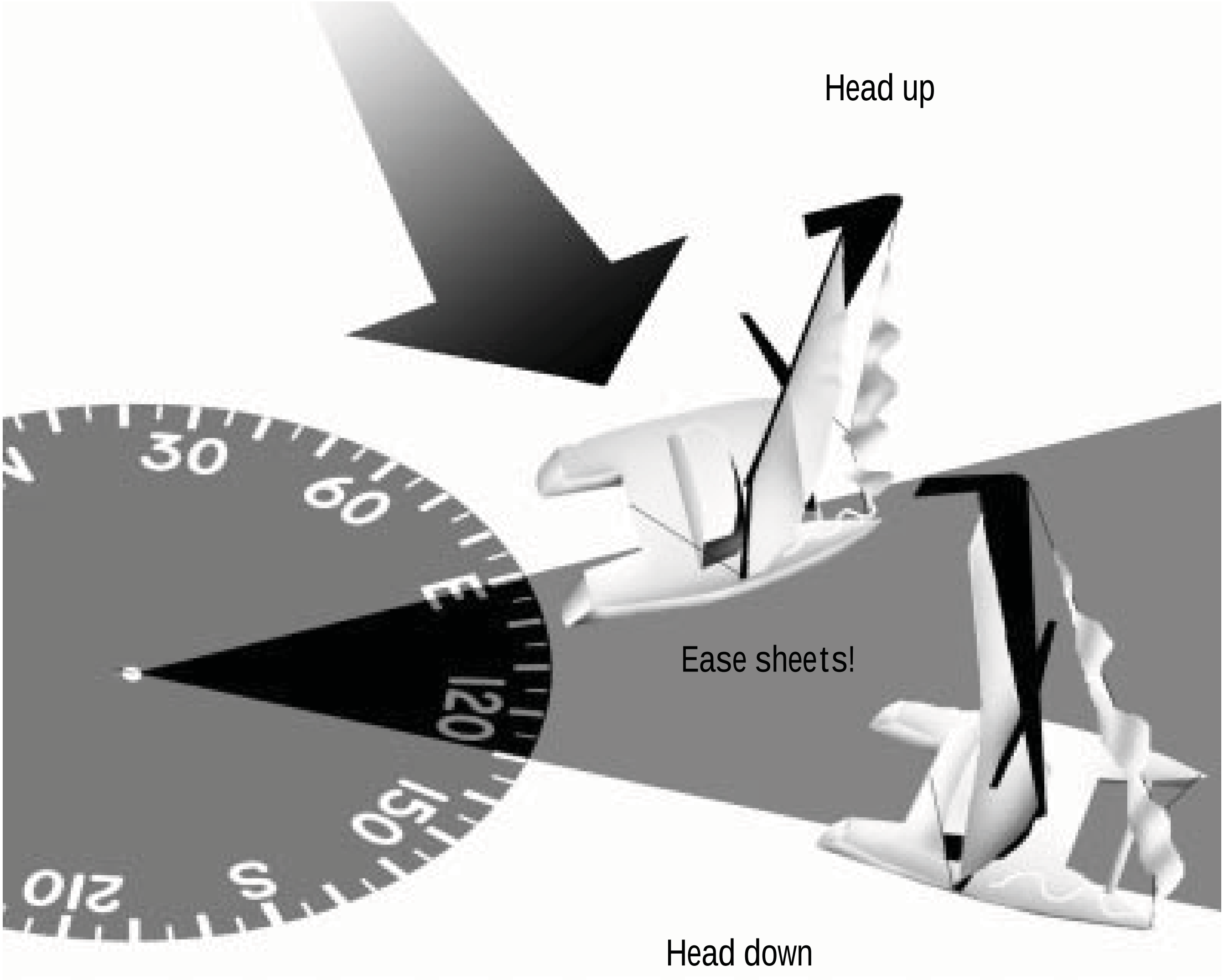
If speed is too high, there is a trajectory coming through the wave crest. Multihulls are so much lighter than monohulls that they tend to fly off the face with lots of acceleration, dropping into the trough. The resulting return to the sea is most uncomfortable, and hard on structure. So speed needs to be carefully monitored to avoid going too fast.

Picking the correct angle to penetrate the crest is also tricky. Your options are restricted in many cases, as you do not want to get too far off the wind, where capsize pressures increase.

There is a fine balance in all of this between wind force, sail area, boatspeed, and wave-penetration angle. It takes alert and careful crewing to get it right.

On the helm, it often works best to head up and luff through the puffs and wave crests, then bear off and accelerate in the lulls and on the back sides of the waves.

Given the conditions in this photo, in most situations you would not be sailing upwind in a multihull, according to most of the experts. However, this might be the quickest way out of the storm (as opposed to running in the same direction as the storm system) or there might be navigational constraints such as a shoal or headland. In any event, this takes very careful work on the helm so that you do not find yourself at too wide an angle where the wind or seas might overpower your stability. Speed is kept to the minimum necessary for good steering control while wave and wind angle are kept close to the nose by pinching—sailing as close to the wind as possible.



Multihull sailors have a wonderful term—"zone of death"—to refer to the sailing angle where they cannot head up or down when hit by a puff. The only action that can be taken to relieve heel is easing the sheets. Otherwise, when broad reaching and the boat starts to load up, you head down. When close reaching and the boat begins to heel, you head up.

The actual angles at which you head up or down will vary with wind and sea state, and, of course, boat design. The faster the boat accelerates (the lighter and more highly powered it is) the wider the zone of death. Steering control, which varies with design and between cats and tris, also figures into this equation.

Reducing Power

Before closing this chapter, we should reiterate that there are two methods of reducing power. One is to head up when close to the wind, or down when off the wind.

When you start to feel overpowered, reaction on the helm is usually the first step.

The next is to ease the sheets. Typically, the mainsail will be cracked first. However, when sailing upwind one needs to be careful not to ease it so much that the bow is blown to leeward by the jib.

In squally conditions, during frontal passages, and when traversing areas where the topography brings stronger winds down from aloft, it is wise to have someone ready to ease sheets.

To do this instantly means a minimum number of wraps on the winch and the sheet flaked and ready to run.

Heaving to

If you are lacking in stability, don't have room to leeward, or running is the wrong direction, heaving to may be worth some experimenting.

Often it is possible to get multihulls to lie at moderate wind/sea angles by easing a deeply reefed mainsail down on the traveler, and then putting the helm into the wind.

Some multis will heave to without sail. In moderate conditions, twin riding sails, toed in toward the centerline, will keep your bow pointed into the wind.

If you are hove to and decide to run off, take care with the transition in course. Apparent wind will build rapidly as the boat accelerates and heads off on a beam reach. It will be necessary to ease sheets or reduce sail area before bearing off.

Passive Tactics

Any form of passivity in a multihull—lying ahull, heaving to, or lying to a drogue or parachute—is subject to heated debate.

Just as with monohulls, there are no pat answers. The correct approach depends on the type of multihull in question and the weather.

Lightweight boats, which can pick up their daggerboards to reduce resistance, have a good record lying ahull in the worst conditions.

On the other hand, heavily-loaded cruising multihulls with fin keels would not want to try this approach, as they would not be able to skid to leeward and relieve wind pressure. Check Cam Lewis's comments (page 529) for a detailed description of how this worked in a survival storm off Cape Horn.

Every professional sailor with whom we spoke indicated that in survival conditions, if he was on a performance boat and had the sea room, he would prefer to run off until the most extreme sea state—at which point the boards would be pulled clear of the water and the boat would lie ahull.

However, if the crew does not have the skills for running off like this, or the boat is not of the proper design to employ this approach, then you are forced to utilize some form of drogue or parachute. In the section starting on page 421 you will find this entire subject discussed in detail. For now, keep in mind that none of these tactics represent a perfect solution.

Boat Size

Multihull tactics are a function of boat size and stability. Tactics that work well for an 80-foot (24.5m) catamaran like *Commodore Explorer* are not going to be right for a smaller production cruising cat.

The smaller boat will have to back off and become defensive in conditions where larger vessels are just hitting their stride, and are powered up.

When you consider going offshore in a multihull, bear in mind the size factor and how it relates to sea state.

Designer and offshore sailor Angelo Lavaranos on multihull tactics:

"Cats need to be slowed down sailing upwind when the risk exists for ramping off the waves. This is accomplished by reducing sail and sailing closer to the wind (except when cresting the waves at which point the boat should be headed off a bit).

"On cruisers with engines an excellent tactic is to gently motorsail with the engine just ticking over.

"If you have stub keels, you need to keep the boat powered up and moving fast so the keels lift—but then you are going too fast for the conditions. A dilemma. But motorsailing may help you avoid this."

Capsize Mechanics

Before leaving multihulls we should deal for a moment with the subject of capsize mechanics, where waves are the initiating force. This is the most common form of capsizing in multihulls (wind-induced capsizes are usually limited to high-powered racers).

As with single-hulled yachts, the ability of the multihull to absorb the wave energy over time and slide to leeward is the main issue. As you can see below, displacement and lateral plan have a huge impact on this battle.

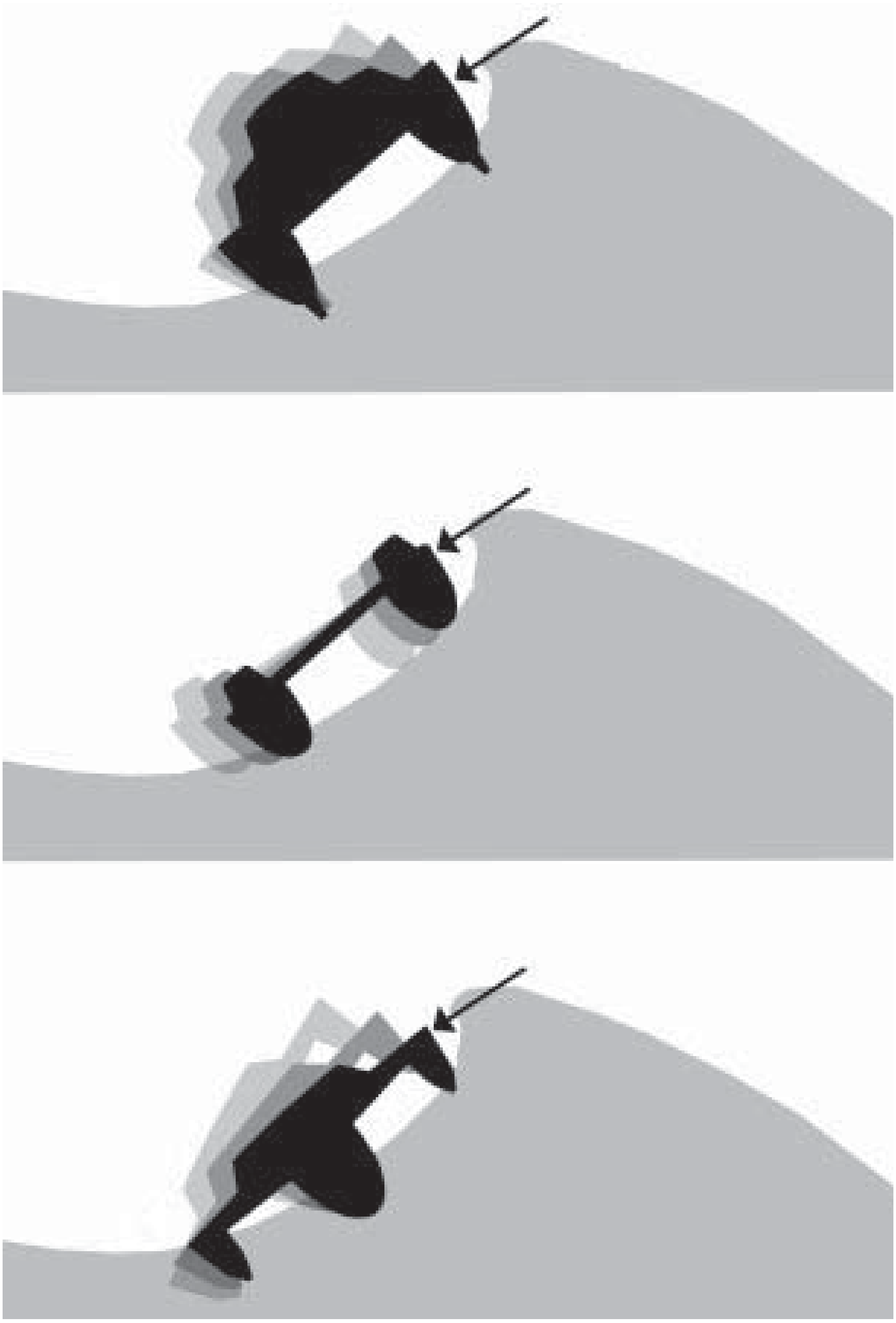
The lighter the multihull, and the less in the way of appendages below the water, the better she will be able to skid off with wave impact.

When you talk to the professionals who race multihulls they will tell you that the ability of the boat to skid off to leeward as it is impacted by a breaking crest is a critical factor in riding out big storms.

This ability is a function of the type of appendages, and the weight of the boat, and to a degree if it is a cat or tri.

The lighter the boat, the less hull in the water, and the more easily it will skid. Rounder hulls do a better job of skidding than V- shaped hulls. And boats that can fully retract their dagger- or centerboards are better off than boats with fixed keels.

Trimarans tend to dig in their leeward hull—but of course they have more lateral stability with which to play the game.



Capsize Preparation

One of the advantages of multihulls is that they will float inverted—assuming of course that they are light enough.

With enough buoyancy, there may even be semi-habitable quarters below. This is a huge advantage, and one of the chief rationalizations for going offshore in a multihull (the other is speed).

To be able to fully take advantage of this you need to be prepared. This means survival suits, somewhere to get out of the water to sleep, food and water access, and the ability to send distress signals.

For a heads-up on this subject, read *Capsize* by Nalepka and Callahan, which tells the story of the *Rosie Noelle*. A trimaran that capsized off New Zealand and given up for lost, her crew washed ashore three months later, somewhat worn but in general good health, on one of the islands near Auckland. You'll find excellent ideas for living the inverted life.

Queen's Birthday Storm

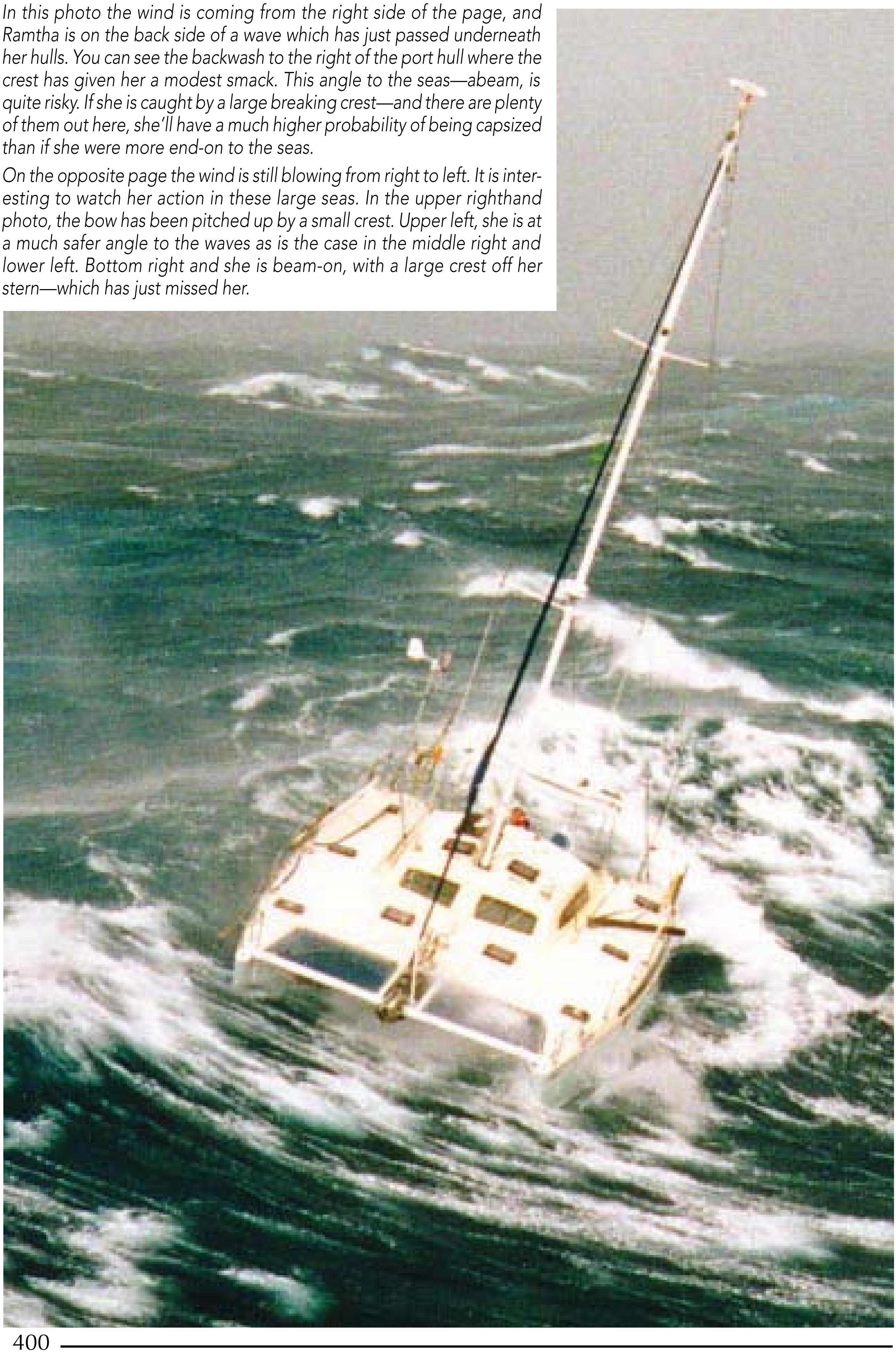
We will discuss this blow in more detail starting on page 575, but right now we want to show you a series of remarkable photos taken during the rescue of the crew of the 38-foot (11.6m) catamaran *Ramtha*. The winds in these photos are blowing 60 to 70 knots, and seas are any where from 20 to 40 feet (6.1 to 12.2m) or more. *Ramtha* was later found upright in good condition and towed to Tonga.

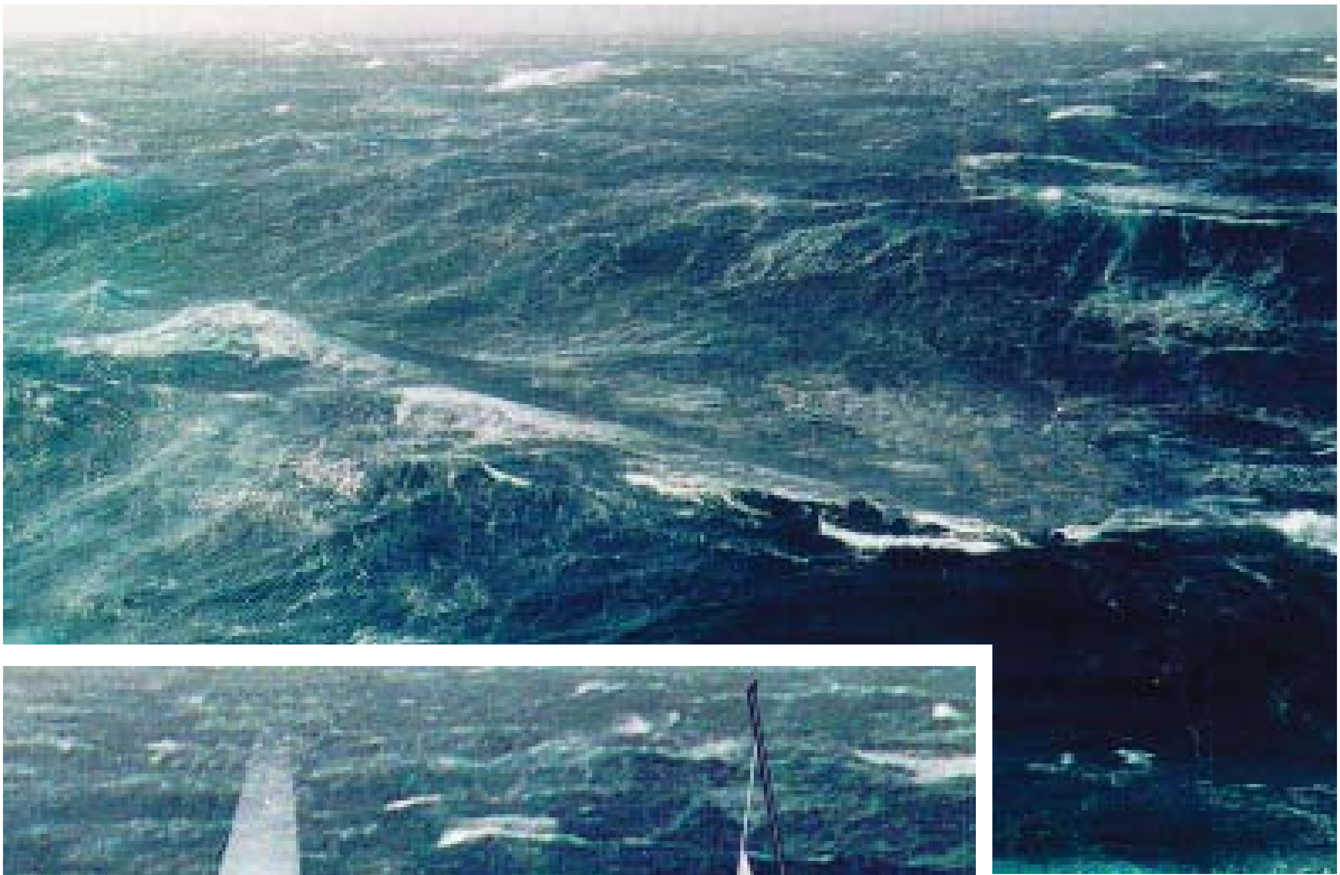
In the photo below Ramtha is powering slowly abeam of the seas. Her steering has failed and her course is being adjusted by varying engine thrust to the two separate propellers. It is blowing a steady 60 to 70 knots, gusting higher.

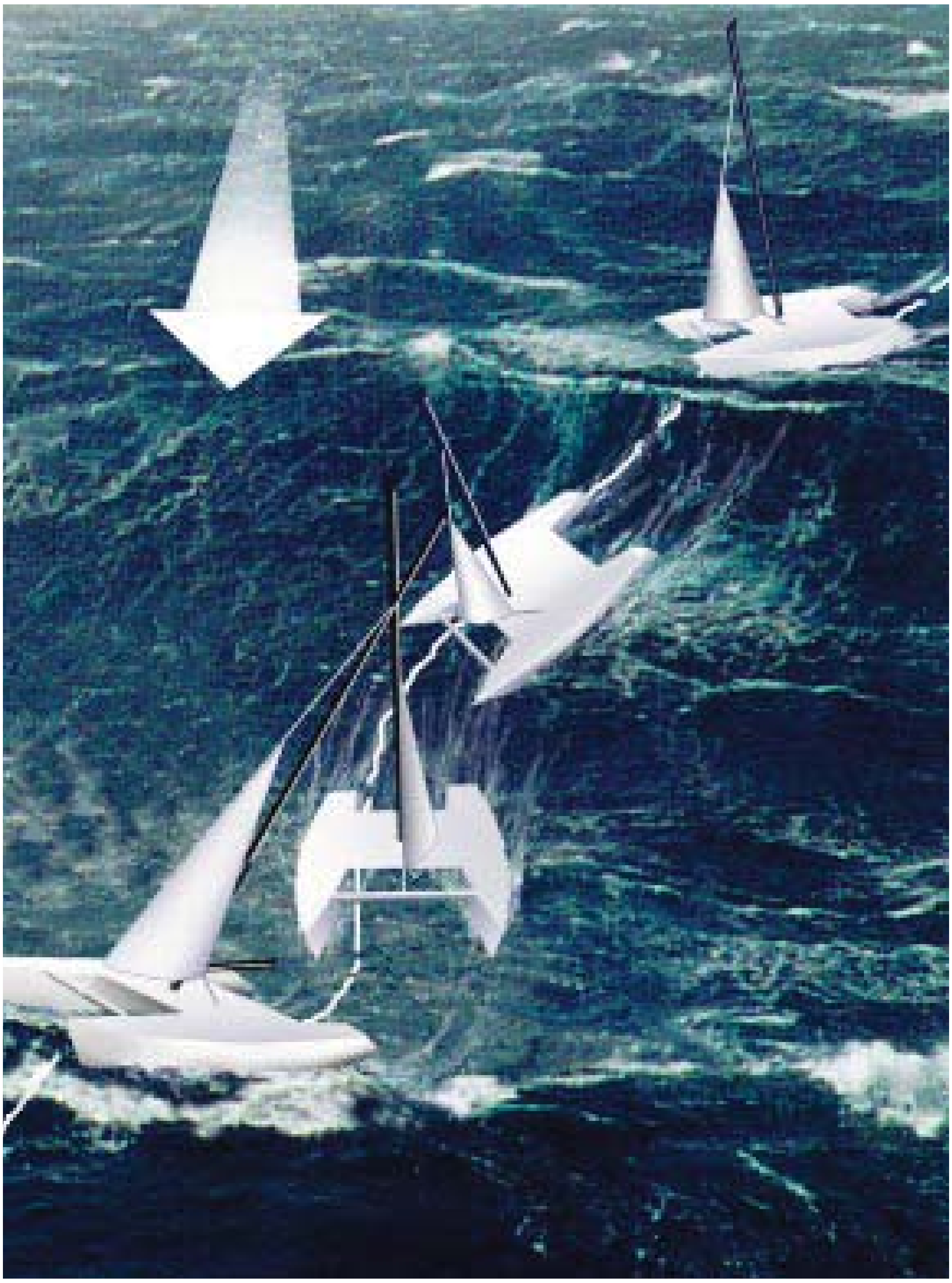
This and subsequent photos Lindsay Turvey

In this photo the wind is coming from the right side of the page, and Ramtha is on the back side of a wave which has just passed underneath her hulls. You can see the backwash to the right of the port hull where the crest has given her a modest smack. This angle to the seas—abeam, is quite risky. If she is caught by a large breaking crest—and there are plenty of them out here, she'll have a much higher probability of being capsized than if she were more end-on to the seas.

On the opposite page the wind is still blowing from right to left. It is interesting to watch her action in these large seas. In the upper righthand photo, the bow has been pitched up by a small crest. Upper left, she is at a much safer angle to the waves as is the case in the middle right and lower left. Bottom right and she is beam-on, with a large crest off her stern—which has just missed her.







Conditions similar to what we've just seen with Ramtha.

Assuming you have good steering control and room to leeward, one of the suggested tactics is to run off with the wind on the diagonal across the hulls so that maximum stability is working for you.

If you keep the wind on the quarter, you also have an escape route of heading down towards a run, should the windward hull begin to lift.

In the image beside, the skipper is heading up to reduce speed as he climbs the waves; then he drops over the crest on the diagonal. In the middle of the trough he heads down to reduce the tendency to heel, which could have been caused by a wave slap, gust of wind, or a combination of the two. At the next crest (bottom of image) the boat is once again heading up to slow down as it climbs the crest.

Here is the opposite approach—motorsailing slowly to weather, flying a trysail. This technique is the same as with a monohull. Maintain just enough boatspeed for steering control so you can weave your way around the crests. However, take care when heading off (whether due to steering or wave slap), as the boat will rapidly accelerate and could begin to lift a hull.

In the middle of the image (second boat from the top), a cross sea has built up to a height of 6 or 8 feet (1.8 or 2.4m). The ideal tactic, if there is enough time, would be to head up into this sea—or at least get it on the diagonal.

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It doesn't matter if you're on a large ship or a little runabout, the issues of how you deal with the seas are constant—only the scale changes. Big ships use the same tactics as small yachts.

A strong-displacement motorboat should be able to cope with most conditions. The main risk involved isn't so much getting the driving of the boat wrong, but trying to avoid a situation where the boat might be damaged.

Any damage can start you on the slippery slope to disaster because it has exposed a weakness in your boat which the waves will tend to exploit.

Powerboat Tactics

Powerboats in heavy weather react to the same environmental factors we've been discussing for sailing vessels. They have to potentially deal with similar winds and waves, and respond to the same forces of hydrodynamics.

The differences come in the area of naval architecture. Powerboat hulls tend to be heavier, beamier, and more shallow than sailing vessels, with considerably less range of positive stability.

The powerboat's ability to maintain a consistent speed in most conditions—and the propensity to look for areas without wind for voyaging—are both advantages. If the skipper of a powerboat understands weather analysis and forecasting, he or she is less likely to get caught out in unpleasant conditions than a sailing vessel because of his or her ability to maintain consistent speeds.

But when the powerboat is caught out, it must be handled with a great deal more care, and there are less options in the heavy weather arsenal.

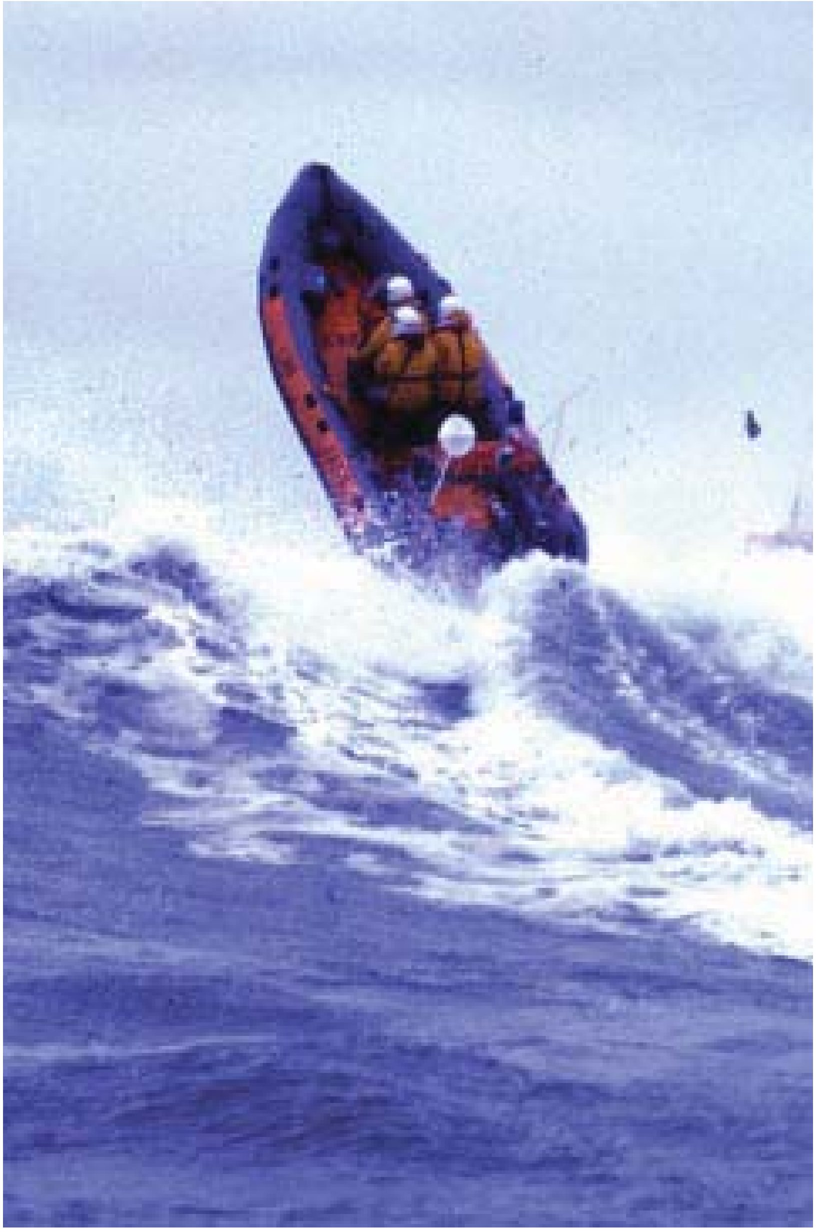
The following comments are the result of interviews we've conducted with numerous professional seamen. We also rely heavily on the input of Dag Pike, an English writer and professional sailor who has extensive experience offshore in powerboats in storm conditions. We are indebted to Dag for allowing us to use some of his material on handling powerboats in heavy weather.

Understanding Variables

Most displacement powerboats have a finite range of conditions in which they can be adequately controlled. The dividing line between controlled comfort and conditions that could turn dangerous is typically finer than in a sailing vessel.

In this context, it is important to find the limitations of your own vessel while shelter is close at hand. In short, try a variety of heavy-weather management techniques in a location where you can quickly end the test if desired.

Everything, of course, depends on sea state and how the vessel reacts to it.



Rick Tomlinson

Rigid bottom inflatables (RIBs) have wonderful sea-keeping attributes, especially considering their light displacement. They accelerate quickly with modest power, which means if skillfully handled they can be maneuvered around breaking seas.

When a light-displacement boat like this one comes through a crest at a extreme bow-up angle, sometimes a quick pop on the throttle will help keep you from going over backwards. However this has to be done at just the right moment. Too early and it will thrust you into the steep face of the wave, which then accelerates you even further into a vertical position.

Defining the Problem

Driving powerboats in rough seas is a mysterious art. It is quite easy to set down some basic rules, but the problem is that the conditions keep changing. There is nothing regular about waves. Every one is individual. As in a sailboat you need to negotiate each wave as it comes along.

This requires considerable concentration: you need to assess each wave, decide the speed and how to attack it, and then match the boat's performance to the wave. It really is a matter of negotiation because you must always remember that the wave is in charge—it sets the parameters under which you operate the boat. You can't change the waves. You have to take what comes along and deal with it accordingly.

Concentration is fine for dealing with rough seas for the first hour or so, but eventually you may find that you can't maintain the necessary level of awareness, and you will start to make mistakes with throttles and helm.

The simple solution to driving a displacement boat in rough seas is to find a course and a throttle setting that matches the conditions and just let the boat follow its nose. Probably 90 percent of the time this will work. You'll find that the boat copes very well, occasionally giving a lunge or two as it meets a bigger wave, but running within its capabilities. Of the remaining 10 percent, the boat will have enough reserves to cope with any bigger-than-normal waves which come along. The movements of the boat in these waves may be a little frightening, but 99 percent of the time the boat shouldn't come to any harm.

It is that remaining 1 percent that causes concern—the risk element in rough seas. This is why you need to maintain concentration, which is not easy when you've slipped into a relaxed frame of mind with the boat apparently coping very well in the rough seas.

Perhaps the best way to define rough seas is to consider them as sea conditions where you can no longer just set the throttles and let the boat take its course. Instead, you have to start reducing speed or even operating the throttles to negotiate the boat through the waves. Much of what constitutes rough seas depends on the size and construction of the vessel, but in general we are talking about sea conditions generated by winds of Force 6 or upwards.

A key factor in the entire heavy-weather scenario is understanding weather.

This is the most important skill needed to keep yourself out of trouble, as it usually leads to avoiding heavy conditions altogether.

But even those who understand weather quite well will occasionally get caught, especially on long passages.

When this happens, it is important to have a clear knowledge of what is causing the current weather pattern; how the time spent in heavy weather can be shortened; and how the effects can be lessened.

As we've said before, sometimes a distance of as little as 30 or 40 miles can make the difference between a fresh gale and storm- or hurricane-force winds.

There are times when running will get you out of the weather soonest, while other times you want to be heading into the weather.

Because your speed and course options rapidly deteriorate as the weather builds, evasive action needs to be taken early when you are first aware of an impending problem.

Steering Control

Steering control is probably the single most important factor in heavy weather tactics with a powerboat. The same factors controlling sailboat steering also work with powerboats—it's just that the hull, rudder, and power configurations are substantially different.

The better the steering control available at low and high speeds, the more quickly you can react to changing seas. Thus, you can run or carry the seas on the beam for a longer period of time with good maneuverability.

Beamy hulls, shallow hulls, and powerboats with fine bows all tend to be slow in responding to their helms. Narrower and deeper hulls, and fuller bows (which do not lock in) respond more quickly.

Rudder configuration is, of course, paramount. The bigger and deeper the rudder, the better the boat will steer at slow speeds—which is going to be the case a lot of the time in heavy going.

Deeper rudders also do better in the oscillating water of large waves.

If you have outdrives or outboards, where steering is done with propeller thrust, you may have excellent control at slow speeds, although a deft touch on the helm and throttles will be required.

Tactical Options

The key to which tactics are employed is based on sea state and the ability to control the boat in existing conditions. You can run with seas on the beam until they start to break, and even then pick your way through the crests if required.

You can run before the seas until the risk of broaching becomes too great, at which point you need to head up and hold station, "jogging" into the seas at slow speed.

Let's now examine the options in more detail.

Because many displacement boats have reduced freeboard amidships, with seas on the beam you also have the risk of seas breaking on board. Breaking seas can fill a cockpit or other deck openings, which makes your predicament worse. Naturally, there will come a time when operating in a beam sea is not the ideal way to go.

Seas on the Beam

Running with the wind and sea on the beam in moderate seas has the disadvantage of discomfort, due to the heavy rolling. In these conditions, full speed can generally be used on a displacement boat without causing any real problems, because the boat is lifting bodily on the waves, and bow and stern have little movement in relation to each other. However, occasionally you may find the boat dropping off the edge of a fairly steep wave front, which can be both uncomfortable and a little frightening. Thus as the beam seas start to get rougher, you have to take more care.

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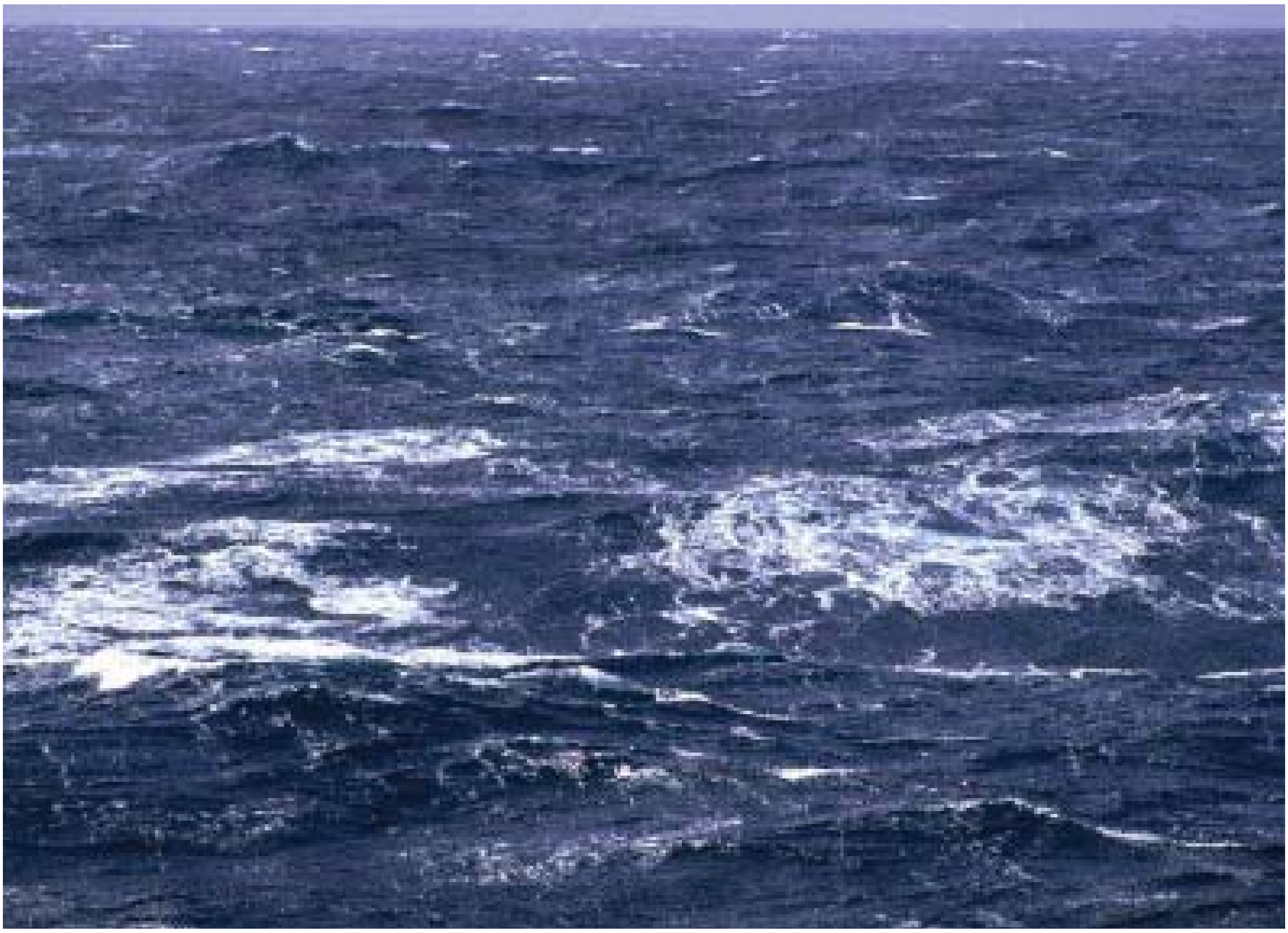
Most commercial vessels and the yachts intended for offshore work have their house set well back from the bow. This reduces the structure's vulnerability to boarding seas. On many motor yachts, the location of the windshield forward and the substantial expanse of windows on the side will put them at risk in even a moderately breaking sea.

When the course to the closest haven is abeam of the seas, and the waves are only occasionally breaking, you can run at speed in the troughs, working your way around and/or through the crests. The technique is a function of the speed of your vessel, how quickly she responds to throttles and helm, and the danger of the seas beginning to break. In the image above, the top boat is taking a course across the wave crest, just before the break. If they were late heading up, so that the crest was about to catch them, it would be extremely important to get the bow into the wave. However, before the crest, as shown here, they can cross at an angle, which softens the drop on the back side of the wave.

The lower boat is working the trough, and is going to try to cross below the crest. This is a more dangerous course of action as they are more vulnerable if caught beam-on. Also, the boat's own wake may start an otherwise stable crest to break. These breaks are typically astern. However, in some waves the wake can precipitate a breaking crest, which reaches out ahead of the boat.



Vulnerability

Running with the sea on the beam exposes a large area of boat to the approaching waves and, in breaking seas, can make the craft vulnerable. The transition from what is an uncomfortable beam sea to a dangerous one depends a great deal on the type and characteristics of the craft—but once the waves have started to break, watch your step carefully.

There are two main problems with beam seas: First, as the waves become steeper, the boat will try to adjust to the surface of the sea, and consequently will heel to quite a large angle. This in itself is not too serious, provided the range of stability of your boat is adequate, but remember that the wind will also be pressing on the windward side of the boat and tending to increase this angle of the heel.

The second problem is more serious, occurring when you encounter breaking waves. The surface of the water is moving bodily to leeward and can exert great pressures on the windward side of the vessel. The pressures are resisted by the still water on the lee side, which produces a turning moment that could develop to the point where the boat capsizes in extreme conditions.

Working around Breaking Crests

Fortunately, a wave rarely breaks along a long front. Rather, it tends to break in patches so that it is possible to avoid breaking waves in beam seas. This means carefully watching the sea ahead and anticipating which part of

A good way to get a feel for these techniques is to go out and practice on moderate days like the one shown above. It is blowing 25 to 30, and the waves are moderate—just right to learn when to head up and when to head down.

When passaging with a beam sea, you will often see the waves approaching on the aft quarter and starting to break. You may think yourself very lucky that you keep missing these breaking waves. However, they are caused by the wash of the boat combining with the approaching wave. This creates an unstable sea, which breaks when it would not have done so otherwise.

Even in moderate breaking seas, you can make life much more comfortable on board by avoiding the largest of the waves and steering around the uncomfortable-looking crests.

However, once the seas start to break, the stakes become higher, and you have to be much more cautious. Steering calls for careful concentration.

the wave crest is going to break. Then, either reduce speed to let the wave break in front of the boat, or turn into or away from the wave so that you pass behind or in front of the breaking crest.

This depends on the type of boat and its capabilities, but the best action would normally be to turn away from the wave. This has the advantage of buying time and will also reduce the impact of the wave on the boat which is then moving away from the wave front. The breaking crest often rolls only a limited way to leeward—you could escape the breaking water altogether by this action. If you do turn away from a breaking wave in this fashion, be sure to open the throttles wide—to get the maximum steering effect, and also to keep your distance from the breaking crest as long as possible.

If you choose the opposite course of action and head into the wave, then reducing speed will probably be necessary to lessen impact.

Running downwind, you want to keep your stern square to the seas. Also, if you have enough boatspeed, watch for soft spots—areas where the crest is smaller than others—to head downwind. If you are moving at displacement speed, the only steering option is to work at staying perpendicular to the waves.

Running Off

At first glance, it would appear that running before the waves and travelling in the same direction as the wind and sea would be a far safer course to take, rather than battling against the waves. However, a boat needs a good flow of water past the rudder for steering to be effective. If you find the water flow reduced or even reversed because of an overtaking breaking wave, you will have much less control of your craft. This factor presents the greatest hazard in a following sea.

Running in Breaking Seas

In a breaking wave, the surface water is moving forward in the wave's direction of travel, but slightly faster than the wave. This forward movement of the breaking crest is transient, starting as the wave crest becomes unstable and ending when the wave has reached stability again. The behavior of a boat in a breaking, following sea will depend on the position of the boat in relation to the crest as it breaks. This is also affected by the design of the vessel itself.

If the wave rises up and starts to break immediately astern of the boat, there is a real danger that the breaking crest will fall onto the craft. This is more likely to be a problem with the type of heavy breaking wave found when waves approach shallow water, rather than the open-sea breaking wave, which tends to have more of a rolling crest. The downward angle of the boat on the forward surface of the wave is in your favor at this point. This angle will help to increase the speed of the craft and might even enable it to accelerate away sufficiently to escape the breaking crest. If not, the crest, in falling, will accelerate and take the boat with it. This also helps increase the momentum, particularly if the boat has a large transom stern which faces the oncoming rush of water. On a double-ended boat with a canoe stern, the theory is that the pointed stern divides the oncoming water and allows it to pass safely along each side of the boat.

So here we have a craft speeding up under the combined influences of the rush of breaking water at the stern and the downward slope of the face of the wave. All would probably be well if the boat could just keep accelerating in this way. However, the time comes when the bow of the boat starts to bury into the wave ahead as the stern is lifted. The bow begins to act as a pivot, and resistance to forward motion increases rapidly, due in part to the flare of the topsides forward.

Broaching

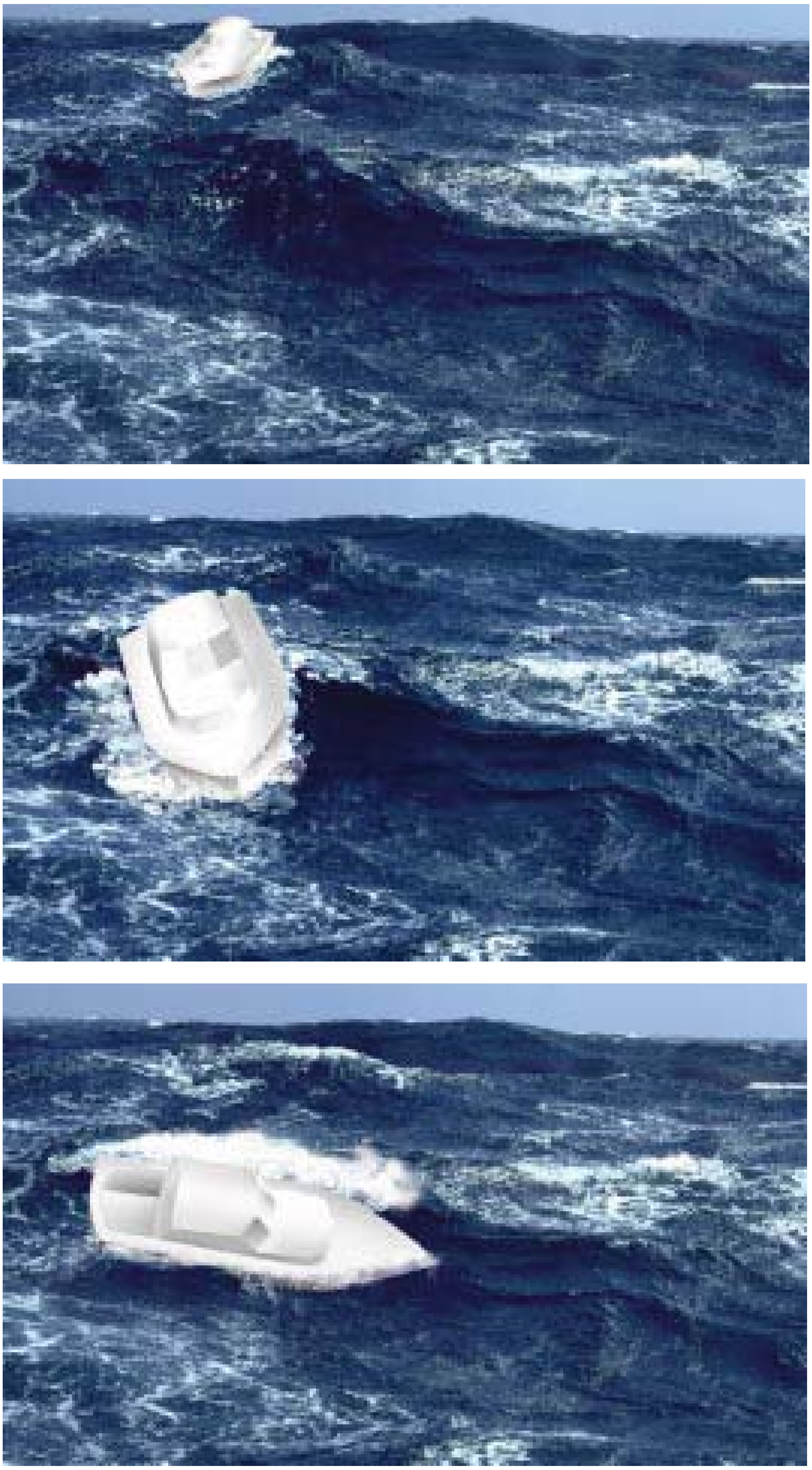
At this point the risk of broaching occurs, with the bow trying to stop and the stern swinging to one side or the other under the influence of the rush of water. This strong turning effect can place the boat broadside in the classical broaching situation. Once broadside to the sea, the turning moment reduces but is then replaced by a capsizing moment similar to that which can be found in a beam sea. Even if the boat escapes this particular situation, it could well find itself vulnerable to the next wave that comes along, because it is unlikely it will have recovered in time and achieved the steerage way necessary to cope with the situation.

An average open-sea wave will be travelling at somewhere between two and three times the speed of a displacement boat, so it will take some time to pass the boat.

When the crest of the wave approaches the stern, the face is the steepest part and the bow will be pointing downwards towards the trough. In this position, gravity will exert a downward pull on the boat, which combines with the thrust from the propeller into increased forward motion.

When the boat is on the back of the wave with the bow pointing upwards, it is, for all intents and purposes, going uphill and the speed will be correspondingly reduced.

These involuntary increases and decreases in speed can be controlled to a degree by opening and closing the throttle as the circumstances dictate. However, the effectiveness of working the throttles depends on the response time of the boat to her prop.



Broaching in powerboats is typically started where the bow digs in; the stern is pivoted around by a wave astern and by the momentum of the boat itself. In these three images, we start at the top with the boat running downhill. In the middle image the bow catches and digs in, and the boat begins to pivot. At this point there is little that can be done to recover. In the third image the boat has now rotated 60 degrees or so and is abeam to the oncoming crest. This is the point at which you find out how well the boat is built, if the glazing is sound, and if there is an adequate positive range of stability.

A deep-draft vessel with its rudder well-immersed should retain steerage control in this following sea situation because the breaking water of the wave tends to remain fairly close to the surface. Conversely, the shallow draft boat may be much more vulnerable. The hull design of the boat has a bearing on its behavior as well, and a boat with a sharply angled forefoot is likely to create a pivot point more readily than one with a cutaway forefoot. A transom stern also makes the boat more vulnerable.

Helming Technique

If you find yourself with a breaking wave approaching astern, there is not a great deal you can do. Try to keep the boat absolutely square on to the sea for as long as possible. This will demand concentration and hard work with the helm, as the rudder could become virtually ineffective in these conditions. As a general rule, you will want to open the throttle as wide as possible to try to run from the breaking wave or at least reduce its impact, and to retain steerage control for as long as possible. This will also have the effect of lifting the bow to a certain extent.

Speed Settings

When running before a following sea which may be large but not breaking, you would normally want to use full throttle. Thus, you maintain steering control and try to keep pace with the waves as far as possible. In these conditions you may notice that the waves astern are starting to break, but again this is usually the influence of the boat's wash combining with the crest.

When running before a moderate following sea, which is not breaking, there can still be a considerable change in the trim of the craft as a wave passes underneath. Here you notice this angle change more than you would in a head sea because the wave takes longer to pass under the vessel, giving it more time to adapt to the angles of the different faces of the waves. You will often notice that when the crest of the wave is passing underneath, the boat feels rather unstable. This is due to the fact that the boat is only supported amidships, rather than over its whole length, and its form stability is considerably reduced. This is a temporary situation—stability is rapidly restored as the wave passes. If, however, you should find yourself running at a speed close to that of the wave, this period of instability will last longer, and it might be sensible to consider reducing speed to allow the wave crest to pass more quickly and thus reduce periods of instability.

One problem found on many boats when operating in a following sea is that the visibility astern is not as good as it might be.

Maintaining Situational Awareness

If the sea is starting to become rough, and you are running before it, you can find yourself in quite dangerous conditions. This may be due in part to the fact that you have been unaware of just how bad things are getting. The lack of impact of the waves in a following sea can lull you into a false feeling of security. A sensible precaution is to stop every now and again, turn around and head into the sea, just to see what conditions are really like. It might be frightening to realize just how the waves are building up, but it is better to be frightened in this way than to be caught unaware.

Changing tactics:

- ❑ It is important not to get locked into any specific tactic, speed, or steering technique.
- ❑ Stay alert for changes in wind and sea state.
- ❑ Keep track of current, and any sea bottom characteristics that could cause the waves to break.
- ❑ Maintain a close watch on the weather.
- ❑ If conditions do change, be flexible in your approach. If you are reaching or running, the time may come when the safest tactic is heading into the seas.
- ❑ The safest approach is to change tactics before you are forced to.

Turning into the Seas

The turn from running off to heading into the seas must be accomplished with care. The key is to pick a smooth spot between crests, which allows you to complete the turn, and slow down before the next wave is upon you. Obviously, being caught beam-on at this point is extremely dangerous.

With large ships, where the rate of turn is extremely slow, the transition from running to heading into the seas is their most dangerous maneuver.

Watch the seas for a significant period of time. Try to feel their rhythm, and look back well to windward for any big crests on the horizon. You will usually be able to find a calm period with a couple of waves smaller than the rest.

Good visibility aft is a critical factor here. If not available, it may be worth giving the helm to someone else and standing aft for a few minutes.

The Aldernay, a UK lifeboat in action. These vessels are designed to go out in the worst imaginable conditions and bring their crews and rescued personnel back safely. They are capable of a complete rollover, as the buoyancy of the superstructure rights them quickly.

Heading into the Wind

When operating in a head sea, the main thing to do is find a speed at which the boat runs comfortably. Even in rough seas it's possible to find a speed where the boat will lift over the wave and drop down the other side without too much discomfort to the craft or the crew, provided the boat is strongly built.

Matching the speed to the conditions is the secret of operating in head seas, as long as the waves have a normal shape and a wave length, which allows the boat to operate without undue change in attitude.

When a displacement boat is driven hard into a head sea, the bow will lift to the wave. At the crest, the bow becomes unsupported as the wave crest passes aft. In this situation, the bow will drop to restore equilibrium before lifting once more to the next wave. The problems start in a short, steep sea when the bow may not have time to lift to the next wave, particularly as the stern will still be raised under the influence of the last wave, which has just passed. A slower speed will give the boat more time to adjust to the changing wave profile and will thus help to make the motion easier.

If the vessel is driven too hard in a head sea, there is real danger of a wave breaking onboard as the bow is forced through, rather than over, a wave. Solid water breaking onboard in this way has surprising weight and force and can cause structural damage. In this situation, the most vulnerable parts of the boat are wheelhouse windows.

In a boat with a fine bow, there's a greater risk of the bow burying into a head sea because it has less buoyancy.


Stock Newport

Clouds of spray look sexy in a photo, but are indicative of a boat being driven too fast into the seas—especially in moderate conditions like these. The spray makes it impossible to see the next wave, not to mention any traffic that may be in the area.

Upwind Speed

When you are trying to find a comfortable speed for operating in particular conditions, it is important to take care that you maintain sufficient speed to give steerage way. At slow speeds, the response of the helm will be slower and the bow could fall quite far off course before the corrective action on the rudder starts to have effect.

The safe minimum speed to maintain steerage will vary from boat to boat. It's unlikely to be less than 3 knots, and will be more on a craft with a small rudder.

If, at this time, a wave should rise and strike against the weather bow, the slow rudder response may cause the boat to be knocked around, beam-on to the sea, before any corrective action has a worthwhile effect. In this situation, opening the throttles is one way to get a fairly immediate improvement in the steering effect. This can bring the boat back on course quickly without rapid increase in momentum.

Working the Throttles

If the sea conditions deteriorate to the point where the boat must be forced hard to maintain steerage, the time has come for you to start nursing the boat over the waves. This is when you can use the throttle to good effect. By opening the throttle as the wave approaches, the bow of the boat will lift. The burst of engine power also improves the steering effect. As the bow lifts to the wave, ease off the throttle, before the bow punches through the crest. Easing the throttle will cause the bow to drop slightly, reducing the ten-

Dag Pike

With a big sea like this (above) coming at the bow, you will want to work the throttles with care.

Accelerate at the beginning of the wave face to lift the bow and generate energy to punch through the crest.

As the bow starts to dig into the crest, back off on the power to ease the bow through and down the backside.

dency for it to fall heavily into the trough. You then have to be ready to open the throttles again as the next wave approaches.

By using this throttling technique, reasonably comfortable progress can be made to windward. You feel in control of the boat and will be well prepared if a larger-than-normal wave comes along. However, this type of operation requires concentration, because there is always the risk of being caught out of step by irregular waves. Always keep your eyes open for that unexpected big wave.

Optimal Wave Angle

When conditions get to a difficult stage you may want to consider changing course for an easier ride. It doesn't take a degree in mathematics to see that if you adopt an angled course across the waves the effect will increase the wave length and create a more gentle gradient for the boat to climb. A 20-degree change in course can dramatically improve the boat's motion, and will not take you too far off your intended course. However, a broader course does expose the boat to the risk of being knocked beam-on if a breaking wave comes along. Nevertheless, the fact that you are probably running at a higher speed and have better steering control usually counteracts this risk—and you can always turn into a bigger wave if it comes along.

Dag Pike

Another spectacular photo of a planing hull going too fast for the conditions—even if it is a race boat.

Planing Boats

If you are operating a planing boat at displacement speeds, you may find yourself more vulnerable than in a displacement boat in the same conditions. There are two reasons for this: First, if you are at the point where you have to slow down to displacement speeds in a planing vessel, then conditions are probably becoming quite bad. Second, a planing boat is not designed to run best at displacement speeds, and control will be poor.

Design Factors

In terms of hull shape, planing boats tend to have fine bows and full sterns—not necessarily a happy combination in rough seas.

At the bow there can be a lack of freeboard if the boat has a reverse sheer. This, combined with a fine bow, gives a lack of buoyancy, which can mean the bow buries readily into both a head sea and a following sea. The craft is also much lighter and probably more affected by wind, so that you may find it more difficult to maintain steerage at low speeds, as the bow will tend to be blown off to one side or the other.

This situation is further exaggerated because the rudders are smaller and less effective at slow speeds. However, vessels fitted with outboards or stern drives, where the propeller thrust is used for steering, will maintain good control at low speeds.

Dag Pike

If you look carefully at the photo, under the arrow, you'll find a small yacht heading into these breaking seas—not for the faint of heart!

Most planing hulls are equipped with trim tabs. These can be worked to advantage on many occasions.

- ❑ When running, maintain an upward bias on the tabs to keep the bow riding high. This helps to prevent the bow from burying into the backside of the sea you are overtaking.
- ❑ When heading into the seas, maintain positive (down) trim to keep the bow from riding too high. Avoid excessive bow-high attitude as it will lead to more pounding.

Throttle Technique

A delicate hand is needed on the throttle at displacement speeds—a small movement of the throttle can produce quite a large variation in the speed. However, you can use this to good effect when you want to nurse the boat through the waves. You will probably use the throttle a lot more on this type of boat—short bursts on the throttle help maintain heading, in addition to helping the bow lift to approaching waves.

Planing Hull Tactics

Rather than reducing speed when operating a planing boat in a head sea, you'll often want to look for an alternative heading for the boat where it can still be operated at higher speeds. For instance, a planing vessel might need to slow down in a head sea, but can still maintain good speed in beam seas or especially in following seas. This could well be a safer course of action to take. Much will depend on where you are heading and what your options are with the weather, but fast speeds in a following sea can often be safer for a planing boat than for a displacement boat operating in the same conditions—because the fast speeds allow the craft to dictate its position with respect to the waves.

Survival Storms

Before we leave this section on tactics, we'd like to discuss the concept of the survival storm. This term is much bandied about, and has a sinister connotation.

We think of a survival storm as one in which a mistake by the crew or a major breakdown in systems could lead to disaster.

While we have so far shown you a lot of photos of horrendous-looking conditions and discussed some unpleasant experiences, these are a rarity.

Prior to the last decade one hardly ever heard of people in trouble offshore. And today, even with more people cruising with less experience, only a tiny minority get into difficulty. You're probably more likely to be hit by a drunk driver on a Saturday night, than to face danger in heavy weather.

The Odds Are in Your Favor

The odds when passaging are in your favor if you use a bit of judgement, don't let yourself be pushed by schedules, and practice preventative maintenance.

It bears repeating that a key factor in dealing with heavy weather expeditiously and avoiding it in the first place, is understanding weather analysis and forecasting—a skill that is within the reach of everyone.

Stay Alert and Adapt

You've seen many examples by now of why it is necessary to stay alert and adapt to conditions as they change—and the odds are, they will change.

That frontal shift you're expecting will probably arrive at 0300, just after you've finally gotten warm and dry in your bunk. The time to change direction or tactics is as soon as you detect the need.

Avoid Being Broadside

If there is any single rule in heavy-weather tactics, it is to avoid being broadside to the seas.

Almost all problems we know of have occurred because a yacht was broadside to breaking seas for one reason or another.

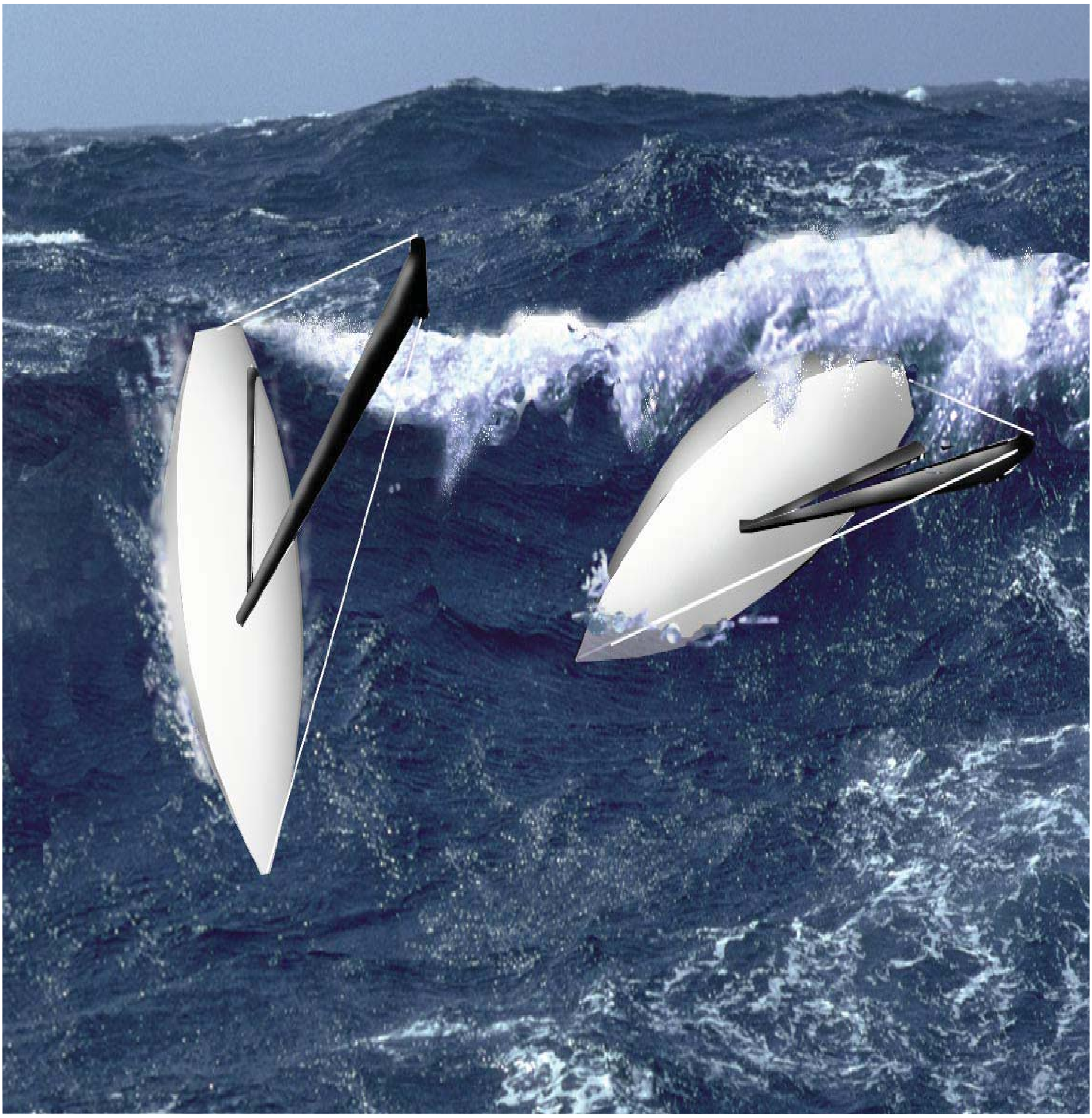
If a mechanical problem makes it difficult or impossible to steer, use some form of drogue, parachute anchor, or even a sail to get one end of the boat into the seas.

Always Continue the Fight

We've already discussed a number of situations where sailors in trouble continued to fight on against seemingly insurmountable conditions and come through fine.

The human body is capable of amazing feats of endurance, if you have the will to continue battling.

One more reminder: The vast majority of all yachts abandoned by their crews are later found afloat.



The entire issue of sea anchors and drogues in heavy weather comes down to the question of how you deal with breaking seas.

While there are many variables, the one thing we can agree on is that being beam-on to the seas—or even at a 60-degree angle—is far more dangerous than having one or the other end of the boat pointed into the waves.

Whether this end-on attitude is best achieved by sailing, or with a drogue off the stern or parachute anchor off the bow is the matter of some debate, which we will investigate in detail.

However, we would like you to keep in mind throughout the following discussion the fact that in many situations there comes a time when it is safer to have the boat moving—with the rudder under control so you can work the waves—than to be passively tied to some form of sea anchor or drogue.

Drogues and Sea Anchors

We want to start out this section on slowing the boat down with a caveat we've mentioned before—in heavy weather tactics, there are no magic bullets.

Different wind and sea conditions require different tactics. What works in a 50-knot gale may not work in 65 knots or when the wind shifts with the frontal passage.

On some boats you will have to slow down. On others, the safest thing to do is keep moving.

Your position relative to the weather system also needs to be factored in to the decision. As we've said before, moving 50 or 100 miles in one direction or another often substantially mitigates the impact of a given storm system.

Keep in mind that drogues and parachute anchors are a means to assist you in different conditions, but you must remain alert to changes in the conditions which may require a different approach to the storm.

Slow Down or Stop?

If you cannot control your vessel in the existing conditions (whether due to wind and sea state or a steering-related mechanical problem), the use of a sea anchor or drogue may provide the only way to increase security.

It is safe to say that in moderate storm conditions, where risks are low that a breaking sea will cause a capsize, slowing down is an excellent means of getting some rest, and/or putting off a landfall until more propitious weather.windshift

It is also an excellent tactic if you are required to take a more active role in the defense of your vessel later as the storm matures—assuming, of course, that active sailing in the early phase of the storm did not get you out of harm's way.

Frontal Passage

If you are safely riding to a sea anchor or drogue and the passage of the front brings about a windshift, a new set of waves will be coming at you from a 90-degree angle. If you cannot accomplish altering the angle of the boat relative to the wind and sea, it may be safer to begin to sail again so that you have better control.

This may also be true if the sea state is chaotic, and you are not sure from which direction the next breaking sea will arrive. In this case, it is almost always better to keep sailing so that the helmsman can adjust course as required.

Engine exhaust considerations:

Any time you're sailing with a following sea, there is risk of a wave slap on the transom forcing water through the exhaust system and into the engine.

Add a drag device of some sort off the transom and that risk increases by an order of magnitude.

Even with a high loop, muffler, and Aqua Lift, it is still possible for water to get into the engine.

On our Sundeer prototype, we had an exhaust loop which reached 5 feet (1.5m) above the waterline, along with a muffler and Aqua Lift. We had been running at high speed down the Oregon coast in a fresh gale when the wind suddenly shut off. Without speed, we were popped on the stern by a couple of overtaking waves. The result was an engine full of sea water.

The answer to this problem is a valve in the exhaust line, placed on the downward slope of the exhaust loop.

If the exhaust exits anywhere near to horizontal, where a flapper valve will work, this automatically keeps out breaking seas in most conditions. But to be truly safe, you need to have a valve—and shut it tight.

Whether you are in a monohull or multihull sailboat, or a motor vessel, the same issues affect which type of drogue or parachute system suits your needs best.

Hull shape; how the boat lies at anchor (from which you can infer how she will lie to a para-anchor); steering system; and the position of the cockpit and companionway entrance all should be taken into account.

Do not assume that what works for another vessel will work for you, unless you have relatively similar designs.

Bow- or Stern-To?

A fundamental question—do you slow down with your bow or stern pointed into the waves?

Bow forward offers some advantages. The bow is sharp and penetrates waves more easily than the blunt transom. It is also going to absorb wave punishment more easily than will a broad stern.

But the most important issue is the companionway and cockpit area. These are almost always areas of vulnerability. It is nearly impossible to make companionway slides and the tracks in which they move strong enough to take the force of a breaking wave.

The same holds true for cockpit wells and seat lockers. You have a bunch of angled structural connections, often without supporting bulkheads below, making these much weaker than the relatively flat plane of the forward deck area.

On the other hand, many boats have a difficult time lying bow-in to the wind. The bow shears off to one side or the other (just as at anchor in a harbor when the wind is up). If caught by a breaking sea at the end of a shear, you will be vulnerable to knockdowns.

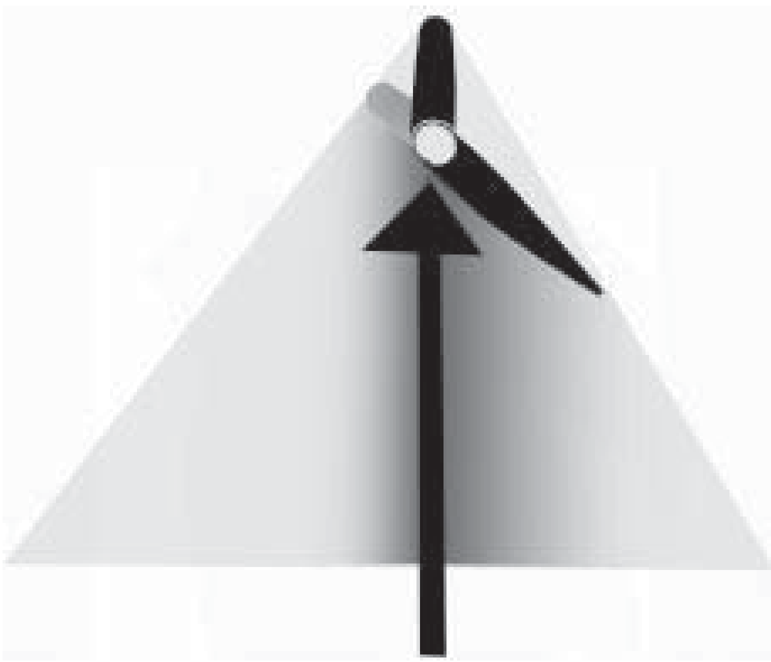
Boatspeed and Wave Impact

When you are fixed in the water, tied to a parachute or Jordan series drogue, the full impact of each wave is felt as it hits the vessel.

If you are heading into the seas at speed, then the speed of the wave added to boatspeed increases impact. On the other hand, when you are running with the sea, the speed of the boat is subtracted from wave speed.

Consider that the impact energy of a wave is a function of its velocity squared: you can see how reducing this relative impact speed, even a modest amount, has a big effect on the energy absorbed.

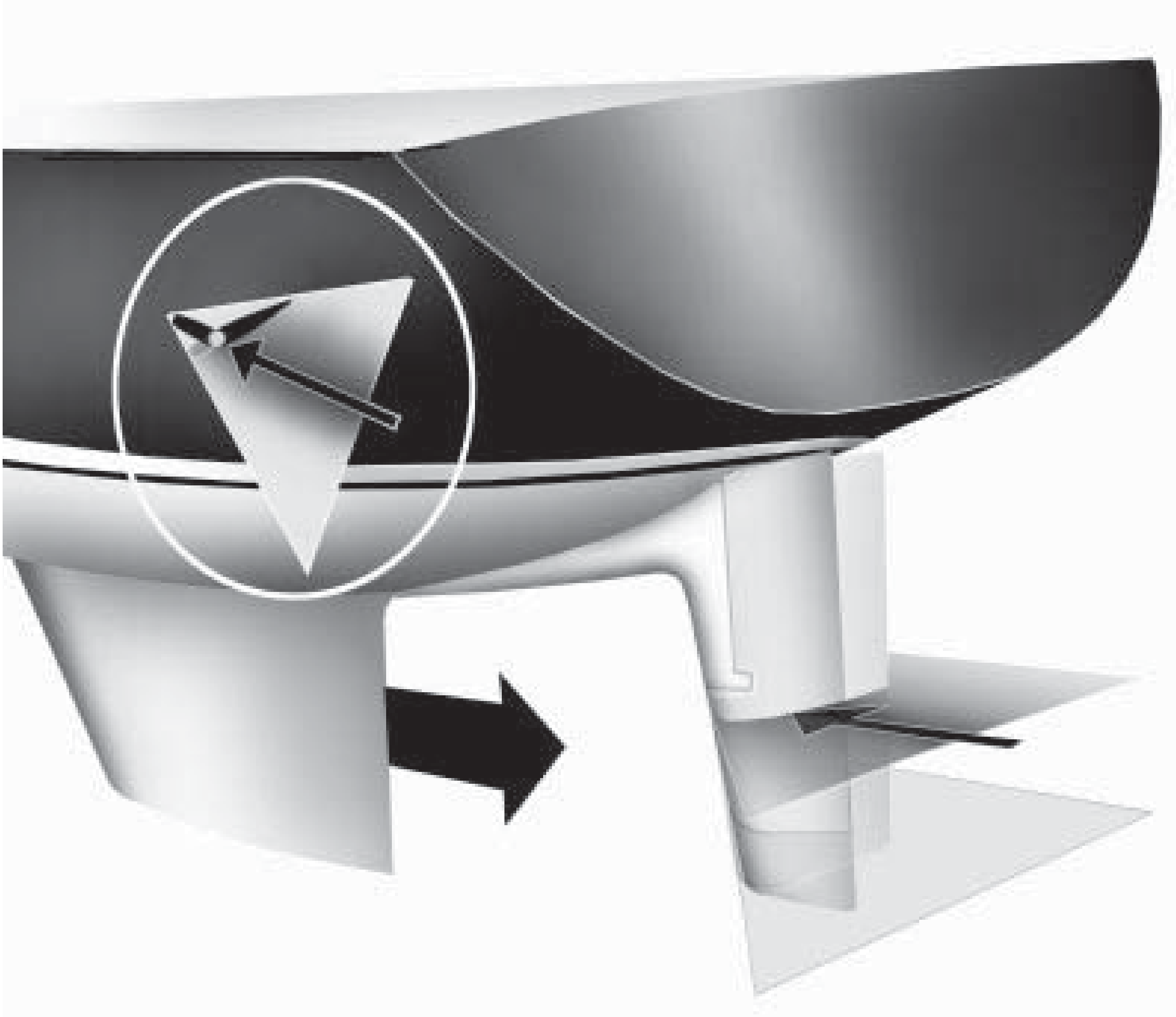
You can infer from this that the faster you go downwind, the less problem the waves will be. This is how it works in the real world, assuming you can control the direction in which the boat is travelling, and you are not dropping into large troughs.



Here is a view looking down at the top of a skeg-mounted rudder. With the force of the water on the trailing edge of the rudder, the load build-up as the rudder turns is enormous. Couple this with the acceleration forces as the boat is shoved rapidly astern, and you can see why this is a potential problem when hanging by the bow.

Rudder Vulnerability

The second area of vulnerability is the rudder system. If you are bow-to and are thrown backwards, the rudder may be slammed against its stops. This creates huge forces, which can tear out the rudder and/or bend the quadrant or hydraulic steering rams.



When the boat is shoved aft by a sea, the rudder is loaded in reverse of the direction for which it is designed. Instead of pivoting on its hinge point or points, with the load in tension, there is suddenly a bending load of huge proportions. The more rudder area aft of the hinge point, the greater the loading.

This is a risk anytime you are bow-to, so it is important to understand how it affects different types of rudders.

When the boat is going backwards, the forces on the rudder start at the trailing edge and build up towards the hinge point. The more angle on the rudder, the greater the force.

If you can keep the rudder centered, and the boat is moving straight back (not sideways), then loads are minimal. But even the slightest angle on the rudder will generate huge amounts of force.

The rudder configuration is an important structural factor. When you have a keel-hung or skeg-mounted rudder going backwards, the total area of the rudder is bearing on the hinges.

With a balanced-spade rudder, anywhere from 10 to 20 percent of the area is forward of the rudder shaft, so the forces are substantially less. You can therefore reason that, all other things being equal, you can take more reversing risks with a spade-rudder design than with other types.

Consider the loading on a keel-hung rudder (above). When the boat goes in reverse 100 percent of the rudder area is developing a bending force, which the rudder shaft and hinges must handle. The shaft, running down the leading edge of the keel, is quite small in diameter and is not engineered to take any bending loads. The skeg--mounted rudder (below) fairs a little better. Its aft end is somewhat offset by the small area projected forward of the skeg, and the rudder shaft itself is likely to be larger relative to the size of the rudder and forces involved, than is the case with the keel-mounted rudder.

Locking the Rudder on Center

Since small amounts of rudder deflection rapidly increase rudder load, it is essential to have the steering system locked on the centerline.

If you have worm gear steering, the gear itself will hold the rudder in place. With cable steering you will have to tie the wheel—do not rely on the binnacle friction brake on the steering wheel shaft.

A tiller is best in this situation, as it can be lashed amidships with no intervening complex of cables, pulleys, and quadrants to move and stretch.

In fact, if you have an easily installed and strongly made emergency tiller, it may make sense to use it to lock off your hydraulic or cable steering system.

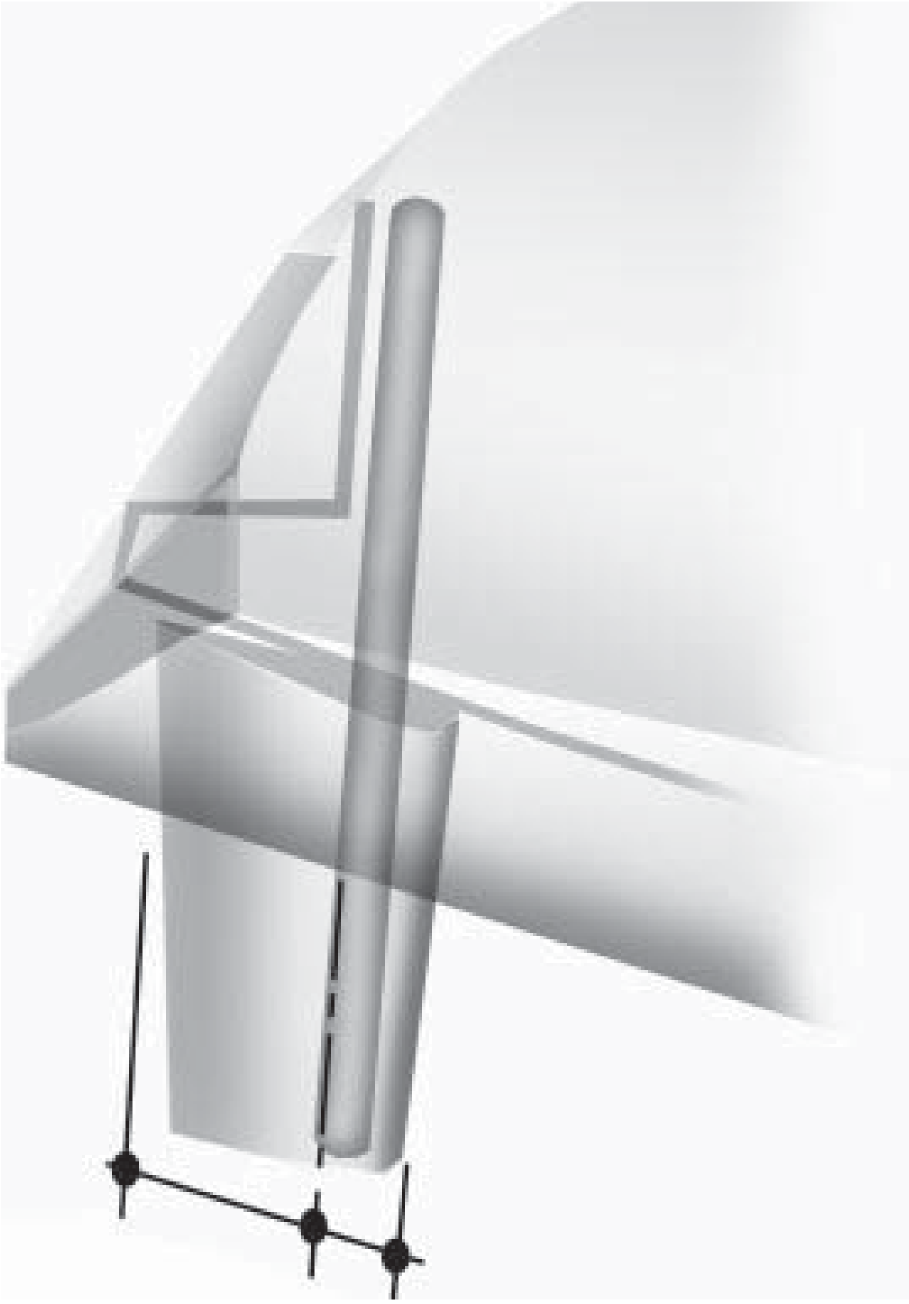
Another approach, if you have a hole in the top aft corner of the rudder, is to secure this with low stretch line to the stern cleats—thereby removing all of the load from the steering system.

Practice

The time to learn about handling your sea anchors and drogues is not when a gale is blowing at 0300 on a pitching deck. It's far better to practice in moderate conditions.

With practice you'll then understand what is involved in the setting process, and be less reluctant to venture on deck when the time comes to use this gear in earnest.

You will want to work on deployment, where to secure the rodes, and adjustment under load. Retrieval is always an issue. After you've got a handle on the technique in moderate conditions, give the gear a test in a gale—even if it's not required.



A balanced spade rudder when making sternway is much stronger than other types.

First, you have a balance area ahead of the rudder post of 14 to 18 percent of the total rudder area. This counter balances the forces acting to twist the rudder in reverse and also reduces the amount of rudder area aft of the rudder stock.

The net result is a reduction in load of as much as 50 percent, compared to a keel-hung rudder.

Now, take into account the rudder shaft, which is designed to take the full bending load of the rudder when the boat is making speed on a reach.

Relative to the backwards loading when the boat is thrown aft, the loads on the shaft are not nearly as high in proportion to its strength as with skeg- or keel-hung rudder systems.

When spade rudder systems fail from the boat being thrown back it is typically not the rudder shaft but the quadrant, steering cylinder, steering cables, or the rudder stops that give way.

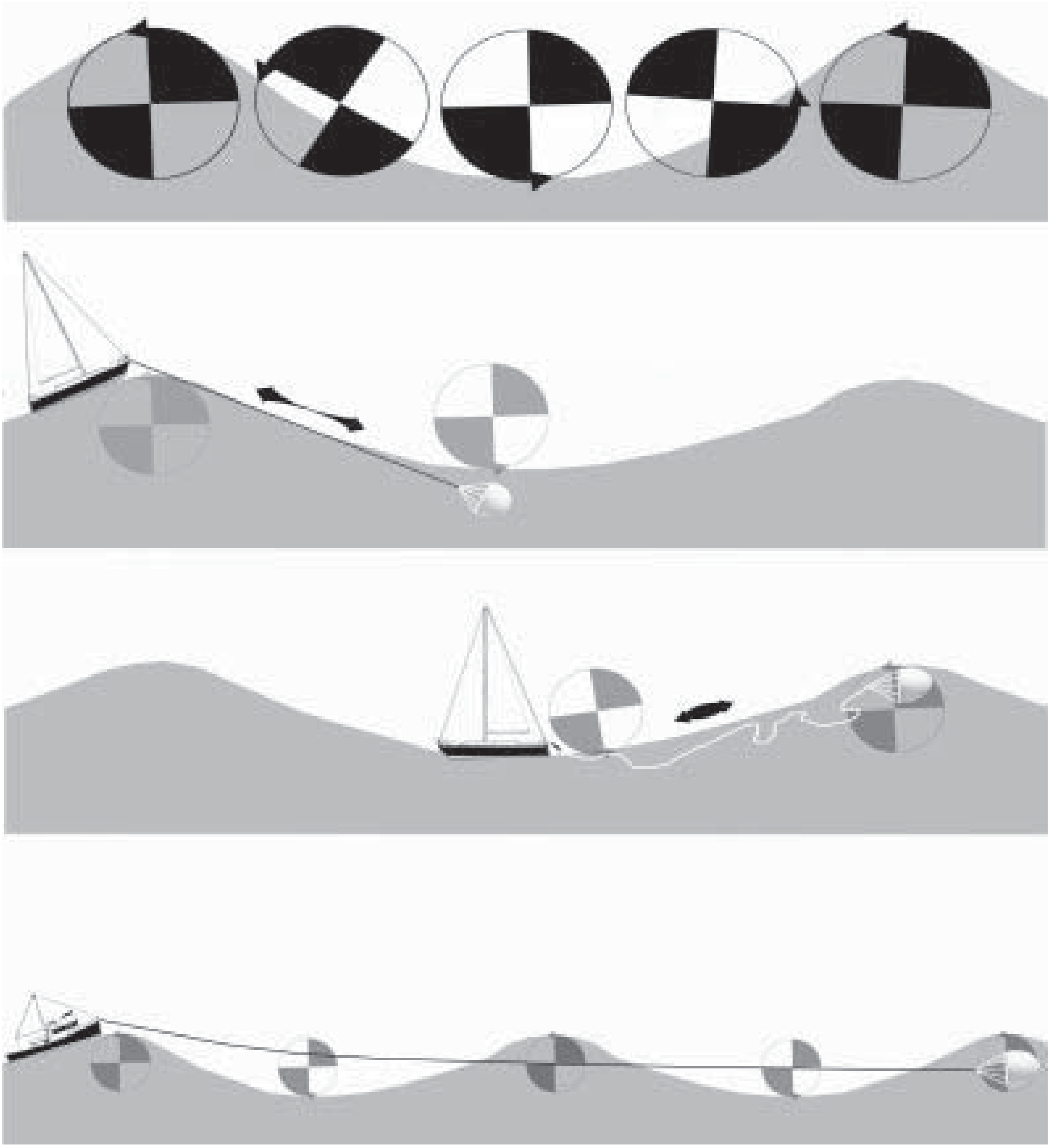
Overall, our feeling is that this is the safest rudder with which to heave to.

Wave Particle Motion

A major factor in the use of drag devices is understanding how wave particles move. The particles within each wave rotate in a circular or orbital motion. In other words, the particles themselves stay more or less in one place and rotate around as each wave passes by.

As we've discussed before, this means that in certain parts of the wave the particles will be moving up; at others the particles will be moving down; while across the top and bottom of the orbit (corresponding to the top and bottom of the wave) the particles move horizontally.

The relative motion of these particles has a major impact on how parachute anchors and drag devices work. Particle motion explains why drag devices must be properly positioned within the waves to maintain the highest level of effectiveness with the least risks.



Understanding how wave particles rotate is necessary to properly use drogues and parachutes. The water itself does not actually travel. The energy in a wave is rotational (top drawing) and the particles rotate in an orbit relative to the wave crests. At the top of the wave they are moving downwind with the wave, while under the wave they are continuing the rotation upwind. On the downwind side of the wave face the particles are headed downhill, while on the upwind back of the wave they are headed up. This rotation carries on through the trough and up the next crest in a series of orbital motions.

In the middle drawings you have a boat hove to with a parachute or drogue, with the drag device in the trough 1/2 (or 1 1/2) wave lengths away. The boat is in water particles that are rotating in the opposite direction to that in which the boat lies. The result is a load surging as the boat and drag device oscillate back and forth.

In the bottom drawing you have the correct relationship; the drag device is a full wave length (or two) away from the boat. This way they oscillate together and the rode stays tight.

When towing drogues, the same logic and gear applies equally to power vessels and sailing yachts. In both cases drogues slow you down and offer the potential for better steering control. The bridle off the stern spreads the load and, if evenly adjusted, keeps the boat stern to the rode.

DROGUES

When running off before a storm, if you are reaching the limit of steering control (or the crew is too exhausted to keep steering), you might desire some means of slowing the boat and keeping the stern aligned with the waves so the bow cannot broach.

In an ideal world, this device would be easy to deploy and retrieve, would stay deeply immersed in the waves, and would be simple to adjust so boatspeed could be varied as necessary.

Rather than stopping you totally, such a system should allow enough forward progress for good waterflow over the rudder to maintain steering control.

It should be deployed far enough astern so that it would be beyond an oncoming crest, and buried deep enough so that if the crest broke it would not simply toss the system into the cockpit (which has happened more than once).

Drogues must not turn inside-out or twist when subject to acceleration and deceleration—a common problem in breaking seas.

Commercial Products

A variety of commercial products on the market are designed to slow you down and hold your stern into the sea.

Among these are products like the Galerider, Attenborough sea drogue, Sea Brake, and the Para-Tech Delta drogue.

All have adherents on one type of vessel or another. The key to finding the best unit for your needs is to talk with folks who have experience using the gear in question on a similar type of vessel.

Both photos Kim Taylor

Top photo: A simple yet robust canvas drogue of the "traditional" style. Note the turbulence when it is towed at 4 knots.

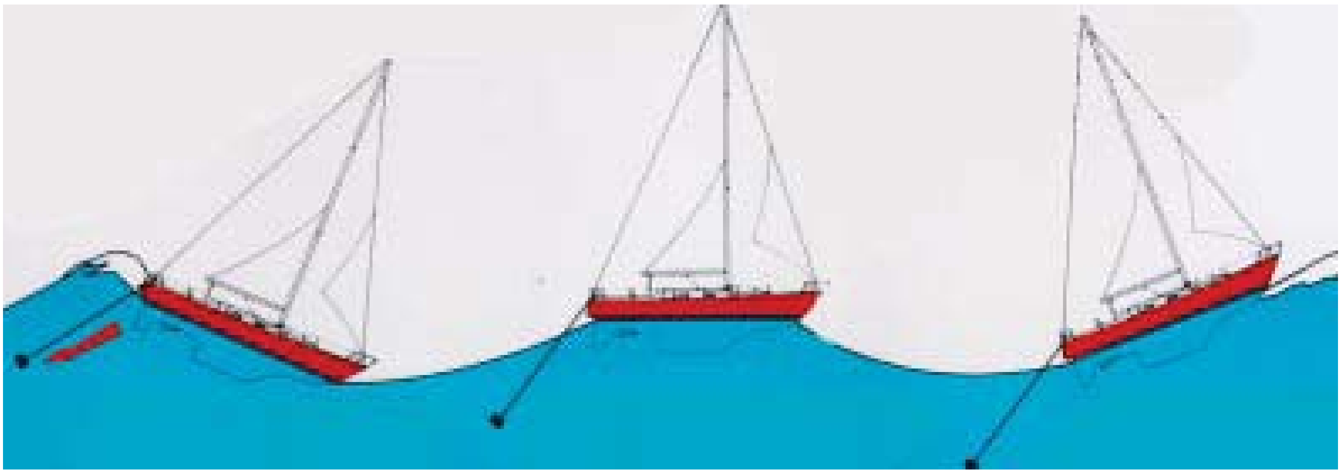
These drogues work well in moderate conditions, but when used in large breaking seas they sometimes fail structurally, or collapse in the cyclic motion of the wave itself.

Right photo: The drogue is attached with an old Dacron sheet. It would be better to use heavy nylon for shock absorbing. A splice is preferred over a bowline as it does not reduce the strength of the rope. If a bowline is used for connection, the end should be seized (sewn) so it cannot unravel if the drogue is vibrating or pulsing.

All photos John Neal

John Neal shows off the Galerider that he is about to test in the South Pacific. This is an extremely strong approach to the problem of slowing the boat down—probably capable of taking just about any load. The concept is to reduce boatspeed substantially, so that broaching is not a major risk, while still allowing enough speed for a moderate degree of steering control. On a boat like John's Mahina Tiare, a Halberg Rassey 46, the Galerider will slow their speed from 8.5 knots to 4 knots or so.

Notice the eye splice and thimble at the bitter end of the rode. The thimble is important for chafe protection against the shackle of the Galerider. John feels you can also use the Galerider as an aid in crew-overboard recovery (upper right photo).

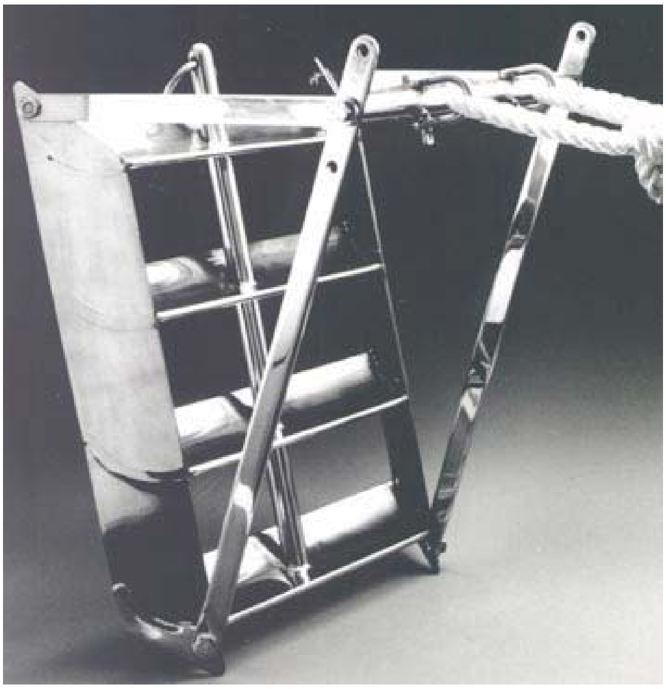


These photos and drawings show Neil Attenborough's sea drogue. A stainless steel weldment, the sea drogue depends upon a series of vanes operating at an angle of attack relative to the water to create drag. The concept is much like a hydrofoil. The faster the boat goes, the more load the vanes generate and the deeper into the water the sea drogue digs itself.

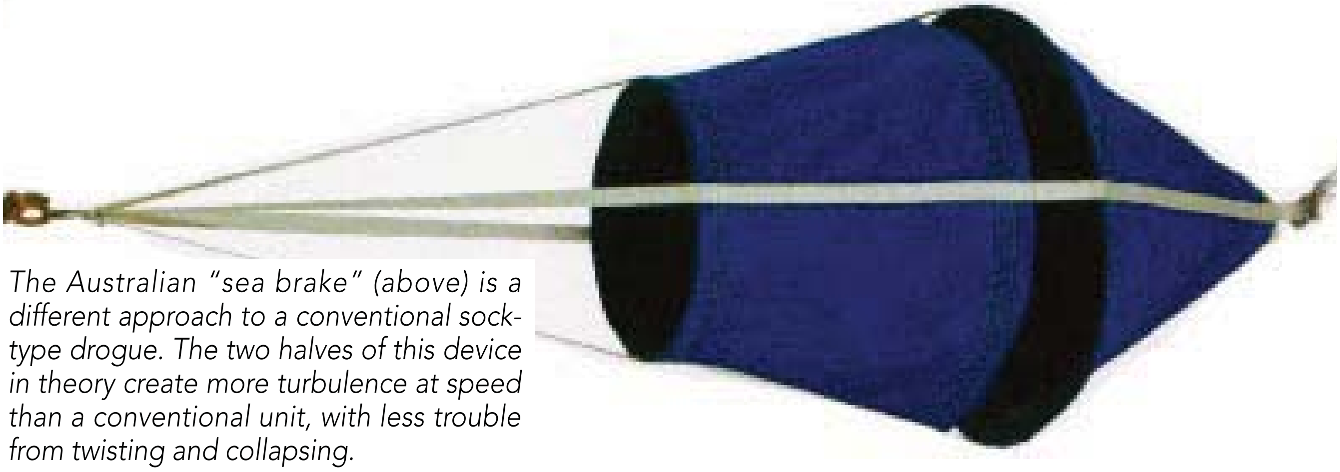
In the sketch above (from one of Neil's brochures), you can see how it is supposed to work. As the boat accelerates with the oncoming wave, load is increased on the vanes—and they hold the stern down and back against the force of the wave.

These units can also be used for steering (lower drawing and photo). The angle of attack is changed so the drogue does not dig as deep in the water, Then it is adjusted in one direction or the other at the stern quarters.

We have not talked with anyone who has used these devices in heavy going, but Neil says they have been used by fishing vessels and motor lifeboats in the UK.



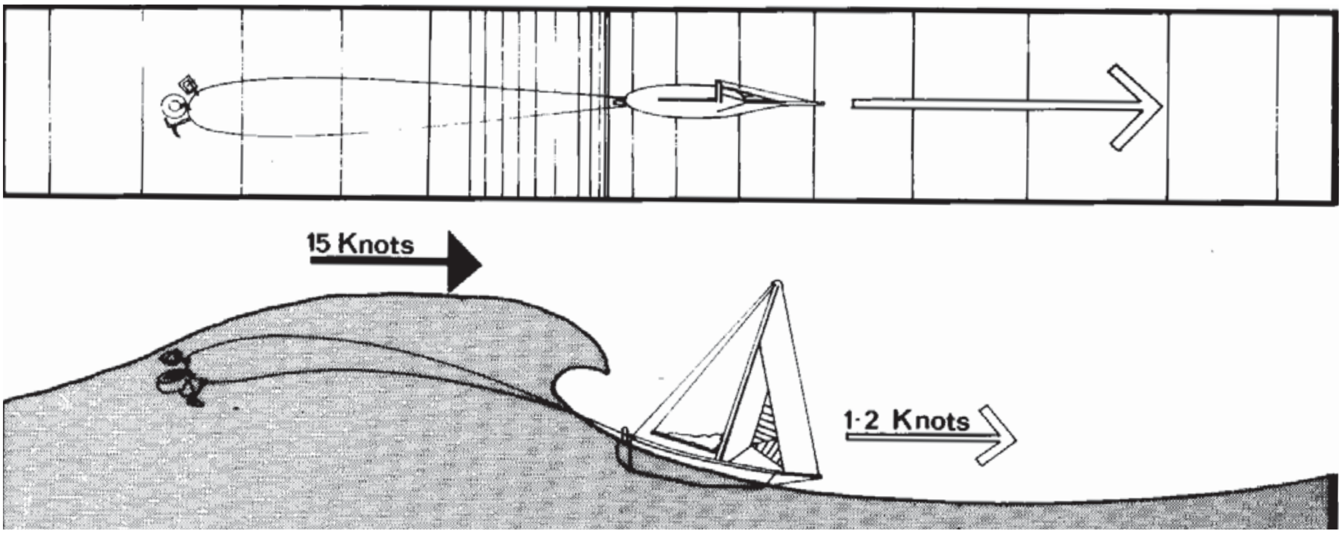
Neil Attenborough



The Australian "sea brake" (above) is a different approach to a conventional sock-type drogue. The two halves of this device in theory create more turbulence at speed than a conventional unit, with less trouble from twisting and collapsing.

An aerial view of a Para-Tech drogue in use at the stern of this sloop in the Santa Barbara Channel. Note the turbulence in the close-up shot (center, left). The boat is moving on a broad reach at about 2 to 3 knots in 25 to 30 knots of wind. In large seas you would want to have the drogue trailing much further behind the boat than shown here—ideally on the second wave back.

Para-Tech



Bights have the advantage of being easy to adjust; letting out more in stronger winds and bringing in line during lighter spells. However, the drag produced by this approach is far less than by shaped devices.

Whatever the drag device being used, it is important that the rode be able to run freely without tangles when it is deployed. Speed of extraction will be high and the loads enormous. If something gets fouled, the odds of clearing the foul are not good—unless a knife is used. The bottom photo shows a West Marine rode storage bag. Your rode is flaked into the bag and then runs out cleanly. Remember to lead it clear of any deck gear and to tie off the bitter end.

Bights of Line

Using a bight of line (a "U" of line connected to each corner of the transom) is a time-honored tradition—albeit one without the drag forces of the shaped drogues previously discussed.

This has the advantage of imparting some directional control and slowing the boat down. Ideally the bight will trail behind the boat 300 feet (90m) or so, which means you need 600 feet (180m) of line to start.

The bight is typically made up of an anchor rode or rodes knotted together, sometimes supplemented by spare halyards and sheets. Tires have been used for years to increase the drag of bights—sometimes several will be used at once. These are strong, cheap, and readily available throughout the world.

If you refer to Rich Wilson's story on page 552 you will see a situation where putting knots into straight towed sections of line worked quite well.

You'll need some system of keeping the line immersed. This can be sections of chain, anchors, or both.The important thing is to keep the bight from surfing or planing on the water's surface. Once this happens, drag will be substantially reduced. There is also the risk of having the bight of line complete with attachments tossed into the cockpit by an overtaking wave.

You can also use a well-secured and weighted sail bag (with the sail still enclosed).

Both photos John Neal

Ace Sailmakers

The Jordan series drogue consists of numerous small elements, each of which contributes a modest amount of drag; the aggregate of which is an enormous braking power.

Jordan Series Drogue

The Jordan series drogue takes a different approach to the problem of stability in breaking waves. Don Jordan, the developer, wanted a system which would hold the stern aligned with the wave, thus eliminating a broach and roll.

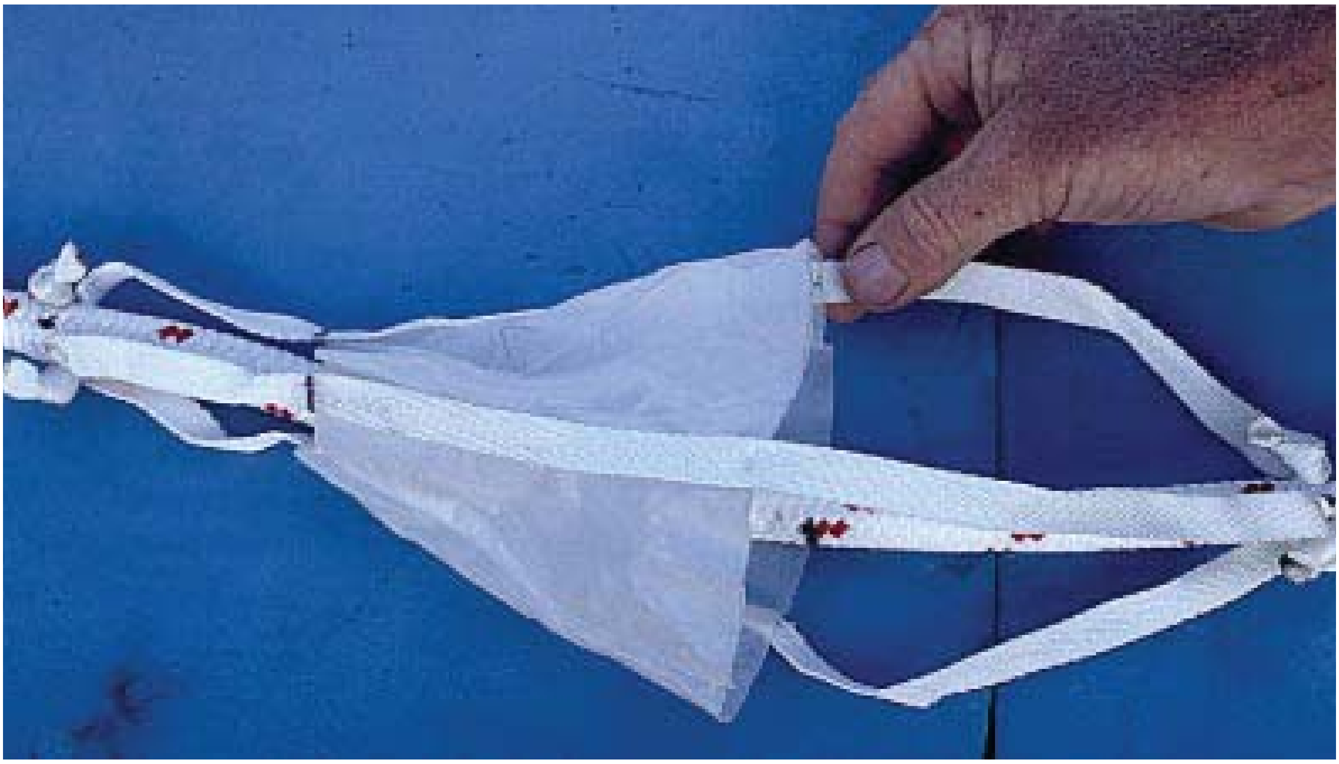
His approach is extremely clever. He uses a series of small cones attached to a single line. As the cones come under load, they open up. The fact that there are so many cones in line creates a huge amount of resisting force.

In the process of writing this book we have had many interesting conversations with Don. We have talked to several users of his system, returned to him with more questions, and then gone away to mull the subject some more. Don makes a cogent case for his system, and his thoughts are worth pondering.

My early studies clearly indicated that I should concentrate on the far end of the boat dynamics spectrum: namely the rare and worst-case scenario in which the boat is imparted with enough energy by a breaking wave that it becomes airborne with a specific velocity relative to the still water and with a specific angular velocity in roll. The *Tzu Hang* capsize is representative of this type.

If the survival gear can handle this, it will handle all lesser dynamic events. It is fortunate that nature made it possible to create gear that would satisfy the requirements. For awhile I thought it was impossible. My research indicated that the most important boat design characteristic for survival in a worst-case strike is the displacement.

This is understandably very difficult for sailors and boat designers to accept. In comparing *Tzu Hang* (discussed on page 199) with a modern boat, the modern boat can have a better structure and can be controlled to avoid broach. But if struck by a Smeeton wave, the modern lightweight boat would be thrown



Both photos Kim Taylor

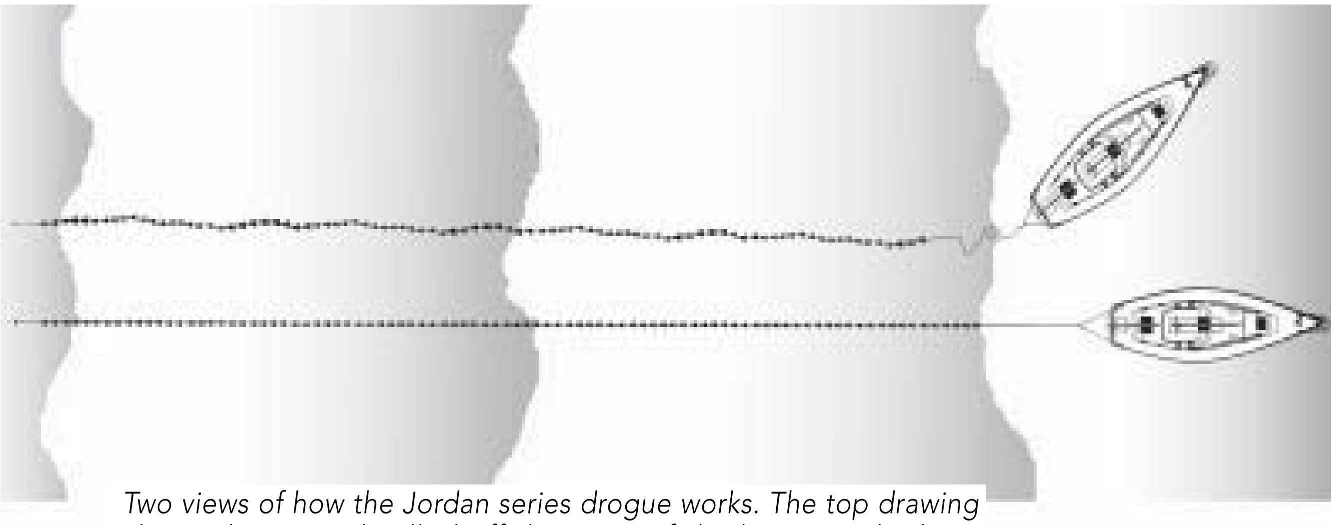
A couple of close-up views of the cones. In the top photo you can see how these are made from light cloth, typically rip-stop nylon (spinnaker cloth).

Webbing is sewn onto the cones, then worked into and through the rode itself (bottom detail).

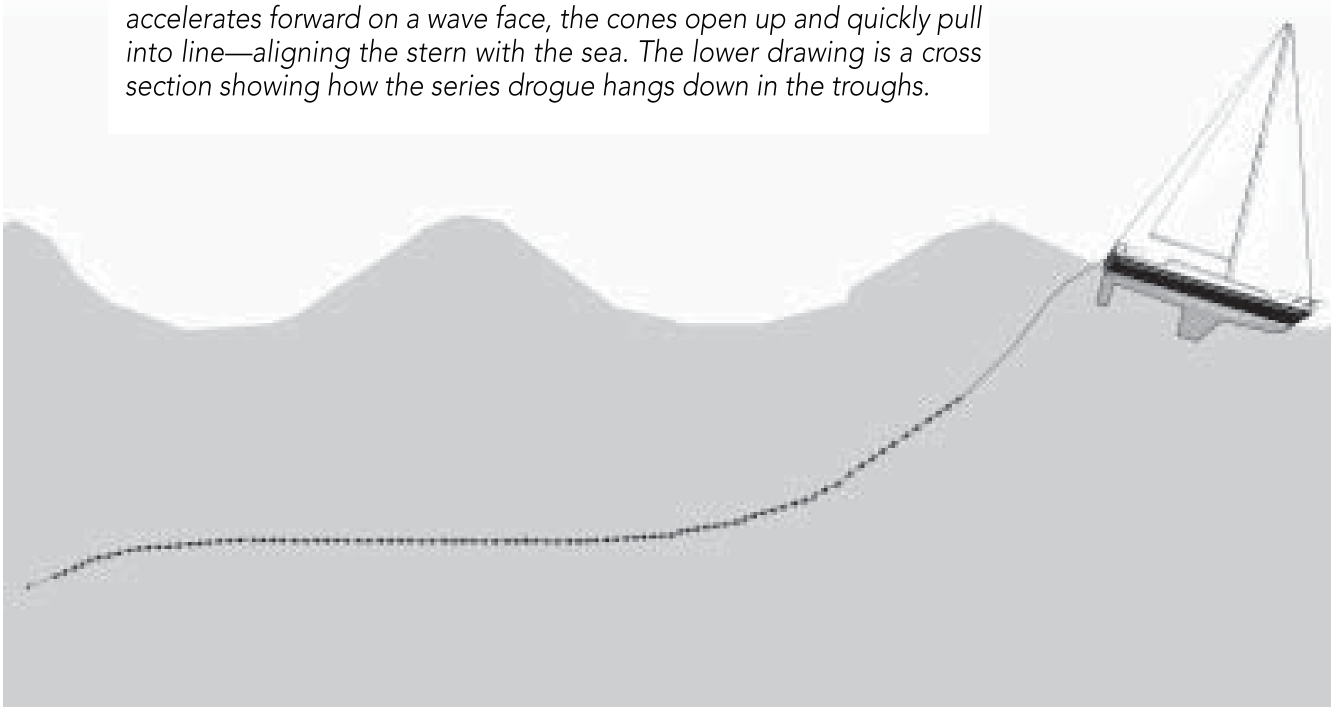
You can make one of these yourself, by ordering a kit from Ace Sailmakers; or obtain a completed Series Drogue.

further and with a higher angular velocity. I actually tested a model of the boat that won the 1923 Fastnet compared with the boats (light displacement, fin keel, spade rudder) in the 1979 Fastnet. Of course, the series drogue is mostly applied to normal storm conditions.

The bottom line is that the series drogue has been through many storms up to hurricane strength and no boat has sustained any damage, including multihulls which often have a large cockpit and doors. In fact, even the self-steering gear has survived intact.



Two views of how the Jordan series drogue works. The top drawing shows the cones bridled off the stern of the boat. As the boat accelerates forward on a wave face, the cones open up and quickly pull into line—aligning the stern with the sea. The lower drawing is a cross section showing how the series drogue hangs down in the troughs.



Catching the Boat

There are fundamental reasons for this type of behavior. The drogue plays no part in the action until the boat is accelerated up to wave speed. It does not hold the boat back. It catches the boat, aligns it, and decelerates the boat at a rate that does not develop excessive loads on the boat.

Don feels that a key element in the use of his series drogue is that the system must be connected to the stern of the boat. This has the rudder upwind where it is least likely to be damaged, as the boat briefly accelerates forward before the series drogue takes up slack.

There is no question that these drogues work. A number of end users have testified to that fact. The problem is that in severe conditions the series drogue may work too well, holding the stern down against an advancing sea, so that the rear end of the boat and local structure, such as the cockpit and companionway, are at risk. In spite of Don's comments, this remains an area of concern for us when considering boats with vulnerable structure at the stern.

Peter Sanne

Robert Burns is an Australian sailor with hands-on experience using the Jordan series drogue. His account of its use during a Gulf Stream gale first appeared in *Yachting Monthly* in the UK.

My experience relates to a Gulf Stream crossing in June 1992. I encountered sustained Force 10 conditions for about 18 hours and confused seas from at least three directions. Waves of 30 feet (9m)on average were encountered. I was captain aboard a 1973 center-cockpit Contest 40 (8 tons) fin-keel skeg rudder. We ran before the gale for about six hours surfing down breaking wave faces. It was too dangerous to continue and at dusk we set the Jordan series drogue from the stern. As I recall the JSD had 85 cones and 300 feet (92m)of 3/4-inch (19mm) double-braid nylon.

What makes this account interesting is that we lost the drogue due to chafe of the bridle at the height of the storm. All the crew was below. I noticed the change in motion but did not attribute it to losing the JSD.

Within moments of losing the JSD we were lying beam-on to the sea. We were struck by a breaking wave and knocked down; the boarding wave stove in the main companionway hatch and flooded the main cabin. Water was taken into the aft cabin although the hatches were not damaged. The cockpit was flooded and took several minutes to drain. One of the cockpit seats provided access to the engine space. This hatch had been secured but in no way was watertight. We may have taken in water there as well.

There is some vulnerability in the companionway as the JSD will pull a vessel backwards through a breaking wave. However, this is the most stable position for a monohull riding to a JSD.

The point of detachment is determined by several factors: 1) the underwater profile of the vessel and 2) the willingness of the crew to allow the vessel to drift backwards in heavy seas.

If the vessel, when allowed to drift, turns bow downwind, this is a clear indication that the JSD should be streamed astern. Some cats may have a symmetrical underwater profile. The main point is unlike a para-anchor that holds a vessel in place. The JSD allows the vessel to drift at about 1 1/2 knots.

Robert is familiar with the details of the 1998 Sydney-Hobart Race, so we asked if he thought the series drogue would work under the breaking sea conditions encountered.

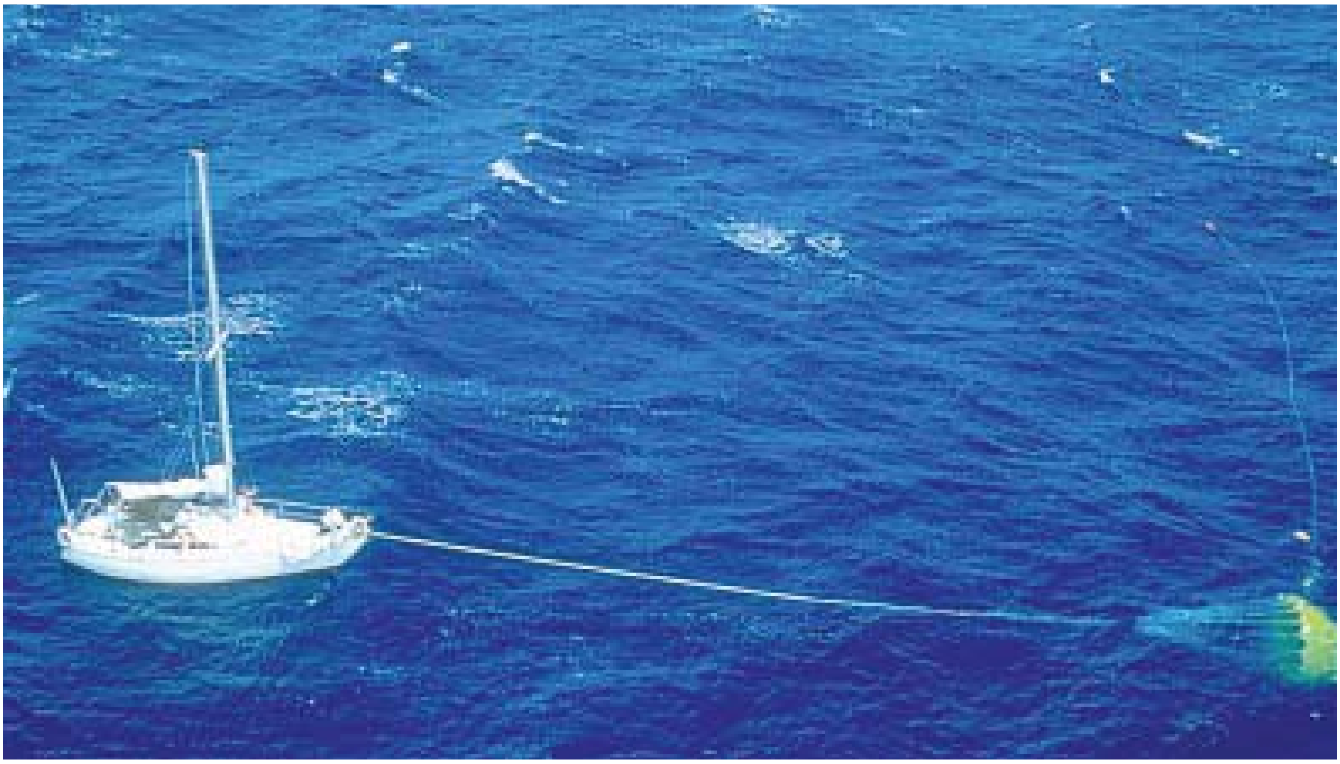
ABSOLUTELY. Several vessels were lost running before the gale seeking shelter. Running is not as safe a tactic as lying to a JSD. I have sailed in this area as well and the South Australia current with a Force 10 blowing against it can set up a powerful sea.

If you have a boat with a strong stern and a midship cockpit, where a boarding sea is not going to cause problems (a good example would be a Peterson 44), the series drogue may be the ultimate weapon. This would also apply to flush-deck designs with horizontal companionways, where the sea does not have a direct shot at the wash boards (such as the early Swans).

On the other hand many cruising catamarans, with their aft sliding doors, would be extremely vulnerable to a boarding sea from the stern—as would any modern racing or cruising yacht with an open transom.

One of our concerns is about what happens in a frontal passage, when the wind and seas shift 90 degrees:

"The drogue line is so long that it tends to take an average position to the wind and wave trains. The vessel, however, will align with the current wave it encounters. In other words, the vessel will align itself stern-to the wave that is passing under the hull."



Para-Tech

Parachute Anchors

Parachutes have been used as sea anchors in one form or another since the end of the Second World War. Commercial fishermen on the West Coast of the US were the first to discover that they could comfortably heave to behind one of these devices for a restful evening, when changing fuel filters, or when waiting out bad weather.

Since then they have been used by commercial and amateur sailors around the world.

Before we go further into the details of this subject, we would like to return to the case of the yacht *Freya* and the Burman family discussed (starting on page 65).

Freya Parachute Anchor Analysis

As you will recall the Burmans had been comfortably riding to an 18-foot (5.5m) diameter Para-Tech para-anchor. The anchor was attached to the boat with 450 feet (138m) of 3/4-inch (19mm) New England Ropes three-strand nylon, with a breaking strength of 16,700 pounds (7,573kg).

Bruce Burman had been easing the rode every two hours to make sure chafe was not a problem.

Bruce is certain that their anchor rode parted at the same instant when they took their first knockdown (or rollover).

What Caused the Knockdown?

In order for *Freya* to have been knocked down, she would have had to be at a substantial angle to the direction of the breaking crests. This implies either a crossing sea got her while she was held to the primary wind direction, or that her bow had somehow blown off the wind before she was caught by a primary sea crest.

Freya questions:

- ❑ If *Freya* was lying to the parachute anchor more or less comfortably, what would cause the boat to get into a position where a knockdown or rollover was possible?
- ❑ Could the loads really be so high that they would break a piece of three-strand nylon that regularly tests above 16,000 pounds (7,256kg) in breaking strength?
- ❑ Is there anything that could have been done to make the system more effective?

When we asked Bruce about the motion below, and if he had noticed any shock loading or shearing he replied, "I don't recall any shudder in the boat but there was lots of pulling motion, hard to describe, like pulling back and moving ahead, akin to being on the end of a rubber band, sort of! The boat moved side to side, but it wasn't an uncomfortable motion."

Given the anecdotal evidence of other users it is probably safe to conclude that *Freya* was indeed shearing back and forth against her parachute anchor.

Ralph Naranjo is a professor at the Naval Academy, as well as Technical Editor of *Cruising World* magazine. He also used to run a boatyard with a mooring field, so we decided to ask him what sort of mooring pennants he would have used for *Freya* when he was running his operation in Oyster Bay, New York. His reply is sobering. "Anything less than dual 1-inch (25.3mm) pennants would fail in short order."

Remember, Ralph is talking about a protected anchorage—not the open sea.

We can find no evidence in the meteorology for anything but a steady wind state from the east. The satellite images, computer analysis, and rescue helicopter data all support this.

Freya was too far offshore for a reflected wave to have caused the problem, and there were no other large-scale weather events taking place in close enough proximity to have created a breaking, crossing swell.

So we are left with the conclusion that *Freya* must have been shearing back and forth on her parachute anchor rode, in much the same fashion as she would be tied to a mooring or her own anchor in a severe blow. She was probably caught by a crest during one of these shears.

If you stop for a moment and consider the behavior of different vessels when anchored, you can readily see how this would happen. Take the issue of chain versus line. Vessels on chain are always more stable than those on nylon because the chain does not stretch and snap them back and forth as nylon rode under load—although catenary, or sag on the chain, will act to absorb shock loading.

Some vessels lie to their anchors better than others. Ketches and cutters, for example, typically do better than sloops as their rig's center of windage is further aft.

Rode Implications

The anchor rode ran over a fair and smooth bronze chock, and was attached to a bronze cleat which had been aboard the boat since she was built. The fasteners, four 5/16-inch (8mm) stainless-steel bolts, had been replaced two years prior, and a 1/4-inch thick (6.3mm) stainless-steel backing plate had been installed under the deck.

From this, we can infer that the cleat and its attachment were barely capable of taking the full breaking load of the rode.

We called Mike Dahill, the production manager of New England Ropes, to discuss the structural issues. Mike told us that chemical attack, and, to a minor degree, ultraviolet radiation from the sun could weaken the line.

However, this was brand-new rode, stored on a roll in the lazaret, had never had diesel, bleach or any other chemical on it, and had never been exposed to the sun.

He explained that "hockles" (twisted bumps) in the line can occur from excessive loading, and these are stress points, much weaker than the rest of the line. However, Bruce Burman did not see any hockles in the broken line and hadn't noticed any before (if you have a line with hockles, cut out that section as it will be substantially weaker than the rest of the rode).

Another issue is twisting or untwisting of the line due to rotation of the parachute. This is more acute with three-strand construction than with a braid, as the line may tighten or unlay depending on the direction of twist. This weakens the line and is why stable drogues and/or high-quality swivels should always be used.

But Bruce saw no evidence of the lay of the line being changed on the piece that was hanging from the bow, and he used the swivel that came from Para-Tech with the sea anchor.

The final issue Mike raised was internal heating. When nylon rode stretches and relaxes under load it generates internal heat. Over time, this heat reduces the strength of the nylon. If anything besides chafe weakened the rode, internal heating was probably the culprit.

Looking at this from a different perspective, we asked Doug Whillden of Para-Tech for his comments, and he gave us an interesting structural benchmark. "The 18-foot (5.5m) Para-Tech will blow a panel at around 10,000 pounds (4,535kg) of load, so there is no way it would have broken the 3/4-inch (19mm) rode."

This leaves us with internal heating and/or chafe as the probable culprits, both of which point to a heavier-duty rode as the answer.

Mooring Comparisons

Anchored in a protected harbor in 50 or more knots of wind, with the boat sailing back and forth, the loads on the rode are going to be really high.

Now add in large seas, with the boat in one part of wave oscillation while the parachute is in another. The loads on the rode obviously multiply enormously with the wave loading.

The rope-making industry and mooring area managers around the world have lots of protected water experience with these issues.

When seasonal storms hit, if the moorings are not up to snuff, boats come adrift. The most common weak point is the mooring pennant, between the boat and mooring buoy.

Reducing Knockdown Risks

In hindsight, there probably comes a time in every situation where the parachute anchor is simply not going to be able to guarantee success.

This may be because the boat won't lie still and sails back and forth too much, or it could be the result of a wind shift or the advent of a new set of seas from another storm.

However, there are a few things that would have helped in the case of *Freya*.

The first is the use of a riding sail or back staysail. With no mizzen to set to hold them into the wind, a storm jib could have been hanked on the backstay, hoisted with the main halyard, and sheeted hard.

They could have imparted some angle to the boat with a back staysail (or mizzen) by sheeting it off-center. This way, if the wind was at an angle to the waves—a common occurrence—the boat might have been brought more in line by off-center sheeting.

The next thing was to reduce windage forward by removing any roller-furled headsails. Obviously this would have been impractical once the storm was well underway, but in the early stages—before heading up and setting the parachute anchor—the jib could have been dropped in the lee of the mainsail while running off. This would have had a huge impact on shearing back and forth.

Finally, a heavier rode with less stretch would probably have reduced the shearing action as well.

We know that 3/4-inch (19mm) line is too small for this application (although that is what is recommended by all the parachute manufacturers). If you go up in size to 7/8-inch (21mm), the breaking strength shoots up to 23,500 pounds (10,680kg). To what do you attach this?

- A single bow cleat on *Freya* would not be strong enough. No common windlass or cockpit winch would do the job either.
- The answer is a really strong sampson post, with a "moment connection" between the deck and a shelf below the deck by which you could literally lift the boat if required.
- The other approach—favored by commercial fishermen—is to use a rode of sufficient strength to withstand the cyclic loading, attached at the boat end to the anchor or anchor chain. The chain system then takes the termination load. This has the advantage of also reducing chafe as an issue.However, few (if any) windlasses will take the full breaking load of their chain, so it is important to have a well-built chain stopper to carry the load.

Parachute Anchor Choices

We feel that in certain instances parachute anchors can make a lot of sense. They provide a means of heaving to and holding station—although conventional heaving to, using sails, is probably more comfortable.

More importantly, if you've lost your ability to manage the boat due to a system failure (loss of steering, structural problems with the rig, crew fatigue) they can be extremely valuable.

Some boats make better use of them than others. This may be because they have fewer tactical options, or because they lie at anchor calmly and tend not to sail—a ketch, schooner, or yawl for instance, with the ability to set some sail area aft.

Rode Solutions

The rode, which makes the most sense to us, is a combination of line and chain. The purpose of the rode is to provide the minimum shock-absorbing capacity required by the boat and the parachute anchor itself.

The chain absorbs some shock by virtue of its catenary, but for the most part is going to be stretched out tight.

Chain eliminates the problems of chafe, although you need to be sure the bow-roller assembly is up to the load of the full breaking strength of the chain.

Combining chain with a heavy piece of rode gets the parachute far enough forward to be in the right position in terms of the waves and makes it simpler to adjust distance to the parachute using the windlass.

And remember, some form of securing the chain, capable of taking the full breaking strength of the chain with a factor of safety left over, must be used ahead of the windlass.

If you don't have a windlass, the answer may be a combination of line sizes. Use standard-weight line from the parachute, for stretch, and then one or two sizes up as a long pennant for attachment to the boat.

At the boat end this may end in a double pennant, one to each side, as you would do with a long-term mooring.

If the bridle is properly set up, with heavy line and chafe protection, it will not have to be eased out over time.

If you are seriously thinking about a parachute anchor, it needs to be looked at as a total system. This includes the parachute itself, the connecting swivel, the rode, any float system; and attachment to the boat. Each part of the system needs to be matched to its job. To the extent that space or budget forces compromises, they must be made cautiously, so the crew understands the limits of the total system.

While we've already stated that we feel a parachute anchor can make sense in some circumstances, its use is not without problems. In the small sampling, which we made for this book, we found over half the users experienced some form of difficulty—from jammed rudders to loss of the parachute, to some form of chafe or structural failure, to the inability to retrieve the anchor when conditions called for a change in tactics.

This photo shows a basic parachute system from Para-Tech. The bag in the lower right-hand corner stores the chute before deployment. The light pennant from the bag bottom is a retrieval line. The shroud lines connect to a heavy section of webbing, which is in turn connected to a shackle to which the rode is fastened.

Rope Selection

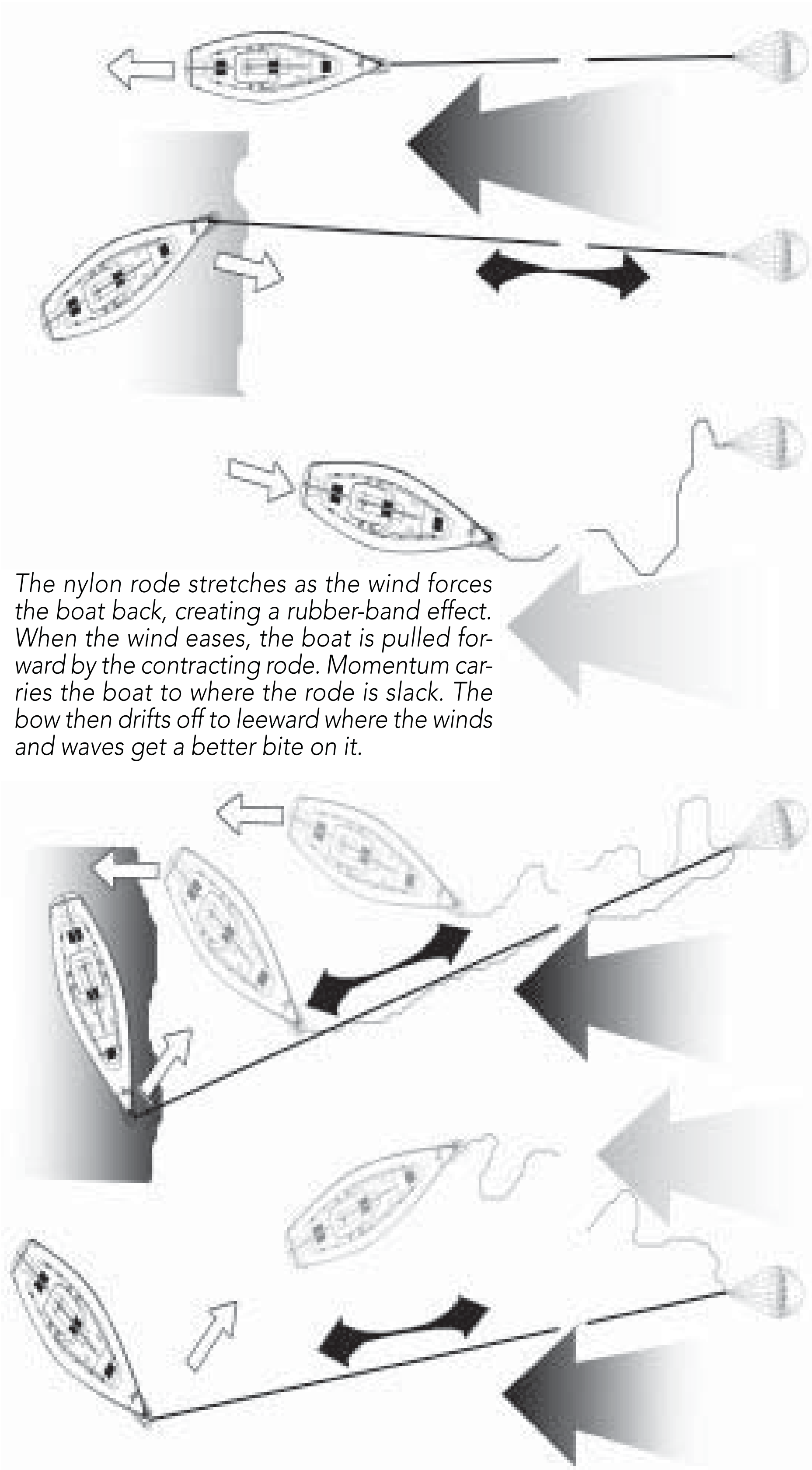
We now come to the difficult topic of rope rodes. The issue of internal friction with nylon line, briefly discussed in the preceding pages, may have a major impact on the use of a parachute anchor in severe conditions.

At the end of World War II nylon became the *de facto* choice for mooring and towing pennants—its cost benefits and behavior were orders of magnitude better than the hemp hawsers, which preceded nylon.

Starting in the late 1970s and early 1980s, research was carried out by military and civilian entities on the capability of nylon, and some interesting data resulted.

First, nylon is subject to internal chafe and creates internal heating, which can quickly reduce the breaking strength by 50 percent or more.

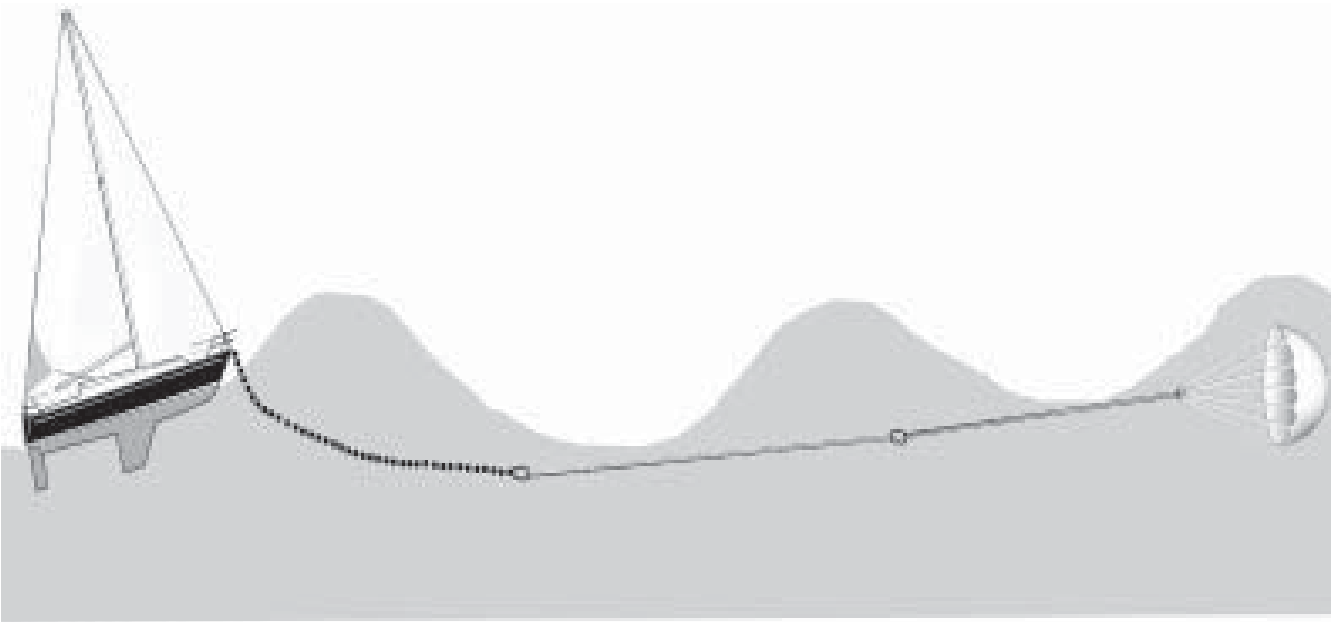
When nylon is wet, the problem is worse than when it is dry. It is also worse under repeated cycles of high load, such as one encounters when lying to a parachute anchor in severe conditions.



The nylon rode stretches as the wind forces the boat back, creating a rubber-band effect. When the wind eases, the boat is pulled forward by the contracting rode. Momentum carries the boat to where the rode is slack. The bow then drifts off to leeward where the winds and waves get a better bite on it.

In this entire discussion, that which concerns us most is the rubber-band effect, caused by variations in wind and wave strength working against an elastic mooring rode.

Some form of elasticity is required. There is simply no alternative or the shock loads will be too high. However, excessive elasticity, breaking seas, and a vessel that sails at anchor is a potentially disastrous combination.



This approach of connecting the boat to a parachute anchor provides some cantenary for shock absorbing, but reduces the rubber-band effect. A braided pennant of heavy nylon leads from the parachute to a section of single-braid polyester. This in turn is connected to the anchor chain, which provides a catenary for absorbing shock loads.

The closer you approach the breaking strength of the line, the greater the internal chafe and heat.

Line construction is also an issue. As previously discussed, three-strand stretches more, is subject to hockles at higher loads, and has more internal chafe than does a braided line. Among braids, single braid has less internal chafe than dual braid.

The problem we have here is with the cyclic loading nature of the parachute anchor, added to the poor performance of nylon in this environment. To be safe we need to increase line size well above current practice—if you expect the system to have a chance of working in the worst conditions.

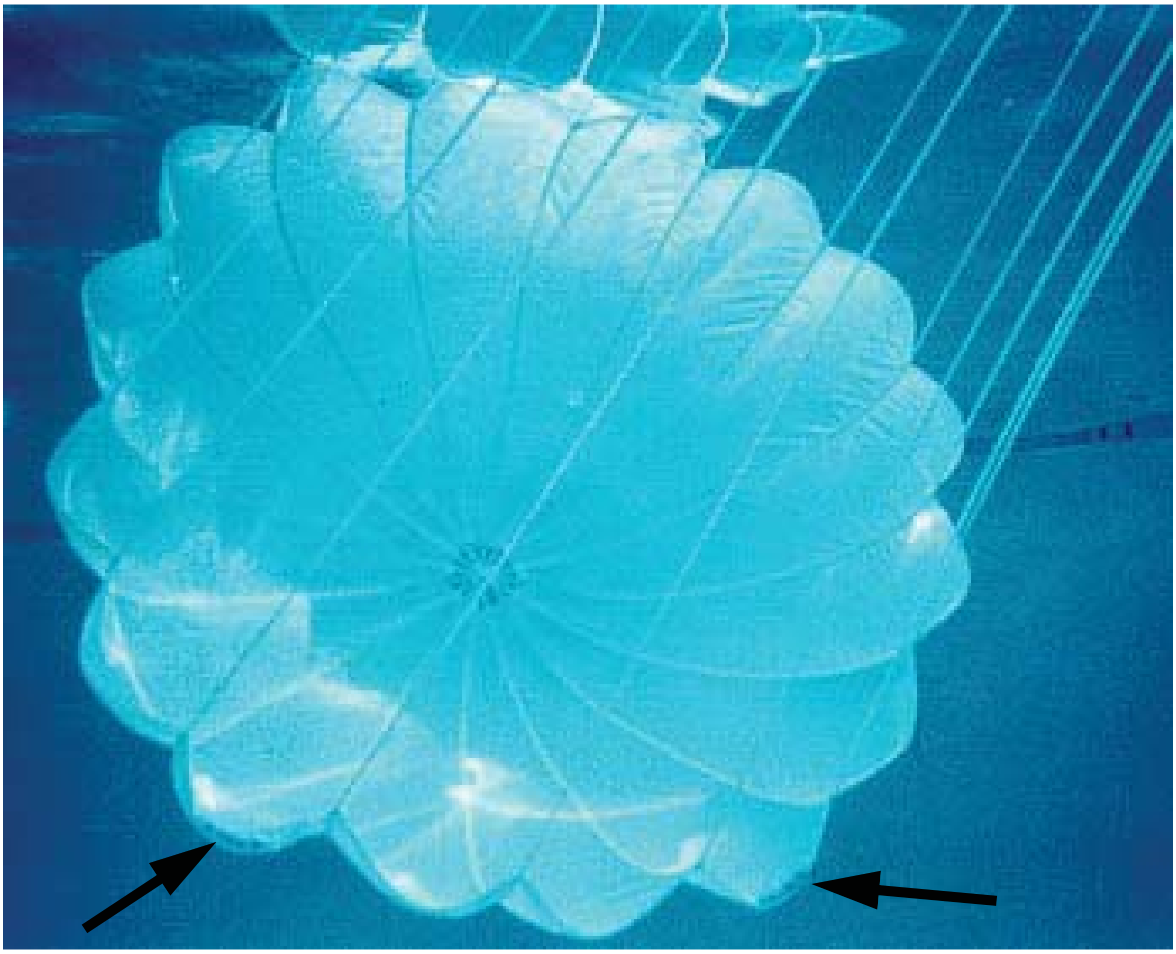
In *Freya's* case this means a rode at least 1 inch (25.4mm) in diameter—perhaps even larger. We are talking now about a rode that is probably twice as heavy, takes double the storage space, and costs a lot more.

The extra strength is not required for ultimate loads, but to reduce the working load so that internal chafe and heating is brought down to a tolerable level.

Polyester (Dacron) is virtually unaffected by wetting, has significantly better chafe resistance than nylon, and does not suffer from internal chafe and heating; so it may be the best rode material.

The one theoretical drawback is that Dacron does not have the stretch for absorbing shock, which you get with nylon.

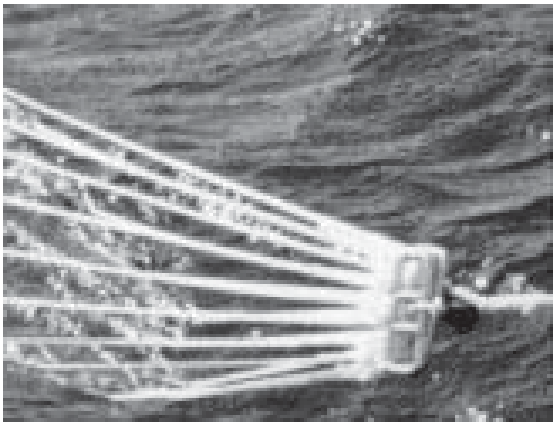
But is this stretch really desirable? If you come back to the question of shearing back and forth, and the rubber-band effect with long stretchy rodes, we feel a case can be made that the stretchiness actually makes the problem worse.



One of the design issues debated among parachute manufacturers is rotation or oscillation. Another is fouling of the chute due to collapsing and filling in wave action. Fiorintino addresses these issues with a design approach that is different from the others.

First, they incorporate weights (arrows/top photo) in the hem of the parachute. These sink, and with a long lever arm from the center of rotation, the small amount of weight apparently keeps the chute from rotating.

Next, they have an elongated buckle to which the shroud lines of the parachute are attached. This buckle accumulates the considerable load of the individual shrouds and transfers it to the rode. The flat (as opposed to round) shape also tends to reduce rotation.



All photos Fiorintino

Commercial fishing boats were the first to use parachute anchors for heaving to when drifting at night or when waiting out bad weather.

Fiorintino

Some form of shock absorption has to come from catenary provided by a line-and-chain combination, or by the use of a substantial weight mid-length in an all-line rode.

We'll let Mike Dahill of New England Ropes have the final word on this subject:

I have no experience with a sea anchor, but in thinking about the way it works and the environment, I would probably choose a polyester single braid. Given the length of the rope typically deployed, and the natural sag, there will be a pretty good shock absorber if the rope has any stretch at all.

My preference for single braid is based on two factors. First, twist is a bigger problem for three-strand ropes than it is for braids. Single braids absorb twist better than either three-strand or double braids. Second, single braids are less likely to kink during deployment and retrieval, and would flake down better in a bucket or locker for storage.

The Pardey Bridle

Lin and Larry Pardey have been advocates of heaving to with a parachute anchor for years. In their *Storm Tactics Handbook*, they go into great detail on their system for using parachute anchors.

It is their feeling that the parachute anchor represents the ultimate survival storm tool. We don't agree with this blanket assessment. However, there is no denying that is has worked for them over many years.

Part of that success may be due to the design of their vessel. She has a heavy displacement, modest beam, and a full-length keel.

The hull shape and displacement make this design the equivalent of a much larger, albeit lighter-displacement design.

One of the key ingredients in Lin and Larry's use of the parachute anchor is a bridling arrangement, between the bow and stern quarter. By means of this bridle they hold their bow at an angle to the wind and sea.

With a scrap of sail set they are stabilized, and even without sail the bridle

helps them to avoid the tacking back and forth, which is uncomfortable and potentially dangerous when hanging just by the bow.

They describe keeping the boat at a 50-degree angle. We feel that in seriously breaking seas, this presents too much of a clean shot for a wave to impact the topsides and start a rollover. However, in non-breaking conditions, it is fine.

A final word on the Pardey system. It appears to us a key element is the ability of *Seraffyn* to produce a windward slick to calm the breaking crests.

This slick is quite difficult to achieve, and none of the sailors we've spoken with, who go to sea on modern vessels, have ever been able to reproduce a slick from their hulls or keels.

So, it may be that this system, using the parachute on a bridle in severe weather, is one which is primarily suited to vessels of the same design type as *Seraffyn*.

By using what in effect is a "tweaker line" (image above) off the parachute rode, you can adjust the angle at which the boat lies. In non-breaking seas this is more comfortable than lying head to wind.

To swing the bow more off the wind, tighten the tweaker line. To head farther into the wind, ease the tweaker.

Rode Length

One of the key factors in reducing shock loading and having a comfortable ride behind a parachute anchor is keeping the parachute exactly in phase with the boat, relative to the wave period.

While you are on a crest, you want the sea anchor also on a crest (either one or two crests to windward).

If you are out of phase, (the parachute is in a trough while you are on a crest), the shock loads will be greatly enhanced.

Parachute Size and Strength

For a parachute anchor to work properly it must find a balance between holding you into the wind so that the bow does not fall off, and not holding you so tight that there are structural problems.

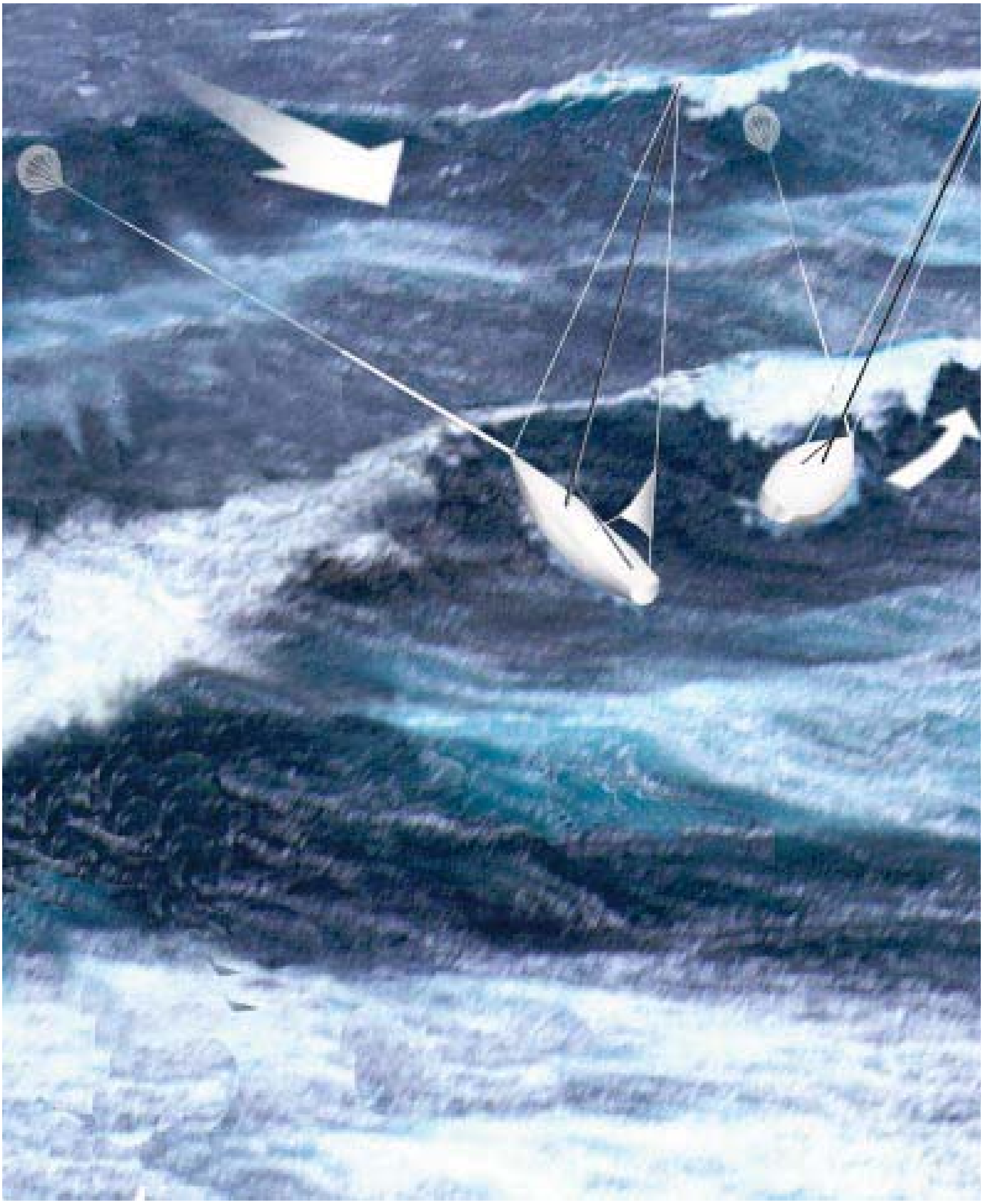
This is a function of the design of the vessel, the design of the parachute, the size of the parachute, and the ability of the vessel's steering system to absorb some backward movement.

John and Amanda Neal run a sail-training business as they cruise throughout the South Pacific. Their emphasis is on heavy-weather boathandling. As a part of this program, they give their clients a taste of using drogue and parachute anchors—which is what is going on in these photos.

From numerous interviews we've conducted with para-anchor users, we've concluded the following: They are typically easy to deploy but very difficult to retrieve. There are definite techniques to the process, and the only way to work these out is with real-world practice.

In this series they power up to the para-anchor, making sure to keep it clear of the keel, rudder, and prop. The trip line and float are picked up with the boathook. The chute is then brought aboard. The final step is to lay the parachute out on deck, clear the rigging, and then repack it into its deployment bag.

All photos John Neal



Before we leave the subject of parachute anchors, we want to come back to the issue of keeping the bow head to wind. In breaking seas everything possible must be done to maintain this attitude. This means reducing windage forward by getting rid of roller-furled sails and increasing it aft with a back staysail. If you are successful, the boat will lie more or less quietly head to wind, and the breaking seas will be more likely to pass you by without imparting huge impact loads. The alternative, shown with the boat to starboard, is to have the head fall off and lie at an inviting angle to the waves. If a big one catches you in this attitude, the loads generated are likely to be so huge that no conventional parachute, rode, and deck hardware combination is going to cope. The result will probably be a knockdown or rollover.

The strength of the parachute is also a major issue. You want to be sure that the parachute fails before the rode; but it should be able to carry the load of the wind and sea state you expect to use it in.

We realize that we are leaving this issue of strength vague. That is because the loads are hard to predict and vary with wind, sea state, and vessel design.

Practice

The initial use of a para-anchor is not a simple exercise. It requires understanding the process, forethought, and coordination.

Preparation must be done early and should be thorough. The time to be learning this is not during a gale.

Practice deployment, retrieval, and getting the boat to lie quietly behind the parachute anchor in calm water first, then move on to the open sea.

Multihulls and Parachute Anchors

The issue of parachute anchors on multihulls is somewhat different than with monohulls. Multihulls offer some advantages: They have an inherently stable platform and are not subject to the sometimes violent rolling of monohulls when head to wind.

The wide spacing of their hulls also provides excellent bridling possibilities which in turn tend to keep them head to wind, where monohulls might shear back and forth.

However, as Erik LeRouge points out in his comments on multihull tactics (page 388) you need the correct hull shape. Multihulls with extremely fine sterns are candidates for reverse pitchpoles in breaking seas. This may sound a little far-fetched, but there have been several instances of this occurring within the last decade.

The other issue is structural integrity. If your bow is held into breaking seas by what is in effect a fixed mooring, the forward structure of the boat will experience huge impact loads. Wing decks, houses, and especially windows must all be extremely strong if they are to withstand this type of abuse.

In order to take advantage of the bridling advantages inherent in the widely spaced hulls, some form of structural hard spot needs to be built into the bow area for bridle attachment.

The bridle itself should be quite long to lessen the compression load on the hulls, as well as to reduce tension load in the bridle. Typically bridles of five times the beam are ideal (if your beam is 20 feet/6.1m, this means a bridle length of 100 feet/30.5m). This is longer than many of the manufacturers recommend, but anything less and the loads escalate rapidly due to the flat angles.

At the connection point of the bridle to the bows, there will be some form of tang to which a heavy-duty snatch block is attached. You will want to be sure that under load the lead back to the cockpit winches is absolutely fair. There can be no chafe points en route, no matter how slight. Otherwise, under storm-strength loading the bridle will chafe rapidly.

By now you will be familiar with the concept we've repeated over and over again about keeping the bow into the seas. As you know, the seas and the wind rarely coincide in direction. Maintaining the correct heading into the worst of the sea state is critical, and with such a wide bridle base you have excellent capabilities for adjusting the boat angle relative to the wind.

In order to utilize this advantage, however, there must be one crewmember on watch, keeping an eye on the wind, sea state, and how the boat is doing relative to the situation.

Changes in wind and seas can come rapidly, and you may not have more than one chance to get the angle of the boat adjusted before you are nailed by a wave.

Finally, in the same context that we discussed under multihull tactics, do anything possible to reduce lateral resistance. This means raising dagger- or centerboards as far as possible—with elliptical tips clear. This will allow the boat greater ability to slip to leeward, if caught by a breaking sea at an angle not on the bow.

One of the biggest challenges with cruising multihulls when they are hove to under a parachute anchor is maintaining the structural integrity of forward windows. The impact of breaking waves will put enormous loads on the glazing and surrounding structure. Few cabin houses or their windows will withstand a direct hit while tied to a parachute anchor.

The other issue is having sufficient buoyancy in the stern of the boat to prevent a backwards pitchpole as shown below. This has happened to several catamarans in Europe.

Adjusting Angle to the Waves

We've touched briefly on the subject of adjusting your angle to the waves using a bridle with a parachute anchor off the bow. You can also change your angle with drogues off the stern as well.

The angle of the boat to the waves is a function of where and how the load from the drogue device is taken onto the boat. For example, by taking the load onto a windward quarter the boat will lie with its head 10 to 20 degrees into the wind. With the rode to a leeward cleat you will lie some distance below down wind. Bringing the attachment point forward along the quarter allows a degree of steering control across the wind on a broad reach. If the seas are breaking, this may not be ideal, but if safe harbor is 30 or 40 degrees up from a run, and there are steering problems, this approach may just get you home.

How this works varies from boat to boat. The key is to experiment early, when you have time and sea conditions which are challenging but not dangerous. Once you've made log entries for the future, you'll know what to do if a drogue ever becomes a necessity in risky conditions.

Let's take a closer look at how this process works with the drawing on the opposite page. This is shown using a series drogue, but the concept applies to all forms of drogue devices. To begin with, we have the waves skewed at 20 degrees or so to the wind. If there is a second set of seas, perhaps from a frontal passage, allowance should be made for the system that has the greatest risk.

The drogues shown on the drawing are oversized to make them easier to illustrate. In reality, they would be much smaller, as you've seen in the photos in previous pages.

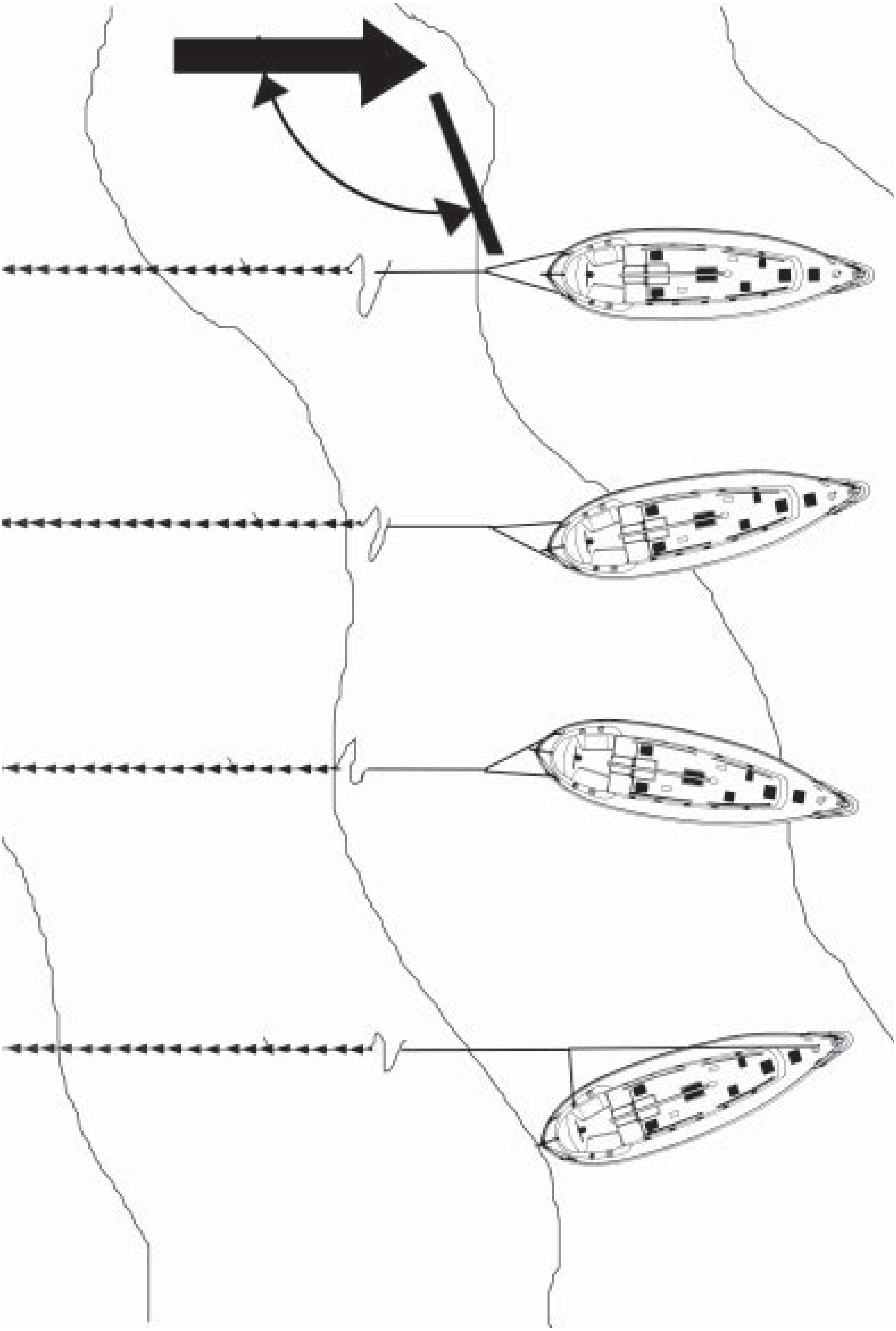
In the top drawing the drogue is off the transom, pulling straight onto a bridle. This will align the boat to the restraining force of the rode, with very little latitude for steering correction. Depending on the size of the drogue, the speed of the boat, and its steering characteristics you might be able to coax 20 degrees of steering angle from the combination—the smaller the drogue, the lower the force, the better the steering angle—but the faster you're going.

In the second drawing the bridle on the stern has been loosened on the starboard side, so the bow rotates a bit into the wind on port jibe. This gets the stern swung more in direct line with the prevailing swell direction as it is shown here.

If this were in the Southern Hemisphere, and a front had just passed with the wind going from northwest to southwest, there would be a significant cross swell from the northwest intersecting with the new swell from the southwest. In this case what might make the most sense would be to ease off on the port bridle, and allow the bow to swing to starboard. This would split the difference between the waves.

The bottom drawing shows the bridle taken well forward. This allows the boat to be rotated more onto a broad reach, with more range in steering control. The optimum location of the bridle points varies widely, and you need to do so some experimentation to find the best combination.

There may be times when you will want to use this approach in an opposite context—where the wind is trying to blow the bow one way, at an adverse angle to the waves, and you want to try to restrain the angle of the boat. In this case the bridle would be adjusted in the reverse of what we've shown here. Sometimes rather than a bridle, it is enough to just bring the rode to a stern cleat, or some modest distance forward onto the toe rail, and thence to a primary winch.



Gary Danielson

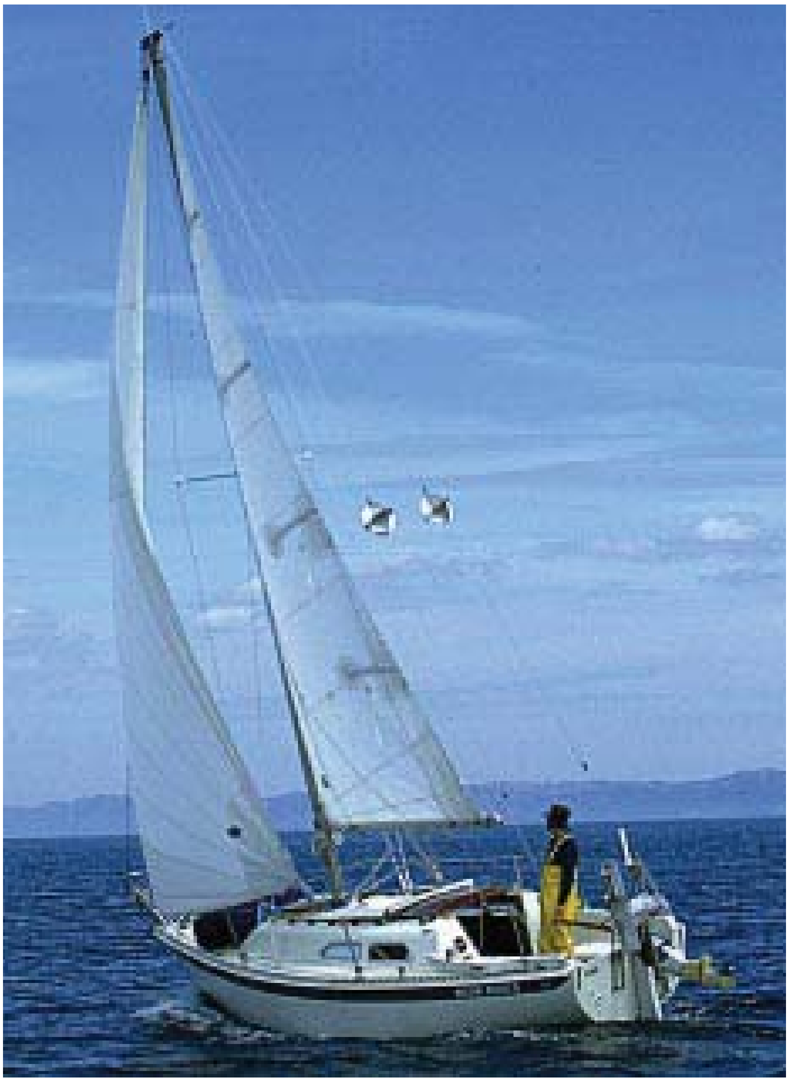
When you start to investigate the subject of sea anchors and drogues, you will find numerous manufacturers, concepts, and even books on the subject. Various governmental organizations have conducted tests, and wave simulation tanks have been used to try to ferret out the best system.

But it is rare to find real world research, where someone takes a small boat out and tests different systems in gale-force (or higher) winds.

When we received a letter from Gary Danielson, dealing with some on-the-water testing he had done in preparation for an Atlantic crossing, we were intrigued. Gary is an attorney living aboard and working from an office on his boat.

Several lengthy telephone conversations with Gary convinced us that he had the experience and mindset to conservatively evaluate real-world data.

He has owned nine different sailboats between 21 and 30 feet (6.4 and 9m) and has sailed more than 40,000 miles including two single-handed passages across the Atlantic.



Gary Danielson

Moon Boots is a medium-displacement, internally ballasted, centerboard, whale-bottom-type sloop with no keel or stub as there are in many other centerboard-type boats. When the centerboard and rudder are raised, the draft is 27 inches (0.7m). The boat has very little wetted surface area and Gary says she moves particularly well in light air and off the wind.

In the late 1980s, Gary decided to do some offshore cruising and set about in a very methodical manner determining which was the best drogue or parachute system for his boat, a Ted Hood-designed Erickson 25.

Prior to departing, Gary tested a number of different systems, then put those test results to work in the real world.

Gary's comments follows:

In January 1988, I purchased a 25-foot (7.7m) sailboat for a planned single-handed sail across the North Atlantic Ocean in the spring of 1989. I spent a great deal of time sailing the boat long distances in the summer of 1988 in order to become familiar with the way it behaved in all weather conditions.

I purposely sought out rough weather in order to refine the systems that I would be using during the gales that could be encountered on the passage. During this period I had occasion to sail the boat in storms, which had sustained winds of 35 knots, gusting to 52, and seas of up to 18 feet (5.5m).

Heavy-Weather Trials

With respect to its heavy-weather performance, I learned the following as a result of the summer sailing trials:

1. In 35 to 45 knots of wind, with no sail up, the boat will move at 5 to 6 1/2 knots with little wave action helping the speed.
2. Coming down large seas, with no sail up, the boat routinely exceeds 10 knots and has gone as high as 12 1/2 knots.
3. Steering control is excellent up to 8 1/2 knots and passable up to the 10-knot mark. However, at speeds in excess of 10 knots the boat does not respond particularly well to the helm and has a tendency to broach.
4. When the boat is doing better than 10 knots and broaches coming down the face of a wave, there is incredible pressure on both the centerboard and the rudder.

This testing identified three problems that would have to be solved. It was clear that the boat would reach speeds in which it is only marginally controllable in even moderate gale conditions. It was therefore determined that a way to keep the boat below surfing speeds must be found.

Maintaining Directional Control

Gary knew from research as well as his own experience that he needed to keep the boat's longitudinal axis within 15 to 20 degrees of the wave face in order to avoid capsizing. He had to do this while steering, which meant keeping speeds in a useable range, and the boat needed to be able to look after itself when he was asleep:

After a review of the material I decided to gather the most promising sea anchors and drogues and to thoroughly test each one.

The selection of a sea anchor was relatively simple, as all of the manufacturers recommended an 8- to 9-foot (2.5 to 2.8m) sea anchor for *Moon Boots*. And, with the exception of some construction details, all the sea anchors were based on the same design principles as a parachute. As a result I ordered a 9-foot parachute-type sea anchor to be used for these tests.

The area of drogues is much more confusing because there are so many different types of products in this niche of the market. Ultimately, I decided to test two quite different types of drogues. The first is produced by Hathaway, Reiser and Raymond and is called the Galerider.

This drogue is essentially a paraboloid of 2-inch (51mm) nylon webbing sewn together on 6-inch (152mm) centers much like an airplane cargo net. It is theorized that the open nature of the design will give it an inherent stability so that it will create constant drag. The 30-inch (0.8m) Galerider model was tested on *Moon Boots*, as it was the smallest one made and the one recommended by the manufacturer. A nice feature of the Galerider is that it folds up into a container measuring 2 feet (0.6m) in diameter by 1 foot (0.3m) thick and weighs only about 10 pounds (4.5kg).

I commissioned Para-Anchors International to build me a Jordan-style drogue for *Moon Boots*. Victor Shane, the owner, did a great deal of testing to come up with a real-world example of a Jordan drogue, which would be sufficiently strong and reliable.

This resulted in changing a variety of specifications to enhance the strength and durability of the device. Ultimately, Victor came up with a Jordan-style drogue that had a specification of a 30-foot (9.2m) bridle of 1/2-inch (13mm) Dacron braid (that would attach to each of the stern quarters of the boat) and a 300-foot (92m) long 1/2-inch (13mm) diameter Dacron braid for the rode. Attached to it were 90 5-inch (127mm) cones, each capable of creating 200 pounds (91kg) of drag before rupturing. At the end of the rode was a 15-pound (6.8kg) mushroom anchor.

Initial Test Results

The test results, by product, were as follows:

A 9-foot (2.8m) sea anchor was deployed over the bow attached to 300 feet (92m) of 3/8-inch (10mm) braided nylon rode. The centerboard and rudder were both raised and all sails were lowered for this test. The sea anchor was very easy to deploy and there was no shock when it grabbed hold of the boat. It did an extremely good job of keeping the boat in place as sternward drift through the water ranged from 0.25 to 0.75 knots.

"To make the test results as reliable as possible, all testing was done on a single day in constant conditions. My crew for this test, Sue Kuehl, was along solely to take measurements and record data. The test was conducted in November, 1988, on Lake Huron. On the day of the test the sustained windspeed varied between 20 and 25 knots, with gusts as high as 31 knots. The waves varied between 6 and 8 feet (1.8 and 2.4m)."

The problem was that the boat was yawing through an arc which totaled almost 100 degrees (putting the bow of the boat almost 50 degrees off the waves). It was yawing very slowly from side to side so that there were lengthy periods (60 seconds) where the bow of the boat was as much as 50 degrees from the wave direction. Since the boat spent so much of its time not being bow-on to the waves it rolled quite heavily (in excess of 20 degrees), and relatively quickly, while riding to the sea anchor. Had the conditions been more severe, this could have proved to be dangerous.

The rode was then shortened to 150 feet (46m) of scope to see what effect that would have on the yawing of the boat. Repeated measurements showed no substantial variation in yaw even with the shortened scope.

The sea anchor was very difficult to retrieve as *Moon Boots* has no anchor windlass on the foredeck and as no trip line had been attached to the sea anchor.

The next item tested was the Galerider drogue. This was set from the stern utilizing a 30-foot (9.2m) 1/2-inch 13mm) braided Dacron tether which was connected to each of the stern quarters of the boat and then attached to a 150-foot (46m) 3/8-inch (10mm) braided nylon rode.

Initially the Galerider was utilized with no sail up, with the centerboard and rudder both retracted. The Galerider drogue had a steady and constant pull and did not jerk when it was deployed. Speed averaged anywhere from 0.5 to 1 knot with an average speed range of 0.75 to 1 knot. The Galerider was running below the surface, but only by about 5 feet (1.5m). Therefore, in heavier conditions it may be somewhat more susceptible to surface wave action. It did not pull the stern down much at all and gave the boat, overall, a very nice ride.

Then, the rudder was lowered and allowed to swing free and the centerboard was lowered while the Galerider was still out. It was noted that the boat then yawed through a total of about 70 degrees (35 degrees per side). The boat still rolled very little and did so slowly.

Next, a small jib was raised to see how the boat sailed with the Galerider out. The boat could be sailed through a total arc of 90 degrees (45 degrees per side). The boatspeed ranged from 2.5 to 4 knots. There was no tendency whatsoever for the boat to surf and, of course, at these speeds it was very responsive to the helm.

The Jordan-style drogue was then deployed over the stern using the tether to each of the quarters of the boat and attached to the 300-foot (92m) rode as described earlier. The centerboard was up, the rudder was up, and all sails were lowered for this test. This drogue was easy to deploy and caused no shock loading when it began to take effect. The Jordan-style drogue appeared to sink very deeply into the water and, in fact, created a substantial downward as well as rearward pull on the boat. Consequently a number of waves washed in over the transom of the boat while the Jordan drogue was deployed.

The Jordan drogue slowed the boat so that the average speed was between 0 and 0.25 knots with the highest registered speed having been 0.5 knots. The boat yawed a total of 10 degrees (5 degrees per side). The boat rolled very little with the Jordan drogue out, only 10 to 12 degrees per side, and did so slowly.

Test Results Analysis

While a sea anchor would be useful to stop the boat from drifting, it did not resolve the problems related to heavy-weather survival. For that reason I deemed it to have had no value for *Moon Boots*.

In the moderate conditions of the test, the Galerider was definitely the best product tested. Advantages are its small storage space; its ease of deployment and retrieval; and the fact that it stops the boat from rolling and keeps the stern pointed into the waves. It has the additional benefit of having enough drag that the boat can be actively sailed, but will not surf, should you find the wind blowing in a favorable direction.

Even if the boat is not actively sailed, it allows the boat to move through the water at a faster rate than the Jordan drogue and therefore would be useful if the wind was blowing in a favorable direction. It would be useful if repairs were needed, since it stops the boat from rolling. The Galerider is also good in that it does not seem to pull the cockpit down which would make it vulnerable to breaking waves.

The concerns I have are that it may not ride deeply enough to avoid wave action in heavy weather (resulting in a possible loss of drag), and it is possible that it may not offer enough drag in the ultimate storm to pull the stern into a serious breaking wave. However, overall, I believe that it would be the best product in anything short of a survival storm.

The Jordan-style drogue would be helpful to keep the boat from rolling while some repairs were made and is the best at keeping the boat in a stationary position if drift were undesirable. It was also the best at keeping the stern directly into the waves, and at exerting a constant pull.

Finally, I am confident that its design of multiple drogues coupled with its deep riding nature would ensure that no matter what the wave situation it would never be caught in wave disturbance and lose any appreciable amount of drag.

Retrieval:

"The Jordan-style drogue was easier to retrieve than the sea anchor but more difficult than the Galerider. It was easier than the sea anchor because every few feet of rode that were retrieved resulted in one less cone being in the water to create drag. Therefore, drag continued to be reduced as the rode was brought in.

"With the sea anchor, since the anchor itself is what creates all of the drag, and since it is the last item to be brought aboard, every foot of rode must be brought in against 100 percent of the drag.

The difficulty with retrieving the Jordan-style drogue is that it cannot be retrieved utilizing winches because the cones get tangled up in the winch. Therefore, retrieval can only be done by hand.

"The Galerider, conversely, was particularly easy to retrieve as the rode with which it had been deployed was wrapped around a cockpit winch and winched back aboard."

"Overall, I believe that the Galerider is the best tool for use in moderate conditions, when the boat is unattended, if the amount of drift is not critical. It is also the best tool to keep the boat from surfing during conditions in which hand-steering is desirable.

"The Jordan-style drogue is the best tool to keep drift to an absolute minimum where drift is unwanted. I believe it is also the best tool for an unattended boat in the ultimate storm.

"Both drogues would be good tools to use if repairs needed to be made on a boat and roll was to be kept to a minimum during the repair period."

The disadvantages to the Jordan, as tested, are that it rode too deep and exerted too much downward force on the stern of the boat. However, I will be putting a smaller weight on the end in an effort to reduce the downward pull.

This is a very thorough and interesting test—the results of which are obviously valid for the type of boat on which the tests were carried out. But for other yacht designs, the reactions to the parachute anchor, as one example, might be totally different.

The methodology, however, applies to anyone making this sort of choice. It is worth testing in advance any gear upon which your safety may at some point depend.

Offshore Applications

Gary left Newfoundland in the early summer of 1989 on his single-handed passage to Europe. He made an uneventful and fast (20-day) passage, beating most of the way.

En route he had occasion to slow down twice, using the Galerider.

Gary's log entries for the two instances of using the Galerider follow. (Note: all of Gary's windspeeds are based on a handheld anemometer, at deck level. Had these been masthead readings—which you are probably used to seeing—they would be 15 to 20 percent higher.)

After cruising the UK and Europe, he returned via the southern route, again single-handed. This time, with mostly tradewind conditions, there was no need to use any sort of drag device.

Two years later in the spring of 1991 Gary was headed for the Bahamas when he encountered a depression off the East Coast of the US. This time he put to work a Jordan series drogue. (He had purchased this one used—it had been carried by Neil Gillette when he rowed across the Drake Straits between Cape Horn and Antarctica.)

Offshore Conclusions

Gary feels that the Jordan series drogue truly works as advertised.

It was far and away the best product I used to keep the stern into the waves. The problem was that it is so good that we were getting pooped all of the time. The stern would try to rise to a wave, but the Jordan drogue would resist this and we'd get whacked. The Galerider didn't have nearly as much pull and did a fine job for the boat, and we didn't get pounded so hard.

The fronts Gary experienced were of moderate intensity. We asked him his thoughts about a big storm, say one with

JUNE 1989 (HEADED FOR ENGLAND)
51° 04' N, 20° 45' W

	Time	Wind Direction	Wind speed (Kts)	Seas	Comments
7 June 89	0100	SSE	25-30*	6	
	1300	SSE	25-30	8	
	1730	S	35-40	12-14	Galerider out
	2200	S	35-40	13-15	
8 June 89	0500	W	30	12-14	**
	0700	W	25	10-12	Set sail.

* Note: In all cases wind speed measured at deck level (5 feet off the water) with a handheld windspeed indicator.
** With change in wind/wave direction, my log shows "boat rolling violently." Sails down, centerboard and rudder up. Until change in wind direction, boat doing very nicely while I stayed below.

70-knot winds and large breaking seas:

If it were blowing 70, I think I might prefer the Jordan drogue. But you would need a transom and companionway beefed up to take the loads of the breaking seas coming on board. The ideal boat for heavy weather with the Jordan drogue would be a double-ender with a center cockpit.

JUNE 1989 (HEADED FOR ENGLAND) 50° OO' N, 14° 00' W					
	Time	Wind Direction	Wind speed (Kts)	Seas	Comments
10 June 89	0600	S	30	10-14	
	0900	SSE	30	10-12	
	1130	S	35-40	12-15	Galerider out
	1500	SW	30-35	12-15	
	1730	SSW	30-35	12	
	2230	SE	35-40		
11 June 89	0145	SE	35-40	12-15	
	0530	S	15	10-12	Sailing again
	Centerboard down (very little rolling). Small bit of jib rolled out and sheeted flat kept boat dead downwind. I was below sleeping. Very successful (but wind was always from same direction).				

If I was caught out in a boat in which I was worried about the stern structure or cockpit, I think I'd stay with the Galerider.

And what about in a crossing sea pattern, after the front has passed?

There's going to be some risk at that point. I'm not sure if you are better or worse off with the boat slowed down. If the boat doesn't steer in those conditions you have no choice but to wait it out—you don't have the choice of staying at speed and steering. Bigger boats have more options because you can steer them at faster speeds.

Gary Danielson's conclusions cannot be argued with for his particular vessel. However, what works and what doesn't work on his boat may be different from your own.

This is why it is vital to test this gear before your safety depends on the outcome.

MARCH 1991 (HEADED FOR BAHAMAS) 24° O4' N, 67° 19' W					
	Time	Wind Direction	Wind speed (Kts)	Seas	Comments
10 March 91	1045	W	25-30		
	1830	W	30		
	2030	W	35	10-14	Put out Jordan drogue
	2100	WNW	35	10-14	
11 March 91	0200	WNW	38-40	12-14	
	1100	WNW	40-45	12-15	
	1730	W	25-30	10-15	
	2130	WNW	30	10-15	
12 March 91	1245	NW	15-20	8-12	Sailing again
	Log shows waves regularly breaking into cockpit (stern won't lift and boat won't move forward when hit by a breaking wave). Latch/lock on main hatch broken by a wave. Jammed hatch shut down but a few waves broke it open from time to time.				

RUTEA

The Schneider family—Neil, Ruthie, and their three children—were reaching the end of a 15,000-mile cruise. They had departed from Honolulu, Hawaii on May 31, 1997 with a destination of Sitka, Alaska aboard their 48-foot (14.7m) ketch, *Rutea*. *Rutea* is a 1984 Contest 48, built in Holland by the Conyplex yard. She's ketch-rigged with double head-sails, each on a Reckman roller-furler, a fin keel, and a skeg-mounted rudder. She has a 37-foot (1.3m) waterline, a 14-foot, 6-inch (4.4m) beam, and displaces approximately 40,000 pounds (18,000kg).

Neil picks up the story:

Before we left Honolulu, we studied the weather forecasts. In the South Pacific, Typhoon Nestor was westbound and kicking up quite a fuss. We felt fairly confident with it 2,000 miles south of us to leave the Hawaii Yacht Club for good.

Rutea had spars by Selden (Sweden) both of which were substantial in stiffness. Her lower shrouds are mounted aft of the cap shrouds, reducing interference with the staysail leach.

The problem with single lowers, especially if they are lead aft, is that they will allow the mast to pump in some conditions.

However, the cutter stay should have prevented this. Thus the odds are that the rigging tension on Rutea needed to be adjusted.

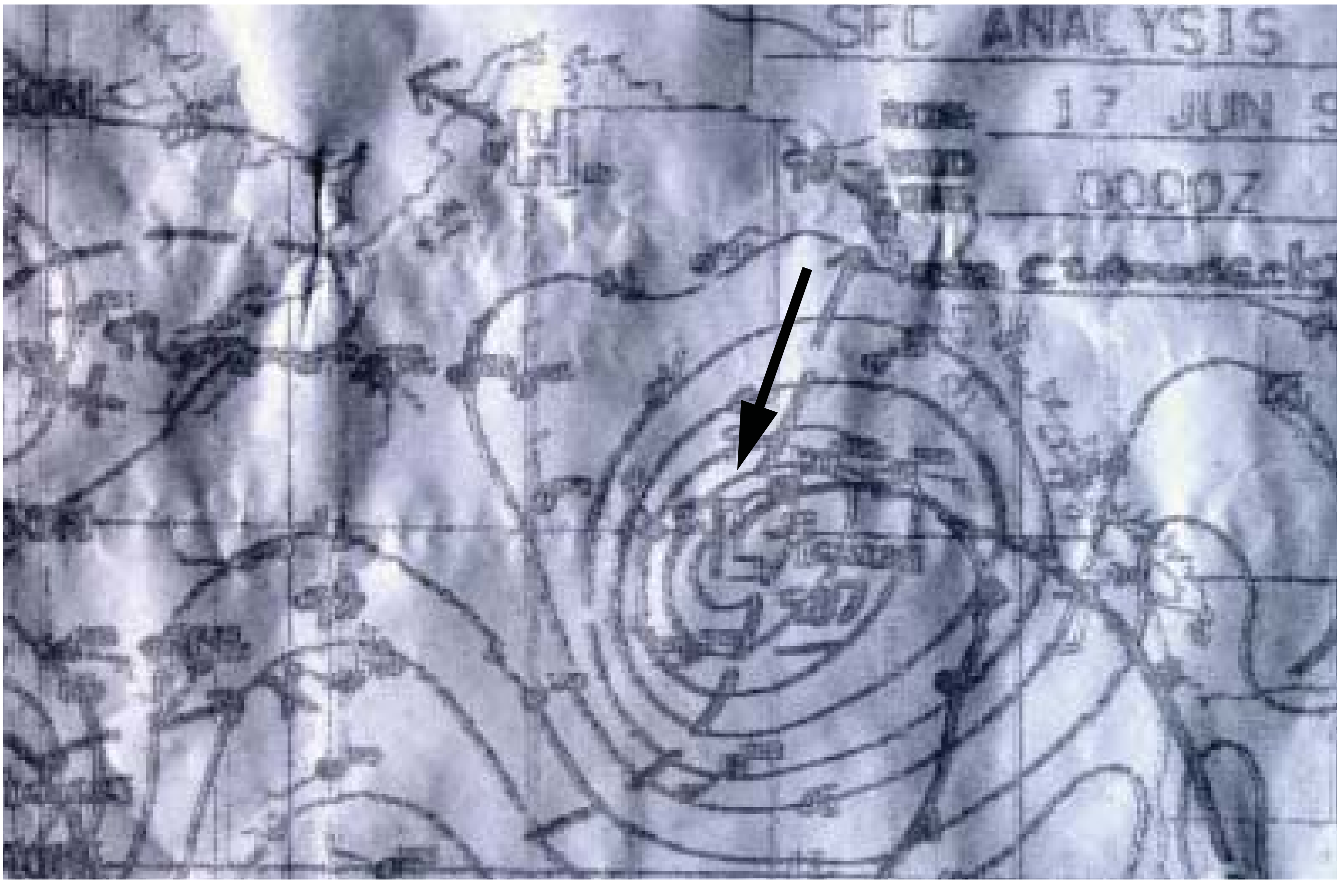
Our trip north from Hawaii had been plagued by very light southerly winds: It had taken us 20 days to get north of 50 degrees North. We collected weatherfaxes twice a day, and it wasn't until the middle of June that we realized that Typhoon Nestor was off the coast of Japan and beginning to turn eastward. It didn't seem possible that a typhoon could cross both the South and North Pacific. But it was heading our way.

Obviously, it could change course and head north, as storms frequently do in the Gulf of Alaska—but the jet stream was a flat line right across the top of us. I began to make preparations for the storm to hit us.

Storm Preparation

I wanted to secure everything loose and move as much weight towards the keel as I could. I moved all the books off their shelves and stowed them under a settee. In retrospect, I can't figure out how I found room. It seemed as though everything was jam-packed already with books. (After all, we were home-schooling three kids.) The workshop got a thorough cleaning and all tools were moved to the lowest possible spot. The trysail was bent to its track before we even left Mexico, but I removed the big genoa and put the new heavy jib in its place. The roller-furling on the staysail was broken so it remained furled the entire trip.

The biggest problem that I had to deal with was the anxiety of



The fax above was recorded aboard Rutea. The black arrow indicates their position. One of the concerns here is getting caught in a compression zone between the developing high to the southwest and the depression in the Gulf of Alaska. This would have made it too chancy to run off on port tack to the south to get away from the depression center. However, reaching on starboard tack would take you away from the depression in a westerly direction, without getting caught between the low and high.

knowing we were going to get hit. It was almost like someone was saying, "In six days, I'm going to beat you up." "In four days, your ass is grass and I'm a lawn mower." "Just two more days before I stomp your rear."

Every weather fax brought the storm closer and made it seem more ominous. True, it was only storm force now, with the center at about 986mb and it was moving pretty fast at about 31 knots. But, this was going to be our first real gale and we were pretty isolated. We knew that we weren't going to get any help from anyone if a major problem developed.

Father's Day. I made a sincere effort to be pleased with my gifts and not be preoccupied with the approaching storm. We took lots of photographs with me holding my new t-shirt (too small). I smiled as I sat between my two daughters.

The Barometer Drops

As I checked into the Pacific Maritime Net that evening, I reported that the barometer had dropped 12 points in the last 4 hours. My son, Ian, was on watch when the wind shifted to the west and increased to about 25 knots. He changed course and woke me. We were expecting the gale and I felt I was prepared for it, but its arrival was still startling.

It was about 0200 and not quite ready to get light (we had sunrise at about 0300 but due to the heavy cloud cover, it remained dark longer). I reefed the main to its third reef point and roller-reefed the North Sails jib to its second reef point. The seas were building, and it was raining pretty hard. The mainmast started pumping so I furled the jib altogether.

> "Close-hauled, we were making about 6 knots under triple-reefed main. The wind increased to about 35 knots and now the seas were beginning to resemble haystacks. The spindrift was being blown off the tops of the waves, and the entire ocean was frothy with foam. The wind continued to increase and at 1000 hours with it blowing 40 knots, I decided to deploy our 18-foot (5.5m) Para-Tech sea anchor."

Rigging the Parachute Anchor

Before we left Mexico, I had rigged the sea anchor so that I could shackle the end of the 600 feet (184m) of 5/8-inch (16mm) twisted line directly to our 66-pound (30kg) Bruce anchor, kick the sea anchor overboard and have it deployed. That's almost exactly what happened.

My wife Ruthie was at the helm, trying to keep the boat into the wind (which was tough) while I got everything ready. I threw the sea anchor overboard, signaled Ruthie to put the engine in neutral and the line sang out of the forward locker, down to the last 20 feet (6m) or so.

It had gotten caught on a spare Danforth anchor I kept in the bottom of the locker and I could tell that the pressure on that line was enough to launch that anchor into orbit—or into me.

Thinking back, I don't remember how I got it freed—I do remember my reluctance to climb down into the locker. I let 100 feet (30m) of 3/8-inch (9.6mm)chain go out and rigged the 1-inch (25.4mm)snubbing line.

Rutea swung into the wind and suddenly all of our apprehension about the storm disappeared. Yes, we were rolling badly from gunwale to gunwale, but we all felt very secure and confident that now we were safe. I had tied the wheel so the rudder was in line with the keel and we were moving backwards at about 1 knot.

Ruthie and the kids were snuggled in the aft cabin. I made some soup for everyone. In talking with the children, I could tell that the anxiety was gone from their voices, too. Frequently, I went on deck to check for chafe. The snubbing line and anchor chain were as straight and tight as a banjo string. We took turns announcing our position on the VHF as a security.

The boat did not feel like she was surging behind the parachute anchor. What did impress me was how the sea anchor kept the chain and a 66-pound (30kg) Bruce anchor straight out like it was welded together. I had assumed that the Bruce would provide a catenary but it didn't.

The bow fell off about 30 degrees to port. I don't know why. It didn't change. If the wind had increased to 60-70 knots I don't know if the bow would have fallen off further.

I slept (if you could call it that) in the main saloon and everybody else was in the aft cabin. The wind began to lighten up at 0100 and at 0230 it was light enough that I could see what I was doing on deck. Ian and I donned our foul weather gear and harnesses and made our way to the bow. The wind was down to about 25 knots and the seas down to 10-12 feet (3 to 4m).

Retrieval

With Ruthie at the helm, *Rutea* powered forward as we pulled in the sea anchor. The weight of the sea anchor caused it to go straight down, once the tension was taken off the line.

The first 100 feet (31m) of retrieval was easy: It was all chain and the windlass just pulled it up. Once we got to the nylon rode, however, it became very difficult. We wrapped the rode around the horizontal drum of the windlass but couldn't develop enough friction to pull the sea anchor in—it was just too big a load.

In a way, it was the fact that the seas were still running at such a high level that allowed us to reel the big chute in. As *Rutea* would go up over a wave, the line would go taut. But, as she came down off the wave, the line would develop about 10 feet (3m) of slack. Ian and I would pull like crazy during the slack time and just wait patiently as her bow went up. Obviously, we hadn't rigged a trip line. I was too worried that it might get tangled with the sea anchor and foul it. It took us two hours to finally get it aboard.

We were exhausted as we finally crawled back into the enclosed cockpit. I unfurled the jib as the wind had clocked back to a westerly. *Rutea* was back underway. We sailed into Sitka without any further incidents.

Second Thoughts

In reviewing the whole scenario, I think I should have explored heaving to. Not that what I decided to do wasn't prudent but maybe it was too cautious. I was just concerned that things were going to get a lot worse (they didn't) or that maybe a rogue wave would come along when we were off the wind enough that it might do some serious damage.

Retrieval was a real pain in the ass. In retrospect, I think it was quite dangerous. Working with high loads on light-duty machinery on the pitching deck of a small sailboat is almost a disaster waiting to happen. The sea anchor had to represent thousands of pounds of load and whereas I have a "heavy-duty" electric windlass, this was too much of a load for it or even something substantially larger. Fortunately, we didn't have any accidents.

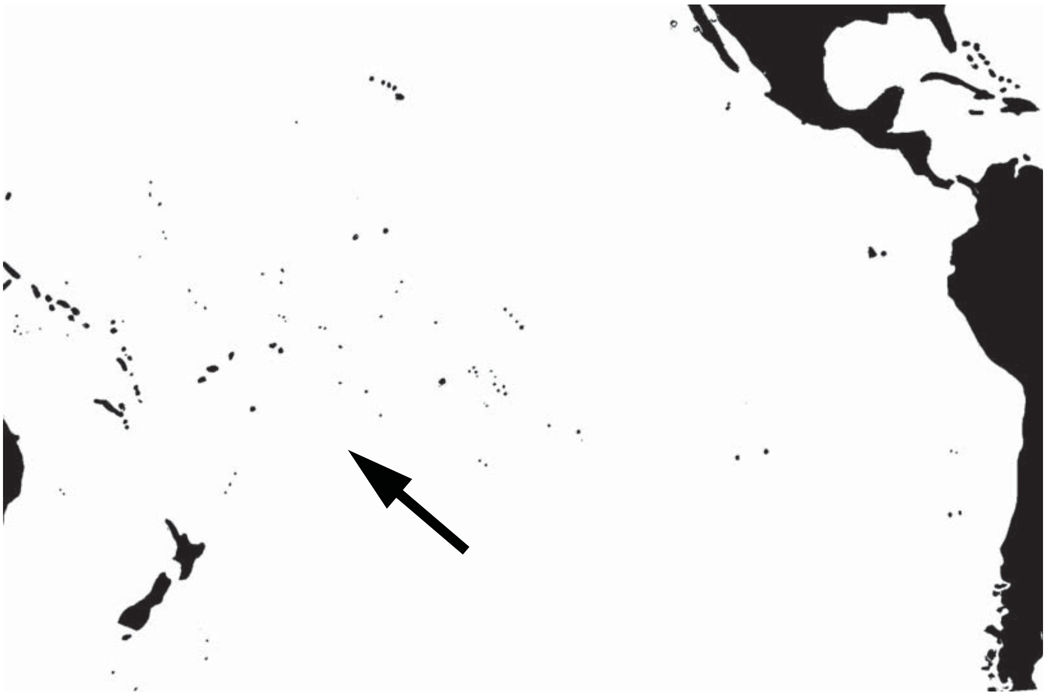
Since I have returned from my trip and have spoken with others regarding this issue, it was suggested to me to use a large float—one that could float 150 pounds (68kg)—as a trip line. If you used, say, 50 feet (15.3m) of line from the center of the chute to the float, it would keep the chute from sinking when the vessel motored ahead on the line. One of the main problems with that solution is the float would have to be huge—larger than my largest fender. That could be difficult to maneuver into position to deploy it under adverse conditions.

While we were lying at sea anchor, at first we were held directly into the wind and the boat didn't "sail" at all (which it often does when hanging off a conventional hook). But after about six hours, I noticed that we were holding about 30 degrees off the wind—I never did figure out why. The winds were strong enough that I didn't want to have any sails up, although looking back on it I feel I should have experimented with the trysail.

I've thought about what I would do in a real blow, but I have no answer. I do own a drogue but have never deployed it. It might make a difference as to how fast the storm is travelling. With a fast-moving storm, if you just sit still for a while, it should move over you pretty quickly. I hope I never have to make the decision.

Regardless, I will feel much better prepared for the next gale that hits us. Undisputedly, the experience has made us better sailors.

"We had such light winds for most of the trip that we had motored extensively. I was getting concerned because we were down to about 60 gallons of fuel, which isn't much for *Rutea* (even the genset uses a gallon per hour!). *Rutea* doesn't have any solar panels or a wind generator, and we consume huge amounts of electricity. This means that fuel can be a very precious commodity. Since we were only 400 miles from Sitka, it was just a concern, nothing more. But I didn't feel that we could 'turn tail and run' in an effort to dodge the storm. So we just let it hit us huge."



Double Bullet was 600 miles south of Rarotonga when they were caught in hurricane-strength winds.

Double Bullet

Bob Hanel has been racing and cruising big catamarans since the late 1960s. His current boat *Double Bullet II* is moored not far from *Beowulf*'s temporary home in Southern California. So one day when discussing things nautical, the subject of heavy weather tactics came up. Bob started to tell us about a blow he was caught in en route from Auckland, New Zealand, to Papeete in French Polynesia in March of 1982.

At the time he was sailing *Double Bullet*, the smaller predecessor to his current boat, with a crew of four plus himself. *Double Bullet* was 65 feet long (20m), 32 feet wide (9.8m), and weighed 7 tons. She had a wing clearance forward of about 4 feet (1.2m)—a little less aft. She had a small wing deck between the main beams and netting forward. All accommodations were in the hulls.

About halfway into the passage, a week after they'd left Auckland and 600 miles south of Rarotonga, they were caught in what Bob characterized as a double low—a system that was 800 miles wide in a north/south direction and 2,000 miles across from west to east. The wind was from the east, indicating that the center of the low was to the northwest. Their course towards Papeete was northeast so the wind was almost on the nose. The breeze continued to build until it was blowing a steady 50 to 60, gusting higher. The waves were 25 to 30 feet (8m to 9.2m) in height, with the top 10 feet (3m) breaking in crests 100 yards (92m) long, when he decided to give his parachute anchor a try.

Using a Parachute Anchor

The parachute was a war surplus unit, the type used to drop hardware, 9 feet (2.8m) in diameter. This was the first time he had deployed it.

Sailing under bare poles, they dropped the parachute from the stern, on a

The parachute was dropped from the stern, while they were sailing under bare poles, on a 150-foot (46m) long bridle connected to a 450-foot (138m) rode. A large swivel was in place between the rode and bridle. They set a 150-square-foot storm jib on the headstay to slow their motion, and the boat came to rest feathered dead downwind.

150-foot (46m) bridle connected to a 450-foot (138m) rode. A large swivel was in place between the rode and bridle. They set a 150-square-foot storm jib on the headstay to slow their motion, and the boat came to rest feathered dead downwind. They stood watches of two hours on, eight hours off, with one crew on deck at a time.

The storm-force winds continued from the east, now gusting to 85 knots (Papeete had westerly winds and there was severe flooding and damage along the shore—the worst storm since 1905.) Given Bob's location (the subtropics) and the time of year (height of summer) this was probably a tropical cyclone hooked up with a subtropical depression. The fact that the winds were from the east indicated that the center of the storm was most likely headed away from them—in this part of the world, depressions on the edge of the tropics typically travel in an east-to-southeast direction.

Half a dozen times during the storm, breaking seas caught their rear cross beam and pushed the boat 50 to 100 feet (15m to 31m) to leeward, stretching the rode. When the sea passed on, *Double Bullet* would slingshot herself back to windward as the rode contracted. However, as she was lying nicely with her head facing downwind, there was no tendency for her to yaw. This technique would probably not work on a cruising boat where there was an exposed aft cabin structure—the breaking seas would in all probability stove in any vertical surfaces.

The wind and sea from the east remained steady, indicating the hurricane was probably stalled somewhere to the east. In 69 hours of lying to the parachute they lost 39 miles to leeward—a drift rate of half a knot. The next day, with the breeze down in the 20- to 25-knot range, they got moving again. However, they were slammed by a couple of big seas in the dark and decided to heave to under the para-anchor until things calmed down.

Noel Dilly

Twister Bits

As you will recall, we started this section of the book with data by Gary Danielson, in which he concluded that the Jordan Series Drogue had too much holding power for his boat.

The following comments come from Noel Dilly, and extremely experienced English sailor who has a different opinion. Noel started sailing in 1944 and has sailed on all the oceans of the world except the Antarctic. He is a Royal Yachting Association Ocean examiner, and has skippered many different vessels. Included in his experience is the 1979 Fastnet Race aboard a Contessa 32.

His current boat, *Twister Bits*, is a 28-foot (8.6m) old-fashioned yacht with a transom-hung outboard rudder attached to the end of a long keel. She has an aft cockpit just too short to stretch out in and fall asleep. Draft is 5 feet (1.5m) and displacement is 5 tons. Noel built her in late 1970s and says she is "probably over-rigged but I put the rigging up just after Fastnet '79 and it focused the mind somewhat."

Using the Jordan Series Drogue

Noel's comments on the use of the Jordan series drogue follow, and are based on sailing primarily in and around the UK, North Sea, and Bay of Biscay—areas not noted for placid weather conditions.

I use the drogue whenever going to windward becomes a struggle or when we need a rest: usually Force 8 and above. This happens about three times a season.

Scared witless (in big breaking seas, times when you promise the gods anything) has occurred about three times in ten years.

In gentler winds, heaving to, we use nothing but the rig (no sails) but it is essential not to forereach. I would never lay my boat broadside on to any significant sea.

The wave damping-effect (slick to windward from the keel) is to me a bit like the green flash at sunset—I have never seen it.

The series drogue does infinitely better than a para-anchor can at keeping the bow to a sea.The point is that there is no caterary with the series drogue, whereas with the para-anchor it's like attaching the boat to a bungee cord that is being loaded and unloaded all the time. The bow really flies about. I have tried para-anchors only up to 40 knots.

Breaking seas are a pretty rare event so my experience is about keeping the stern to storm seas up to the Force 10/11 border. I don't want to go any higher and preferably not above 8 for the rest of my sailing.

In the hollows (between the waves) you are out of the wind, so yawing is not a problem. The massive weight on the end of the drogue starts sinking even more when the wind drive is reduced and this sinking motion of the weight not only keeps the drogue relatively tight but actually exerts a pull that tends to keep the boat in its orientation.

Getting Pooped

The stern of the boat is more buoyant than the bow, so it tends to lift as waves pass under the hull. I do get pooped four or five times in 24 hours in a storm but the next wave usually throws all the water out. Wind-driven spray through the wash-boards is a bigger problem.I lost the cockpit sole grating once so now it is tied down.

I used to horrify salesmen at boat shows by offering to plug their cockpit drains and do the test. However the Jordan series drogue is what you need if a pooping is not to become a drama. And remember the cockpit can fill from seas coming aboard from many directions. I repeat, however: In my experience, the next big wave frequently chucks out most of the water from the cockpit.

Thoughts on Parachute Anchors

I used a para-anchor until 10 years ago, when we turned to a series drogue after having been bungeed around off Bermuda.(The best comparison my daughter Sarah has just suggested is think of a wild night at anchor and multiply it by five.)

Any rope hangs in a catenary—physics. So now the boat has to move back with very little resistance until the rope becomes tight.(We won't ask what is happening to the rudder etc. while this is going on other than to suggest that it is highly unlikely that the boat will move in a straight line.)

Then, since the para-anchor is virtually stationary in the water, the rope is stretched until it is loaded enough to drag the boat through the water. As the wave strike load reduces the elastic recoil of the rope, it will drag the boat forwards towards the para-anchor. Since the bow will not be facing directly towards the anchor at the start, the bow will yaw from side to side—sickening.

Since bow-first is the way the boat is designed to go it will move a good distance under the elastic recoil, introducing an even bigger catenary, and so the cycle is repeated. This forced the crew of *Orca* to abandon ship! It forced the Pardeys to put a side bridle on their system.

Noel Dilly on frontal passages:

"When there is a frontal passage, I do nothing. Any work in a real storm takes ages and is exhausting. My long keel usually orients the boat to the seas well enough.

"I have watched the fronts go through, but I have never (yet) been left beam-on. If any boat below about 35 feet (10.7m) gets hit beam-on by a breaking sea (a weight of water of approximately 6 tons moving at 22 knots), the laws of dynamics say it will go over 180 to 360 degrees depending upon design.

"The series drogue acts faster than any other device and it will align the stern to the wave direction soonest after a wave strike. I have never had a beam-sea experience with a series drogue. Perhaps I am very fortunate.

"My ultimate storm: I will face away from it using a series drogue. A series drogue is a mechanical device that does not get tired and is always alert."

All photos Birch Kelley

Wandering Star is a cutter-headed pilothouse ketch, Ed Monk-designed, with a traditional full-length keel built by Skookum (Port Townsend, Washington). She measures 34 feet (10.4m) on deck, 38 feet (11.7m) overall, and weighs in at 16,000 pounds (7256kg). She's anchored here in Hiva Oa in the Marquesas Islands of French Polynesia.

WANDERING STAR

In the summer of1997 Birch Kelly, his daughter, Morgan and son-in-law, Fabian, were headed for the South Pacific from the Pacific Northwest aboard *Wandering Star*. Birch has been sailing offshore for years, but his crew was somewhat inexperienced. He has a very interesting story to tell about the use of parachute anchors. Birch picks up the tale from here:

During the course out on the first leg of that journey—Straits of Juan De Fuca/Marquesas—I, or rather we (my daughter and new son-in-law signed on at a fairly late stage in my preparations) had occasion to use the sea anchor twice—the first time very successfully, the second time with opposite results, for reasons I will attempt to describe.

First Use of Parachute Anchor

First scenario: June 20, 1997—wind at 40-50 knots, wind waves at 20-25 feet (6m to 8m) with heavy residual cross seas. 46 degrees North, 124 degrees West.

This was the first time I had ever used a sea anchor and prior to my decision to deploy, I must admit to a whole flurry of "what ifs..." However, none turned out to be warranted. The deploy-

ment went beautifully and with the tiller lashed amidships and under bare poles. We rode rough (due to the cross seas) but in relative ease for the next 24 hours. Beating into those cold (50 degrees) seas as we had for the last three days—in order to move off a very ugly lee shore and the continental shelf—had taken its toll on ship and crew. The sea anchor provided a most welcome relief.

The following day the wind had finally dropped to 20-25 knots—though the seas seemed slow to reflect that. Since another gale was forecast right behind this one (this was in late June), I decided to haul in the sea anchor and try to work south out of the storm track.

As it turned out, retrieving the sea anchor under these conditions turned out to be a very tricky business. The attempt to use the anchor winch; a very low-geared hand crank, proved both dangerous and impractical. Due to the frequency of the combined seas there was just not enough time between surges for it to be effective. This is to say nothing of the dangers in trying to tail and winch on a violently heaving and wave-swept foredeck. My son-in-law Fabian very nearly lost some fingers when they got caught in a bight on the cathead.

The only other option I could come up with was to rely on the engine to move us ahead enough, between surges, to hand-line and snub the slack. To make this work, it was necessary for me to throttle to full power, holding our head against the cross seas and then to quickly throttle back after cresting the wind waves to keep from over-running our slack and fouling the prop.

Fabian—whose sailing/sea experience pretty much matched the three days since we'd left Neah Bay—was faced with the task of hauling and snubbing without any communication with me, due to the noise levels of wind and sea. Add to the mix a lot of very cold seawater swirling around your most delicate gear and no small amount of raw fear clutching your innards and the picture comes close to complete. A combination of good timing, brute strength and raw tenacity on Fabian's part did much to save the day. The retrieval, though difficult, actually proceeded without incident and we were able to carry enough sail to work south out of most of the following storm's impact.

Second scenario, log excerpts:

June 30—Spoke with M.S. Moku Paha 0930 hours local. 34-15 N, 130-03 W...Nothing on weatherfax worth noting (to the south of us).

Birch was passaging south towards the Marquesas during the same northern hemisphere summer that we brought *Beowulf* back from the South Pacific.

The summer trip south is the more difficult of the two. Headed north, you can heave to in the ITCZ (doldrums) and wait for a clear shot across the tropical belt, which is subject to hurricanes. When the coast is clear, you go as quickly as possible towards the North Pacific high and out of the hurricane-prone tropics.

The trip south, which Birch is undertaking, requires you to cross about 20 degrees of latitude (1,200 miles)—from 27 degrees North to 7 degrees North—before you are into the safe haven of the ITCZ.

The continuous easterly quadrant winds indicate the storm track is to the south of *Wandering Star's* position. Continuing to head south, to cross the storm track, is a risky tactic without good weather data, as it potentially brings them closer to the eye of the storm, where winds are strongest. (Keep in mind, that with hurricanes the area of strong winds is typically confined to less than 100 miles.)

"Note: windspeed and wave heights are all my guesstimates, and as such are pretty subjective, though I've struggled to be conservative. Info received from Hawaii Coast Guard later in the day confirmed—winds to 90 knots, seas to 40 feet (12m)."

Reports of a Tropical Storm

July 5th—Speed dropping to 4-5 knots. 22-26 N, 133-12 W. Could put up more sail, but chose not to as darkness setting in and am concerned about WWV reporting the beginnings of tropical storm located between 10-15 N, 120-125 W, tracking 285 degrees.

July 7th—20 degrees, 11 N, 132-46 W. Reduced to working jib and staysail—still doing 5-6 knots in very rough seas. Trying to hold to 170/180 degrees in easterly quadrant winds and maximize speed till we get past 15 degrees Latitude and out of potential tropical storm track.Continuous snapping roll—whole boat taking spray. Needless to say, no galley fire. Getting cheese-and-crackered out. The barometer is steady.

July 8th—20 degrees, 33 N, 133-23 W. I think there is an international plot to deny me access to any weather info. Still struggling with that one—missed the only weather broadcast I've been able to get, due to radio mode foul-up. WWV info sketchy and unreadable. Wind still NE and barometer is stable.

July 9th—Noon position not recorded, noted barometer at 1015. Then dropped to 978—time not recorded.

In the morning hours of July 9, the typical wind waves out of the northeast are replaced by mountainous swells out of the southeast. The wind begins to pipe up and swings to east-southeast. My daughter points out that hundreds of birds of all marine varieties are gathering together on the water. Though we've seen a number of birds aloft, we've never seen them in such numbers and seldom actually on the water.

Tropical Storm Center

There is now no doubt in my mind about the location of that troublesome tropical storm. The only question is, how bad will it get? Where are we relative to its center and direction of travel? Considerations of that sort now take a distant back seat to the immediate needs to keep the boat afloat—knowing that the answer to those questions will be revealed soon enough.

During the course of the next 48 hours, there are no entries in the log book and the timing of events is pretty much by guess and golly. Time became totally elastic, with some seconds seeming like hours and doubtless a few hours (the time we spent in the eye for example) seeming like seconds, but here it is as I remember:

With the wind out of the east-southeast, it seemed to me (probably a lot of wishful thinking here) that the main body of the storm would be passing us to the south, and that we were somewhere on its northern edge. If that were indeed the case, then it seemed to me that our best move would be to heave to and allow the storm's forward motion to work to our advantage.

1100 hours (still the 9th). Winds by this time somewhere in the 50-knot range and the mountainous swells of the morning were now 30- to 40-foot (9m to 12m) storm waves.

Second Use of Parachute Anchor

Within minutes of deploying the sea anchor, I knew we were in trouble. The sea anchor worked perfectly—it didn't move at all, and therein was the problem.

The anchor was set over the port bow with 320 feet (98m) of 9/16-inch (14mm) nylon rode—12 feet (3.7m) of 3/8-inch (10mm) chain on swivels at midpoint. The only sail up was a close-hauled triple-reefed mizzen, the tiller being lashed amidships to ease strain on the rudder from sternway developed as we straightened out the catenary slack on the face of each successive wave. The rode parted about 30 feet (9m) off the bow 30 minutes or so thereafter.

Hurricane Steering Technique

For the rest of the afternoon and into the evening, the storm showed its teeth. An estimate of wind and wave was impossible—there was nothing but water and the roar of the wind. The air was too full of foam and it was difficult to know where water stopped and air began.

"As we come through the crest we are knocked down by a combination of wind force at the top of the wave and force of the wave. The bow then swings hard to weather and as some steerage develops as we are sliding down the face of the wave I swing the tiller to weather. On the approaching wave face the boat stalls and develops some slick to weather from the keel."

"Let me go back over what was working for us during that time. I interrupt what had become a repetitive cycle, at the point where we have just crested a wave. The bow falls off and the boat pivots almost broadside-to, after breaking over the crest. The wind knocks us hard over—tiller goes alee—weather helm reverses the pivot as we slide down the backside, and swings us almost bow-on to the next sea. By the time we are two-thirds of the way up, bow begins to fall off. Leeway turbulence develops to weather and is definitely a factor in flattening the oncoming crest. Although we are taking a lot of white water aboard, we are not being boarded by solid green stuff. This was rough work, not at all recommended. But after the sudden loss of the sea anchor, and given the conditions at the time, I didn't feel I had any choice. To attempt to turn stern-to and run before those waves was absolutely unthinkable."

2000 hours. Fatigue and exposure is becoming a major player. Although the water temperature was very warm—particularly relative to the 50-degree waters of the north (on July 8 log records water temp of 76 degrees with ambient of 80 degrees), my lack of sleep for the last 30 hours, combined with windchill and a large helping of stress is beginning to affect me both physically and mentally.

"There was really no time to think—I remember throwing the lashing off the tiller, slamming it hard alee as we crested the sea. As we slid down its backside, we apparently picked up some steerage. That and the absence of wind as we dropped into the trough enabled the boat to get her nose back up to some degree and, at least for the moment, we were at less than the total mercy of the seas. By slacking the mizzen boom and hiking it hard to weather on the boom crutch, we were able to meet the seas at a workable angle."

My concentration is wandering, my thought processes slowing down. Night and darkness are closing in—I decide that the importance of attempting contact with the Coast Guard in order to at least make them aware of our situation/position in the event of a Mayday is a priority.

The Monitor windvane had been operating, although disconnected from the tiller the entire time. So I began to very closely observe its reactions through several wave cycles and noticed that it was in fact closely duplicating my efforts. Given my condition; given the inexperience of my daughter and son-in-law; given the risk of one of them replacing me in the cockpit and being lost overboard; given my sense of urgency about making radio contact; given I was the only one at that time who could operate the SSB, I decided to give "Henry" (our name for the Monitor) his big chance, and to my delight he pulled it off without a hitch.

For the next 30 minutes or so I watched the Monitor and, though its reactions were not quite as positive as mine would have been, it was getting the job done.

It was not easy for me to reconcile leaving the cockpit. So far we had been blessed with very consistent conditions—the total absence of any cross seas—but in the back of my mind, the little "what if" voices were making themselves heard. Nevertheless, all things considered, that is what I felt I must do—if only for the length of time it would take for the radio contact. And so I did.

My last transmission by sideband had been through KMI on channel 1205 two days previously. The reception had been perfect, so rather than attempt the Coast Guard emergency frequency (didn't have much faith given my position that 2140 megahertz would give good results) I punched in KMI and was acknowledged loud and clear almost immediately and, at my request, patched in to Honolulu Coast Guard station. Conversation went something like this:

Me: This is the sailing vessel *Wandering Star*—our position is...This is not a Mayday, repeat this is not a Mayday, but we are in some very heavy weather. Over.

CG: Roger your position, *Wandering Star*. (Pause.) Plot shows you right in the middle of Hurricane Dolores. Periodical storm winds to 90 knots, seas 30 to 40 feet (9m to 12m). Do you have life preservers on board? How many aboard, etc.? Are there any other vessels with you?

Me: I sure as hell hope not!

Knockdown

It was just at this point that I remember glancing back over the hatch boards and seeing a tremendous wave coming at us from astern, slightly to port. The next thing I felt was best described as an explosion. There was blackness and I was under water and upside down. My mind was trying to understand what could have caused the explosion and thinking—this is it, we're lost.

What had actually happened was that the boat had been picked up and then thrown in the trough in a kind of pitchpole/broach to about 130 degrees. I had been thrown head-first through the closed (safety glass) starboard side pilothouse window—as far as my upper body would allow. (My daughter attributed my survival to a beer belly.) As luck would have it, the *Wandering Star* kind of shook like an old wet dog and righted herself. I flopped back inside and was greeted with a sight that will never be erased from my mind's eye.

Morgan was looking up at me (God knows I must have looked like some apparition out of the deep) with eyes larger than life, blood running down the side of her face (it seems that our cast iron skillet had arced out of its rack travelling across the cabin roof and bonked her on the right side of her forehead). Fabian came charging through the water and debris from the direction of the forepeak, where he had been firmly wedged trying (at my insistence) to get some rest.

We had taken on enough water above the hatch boards and through the window I had so rudely opened to fill the boat to the depth of about 2 feet (0.6m) above the cabinsole. Although the engine and battery hatches in the pilothouse had remained firm, the weight of all the heavy boxes of canned goods stowed in the forward bilge had blown both of those heavy hatches out (the dings in the cabin roof still show where they hit), and the contents of these boxes were bobbing about like apples in a Halloween tub. Charts, books, bedding, you name it had come adrift and sloshed to and fro.

All the switch panels and radios had been doused when I had pulled myself (an unwitting plug) out of the pilothouse window, and as a result we had no power to the bilgepumps. Thank goodness for backup systems! I was lucky enough to have a young, strong, highly motivated manual bilgepump motor (Fabian), and in the next few hours, the manufacturers of that bilgepump would have seen their estimates of maximum capacity exceeded beyond their wildest dreams.

Morgan was given the task of reaching, sometimes diving, down to keep the bilge suction from clogging. There was no time to try to deal with her injury—it seemed the very least of our worries at the time.

I scrambled back out into the cockpit, unhooked the windvane and did what I could on the tiller to keep us head-to.

One of the major difficulties we experienced at this time was glass. Like blood, a little bit of broken glass goes a long, long way. The glass in the pilothouse window, being safety glass, shattered into small cubes that were certainly uncomfortable on bare feet, but didn't seem to cut or imbed. The chimney glass from our two kerosene lanterns was a different story. When this glass is shattered, it produces long thin very sharp shards that really played havoc with hands and feet—it seemed to be everywhere, and it stayed with us for a very long time.

Another nuisance was, believe it or not, oatmeal. We had one of the regular round boxes of oatmeal that had become part of the general soup, and believe me, it went everywhere: sticky, slimy gobs of it wound up in any place there had been water—which was virtually everywhere. Two years later, after extensive repair; I'm still finding little chunks of archaic oatmeal.

Hurricane Eye

2100 hours. We enter the eye of Dolores. Everything seems to stop. The sudden cessation of noise is dumbfounding. The wind is gone and even the seas—though confused—flatten out, as if they are in a huddle trying to figure out what to do next. The flying spray is gone and a most welcome and beautiful starlit sky is overhead. The stars are distant, silent, serene, timeless. One's significance in the universal scheme of things disappears.

The sea state in the eye was amazing—like someone put the brakes on the waves. Really strange, confused swells, like big humps, not very high, amorphous shapes, smoothed out, maybe 10 to 15 feet (3 to 5m) high. Nothing was breaking. It was really very, very strange.

The question as to our position relative to the storm has answered itself. We concentrate on those things that will hopefully keep us afloat when we exit Dolores through the lee wall. We are able to clear the boat of free water and to at least partially cover the lazaret hatch (the hatch cover itself a kind of raised affair, something like a small "doghouse") which has been smashed to bits.

I can only guess at the length of time we were in the eye. It was probably in the neighborhood of two hours, but in any case we were able to pull ourselves—and our boat—together for what we knew was to follow. During that respite the all-pervasive thought was, "How bad will it get? Have we seen the worst?" Having some knowledge of the structure of cyclonic storms, I felt reasonably certain that we had indeed seen the worst and in fact, as it turned out, that was the case.

The lee wall was not nearly as well-defined and our re-entry (or exit?) was relatively gradual. The wind and seas returned, coming at us now from the south and with none of the previous ferocity. Wind force was down to 40 to 50 knots and easing. The seas, although huge and white-crested, were not nearly as steep, and were not breaking heavily. Within a few hours I decided to set the storm staysail in order to both steady the boat and to work our way to the east in the rough direction I felt was opposite to the storm's travel. Although the spreaders on both main and mizzen had been ripped out in the knockdown, I felt that the staysail would eliminate some of the flex in the upper mainmast without over-taxing the windward lower shrouds, and at the same time would hasten our goodbye to Dolores. This was a gamble, but it worked.

Damage Assessment

The next log entry doesn't come until July 12 (we were left in Dolores' wake by midday on July 10), and when I think back about it, it's as if looking through a fogged glass. But aside from the obvious efforts to get back in order, salvage what we could, etc., there were only a few things, which stand out unforgettably etched in my mind.

In the interest of brevity I'll confine myself to some of the more definitive events of the next few days and, of course, an assessment of damage was the first order.

Injuries: Morgan's encounter with a flying frying pan turned out to be a bad bruise, lump and cut over her right eye. The cut had produced a bit of blood—as facial cuts will—but didn't require stitches and thank God she showed no evidence of concussion.

My encounter with the pilothouse window had produced a few small head and facial cuts (not to mention some bright star bursts when it happened) but no lingering effects.

Fabian's knees were like hamburger from kneeling on the glass-covered sole, while working the bilgepump (we were all picking slivers of glass out of hands and feet) but we were otherwise in decent shape.

Wandering Star, however, had been sorely abused. My log entry on July 12 notes:

"Lazaret doghouse ripped off—jury rig in place; spreaders ripped off and dangling-now back in place. VHF antenna sticks out horizontal, astern from main top. Windvane gone. Sea anchor and rode gone. GPS will not acquire sats. Depth and speed not working. Battery monitor and voltmeter both inop. *Nautical Almanac* (and many charts) gone. Refrig. and SSB inop. Totally dead reckoning on position now, which I have as 16 degrees-02N / 132degrees, 35W. On the plus side: 1) our solar panels, which we had stored out of harm's way up in the forepeak, were in good shape, 2) the battery compartment had not flooded—they were operational, 3) the engine space had remained relatively dry, due to a bulkhead just forward of it—it ran (for a while); 4) All of the switch panels had been thoroughly soaked, hence tripped most all of our circuits, including the most critical one to the watermaker. Salt and moisture would not allow the breakers to re-set. I did something here that I would hesitate to recommend but it worked for us. We had a couple of quarts of stove alcohol on board for pre-heating a two-burner kerosene stove. I filled a spray bottle with the stuff, pulled the panels out and literally hosed them down. It was kind of a last resort, but I'll be damned if it didn't work. Slowly, as the alcohol evaporated, we began to get circuits back and—joy of joys—the watermaker appeared un-damaged; 5) the little Furuno radar (which at that time seemed the least of our worries), despite the random dunking, was working perfectly.

So, okay, we'd had a close call, now what? We had to get out of there, fast.

Remaining Options

The option to turn tail and head back north and east to perhaps San Diego wouldn't work—we would be bucking the northeast trades.

We could head west to Hawaii, but would be right in the storm belt. To the east would be the very ugly (this time of year) coast of Mexico.

It didn't take much to conclude that our best move was to continue south with all haste—head for the protection of the ITCZ.

There remained one major problem, that being the loss of our nautical almanac. The thought of having to dead-reckon for the next 1,200 miles, across the whimsy of the ITCZ, the equatorial current, and countercurrents, was not a pleasant one. As it turned out, for reasons known only to the gods and gremlins, at 1900 hours on July 14 the GPS started acquiring satellites. I happened to be on watch and had spent some time basically punching buttons, hoping to perhaps re-initialize off our dead reckoning position, and bingo!

"It was a very, very long ride. We were all suffering from a combination of fatigue, shock, wind chill, and that almost paralyzing low ebb, which follows an adrenaline rush. My mind would simply not work. I remember the tremendous effort it took to hold a small flashlight on the compass (compass light gone) as Fabian and I took turns on the tiller, one steering and one holding the light. Hours passed in this fashion before one of us—I'm not sure who—had the presence of mind to simply duct tape the light to the mizzen right above the compass."

One of the interesting lessons for us about Birch's experience is the loss of his *Nautical Almanac*. From now on, ours will be carried in a sealed plastic bag.

A comparison of our GPS position at that time and our dead-reckoning position (uncorrected sun shots) showed us about two minutes off on longitude and 18 minutes on latitude—a Bligh I am not.

Note: Some 20 days later as I entered Atuona Harbor, Hiva Oa—at night with no engine and little wind, no chart and no fathometer—the radar absolutely saved the day.

Hindsight

Not surprisingly, I've spent a lot of time re-hashing the events during our meeting with "Dolores" and I feel a certain responsibility to pass on to others some of my thoughts so that they may be assessed and perhaps applied if it should ever, God forbid, come to that.

The fact that we survived indicates primarily that I had a damn tough boat, and secondarily that at least a simple majority of decisions were good ones; but the point of this exercise is to highlight a few of those that weren't so good.

1. Though the odds of making it through the hurricane belt at that time of year were still in my favor, I dealt myself (with a little help from El Niño) a losing hand. Simply put, that was a very bad call. Don't gamble unless you can afford the loss.

2. My lack of input regarding weather information was largely my own fault. I hadn't done my homework well. There are (I now know) several options or backups to WWV. If I had been more familiar with the broadcast schedules and frequencies, it is possible I could have avoided the storm entirely.

3. Any sense of security at having a sea anchor (particularly in light of our previously successful use in gale conditions) was misleading. I'm going to hazard a rule of thumb by saying that whenever wave heights exceed your waterline length (monohulls) you would be wise to have your hatchet handy.

Consider what rode could be expected to stand up to repeated loads ranging from zero to that of the full dynamic weight of a loaded vessel, whose bow is being smacked by breaking crests as you literally hang on the face of a wave.

Consider (if you have a hawser equal to the task) the loads imposed on mooring cleats, sampson posts, and ultimately the entire bow section of your boat under these circumstances.

In my opinion, the use of a sea anchor is subject to so many variables as to make any recommendation a very tenuous venture. Therein lies my disagreement with manufacturers' testaments. As with any tool, a sea anchor is a nice asset to be included in your bag of tricks. There are times to use it and there are times when other options should be elected.

To wrap up here, thanks be to the gods that I was fortunate enough to have my daughter and son-in-law (Morgan and Fabian Andaluz) along for that ride—and ride it was. Two braver, more intrepid, souls don't exist.

"The positive holding characteristics of the Para-Tech sea anchor of the size recommended for my boat unfortunately becomes a negative factor in the face of extreme conditions where a certain amount of leeway is essential.

"I would speak highly of its construction and designed function, however. A sea anchor should only be used to assist your normal heaving to techniques (whatever that may mean for any particular boat) in order to keep her head up between 20 and 30 degrees off the sea. If I can manage this with no matter what device or sail combination, I have found that my leeway wake very effectively reduces the breaking seas to white water rather than the heavy green stuff when it boards.

"Folks, this is what keeps you and your boat in one floating piece on top of that medium, which we as boaters, both love and sometimes fear, with such a passion."

Which System?

It would be nice if everyone had space and budget for an array of drogues and para-anchors. You could then pick and choose among the array for the gear that best suits the conditions in which you find yourself. However, it's rarely the case that a variety of this gear is aboard. So, if you are to carry one of these devices, what should it be?

The decision needs to be based primarily on the design characteristics of your vessel.

As we've discussed, vessels that lie quietly at anchor get the best results from a parachute anchor.

For vessels with protected companionways, such as mid-cockpit boats, the Jordan series drogue may make a lot of sense.

In between, you may want to look at devices which slow you down and help maintain directional stability, such as the Galerider or Attenborough sea brake.

All of the options help you slow down or stop for a few hours of rest when the seas are *not* dangerous—but, of course, in these conditions, heaving to with sails backed can also make sense.

However, when the seas begin to break, where a knockdown or worse is a danger, the use of these devices must be weighed carefully against the tactic of carrying on, either working slowly through the waves to windward, or running off.

Finally, at the risk of repeating ourselves, we want to emphasize one final time how important it is to be familiar with the proper deployment, handling characteristics, and recovery of whichever device you choose.

Practice in moderate weather, so that you understand the techniques involved before your safety depends on the results.

Consider other situations in which you may need to stop. Suppose you have a structural or mechanical emergency of some sort that requires the boat to be stopped for repairs, or perhaps you must keep the boat off a lee shore.

If heavy weather is not driving the decision, then for us the answer is a parachute anchor. Because of the minimal drift rate, this is the ideal method of holding station.

For powerboats without a get-home engine (or with a get-home engine, which only works in moderate conditions) it makes sense to have a parachute anchor aboard to use in case you lose the main propulsion engine—in addition to its use in heaving to.

For sailboats, unless the rig is over the side, there is less of a compelling argument. After all, if the engine quits, you have the sails. If the rig drops, you have the engine.

In Emergencies

Before we leave this subject entirely, we want to spend a moment talking about emergency situations where you need a drogue or sea anchor of some sort, but do not have specific gear aboard for deployment.

Rig Over the Side

If the rig goes over the side, in most cases you will want to get it cut free of the boat as quickly as possible, to reduce the risk of the mast holing the hull.

If the rig is left attached by the headstay or backstay, it will act as a sea anchor and hold the end of the boat more or less into the seas. If you have the option, it is usually better to have the stern facing the seas as the boat will lie more quietly head downwind than head into the wind. However, if you have an open transom where the seas have a straight shot at the companionway, it's usually better to lie head into the seas.

Using Warps

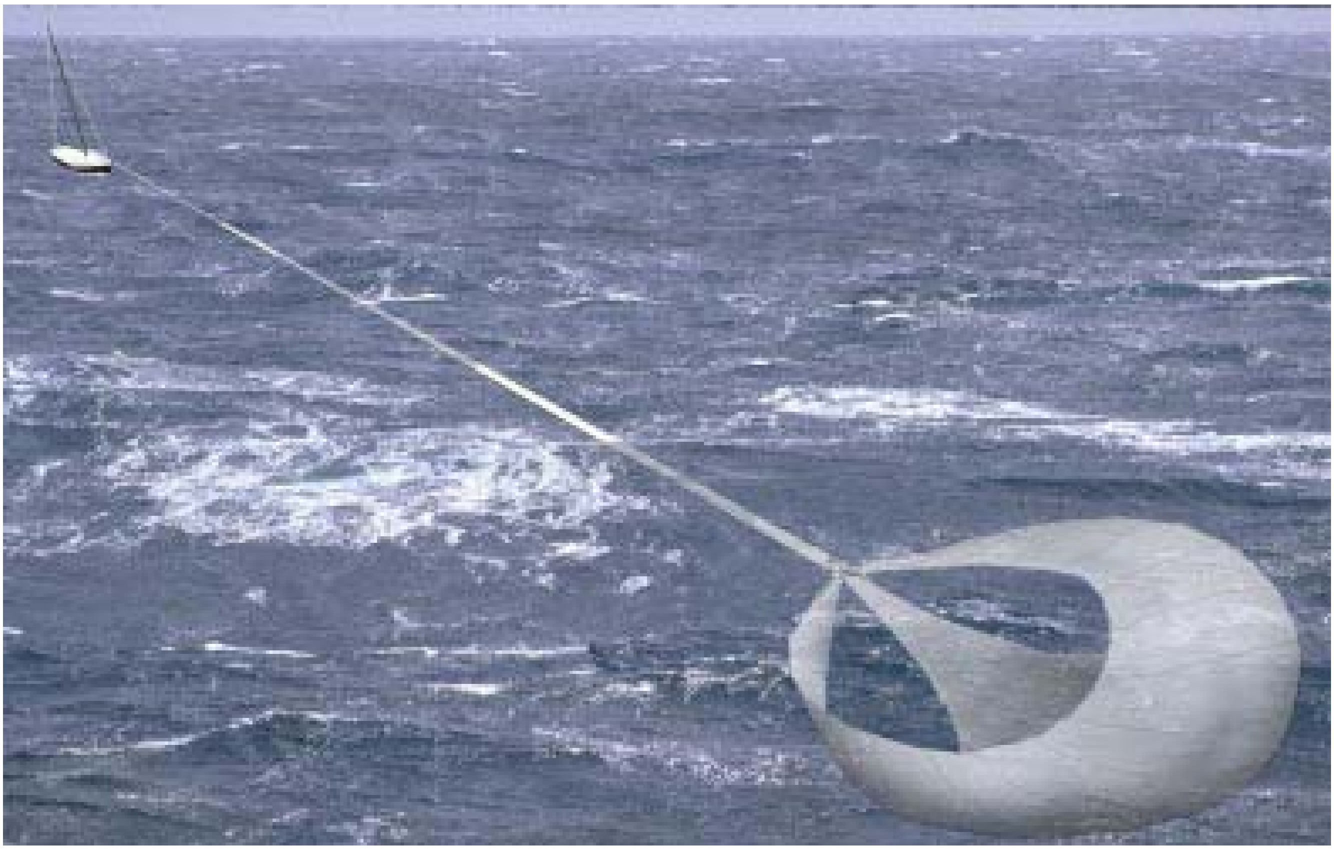
Warps and ground tackle let go over one or the other end of the boat will also help to hold you into the seas. This will work best if the warps/ground tackle are augmented by additional drag items. Weighted sailbags (with ties around the bag) work well, as do sunken dinghies, sails with three corners tied together, and as stated earlier, tires and chain on the end of warps.

Another approach, which has been tried with varying success, is to tie a sail by two corners to the boat, with a float attached at the third corner, so the sail streams out to weather. This acts as both a sea anchor and, perhaps a way to calm the seas before they break.

Bottom image: There have been reports of boats using large headsails, tied by two corners to the bow and along the rail with a weight at the end, both to hold the bow up closer to the wind than the boat would naturally drift, and to mitigate the break of wave crests directly in line with the boat. We've not talked directly with anyone who has used this approach, but if nothing else is working, it is worth a try.

A weighted sailbag (drawing above) makes a reasonably effective drogue when nothing else is available. Chain is used (inside) to sink the bag. A series of lines are run the long way around the bag, through the handle on the bottom and drawstring at the top. A second series of wrappings are run around the smaller circumference.

Another approach to getting the end of the boat into the wind is to take a jib, tie the three corners together, and then set it at the end of a long rode, as you would with a parachute. This works best with low-aspect-ratio sails, like genoas and reachers. It takes some fiddling, and sometimes will work better over one end of the boat or the other. If at first you don't succeed, keep trying. You may just find the right combination to keep from being rolled.



Stock Newport

PROFESSIONALS

When we started out to write this book we were interested in talking with as many mariners as possible to get the widest possible experience base from which to cull our information. It soon became apparent that the experiences of the professionals were quite different from those of amateurs.

As you will see in the following section, there is little real excitement in the heavy-weather department from these sailors. And this is in spite of hundreds of thousands of miles at sea, much of which takes place in high latitudes, or during equinoctal gale season deliveries.

With so many different opinions on what the ultimate tactics should be—whether one should hove to under parachute, run at speed, or beat slowly to windward—hearing what these sailors have to say is illuminating. After all, they go to sea in conditions most of us would rather not even think about. Sometimes they do this while racing, pushing their boats to the limit—so they know better than anyone where the edges of the safety and performance envelope lie.

Sprinkled throughout this section, you will find a few interviews with sailors who do not earn their living from the sea. These have been included because, in our opinion, their approach to the sea and vast offshore experience qualifies them as professionals.

"Commodore" Warwick Tompkins

We were sitting in Marty Seeman's office at Schoonmaker's Marina in Sausalito (where *Beowulf* was temporarily berthed), when "Commodore" (as Warwick Tompkins is known to his friends) poked his head in the door.

The last time we'd shared an anchorage was almost ten years earlier at Hanalei Bay on the north shore of Kauai in the Hawaiian Islands. Commodore had been preparing a large sloop to bring back to Southern California, while we were enjoying a quick trip to the islands aboard *Sundeer* before bringing the kids back to school in Ojai.

Nancy Potter

In short order, we had a date to meet for juice and bagels the next morning to catch up on what had happened in the intervening years.

Commodore Tompkins is the quintessential "old salt." He was brought up on the pilot schooner *Wanderbird*, and doubled the horn at age seven. As an adult, the sea has been his calling, and he has sailed just about every kind of vessel imaginable from traditional yachts to the highest-tech racing sleds. He makes his living delivering yachts all over the world, and putting together racing and cruising programs. Owners hire Commodore to assist them in choosing a yacht, outfitting it, and then teaching them the skills necessary to successfully cruise or race.

With over 500,000 offshore miles under his keel Commodore is a professional's professional.

Delivery Lessons

We have always been fascinated by the folks we know who deliver yachts as a business. All they have to sell is their time, and the condition of the yacht they are about to deliver has a big impact on that. It also has a bearing on their safety.

Successful delivery skippers develop an approach to checking a yacht quickly, to determine whether or not it's up to the task.

As Commodore puts it, "Sometimes yacht owners exaggerate the condition of their vessel to us, so we always make sure we have a round-trip ticket to the boat and back. This way, if the boat isn't up to snuff, we are out some time, but not out the air fare."

We asked Commodore what he looks for when he steps aboard a new delivery.

The fundamental things are to keep the water out; keep the boat under control; and keep the boat right-side-up and the rig intact. The engine is a sort of luxury item as far as I am concerned. It makes the other luxury items work and it is nice to get through calms, but it is not a necessity.

I never go to sea without looking at the rig closely. I look at all the rigging terminals, the way shrouds are joined to the mast, the spreader roots, details of the shrouds over the spreader ends, and I check the halyards by tying the ends together and pulling them through the mast. With wire halyards I run a rag over the wire to check for broken strands. I also check that the halyard sheaves are free-running.

The most important safety gear is a double-bottom life raft with a canopy. An EPIRB is the single best piece of rescue gear we've got.

I insist that the boat have a small headsail, like a staysail or storm jib, and a means of setting it (with plenty of running rigging). I check the stitching on the working sails, check the battens and batten pockets, look at the sail corners and attachments, and look at attachment hardware for the corners.

Commodore's thoughts on communications gear are in line with our own.

I don't get along well with most communications gear. One of my goals in going to sea is to generate some isolation. Modern communications gear is counter to that. On the other hand, it is getting to the point where it is almost reliable, and I do like a weatherfax.

People in our society tend to have the attitude that if they are in touch with others they have an element of security. That's fallacious. In many cases, it is the blind leading the blind. It is almost always better to make your own decisions.

With so many sea miles behind him, Commodore's comments on safety at sea are worth listening to.

Safety at sea comes from the way your head works. If you know how to move with the boat and are not overly fatigued or panicked, you are much safer than when using harnesses or man ropes but not thinking clearly. One of the things that happens to a good seaman is he or she learns how the boat moves in a seaway, and how to correct for it. You can feel a sea coming before actually seeing or hearing it. I train my clients and crewmembers to lock themselves onto the boat before a sea hits. Using your arms and legs around the mast, a stanchion, or even the mainsheet—not depending upon a hand grip—is the best way to stay aboard.

When you learn the motion of the boat, you let the boat accelerate your body rather than fighting the boat's motion. If you fight the motion, it doubles your effort and you quickly become tired.

In Heavy Weather

Now, you would think that with 500,000 sea miles to look back on (and this excludes his childhood years aboard *Wanderbird*) there would be a significant amount of heavy weather to talk about.

Yet when we asked Commodore about his heavy weather experience he paused a few moments and then said, "You know, I have not been in much heavy weather at all. I would say it totals less than 48 hours, if that much."

Still, like any professional seaman, he has definite thoughts on tactics to be employed.

The winds can blow at an alarming rate, even over 100 knots, and the boat will survive. The sails might blow off the spars, and you might lose deck gear, but the wind will not be the problem. It is the seas that cause the problems that you have to deal with.

The long axis of the hull is the best protection against a seaway. You shouldn't lie ahull and you can't heave to when it is really wild. This means running off until you can't steer any more.

And somebody has to be steering the boat so you can react to the waves. If you are running before big seas and go below, leaving the boat to the windvane while you get a cup of tea, considerable risk is involved. The biggest problems come from breaking seas from different quarters.

When you start going too fast, some sort of a drogue is necessary to slow things down. I like the series drogues. But you still need to steer the boat around the big seas.

Parachute Anchors

At some point you may not be able to run before a storm, due to lack of sea room, or perhaps the crew cannot cope. What you do at this point is usually controversial. Commodore's answer surprised us.

The last line of defense is a modern Para-Tech sea anchor. I used one in a 30-foot (9m) Wylie catboat (a cat-rigged monohull) in a 40- to 50-knot storm. Not really that much of a blow, except for a vessel this size (she has a 25-foot/8m waterline and displaces 6,200 pounds/2,800kg) with a draft of 5.25 feet/1.6m), the waves were big enough at 8 to 10 feet (2.4 to 3m).

I had been surfing for eight hours, having a wonderful time on the leading edge of this front. The wind was southwest and we were about 100 miles north of the rhumbline between Hawaii and San Francisco, 800 miles from the coast. The boat was handling the conditions beautifully, but with night coming on, being unable to see the waves, I felt the conservative thing to do was to try the sea anchor so I could get some rest.

I followed the Para-Tech recommendations for rigging. I put the sea anchor in the cockpit and got it good and wet so it would sink. The nylon rode was flaked so it would run freely, and then run to the bow.

In my case I was running off so I didn't have to struggle when I was rigging things forward. When everything was ready I tossed the sea anchor off the weather quarter from the cockpit, making sure it went down into the water so it couldn't be blown into the air.

The next thing is to pick your spot to head up, once the rode has been streamed. The boat will start making sternway so you want to come up into the wind and get the rode winched tight so you don't damage your rudder by making too much sternway. The para-anchor we used was 15 feet (4.2m) in diameter and it held us firm against the wind and the seas.

You must manage chafe at the stem. The best solution is to use a split piece of vinyl hose, slip it over the rode, and then tie it in place.

We were very interested in Commodore's comments on the recovery of the sea anchor. Having heard about all sorts of problems with trip lines fouling things, his answer makes a lot of sense.

You are supposed to use a buoy of some sort on the back side of

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the para-anchor to prevent it from sinking if the load lightens
up. I used a square cockpit cushion, but it did not do a very
good job. I didn't have a trip line. Rather, we just used the
cockpit winches to crank the rode in until the nylon Para-Tech
anchor came aboard just as docilely as you could ask for. I
think it is better not to use a trip line so you don't have to
worry about it fouling.
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How about motion with the bow straight into the waves? "There was a lot of motion. However, compared to what we'd be experiencing without the sea anchor, the motion was not offensive. I wedged myself into my bunk and was able to get to sleep until things quieted down four hours or so later."

Commodore's final comment on tactics is quite interesting. "When I see a sea, which is longer than a boat length in height and starting to break, I want to be bow to."

HOMER HOLM

Captain James E. "Homer" Holm is the quintessential professional seaman. With a 1600-ton master's ticket, sail endorsed for all oceans, he has hundreds of thousands of sea miles under his belt, the majority in large traditionally rigged schooners and brigantines.

He is tall, lean, and soft-spoken, with a natural air of authority that comes from knowing his trade.

We met Homer one summer afternoon as we were rafting *Beowulf* alongside the revenue cutter *Californian* after a sail up the coast to Morro Bay.

We got to chatting, exchanged visits between crews, and had a thorough tour of the two vessels.

The *Californian*

Homer's charge, the *Californian*, was a combination of school ship and goodwill ambassador. He sailed with a core crew, augmented by various adventurous souls, who wanted to sail on a real windjammer.

One look at the lofty rig, square foremast yards, and huge mainsail was enough to tell us that this, indeed, was the real thing—and there wasn't a winch in sight.

The *Californian* is typical of the traditional schooners on which Homer has spent a good part of his career. So the heavy-weather tactics he teaches and employs are based on real-world experience.

As the sun was setting, we asked Homer to join us for dinner at a local restaurant, a short walk from where our two vessels were rafted together.

Heaving To

It wasn't long before our discussion turned to heavy-weather stories, or our respective lack thereof. We asked Homer first about heaving to.

Every vessel is different and requires different combinations of sail depending on sea state and wind, so you need to experiment ahead of time.

When I skipper vessels for the Sea Education Association (on the East Coast of the US), heaving to is a standard tactic so that various scientific experiments can be conducted. We find this a very useful tool for staying on station, with an ever-so-slight sideways drift.

The sail arrangement depends on hull shape. With a cutaway forefoot, less sail area is needed forward as the bow tends to fall away from the wind. With a full keel, we need more area forward. Sometimes we'll even carry the foresail or main staysail when heaving to.

The main is usually sheeted in and driving while the forward sails are backed to weather. The helm is to leeward.

We asked Homer at what point he felt that he could no longer heave to, and would have to adopt different tactics.

I've never actually gotten to that point, as most of these vessels have been quite large. But the key is to give way before the seas start to board the boat. That's when damage starts to occur and you have to run off.

I did have one experience many years ago, where we were hove to in 60 knots of wind about 500 miles west of Point Conception. We were aboard a 50-foot (15.4m) Herreshoff ketch, and were flying a deeply reefed main and small yankee jib.

Lying ahull is something Homer has never tried, and it doesn't make any more sense to him that it does to us. But running off, of course, is a standard tactic.

Running Before a Storm

Before you run off, you need to know where you can go both navigationally and from a sailing standpoint. This is a function of knowing what the boat can do, and what she should feel like when being pressed a bit. You also need to know what the crew can do. Fatigue is always a major factor. In a real storm crews quickly tire and frequently can't do anything.

The course you choose is a function of control. Sometimes you cannot run dead downwind, as the seas slew you around too much. But broad reaching is more comfortable and makes the boat easier to handle.

Your sail-reduction plan needs to be worked out in advance, both with regard to the wind and the crew's abilities. The general rule of thumb on schooners is to set sail from the stern forward, and take it off from the stern first when shortening down. This gets rid of the big, somewhat hard-to-handle mainsail early in the game.

In commercial vessels, we are required to practice both our sail-handling and safety procedures (like man overboard, abandon ship, and firefighting). There is nothing like practice to make this work when things are serious. From a cruising standpoint, I always try to teach these things ahead of time, to make a game of them and make it fun. This way, when the chips are down my students know what to do.

John Jordane

Fisher Paykel is shown here in storm-force winds in the Southern Ocean. She is carrying a storm spinnaker in conditions where most cruisers would be down to trysail and storm jib.

John Jordane

John Jordane has crossed oceans on just about every type of sailing vessel imaginable. From the CCA racing era, through the hey-day of IOR and now IMS and sled racing, he is sought after as professional skipper, navigator, and weather guru.

John has crossed the Pacific 36 times, the Atlantic 12 times, and completed two Whitbread Races, the last in 1989/90 as the winning navigator of Grant Dalton's *Fisher Paykel,* a maxi ketch.

So when he starts to talk about heavy weather, you can be reasonably sure that his approach comes from true experience.

"Heavy weather depends on what you think it is. It is a state of mind as much as weather. What is dangerous depends on the boat, the crew, and what you are comfortable with," is the way John started our conversation:

In the last Whitbread, aboard *Fisher Paykel*, we'd carry a storm chute with a wire luff in 55 knots of wind, in huge seas. But that was with a fully crewed racing boat, in which we had the utmost confidence.

After it's been blowing 45 for a while, 35 knots seems calm. And once you've experienced more wind your whole mindset changes. The key is that you have to be comfortable with your boat, your gear, and your crew. If you are not comfortable with any part of it, your definition of heavy weather is going to move downward on the wind scale.

Delivery Experience

Racing on a well-prepared yacht, with a large experienced crew is one thing. But what about short-handed deliveries?

In the context of over 100 deliveries, I have probably spent seven to ten days total in what might be considered dangerous weather. These were in blows usually lasting less than twelve hours and never more than a day and a half.

I am a strong believer in preventative tactics and keeping the boat moving, of staying in charge of the situation rather than letting the weather and sea take over.

Before we leave on a delivery, I make sure the crew is familiar with reefing procedure and storm canvas. We set the storm jib and trysail, make sure that the head and tack are well marked, and that we know where the sheets lead.

I am not afraid of reefing early. It is better to get ready early for a blow. You can always put the sail back up if you are wrong.

Coming back from Hawaii, for example, you can frequently find yourself in a real blow as you approach the coast, so we keep a close eye on the weather and have our reefing pennants lead and storm canvas ready in advance.

Heaving To in Light-Displacement Yachts

With all of his experience in ULDBs, John is the perfect person to ask about heaving to on these very light designs.

I've hove to lots of times in sleds as well as other yachts. It is a good way to get some rest or wait out adverse weather. Modern boats are tougher than older yachts in this regard. The key is to try out different sail combinations to find the right balance.

It usually takes a storm jib or staysail and maybe some main to get the boats to heave to. Sometimes they will lie abeam of the seas, but just about every boat will eventually heave to.

In Extreme Conditions

As we've already seen, John believes in a pro-active approach to storm management. Lying ahull is not in his repertoire of tactics. This leaves running off when it gets extreme and progress upwind is no longer feasible.

We have always been curious about handling a ULDB sled-type boat off the wind in a real blow. At some point, you have to be concerned about going too fast; and in theory at least, this might come sooner on the wind gauge than with other vessels because of the ULDB's ability to accelerate so quickly.

So we were interested to learn from John if he'd had any good blows while aboard a ULDB.

I was on the Santa Cruz 70 *Pyewacket* during the Route de Discovery Race a few years ago. This was a race from the Canary Islands to the Bahamas. At one point, about halfway across, we picked up a front and accompanying south-southwest winds, which was the direction we were heading.

We carried on until the wind reached 50 knots or so, after


John Jordane

Conditions at the aft end of the boat may look relatively benign with the spinnaker up, but when you walk forward of the mast the situation changes dramatically. With freeboard at a minimum these Whitbread boats often have several feet of water on deck, and you really need to hang on!

which it was no longer possible to make progress without damaging the boat. We ran off before the storm, at first flying just a storm jib. And then we found that this was too much so we went under bare poles.

Even under bare poles we were going too fast away from our destination, so we rigged up some drogues. We took two spinnaker sheets, shackled the ends together and tied this to the stern quarters. We then took our nylon anchor rode, about 200 feet (60m) long and made a second drogue out of it, again tied to corners of the stern. This got our speed down to the 6-knot range. We could still steer and control the boat, but we weren't losing as much ground to leeward. The seas were about 15 to 18 feet (4.6 to 5.5m) and stretched out, with the tops breaking, but pretty uniform in shape.

We asked John what he would have done had his destination been to leeward.

If we'd been cruising I would have wanted more boatspeed to give us better control. A storm jib without the drogues probably would have been just right.

The two problems you have to watch with the sleds is flying off the wave tops when going upwind or close reaching, and stuffing the bow which leads to a broach when heading downwind. You have to manage your speed to avoid these extremes.

In the 1985-86 Whitbread when we were coming in to Cape Town at the end of the first leg, the "Cape Doctor" was blowing 50 knots, with steep, short seas. All the boats had to slow down to 7 or 8 knots to keep from flying off the waves, even though we were racing.

Losing Your Rig

Race boat rigs have much smaller factors of safety than do those designed for cruising. And it is not uncommon to find a rig going over the side now and then. If your rig never falls down, you are carrying too much weight aloft—or so the spar makers would like you to believe.

John has the distinction of having been aboard vessels at one time or another which have lost rigs in every ocean on earth. So his comments on the condition are interesting to hear.

The key thing is to get the rig cleaned up and cleared away before it damages the hull. Rod rigging, especially the cobalt-alloyed rod, is impossible to cut with a hacksaw. So, I always make sure we have a big sledgehammer and something with which to drive out the clevis pins.

We asked John about the motion aboard after the dismasting.

While the rig is in the water it acts like a big sea anchor, so motion is not too bad while you are working on deck. But once the rig is cut away, motion becomes quite severe.

Bermuda Hurricane

The worst conditions I think I have been in were in a hurricane north of Bermuda. We were bringing the maxi yacht *Ondine* back from Spain.

It was blowing 65 to 70, we were down to bare poles, and had put out some drogues. Everything on deck was battened down. We had one person on the helm, steering, with the boat going 9 to 10 knots, running square in confused seas.

Something hit us on the quarter and knocked us right over. I am not sure how far we went, but beyond 90 degrees with the mast in the water. When the boat came up the mast was over the side. One of the diagonals had failed. It was probably a weak point not caused by the storm—it would have gone anyway at some point. We came up with the mast left up to the first spreader.

Luckily we had enough fuel to motor to St. Pierre in the Saint Lawrence River, and from there we took the boat back to Palmer Johnson in Sturgeon Bay for repairs.

Alan Nebauer

Deus Regit II, the Top Hat 25 design by John Illingworth which Alan and Cindy Nebauer sailed from Australia to Canada and back. They are leaving the Bay of Islands, New Zealand for their passage north to Canada.

Alan Nebauer

The Nebauers—Alan and Cindy—have probably seen more heavy weather than most cruisers. As Australians, with the notorious Tasman Sea in their backyard, this is understandable. But throw in a propensity to do a lot of north/south passaging, together with a fondness for higher latitudes, and one begins to understand that here is a good source of sea stories! If you mix in a single-handed around-the-world race, you know we are dealing with sailors of experience.

Both are quiet-spoken, with just a hint of the open sea in their eyes. Passaging is currently on the back burner as they raise their young family and Alan does project management work for owners looking to have a boat put together. We met Alan and Cindy in Marina del Rey as they were helping ready Alan's BOC 50 *Newcastle Australia* for the next Around Alone Race with her new owner, Brad Van Liew. This vessel is 50 feet (15.3m) long, 14 feet (4.3m) wide, and draws 12 feet (3.7m) with a bulbed keel.

When we first asked him about his thoughts on heavy weather he was hesitant about even discussing the subject.

Heavy Weather Experience

"I haven't really seen that much," was his first reply. Knowing that Alan had more than 100,000 sea miles under his keel made us think that this might just be modesty talking.

A bit more judicious dialogue on the subject and Alan began to loosen up.

Any time you cross the Tasman (between Australia and New Zealand) you typically get at least one blow.

My first time was in January of 1980. I was on a 40-foot (12.2m) heavy timber yacht that wasn't in all that good of shape. She was a Sparkman & Stephens design that had been built about 1950. We had a cyclone—80 knots for the better part of 30 hours during a Hobart-to-Auckland Race. It was amazing that the boat didn't fall apart. If I had known anything I would have been scared. But this was my first time at sea. We survived, and the storm gave me a good kind of threshold.

Now, you would expect with all of this high latitude sailing, especially so much done in a small boat, there would be a lot of sea time in dangerous weather. Alan's reply? "I don't think I have really seen that much weather you could call dangerous. Five days at the most."

Cindy and I then built an Illingworth-designed two-tonner. This was a 25-foot (8m) yacht with a cutaway forefoot, full keel, and attached rudder. We sailed her from Australia to Western Canada and back, a distance of 23,000 miles.

In a slow boat like that you are exposed to more weather systems. Yet we only had a real blow a couple of times. The worst was in the North Pacific when we had 50 knots for a couple of days. We laid ahull a couple of times when we couldn't make progress, but generally we kept the boat moving with storm canvas.

When I was bringing the boat home on the final leg to Australia—Cindy had flown home, almost ready to give birth to our first child—I single-handed from Tahiti, and had three or four low pressure systems with winds of 40 to 45 knots. I didn't want to stop as Cindy was due at any time, so I kept plugging away under storm jib when it was really blowing. I couldn't make much progress in the wind and seas, but at least I was going in the right direction. Some days I'd sail 100 miles through the water and make good just 15 after leeway and current.

Small Boat Tactics

Boat size is relative. A 50-foot (15m) yacht may seem small from the deck of a 65-footer (20m). But when you talk about heavy weather from the deck of a 25-foot (8m) vessel—there is nothing relative here.

With this in mind, and the light displacement of this Illingworth design as background, Alan's comments are very interesting.

I don't have a pre-set plan for heavy weather. I just deal with it when it occurs. I tend to be a bit intuitive about what to do. I don't have any hard-and-fast rules. Sometimes one thing works and then sometimes something else does. You have to suit the tactics to the conditions.

I don't usually stop. I like to keep some way on. I feel that heaving to, if it is really blowing, can be hard on the boat. If we start making sternway the rudder can be easily damaged. So when we are hove to I make sure we are forereaching a bit—with the boat moving forward through the water.

On our little boat above 35 knots we couldn't make much progress to weather. The seas would be too much. We'd have up tiny scraps of sail—a storm jib and triple-reefed main, and would be making so much leeway that progress was nil.

I have laid ahull a couple of times, but I don't really like to. I think you are too vulnerable. I'd rather have up a tiny bit of sail, keeping the wind at 50 to 60 degrees and moving at a knot or two forward.

I have never had to run off before a storm, unless it was in the direction I wanted to go. In the one bad blow we had in the North Pacific, with 55 knots we used just a scrap of the genoa unrolled. The helm was lashed—we had no self-steering—and the boat was doing its own thing making 4 knots or so downwind. Sometimes we'd roll the sail away and go under bare poles.

I have never dragged warps. I think that most boats are too vulnerable from the stern for this.

BOC Tactics

With more waterline and stability available to Alan in the BOC you'd think that tactics would be different. But Alan says his flexible approach remains the same.

In the BOC on Leg Two, across the Southern Indian Ocean, I didn't really have any bad weather. Fifty-five knots was the most I saw with 40 to 45 a couple of times. Of course this was in a much bigger, faster boat. On the third leg, we had one good blow about 1,500 miles west of Cape Horn.

About 2,000 miles from the Horn I knew from the weatherfax the low was coming. But I didn't know how bad it was going to be. It felt like it just built and built like one bad blow that wouldn't go away. But I think it was more like a succession of lows that fed off one another.

The first blow was 50 to 60 knots, starting in the northwest and finishing in the southwest. I was down to bare poles when the wind got over 60 knots. Most of the time I was doing 12 knots, which was just a little too fast. However, when I slowed down below 9 or 10, I felt really vulnerable to the seas, which were just horrendous.

In the second blow, the wind went from 50 to 60 to 80 or a little higher. I was under bare poles the whole afternoon. I am really bad about estimating wave heights, but I think they were 40 to 50 feet (12 to 15m). At night I couldn't see the waves or the horizon—there was no sense trying to hand-steer because I couldn't see anything. So I stayed below and let the autopilot steer. I felt it was more important to preserve my strength.

There were severe cross seas from the earlier storm, and these made it harder to pick out the right direction to steer. The major waves were from the southwest, and I was running almost square, with the wind on the starboard quarter. It was definitely better having the swell on the quarter rather than dead behind.

And in hindsight, what would Alan have done differently?

At night, in the height of the storm, there really wasn't anything else I could do. I couldn't develop a plan because the seas were so random, and I couldn't see them anyway.

Bruce Kessler

Bruce Kessler has been crossing paths with us off and on for years. Back in the late 1980s, we exchanged visits between our then-new vessels anchored at Cat Harbor off the Southern California coast.

Zopilote, his very intriguing motor yacht, was based on a "limit seiner" hull used for commercial fishing in the Pacific Northwest.

As such, it was a massive little ship. Just 70 feet (21.4m) long with a beam of 20 feet (6m), she displaced 116 tons while drawing 9.5 feet (2.8m). The bow was moderately fine under water, rising up to a very high bulwark 14 feet (4.3m) above the water with an extensive pilothouse.

Bruce had commissioned *Zopilote* for serious cruising, and that's what he and his wife Joan do. Passages to Alaska, the East Coast of the US, and a circumnavigation were part of the itinerary.

When we asked Bruce how many miles he had cruised, he was taken aback. "I've never really thought about it in that way" he said. "But I've got 11,000 hours on my engines."

That works out to something around 100,000 miles.

Weather Routing

Bruce's newest yacht, *Spirit of Zopilote*, is a smaller version of her namesake. At 60 feet (18.5m), with an 18.6-foot (5.7 m) beam, she displaces 75 tons while drawing 6.5 feet (2m). She cruises at 8 to 9 knots on long passages.

Like the rest of us, Bruce has not really experienced that much heavy weather, especially in the context of the type of vessels on which he passages.

A couple of blows in the Tasman Sea between Australia and Tasmania, once going up the Red Sea, and once outside of Alaska are about it.

Of course he looks for calm weather in which to motor, picks his departure times carefully, and maintains a close watch on the weather.

He also uses a professional weather router to advise him on departure times as well as while en route.

What we found most interesting about his tactics is that he tends to use high pressure systems in a similar fashion to sailboats, at least when his destination is upwind.

When coming back from Hawaii, he follows the clockwise circulation around the high, heading north or northeast, keeping the wind behind him until he can cut through the windless center of the high pressure system.

Upwind Destinations

However, it is sometimes impossible to avoid going uphill. In moderate conditions, he just slows down to maintain comfort and reduce pounding.

When it starts to blow a bit the tactics change:

We usually slow down to where our speed over the ground is 2 or 3 knots, and adjust course 10 to 20 degrees off of dead upwind. Usually one tack or the other will be favored relative to the wind and waves.

We'll maintain this sort of speed and heading until the wind and seas moderate, and we can resume our normal cruising speed comfortably.

We asked Bruce if it was beneficial to manage *Zopilote*'s power as she came over the crest of the waves:

Our response rate is too slow for that type of technique to work well—but it can be useful on lighter hulls, which respond faster. Sometimes on semi-displacement or planing hulls you pull the power right off, or reverse until the crest passes and the bow lets down, before going ahead again.

Running Off

If the destination is off the wind or if heading upwind is too uncomfortable, one option is to run off before the seas.

Here Bruce seems to favor the tactics, which we have found also work well with a sailing vessel:

Run as fast as you can to maintain control, just the opposite of beating. If you are afraid of broaching, tow a drogue. *Zopilote* drew 9 feet (2.8m) with an 8-foot-deep (2.4m) rudder. We had dual fast-acting 1/2 horsepower WH autopilots, and while we never had to steer in these conditions, we were always ready to take control should the need occur.

At some point, when control becomes marginal, you have to head back into the seas. The thing to do is to wait for a relatively calm spot, and then turn the boat as quickly as possible into the seas. You do not want to get caught beam-on in breaking conditions.

Using a Parachute Anchor

Bruce is a fervent believer in parachute anchors, as are many commercial fishermen. He uses a Para-Tech sea anchor, 22 feet (6.7m) in diameter. It was attached to *Zopilote* with 1-inch (25mm) three-strand nylon line. Aboard *Spirit of Zopilote* he uses 3/4-inch (19mm) nylon.

In moderate gale conditions, we figure that we drift just 3 to 5 miles a night. With the sea anchor deployed we just wait out the weather. There is no need to beat ourselves up.

Setting a parachute anchor:

"We always set it to leeward, with the boat heading downwind if it's really blowing hard. This way it can't blow back aboard. In moderate conditions, we set it to weather, being careful not to allow it to get under the boat. Rather than use a trip line, we tie a short line to the head with a float on the end. Once the anchor is deployed, we turn the boat into the wind, making sure that the sea anchor stays to windward.

"In normal conditions, we use 200 to 250 feet (60 to 75m) of line on the parachute. If it's blowing hard we'll add another 100 feet (30m) or so.

"When the time comes to retrieve it, we motor up slowly, pulling the line in by hand as we go. When we get to the parachute, we pick up the trip line and float with a long boathook from the bow and then bring the parachute aboard."

Bruce emphasized that you had to make sure you stayed well to leeward of the parachute, lest you foul it on the prop or underbody.

Steve Vance

Marja and Steve Vance

Twigga is a Cal 2-27, which Steve and Marja sailed more than 60,000 miles during the course of a leisurely circumnavigation from 1970 to 1986 (all navigation was done with a sextant).

Marja and Steve Vance are professionals—they make their living by driving power and sailboats for other folks. For the past six years, they've been skippering the 92-foot (28m) fractional sloop, *Locura*. They cover a lot of miles every year at sea, moving boats from place to place, so they are bound to be exposed to a bit of weather. They were New Zealand-bound from Fiji during November of 1998, the month we detailed in the beginning of the book (see page 22) However, they're very conservative sailors—you have to be with a 92-footer—and by taking their time, picking their weather, and then maintaining good speed on passages they are able to, by and large avoid inclement conditions.

Marja and Steve's comments follow:

Marja and I have decided we tend to be a little long on the sea miles, over 100,000, but short on the storm experience. This is a little by design and mainly by luck, but we do a lot of careful planning before making passages on our Cal 2-27 to attempt to avoid bad weather (look for the squares indicating gales that have zeros or low numbers on the pilot chart).

We sat for four days hove to under a backed storm jib and triple-reefed mizzen in Force 9 winds in the Atlantic during the month of November-about 400 miles east of Georgia, while on our way from New Jersey to St. Martin. The boat was a Dufour 46 (14m) motorsailer, and it was amazing how secure everything was once we fine-tuned the rig. There is something to be said for a long-fin keel and ketch rig in this situation.

We hove to for two days in fairly good-sized seas on *Twigga* during the month of April, on a passage from New Zealand to Fiji. We were definitely in tropical waters by then and were amazed to run into this gale. We raised the storm trysail, which is on separate track and always ready to go, and backwinded the storm jib, which was hanked on the inner forestay (something we added as a Cal 2-27 is a sloop). We were happy with the arrangement. We did tend to get knocked around a lot, probably more due to the size of the boat than the tactics.

Another time, we lay ahull while going from Ahe to Rangiroa during bad conditions, winds about 30 to 35 knots with a good sea of 8 to 10 feet (2.5 to 3m). Our primary mission was to slow the boat down since this was in the days of the sextant and we didn't want to hit anything. We definitely decided that this was not the method to use in bad conditions. I couldn't imagine laying ahull in a real storm following that experience. Just the mental anguish of the waves hitting the beam of the vessel was enough to unnerve me. I remember us laying in the settees, with everything battened down tight, and hearing those waves approach, and then bang, over she would go thirty degrees, and then silence again.

We also found ourselves in a Force 9 storm in September in the Mediterranean, while sailing from the Ionian Sea to Crotone, Italy. We picked up an Italian weather forecast, which once you know the format is quite easy even though it is in Italian, forecasting Force 9 to 10. The winds were already in the 30-plus-knot range. The seas were only 8 to 10 feet (2.5 to 3m), but what seas. We were already snugged down at about 2200 at night and about 40 miles off the coast, with a trysail and heavy weather staysail, the wind just forward of the beam. The seas were breaking on the boat and we hand-steered up into the waves and then off again. We decided to try to make for Crotone rather than run south. Those were the only two options, excepting to heave to. We wanted to get to shelter, if possible, due to the weather report.

The problem in a really small boat is that you just don't have the power or stability range to fight bad weather by sailing against it. We were, however, able to make the last few miles since we started to get some protection from the seas under the land, even though the wind was increasing. We spent three days in the harbor laying to 300 feet (92m) of rode with the harbor closed. It was great to be harbor-bound!

As a side note, our storm tactics on *Locura* are to motorsail into the wind and waves. You can't really deal with a storm trysail the size of *Locura*'s since you wouldn't raise it until 60 knots or so.

"We tend to follow the same philosophy as Lin and Larry Pardey concerning running off under bare poles—we find it scary. It seems like you cut your options since it takes a lot of courage to turn up into big seas once you are committed to running off. Most boats seem to be rolled while running. Having said that, we are intrigued by the idea of the Jordan series drogue, since it appears to cause enough wave disturbance to prevent capsizing in waves and is easy to handle—just attach with a bridle over the stern. The parachute anchor, which we have never tried, seems a little tricky to me. We will probably get or make a series drogue for *Twiga*, if we plan to make any more long ocean passages in her."

ERIK LEROUGE ON MONOHULLS

We met Erik LeRouge earlier in the section on multihull storm tactics (page 386). As a designer who swings both ways (monohull and multihull)—in addition to being someone with extensive offshore experience—his thoughts on monohull heavy-weather tactics are very interesting.

"Our usual sailing weekend: Going east towards Barfleur or St.Vaast with a Saturday morning flow, back with Sunday afternoon ebb.

"The following week, going west towards the Channel Islands with a Saturday morning ebb, back with Sunday afternoon flow. The trick was to start early so that we enter the Race at slack tide to have as much time with fair current as possible in case of light winds. If missed, we drift backwards for 6 hours until the tide turns back again with the result of an 18-hour passage instead of six!

"The first problem is that one leg usually has to be done wind against tide. Most of the time, this is on the way back because we were not silly enough to start the weekend with headwinds, and unfortunately, the return must be done at all costs for work Monday morning. We could always fly back and leave the boat there, but some harbors such as Aldernay were unsafe in gale conditions, and many Cherbourg boats were lost at this anchorage."

Aldernay Race Stories

I was born in Cherbourg on the shore of the English Channel, where tides are some of the most significant in the world with average 40 feet (12m) difference between high and low tide in the Channel Islands. This means that during the flow, an average of 2 knots of current is going up Channel then six hours later, 2 knots of current is going out the Channel during the ebb.

Cherbourg Peninsula is in the way of this huge amount of water going in or out the Channel with the effect of locally increasing current strength.

Barfleur Race, on the east has three severe bars where current reaches 7 knots. I have seen 13-foot(4m) breakers with only a Force 5 northeasterly against the tide flow. Not very high but very short and quite unpleasant for small boats.

The west shore is even more complicated, with the lovely Channel Islands further reducing the gap for water. This is named Aldernay Race where at some spots current can reach 11 knots, some of the strongest of the world.

Many world-class sailors, Tabarly for example, often said that the most dangerous seas they encountered where in the English Channel.

Current is not all bad. An ebb or flow tide can add 20 miles to your six-hour sail, provided you correctly plan your trip.

Once I started designing boats, I needed extra jobs to make my living so did a bit of skippering for the Cherbourg-based charter companies. Our clients usually arrived from Paris by the Friday late evening train, exhausted by a week of office work, and we left Saturday morning for the Channel Islands is in more or less any weather, because they paid for it and had to catch the last Sunday evening train at all cost to be back at work. Apart from being inexperienced, most were of course seasick, being tired without the time to acquire their sea legs. This gave me a good knowledge of the Aldernay Race, in various conditions and on all types of boats.

Red Magnum

The worst I encountered was however on one of my early designs, *Red Magnum*. Fascinated by ULDBs, I managed to persuade a friend of mine to build one for his racing school. Displacing 3.2 tons for 36 feet (11m) was not bad in 1979, but using a half-tonner mast section, most of our friends predicted that we would destroy the boat on our first sail.

The boat was launched in October and after a quick test sail in light weather. Off we went for our maiden cruise, the usual Guernsey weekend. Nice northeasterly Force 4/5 to enjoy our first taste of "light is fast" and "fast is fun" with 14 knots on the clock to take two hours off our own Guernsey record.

Erik LeRouge

The next day was not so enthusiastic with northeasterly gale warnings so we wisely decided to visit the pubs.

Monday morning was worse with an established severe gale, typical of the Channel Islands October weather conditions. My friend Christian, veteran of the first Mini-Transat, said he had seen worse in Biscay and wanted to go. Our crew could not wait any longer. Sure that it was going to be hell out there, I was faced with the dilemma of enjoying a dry flight home or going for it. The excitement of a 26-year-old yacht designer trying his first major design was obviously stronger and I could not resist seeing this boat through a real blow.

The biggest danger was that we had to beat against the wind and needed a fair tide. We knew the Aldernay Race well enough to decide where to aim for the slowest current. Most of all, we had a very fast boat, so we decided to leave unusually early, against the tide, so that we were at slack tide entering the Race to hopefully avoid the breakers.

"We were fools but quite experienced, so we prepared the boat as well as possible. I checked the rig tune, all the shackles, pins, etc. Everything was correctly secured in and outside. The safety equipment was ready to be used."

Without an engine, the first achievement was getting out of the crowded harbour. I guess it was blowing Force 7 at the time and we cast off under storm jib and double-reefed main.

The first tack seemed okay, the mast seemed to be correctly tuned, and the boat felt good, well balanced and quite weatherly so we decided to carry on.

Once out of shelter, the wind picked up and we were soon down to storm jib and triple-reefed main. Waves started to become shorter when we reached Schöle Bank. There Christian's father asked me if we would soon be across the dreaded Race, I reluctantly had to inform him that we were not yet in it.

Once we reached our mid-point between Aldernay and the mainland, the tide turned in our favor and things started to change with a large line of breakers ahead. Night came, of course. I suggested to Christian's father that it would be wise for him to go inside but he did not feel like it, and it seemed difficult for me to give orders to a nice man double my age, who seemed to enjoy the experience!

Now the boatspeed combined with the 7 knots favorable current increased the apparent wind. Wind was further increased by La Hague Cliffs. We did not have any electronics on board, but suffice to say that we were largely over-canvassed and could not put anything smaller (La Hague weather station reported Force 9/10 ashore). We needed speed and power anyway to keep control of the boat.

The first advice is obviously not to leave harbor in these conditions.

If we decided to do it, this was because although *Red Magnum* was an ultralight racing boat for that time, she first of all was designed as an offshore boat with adequate stability, correct scantling, moderate beam, a cambered deck and open cockpit. She proved that she could recover from a capsize and is still happily sailing 20 years later. Her lightness came from her simple layout and efficient foam-sandwich construction with the best materials available at that time.

We had sailed this tricky part of the seas since our childhood and knew exactly where and when to attempt the passage in bad weather. We were quite experienced, knew each other well and had already encountered heavy weather in a variety of boats.

"Once in the Alderney Race, we were covered by 3 feet (0.9m) green water on the deck.

"We were knocked down, mast under horizontal, several times. On the first, Christian's father started to fly overboard. I just had the time to make full use of my long arms to grab him by his oilies. I grew old enough in a few seconds to order him to go inside immediately!

"Breaking waves were coming from all directions, pushing us on the other tack if it broke on the transom or off the wind if it broke on the bow.

"We fell from 20-foot (6m) waves into their troughs with amazing noise. I was so impressed that I mentally checked all my calculations! It was so scary that I went inside to check the structure. Thanks to AIREX foam-sandwich construction, everything looked fine, and Christian's father was quietly securing flying things!

"With such strength of current, there was not much we could do but cope with it and we came through unscathed. I learned a lot from this experience. Wind strength was not that strong; wave height was not that high; but if the distance between waves is equal to their height, this can be extremely dangerous for small boats. So beware of tidal streams!"

Apocalypse

I was asked to skipper an *Apocalypse*, a 43-foot (13m) production ULDB, in the 1988 Transat des Alizés. First leg started from La Baule towards Casablanca.

I knew the *Apocalypse very well*, but had never sailed with the crew before which did not bother me too much since she was originally designed for short-handed cruises.

The start was fine under spinnaker with little wind, and we lead the coastal course before turning out to sea. Wind strengthened the next day and we started glorious surfs with the big spinnaker up. We ran into wooden logs probably swept overboard from some cargo during the previous gale. We ended up by hitting one at 16 knots damaging the speedometer. (Thanks for the Kevlar sandwich hull!) At nightfall, we could not see them at all and decided to calm things down by changing the spinnaker for the heavy genoa. Since the wind still increased, we kept our pace and quickly needed the first reef.

Now that was fun! Superb ULDB conditions. Since I did not trust my crew, I had to hang to the tiller, enjoying myself tremendously. Wind still increased, sea built up, and I started to dream of a record crossing. I clipped my harness for a change. The crew had it on already for a long time.

The trick in these conditions with a light-displacement boat is to keep speed up, slightly faster than the waves, to have good steering control and have time to choose where to overtake the next wave. You should never run straight downwind but with an angle to have the ability to bear off to escape a gust or luff to keep speed up. This also gives the ability to choose where to overtake the next wave.

Too little speed means that you are caught up by the following wave, which tries to broach you; and with not enough relative water flow at the rudder, its efficiency is reduced.

Too much speed means that as you are going down the waves, you accelerate, then up the next one, you accelerate more, until you lose it, digging the bow into a wave. This is exactly what happened to us. I felt that we were doing too much and asked the crew to prepare another sail reduction when a big one pushed us forward like a bullet. I managed to cope with one wave, a second one then lost it and made a crash dive in the third, doing over 20 knots I guess, boat underwater until the mast, stopped, the wave caught us again then half pitchpoled us, half knocked us down, mast well beyond horizontal.

The boat recovered, and we quickly went down to staysail and double-reefed main to finish the night. I had been steering for over 12 hours and needed to give the tiller to somebody else. Only damage found was total loss of electricity. After fearing a battery problem during the capsize, it turned up that something flying across the boat from the galley had simply switched off the switchboard on the chart table on the opposite side! All navigation data was lost, and we were back to sextant on the morning in these pre-GPS days.

I made two mistakes in this adventure:

First, I only took the forecast for our Atlantic coast. If I had taken the Med forecast, a severe low in Lyon was obvious and I would have been aware of an increase and change of the wind funneling between Pyrenee and Massif Central Mountains while getting closer to the Spanish cost.

Second, since I did not have any experienced helmsman for these conditions, I was too busy sailing the boat fast to check my position. As it turned up, I chose the inshore tack which seemed at first logical. But steering to the waves and wind, I was unaware that we were slowly going inside Biscay with veering wind.This is always wrong. Waves become more difficult inshore and conditions after gibing along Spanish coast are not that good. The boats, who chose the offshore tack had much better conditions and avoided the Mediterranean influence.

Being capsized was not a real mistake. The beauty of these slim ULDBs is that you can push them as hard as you dare without getting more trouble than wet spreaders. Remember, we were racing and this was part of the game. I had gained enough knowledge of the type to be perfectly cool about it.

My belief is that a well-ballasted, light-displacement monohull is almost foolproof offshore provided she is not too wide to recover after a capsize. You can drive very fast, yet leave her taking care of you under autopilot.

"Biscay is famous for many losses among Breton tunaships in the good old days of fishing under sail. The westerly swell from the Atlantic ocean becomes shorter near the coast, and, being sandwiched between Spain and Brittany, we get frequent cross seas from a different direction from the wind.

"Crossing Biscay is not that bad in most conditions. You have sea room, no current. The problem lies in the fact that most do it on their way to catch the tradewinds, which means during North Atlantic autumn gale periods. It is not unusual to catch the end of an hurricane, finishing its life after crossing from the West Indies. Some of these boats are leaving Europe for a peaceful sunny crossing towards paradisiac islands and are quite unprepared for bad weather. What chance to get it during a three-day-crossing with nowadays forecast? Yet, every year, a few sailing boats are abandoned in Biscay."

Phil Steggall

Phil Steggall is a top hand offshore in multihulls. Unlike many of his brethren, however, Phil began sailing in monohulls, before "the need for speed" took him into the world of Grand Prix racing.

His resume includes 13 Southern Ocean Racing Circuits (in a row!), Admiral's Cups, Sardinia Cups, as well as passages in and around South America. He also has nine Transatlantics aboard multihulls under his belt—two of them single-handed.

He is currently Director of Technical Services for Johnson Industries Composite Reinforcements.

Heavy-Weather Experience

With so many trips across the Atlantic, you would expect Phil to have a pretty good inventory of heavy-weather experience under his belt:

"The danger of a situation always gets back to the sea conditions more than the wind. The sea is the overriding factor, not a particular windspeed. You can have the wind against the tide or current, and then it really gets nasty. Sometimes in the middle of the Atlantic, you'll have the Gulf Stream fighting the wind. Wave height and direction always dictate what you are going to do.

"And the most important thing is avoiding the dangerous situations in the first place."

In each of my Transatlantics there's been a fair degree of heavy weather. The first trip, we actually got stuck in a hurricane three days out. The second trip, I was on the 85-foot (26m) cat *Formula Tag*, and we were lying ahull in the Gulf of St. Lawrence in 50 knots of wind, with short confused seas and fast rollers. We eventually went on to break the clipper ship run for 24 hours—518 nautical miles!

Probably on a dozen occasions in total we were in serious, potentially dangerous weather. Usually blows pass through in six to 24 hours, but once or twice we've been stuck for several days.

Sebago

If you are making a landfall on the British Isles from the west, the odds are that you will cross Great Sole Bank at some point.

This is one of the most dangerous patches of water on the planet. You have the Atlantic Basin, typically 6,000 feet (1,800m), shoaling to a depth of a couple of hundred feet (60m) in very short order. There are tidal currents sweeping the area, and the weather can deteriorate rapidly. The Fastnet Race transits this area every year and occasionally the sea gets the better of the entrants (as in the 1979 Fastnet—see page 598).

A lot of boats have come to grief in this area over the years. If it looks like you and the weather are on a collision course, it's often better to heave to off soundings, in deep water, and wait for the weather to improve before venturing into the shallower waters.

Let's listen to what Phil has to say about two of his crossings off Great Sole Bank:

We had a situation in 1988, when we were sailing from Quebec to St. Malo in France. We had to go around Fastnet Rock, which meant transitioning from the Atlantic to Great Sole Bank. We were sailing on a 60-foot (18.4m) tri, *Sebago*, trying to outrun a depression that had been following us across (*Sebago* had a 60-foot/18.4m beam and weighed just 7,500 pounds/3,400kg).

The wind had been blowing 18 to 20 knots from the northwest, which meant that the low center was north of us. We were moni-

Phil Steggall

Sebago was radically light for her day, with limited-volume floats. She had a rotating wing mast—now standard, even on some Around Alone monohulls, but quite extraordinary for an ocean-going multihull in her day.

toring its progress carefully with our barometer and a weather routing service, and knew we had to average 350 miles a day to cross Great Sole Bank before the gale arrived.

Carrying spinnaker, and then main and jib, we were just able to maintain our pace.

Unfortunately, the low accelerated and crossed to the south of us, and then began to head northeast. This brought a shift in the wind direction to the east. You could sense that we were in for it, and in five hours the breeze built from 25 to 40 knots—just as we were crossing onto Great Sole Bank.

This set up a very difficult cross-sea condition. We had primary wind waves coming from the east, secondary swell from the northwest, and the boat was getting hammered from both directions. We were hard on the wind, carrying triple-reefed main and number-4 jib (about 65 percent of the forward triangle), doing eight to ten knots. Occasionally, we'd be completely airborne—a common occurrence in this type of condition for *Sebago*.

We'd been going like this for a few hours—becoming airborne periodically. The boat slammed against the daggerboard as she dropped, taking the full sideways impact on the board. Then there was a cracking, grinding sound that only comes from carbon grinding on carbon as the board failed. The daggerboard housing

"It sounds like we were pushing too hard, but with these wide trimarans you have a problem if you back off. If you don't keep going the heel drops, and the windward ama takes a hammering from the seas—so you have to keep moving at speed."

lifted through the main hull, splitting it.

My first consideration was the safety of the crew in the deteriorating weather conditions—it was forecast to go to Force 10 within a few hours. We got on the SSB and VHF radios and requested assistance from any nearby vessels. An oceangoing tug came back right away.

Transfer to a Tug

The tug, a 300-footer (90m) was on the scene shortly after. They launched an inflatable to pick us up. The transfer from the inflatable up the side of the tug wasn't too bad, but the conditions were deteriorating by the minute. We took *Sebago* under tow, with a hawser attached to the cockpit winches—but within 20 minutes the towline had parted. In the process of trying to reattach the line we nearly lost two of our crew—conditions were by then too rough and we abandoned the boat.

Within a short period, it was blowing 60 to 70 knots and the seas were some of the biggest I have ever seen. That is just a lethal patch of ocean!

Bonafacio

The Great Sole Bank also happens to be where we got into trouble in 1981. We were sailing in the double-handed Transatlantic, aboard the 45-foot (13.8m) trimaran *Bonafacio*. This was a 30-foot-wide (9.2m) Dick Newick design.

We were actually hard on the wind, beating in 35 to 40 knots of breeze, with our storm sails up. The breeze had started to drop, and we were in a very strange sea pattern.

All of a sudden a big rolling sea on the beam caught us and we flipped. It came from the side, not from the prevailing sea direction.

In hindsight, my crew, the designer, and I all felt we'd have been better off if we'd been going faster. We were down to 6 to 7 knots at the time, and had we been doing 10, there would have been more buoyancy in the leeward ama (outer hull) and we'd have had better steering control.

I was inside when the boat went over. My crew was outside in the cockpit, and he dove through the companionway after the boat inverted. I remember worrying about him being encumbered by all the ropes in the cockpit area.

We had an immediate problem with the batteries. They dumped acid into the seawater, making a toxic gas. We had an emergency hatch in the "wing deck". This was made from plywood, with wing nuts on either side, so you could operate it from inside or outside of the boat.

The boat floated amazingly high—we had less than 18 inches (0.45m) of water inside (everyone is always surprised at how high these boats float when capsized). We had a "calamity" kit containing our handheld radio, food, flares, first aid supplies, money, and our passports. Having all of this in one place

Hindsight:

"If we had been aboard when it was blowing really hard I don't think we would have stopped to lie ahull. I suspect with *Sebago* we'd have tried the parachute anchor tied off the bow, although I've never actually used one before.

"We'd have had to use 300 to 400 feet (90 to 120m) of line to absorb wave shock.

"These boats have a lot of windage relative to their displacement—*Sebago* had a 72-foot (22m) wingmast, which had a maximum width of 4 feet (1.2m), so she had a lot of sail area when under bare poles.

"The other alternative would have been to keep the boat moving upwind or on a close reach, in which case it is easier to keep the boat from going too fast. Off the wind, we'd have had to use some form of adjustable drogue to moderate our speed, keeping us from surfing off too fast.

"If we had not been racing, we'd have waited offshore in deeper water until the blow had moderated, before closing with shallow water and approaching shore."

saves valuable time which otherwise would have been spent looking for these items—we knew right where they were.

We had a raft, but did not consider using it. My philosophy is that the boat is a much safer place to be—and you should only step up into the raft.

We set off our EPIRB and 11 hours later were sighted by a Royal Air Force plane. The plane flew over us several times, and we fired off flares to be sure they saw us.

The plane then diverted a merchant ship towards us, but in the leftover sea the ship could never slow down enough for us to get across. The ship eventually got to weather of us and drifted down. In the process they slammed into our weather ama, breaking it off. We were now in danger of capsizing so we got into the life raft.

The plane then diverted a navy ship with a helicopter, which picked us up without further incident.

The transfer to the helicopter was no big deal. We had on our survival suits, which protected us from the lifting lines, and a safety swimmer winched down from the chopper to assist us.

Heavy-Weather Philosophy

With so much direct heavy-weather experience, and several unhappy endings, Phil's approach to storm tactics is of interest:

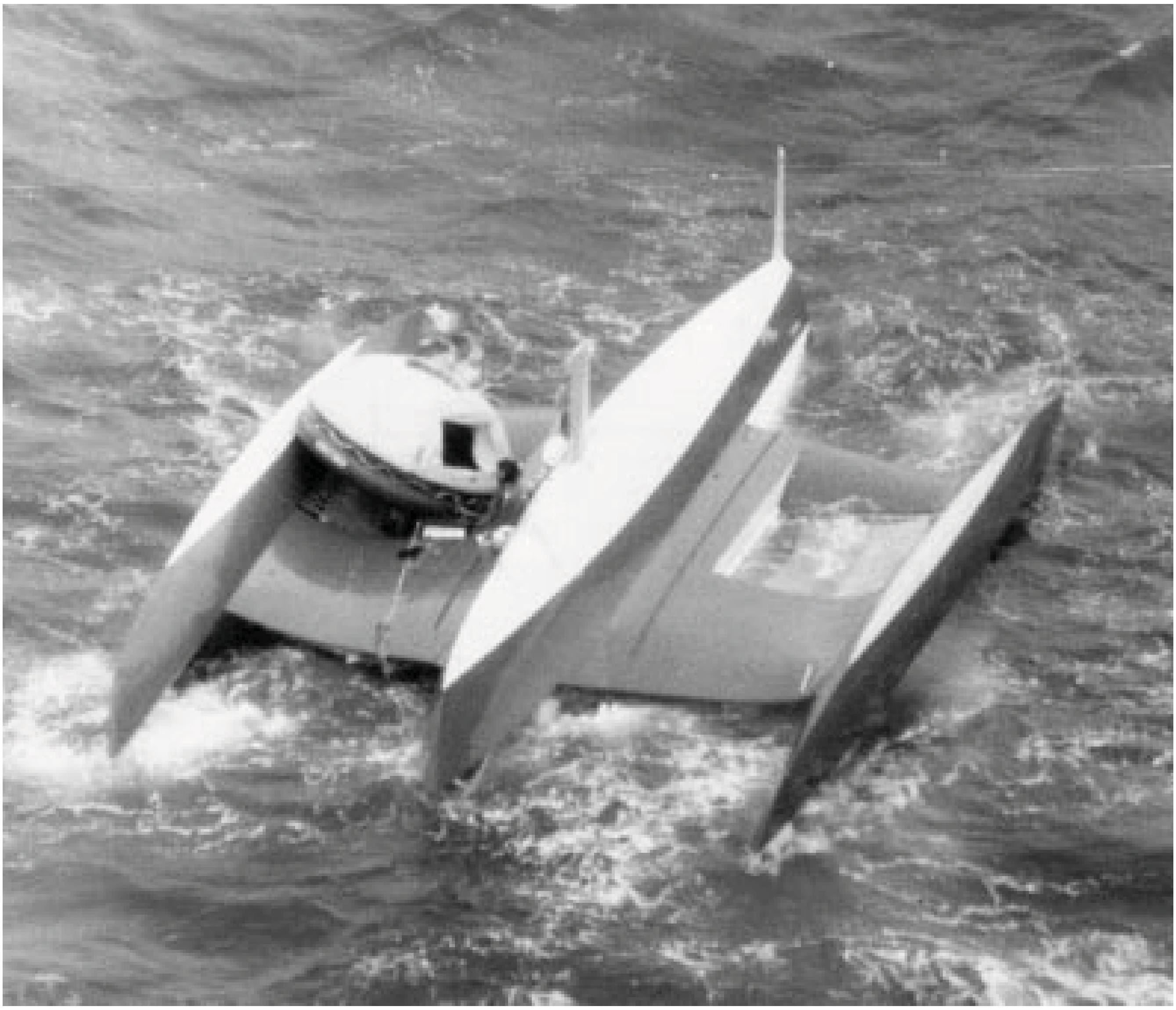
I use a rule of thumb for racing and for heavy-weather avoidance: if you're in a storm and trying to get out (or avoid it), keep the boat moving as fast as possible, even when you don't feel like it. Pay attention to sail trim and how the boat is behaving. If you are on the wind, you may have to slow down so you don't fly off the wave faces, but off the wind you can keep the speed up. This is the best thing about a fast multihull—you have the speed to stay out of trouble if you keep pushing, but you must know the exit strategy—where the exit door to the situation is located.

With a good pilot to do the driving, you can monitor the wind direction, speed, and sea state, so you can figure out where you are in relation to the low. These are the important things. If you think you can get clear of the low by running off fast and there is sea room, then that is usually the best thing to do.

But the key thing is not to run out of water. People do well in the middle of the ocean. It's near land where the big problems occur. If you are out in bad conditions, do not try to run for shelter unless you know absolutely that staying out with the forecast is more dangerous than running for shore. The margin for error becomes very small, when you are closing with a lee shore in unfamiliar waters and poor visibility.

And what about the catamaran versus trimaran debate?

Cats may be more stable in heavy going or in ultimate survival situations—although if I had to beat off a lee shore, give me a tri.



Phil Steggall

The photo above of Bonafacio will generate a lot of debate in the multihull vs. monohull arguments. You could argue it is proof multihulls are unsafe offshore. On the other hand you could say it provides proof that they are safe, because they don't sink.

Note the liferaft on the underside of the (now upturned) wing. The raft would be washed off, if there were a big sea running.

Approach with Production Multihulls

Phil agrees with the other professionals who deal with multihulls offshore; if you are caught in heavy weather, you want a boat that is sailing on its lines and not overloaded, with plenty of buoyancy in the hulls and good wing clearance.

But what if you are caught in a blow in an overloaded boat, that is, perhaps, too small for the situation?

If you have sea room and are not headed into shallow water, then running off is probably the best bet. You need to control speed somehow, to keep from surfing. Towing warps or a small parachute drogue, which keeps you at 7 to 8 knots is probably the way to go.

Biggest Lesson

The biggest lesson in all of this was going out to search for *Sebago*. You just could not spot anything if there was any shadow or cloud coverage. We searched one area several times and spotted a large container ship we just didn't see the first time over the area. Upturned boats only get found by the use of electronics (EPIRBs), not spotted with the naked eye.

Rocka Romcke

Rocka Romcke is a professional skipper who has passaged in all sorts of boats from turn-of-the-century schooners to the most modern of mega yachts. He is currently overseeing the design and construction a new 140-foot (43m) Frers design.

Rocka has crossed the Atlantic five times, the Pacific and Indian Oceans twice, as well as numerous trips in other directions. Yet when he looks back on his sea time, over 150,000 sea miles, he finds no really dangerous weather, just the occasional gale or storm here and there. If the conditions are not optimal for the passage, he waits until the odds improve.

As we were discussing the issues of heavy weather and tactics he started to tell us stories about the schooner *Vagrant*, which he had sailed over 40,000 miles for several different owners over the years.

Vagrant was the first yacht built for Harold Vanderbilt in 1910. She is a Herreshoff design, 106 feet (33m) long overall, 78 feet (24m) on deck, with a 56-foot (17m) waterline and a beam of 18 feet (5.5m). She carries 5,000 square feet of sail area. We used to race against her in the 1950s when she was called Queen Mab, and she had the reputation then of being wickedly fast in light airs.

Vagrant

I skippered *Vagrant* for 3 1/2 years. I then went back to her 2 years later for 6 months when she was sold to the Japanese. This involved getting her fit for sea and delivering her to Japan. She had been let go a bit and maintenance was a dismal minimum. But she just needed two months and $50,000, and she was fine. I picked her up in Falmouth, UK. Here we did a lot of work in the water and on the rig. Then we went to Camper & Nicholsons to do a planking check. She always needed a plank or two every year. We put in eleven. We also added a diesel emergency pump, all plumbed in just in case as it was her 80th birthday. Added heaps of thick varnish, not to our usual standard, though, just lots of it. We then did a crew's cruise back to Falmouth as I had three Japanese to train.

"We had five permanent crew. On major deliveries (and this one) we went to eight. This gave us four watches of two and lots of scope to double up if things got bad. On this trip, we had five of us and three Japanese trainees."

Left the UK about June 3, 1992. Getting into hurricane season but never saw any. I was getting weather routing radio telexed into me every 3 days or when they saw a nasty blow. I used to give position, speed, and course to them daily. Headed south on a beam reach at 9 knots across the Bay of Biscay, but had to pull into La Caruna with steering trouble. One bad weather day. Lashed on the emergency tiller to do it. Then Canaries and wait for more steering parts. Then across the pond to Antigua. Two bad weather days. Antigua to Panama a dream trip. Panama Canal crashed into dock wall. Thought the bowsprit was going to snap off, but bounced off instead. The plonker pilot released the bow lines before the ship in front had stopped turning his prop and giving us surf. Pilot gave me instructions to go full ahead and full astern, etc. He couldn't understand why I wouldn't do as he said. Fueled up in Balboa and the 1,000-mile motor in light headwinds to Galapagos. All as planned. Had to buy diesel on the quiet, but the harbour master offered it to me at $3 per gallon. I thought it was legit. Dumb me. After hours of delays, a patrol boat came in past dark and started pumping fuel out of her tanks into 55-gallon drums in a dingy. The pump leaked about 3 gallons per drum. Then they overloaded the dinghy and sank it. I went off in my dinghy lassoing the drums that were shut. We filled up by 0100 and left before dawn just in case they tried to blame us for the beautiful environmental Galapagos being ruined. It was a very sad scene indeed.

Rocka's comments on modern megayachts in heavy weather:

"They are big and docile—even the fast ones—due to their weight. I have been surfing down 40-foot (12m) waves in the Indian Ocean off Somalia sitting having a coffee while on autopilot.

"The time table is another thing. We are big and safe and have to make deadlines. If it's blowing a gale and dead on the nose, then we will go anyway. Only if safety is jeopardized, will I not go. That has only happened about three times in over 150,000 miles.

"We power when the wind is on the nose. We just have to go slower and longer and get there. It is heaps quicker than waiting or reaching off for somewhere else."

Towards Christmas Island

We then had 4,065 miles to Christmas Island. Because of three weeks of generator fuel needed we had only about 800 miles of motoring fuel. So the plan was go west on about 2 or 3 degrees North latitude. If wind not around, duck south to Marquesas. West we went, 8.7-knot average, 19 1/2 days later Christmas was sighted. Another dream trip. Since this was August we were hurricane-watching. Our weatherfax was slim so still relying on the route following. At one stage we had Hurricane Iniki tucked up behind us which clobbered Hawaii. We just sailed right between them all. More luck I think as we are not a boat to outrun much, and we were rhumblining it. We stayed in Christmas for a week.

After Iniki kicked Hawaii the seas were a bit confused out there. We had only 40- to 50-knot winds but the most uncomfortable seas I have seen, or felt.

The whole boat was shuddering on these choppy seas. They were only about 20 feet 6.1m). It was the confusion that was amazing. I don't have charts with me but the wind was about 40 apparent angle off the starboard, and we were right on course from Christmas to Wake. The seas were not corresponding to the wind very well and there were two swell patterns. Very short for such an open ocean. The old slack-type rig was just flexing like crazy.

I was worried due to her light construction and age. She was built as a day race boat, long leaf yellow pine planked onto steel frames. She was very flexible. I think this flexibility gave her strength. We did some motorsailing, but this didn't help much. *Vagrant* was great when you got her storm kit up (staysail, foremain and trysail). If things got heavier, we just reduced the fore to a reef and then another and then none. Never got to that though. In this configuration we would get 7 knots at 35 degrees apparent wind angle and so well balanced that we would not need to steer or use the autopilot. But this sea we could do nothing at all. Just hang on and beat ourselves up. We reached off for four hours and got the same beating and went the wrong way, so we just kept going into it.

Rocka Romcke

At about 0430, I was tucked up in bed in the aft cabin. We heard a bang and I was on deck in three seconds. The starboard runner broke.

This is a major problem as being a gaffer with a huge overhanging boom of 50 feet (15m) (our waterline was 56 feet/17m). There were no backstays, only runners, two main and two topmast. Normally if this happens, as it had done once before, you just crank on the mainsheet, which acts as a runner transferring an aft pull up the sheet and up the leach and up the peak halyard. But as we had the trysail it gave very little support. We should have had both runners on. We could have, as the boom was in the crutch anyway. I came on deck and saw the mainmast bending forward like a palm tree in a hurricane. The mast was just so strong it flexed and held on till we got the lee runner on. Very lucky indeed. Well done, Harry Spencer at Spencer Rigging at Cowes.

The stainless steel wire splice broke on the turn. It was put down to stainless steel metal fatigue. This is worse than most people realize. Stainless steel has its place, but not where it has high load and small movement. It was five years old.

Wake Island

We were bound for Wake Island, a US Air Force base, and had been calling, telexing, and writing to them for three months for permission to stop there. So we did what the *Admiralty* pilot says and just called on VHF at three miles out. We did have a valid reason as we were low on fuel and had broken rigging. We were welcomed very nicely. Wake had eight US Air Force personnel and 200 civilians as caretakers. They all welcomed the change of scenery. We bought food, wire, fuel, and ice cream. The fuel was JP5.

This is a high-grade aviation diesel, more like kerosene. It would burn valves and do damage if we pushed our 195-horsepower V8 Commins, but as we were on passage on 50 percent power setting we had no trouble. We stayed there 12 hours. Shame, as we were welcomed so well, offered hotel rooms and all. A very historic place as it was the Clipper Flying boat base for refueling, and where the Japs and Yanks swapped possession a few times.

"We lost one guy off the bowsprit at dusk but picked him up again in five minutes. For an old schooner that was amazing. Lesson learned was: check safety gear. We had it all, but it had been sitting on deck too long and we had to cut away the releases into three parts, Dan buoy, lifebuoy and light.

"The crewman swam around and picked up the bits for us for when we fished him out.

"In 1987, I was Mate on *Shenandoah* (160-foot/49m three-masted gaffer). We were running down the African coast from Gib to Canaries, and I had them on the bowsprit taking in a jib and it ducked under water. When she came up the two crew were gone. *Shenandoah* plowed into the next wave and went right under again and came back up with the crew back on again laughing their heads off. Fear wasn't an issue as they didn't know better."

The Japs made the captured Yanks build the base and then murdered them on the beach. There is a memorial there. Quite moving as the base was full of Yanks, and we had three Japanese onboard.

"We did the Pacific and saw no ships from two days out of Panama to three days into Osaka. This included none on our 48-mile radar. Amazing. My record of contacts on a radar was 45 through Gibraltar Straits. Off Osaka this record was up to 175. Talk about confusing. I got no sleep for two days."

So we left on the last leg Osaka-bound. This trip was uneventful, motorsailed more than half the way.

Heavy-Weather Tactics

We never hove to using sails with *Vagrant*, only once off Hatteras with no sail on at all. Just hang on and save the chafe. In the really bad weather it was always on the nose. We found when it hit we would put the apparent wind on the beam to sort things out, then let her have her head and sail slowly upwind. As I said she sailed magnificently this way, perfectly balanced and no one on the helm, and the helm not locked at all. It just seemed to give and move on every wave. With this setup we had the staysail, and the trysail up, then varying sizes of fore main depending on the wind and sea. We used to just huddle in the doghouse and duck our heads out between waves.

I would be worried a bit to head off downhill in a hurricane as she had so much windage under bare poles and was no surfer. We have plowed the bow a few times on rough day sails but came up fine, but never in a real blow and large surfing swells. In the Bahamas once in a 6-foot (2m) sea we ran dead square, bare poles, and averaged 6 knots. That was in 40 knots true wind.

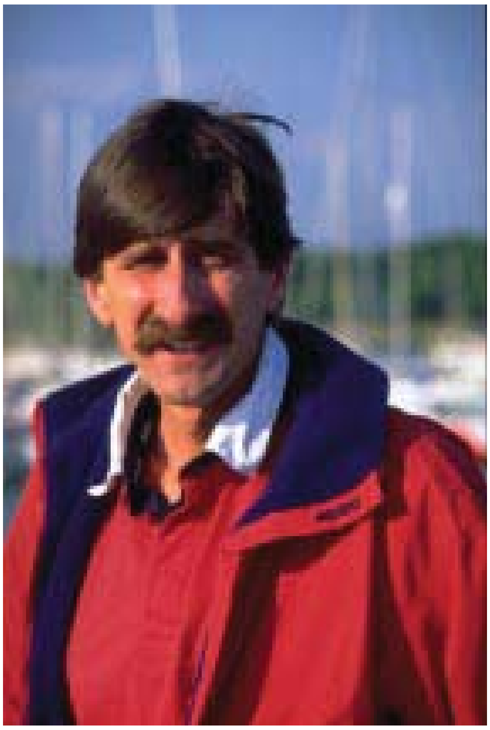
I have just remembered another trip where we got smashed up a bit. We were heading from Ft. Lauderdale to France in June, 1990.

"I put our cook on the helm. She was a good schooner girl. I said just keep the wind 50 degrees off the port bow. This she did but the wind changed slowly so round she went. Six hours later when we were ready to keep sailing I plotted a position and found us back just 18 miles southeast of Hatteras. So changed tacks and went to bed."

We did a fuel stop in Wrightsville Beach, then planned to go to the Azores. The weatherfax report was for a lovely night. So off we went, a fantastic night sail beam reaching out of Hatteras. Then, Wow. Twenty hours later we got kicked badly. I learned firsthand what Hatteras can get like. Will have more respect for her next time. It was six hours frantically changing sail and battening down the hatches. *Vagrant* leaked heaps, which was normal. But changing sails in the dark on an 80-year-old gaffer was all hands and dangerous. The wind just slowly increased. No sooner did we change the kit, when it was time to change again. The wind just kept ahead of us so we were maxed out all the time. We were pushing heaps of water across the deck. Three days later the storm had gone and come back again in full force. It changed direction and the seas got very confused. It then eased off completely to no wind at all. We had to take all sail down, we tried to set a few, but the chafe was too bad. The seas did not abate at all. We tried to motor at a low fuel rate which would normally get us 6.8 knots and we got 2.5 and the sprit dipping underwater every wave. We were also putting the rail under both sides as well. The chop was totally non-directional. So we just stopped, reduced watches to one man and went to bed for 24 hours. We kept a radar watch that was no use as the sea clutter was amazing. Anyway, after a day it dropped down, and the rest of the trip was easy.

Skip Novak

Skip Novak is another professional who drives all sorts of boats. He has done four Whitbread Races, co-skippers the maxi cat *Commodore Explorer*, and does deliveries all over the world. When he's not sailing boats for others, you will find him aboard his own 54-foot (16.6 m) sloop, *Pelagic*, taking adventurous folks from the Cape Horn area to Antarctica, the Falkland Islands, and the New Georgia Group for sightseeing and perhaps a little mountain-climbing. Skip stopped counting the sea miles many years ago when his personal odometer registered 300,000.



Given his propensity to sail in the high latitudes where the frequency of storm-strength and above winds are more common, you would think that Skip has a lot of heavy-weather stories to talk about. We asked him how many days of dangerous weather he'd seen. His answer:

How many days is hard to say. But it is not that many if you consider all the bad weather I've been in the North Atlantic over the years, plus the accumulative time spent in the Southern Ocean, not only on Whitbreads, but also for the last 10 years on *Pelagic* where we are habitually in 30-knot conditions and up, often in 40 and up, and every now and again 50 plus. But actual days of dangerous conditions—not many.

Heavy Weather Philosophy

I think in any bad sea conditions the basic principle is to slow the boat down as much as possible. If racing, more factors come into the equation, but in cruising or passagemaking there is no reason to force the route. However, if you are in a prevailing wind situation (like going against the trades), and it is necessary to keep plugging away, then that is the game. If you are in a variable wind area (say the northern portion of the North Atlantic), there is only one solution for ultimate safety and that is to heave to—stop the boat—and wait for a change in the wind, which will usually come in 12 to 20 hours. We often heave to on *Pelagic* when we get headwinds in the Drake Passage on the way to the Antarctic. There is no point in beating up the boat and the people, just to gain a handful of miles over what will be a relatively long period of time. Of course, heaving to requires that you know the characteristics of your boat when hove to, as some go better than others. This is best experimented with in 25 to 30 knots of wind. Try different combinations of storm sails, backed or otherwise, playing with the position of the main boom and different rudder angles in order to get a comfortable ride.

I have been in so many "storms" that it all runs together a bit. And the fact that (so far) I have never felt threatened by weather really doesn't lend itself to recounting the ultimate storm. The only time I really had a fright was in 10 knots of wind when we were sucked into a tidal race off Staten Island in

"The only tactic that might be dodgy and I might not want to use is streaming warps, as the pull on anything you put over the side in hard running conditions has the potential to destroy gear and injure the crew. you have to be meticulous in paying out the warps and then making sure you have them secured to winches, so you can retrieve them—or have the ability to safely cut them away. If it is the only option then there you go—but I have never personally streamed warps for safety.

"I have never used drogues or parachutes either."

Sometimes the heavy weather you find is in a protected anchorage, in which case a different set of seamanship skills are required. This is about as protected as you can get, but check out the spume being lifted off the water behind Pelagic. It is blowing an easy 60 to 70 knots. She has a line ashore and three anchors on the sea bottom. All in a day's work when anchoring in this part of the world.

Tierra del Fuego. We were trying to pass inside this race, but were quickly shunted right into the breaking seas. I managed to turn the boat around and motor out of it against the current, all the time with these steep to breakers (which seemed as high as the first spreader) just kissing our stern. It took an hour to break free, and as the crew said, my eyes were out on stalks while I was on the wheel. I guess the message here is that the sea is the real problem. High winds mean little in flat water, but when walls of water are met, boats and men tend to crumble.

Cruising Multihulls

I think modern cruising multihulls are generally very fit to cruise offshore. Of course, there are some horrendous examples around, but the trend for large cats is increasing and when you cruise them in tropical waters the benefits are obvious in terms of speed, easy handling, and shallow draft. I would hold no disadvantage over multis with monos except the possibility of getting caught out in tropical storm conditions. I think that if you got your tactics wrong, or were overtaken by a tropical storm or a hurricane, a mono with some ballast would pay divi-

Skip Novak

dends. On the other hand, if you know in which direction to run, the multi can run away that much quicker. When sailing *Explorer* in the Pacific that was my one big worry—getting caught in a typhoon in the Western Pacific, with a boat that had a wing mast with 30 square meters of area!

I think we will see more and more multihulls cruising the tropical oceans—they sail flat, are fast, have little draft, and offer comfortable and spacious living conditions compared to a mono of the same length.

To answer your question about days at risk; at a guess I would say maybe 10 to 20 days, where I have felt threatened and in possible danger—but that still does not imply that I was afraid of the situation. When I say at risk or threatened I can say I always felt in control of the situation. Maybe there was momentary fright like knockdowns and big waves coming aboard, but that panic never lasted beyond the moment.

Granted, the photo above is not about heavy weather, but it is so spectacular we thought it would help to remind everyone that often there are wonderful discoveries to be had at the end of a difficult voyage. In fact, sometimes it seems that the more challenging the voyage, the better it seems once the hook is down.

Steve Lloyd

We first met Steve Lloyd while anchored at Malalolailai in Fiji. Steve is a professional seaman with hundreds of thousands of miles on all sorts of vessels, from huge commercial ships where he spent 12 years in the merchant marine, to the last six years (in mega yachts). His current berth is aboard the 180-foot (55 m) *Itasca* as Chief Engineer. As such he has seen every sort of weather one can imagine, and probably some that we cannot.

His perspective on both offshore power-yacht design and heavy-weather tactics is fascinating. We'll let Steve take it from here:

Design issues:

"Almost all motor yachts would not recover from a severe knockdown or capsize situation. One aspect of motor-yacht design these days is the shallow draft and high air draft of the vessels. The heavy nature of outfitting high up in the accommodation (marble bathrooms etc.) can adversely affect the stability of the vessel, as can the positioning of the tenders and toys.

"Faster vessels rely on planing or semi-planing hulls and are more susceptible to the adverse effects of heavy seas. In an attempt to increase the interior volume of certain vessels, the bow has been given a huge flare and wide foredeck, which increases the vessel's tendency to pitch in a head sea. This in itself is not dangerous, but it does increase the discomfort of the ride."

Tactics

In most cases, the only way to reduce the chances of capsizing or being knocked down is to keep an eye on the weather patterns and plan the voyage accordingly. This obviously will not eliminate the risk of encountering bad weather; and in the event that you do meet heavy seas, it is best to alter course to allow the vessel to ride out the storm with a lesser chance of broaching or being swamped.

The type of vessel will also influence the course of action taken in a storm. A faster vessel close to a refuge can afford to run with the seas with enough speed to prevent being overtaken by the swell. My experience on a large waterjet-powered catamaran, however, proved this to be the wrong course of action for this particular vessel. There was a pronounced tendency for her to pivot about the bow in a following sea, forcing violent course corrections to prevent the vessel from broaching. In a very severe storm, this vessel would not be able to run with the sea.

Most vessels I have been involved with would bear off as much as possible to improve the comfort of the ride and make for sheltered waters. If this is not an option, the speed is reduced and the storm is taken dead on the bow.

All the motor yachts I have worked with have had storm shutters fitted to exposed windows on the weather deck, and in some instances to the doors as well. This reduces the risk of a broken window and the ingress of water, which could damage the vessel's stability.

We asked Steven what he thought about parachute anchors and drogues:

I personally do not know of a large motor yacht that uses a parachute anchor in heavy weather. I guess this would be due to the size of drogue required to have any serious effect.

There is, however, one motor yacht (approximately 200 feet/61m long) I know of that had two drums of heavy rope fitted into the stern lazaret. These were used in earnest when the vessel was caught in a severe storm crossing the North Atlantic. She sustained some damage running into the storm before turning and streaming both ropes. According to one crewmember, the ropes created the drag necessary to prevent the vessel from broaching in the following sea.

When It Really Gets Bad

Maintaining station heading up to the sea is usually the tactic when there is very little else one can do. An easier, more comfortable ride is achieved by running at a slight angle, but if the seas become so severe as to start to knock the bow around, then the vessel has to head up into the oncoming wave.

My own worst experience occurred during a crossing of the North Pacific on a 40,000-ton bulk carrier. The vessel had left Japan and was heading north of the Aleutians in the teeth of a gale. At first we were running at an angle to the oncoming waves in an effort to keep the vessel's speed up and also to reduce the pounding. We reached a point where we had to turn head on into the storm in order to avoid Russian waters.

Two days later, after the storm had intensified, we were hit by one enormous wave bow-on, causing the ship to bear away. Unfortunately the following wave was just as large, caught the bow at an angle, and threw the entire ship sideways. The recorded roll to port was 54 degrees, the roll to starboard 46 degrees. There was considerable damage to the engine room, where spare pumps and motors bolted to welded brackets on the deck broke free, all the spares in the store fell to the deck (they had been stored in the same way for six years), and the main engine tripped on overspeed as the prop left the water. The engine room was constantly manned at this stage, so we were able to deal with this quickly and had the vessel under power within 15 seconds, but it was a very scary moment!

During the rest of the voyage the storm seemed to stay with us, and we had two days battering into the sea at our maximum revs, making only 50 miles per day. Trying to navigate the Unimac Pass proved to be our last ordeal, as the extra current was pushing us backwards, and we could not alter course for fear of broaching. In the end we were able to shear off enough to lose the grip of the current and batter our way through.

During that two-week voyage we received two Maydays, one from a vessel 150 miles behind us. We were unable to turn around and go to their aid as we would for sure have foundered. The second call was from a ship 75 miles ahead, and it took us over a day to get to their position. They were lucky and were aided by a Navy tug.

Another instance would be on the catamaran, leaving Auckland bound for Tahiti. The weather conditions were too bad to make for Rarotonga, so a course was plotted for Tonga. The vessel was taking a sea quartering on the bow, which was the most comfortable position for this particular vessel, the speed having been reduced to about 11 to 12 knots. It appeared that the weather had improved, so an attempt was made to make for Rarotonga again, but this proved to be a bad move. The catamaran was not good at taking larger seas, as the waves were prone to hitting the underside of the "tunnel," causing a brutal slamming effect that shook the entire vessel. We turned back towards Tonga and had a beam sea. The violent and quick motion caused by the two hulls moving opposite to each other (one goes up as the other falls into a trough) was almost as bad. This was not a severe storm, but enough to cause problems whichever way that particular vessel chose to ride it out.

"Most motor yachts do not have the speed to run with large breaking waves, and as a result also run the risk of broaching just below the crest of the wave. This is definitely not the preferred method of handling very severe seas.

"When running before a large breaking sea there is the added risk of being pooped. My own experience is that if a vessel has to run with a large severe sea, it is better to run square on as there is more time available to correct the course if the stern gets caught and starts to come around."

"There is always the dilemma of whether the vessel will survive the turn to run in the other direction. Smaller motor yachts may have the speed to enable them to complete the turn between crests, but I would seriously doubt that most larger yachts would be able to achieve this, risking a broadside hit and the damage that this could bring."

Gino Morrelli

Gino Morrelli is a another multihull designer who has some real world offshore experience to offer. He has sailed four races to Hawaii and across the Atlantic, with numerous other offshore races and passages under his belt.

Gino sold his first commercial design in 1978. Since then more than 60 of his racing and cruising designs have taken to the water, including what has to be the most spectacular sailing vessel ever—the 105-foot (32m) *Playstation*—a fully powered-up racing cat designed to break every sailing record on the books.

Gino and his partner Pete Melvin run Morrelli & Melvin Design and Engineering from their office in Newport Beach, California.

In both of Gino's stories you have experienced sailors actively steering to keep themselves out of trouble. But what happens if it's just a couple doing the sailing, or if the crew does not have the experience to match the conditions?

Gino's suggestion is "to set the autopilot on a course that maintains the correct angle to the seas, tow warps, and then monitor the situation carefully."

And he makes several important points: "Be sure to use a compass course and not a wind angle, as apparent wind will fluctuate wildly while surfing.

"Monitor the wind and sea state carefully, and adjust compass course as required, keeping the true wind and sea angles at 135 to 140 degrees.

"The optimum angle will vary with boat type. As the boat becomes heavier, and the tendency towards rapid acceleration is reduced, a deeper angle can be steered."

Delivery to Hawaii

Gino had signed on with some friends to help deliver a 40-foot (12.2m) Vince Bertelone-designed catamaran, *Deja Vu*, from California to Hawaii. Vince's designs looked very much like the CSK cats of many years ago, with relatively narrow beams, long overhangs, and skinny hulls—and were, by today's standards, somewhat tender.

They departed Los Angeles on October 31, (Halloween) 1980, sailing essentially a rhumbline course for the islands. We'll let Gino pick up the narrative:

We left with a moderate sailing breeze, and had a reasonable run for the first two days and nights. On the third day we started to get into the center of the high and began to motor.

By the end of the fourth day, we had the breeze back and were sailing along in freshening tradewinds,12 to 14 knots, with full main and spinnaker.

During the day on November 4, the breeze started to build. We took down the chute, and then progressively reefed down the main.

By dusk we were down to double-reefed main and no headsail. The breeze continued to build until it was blowing in the 40s, and by 2000 we were running under bare poles. It was pitch black, and you could not see a thing. We would hear, rather than see, the waves as they approached. We were surfing at something like 20 knots, heading down the wave faces, and unable to tell what was at the bottom of the wave.

At 2300 we decided to stream some warps. We made a bight out of 300 feet(90m) of anchor line, then added a second bight from two halyards (240 feet/73m) weighed down with 40 feet (13m) of chain. We made a third bight of additional line.

When we'd take off on a surf, as the wave lifted the sterns, the boat end of the drogues would be lifted clear of the water and begin to skip or plane on top of the seas behind us—and we'd be flying down the wave at 20 knots again.

We finally found that by heading up on the breaking seas, to where the waves were at an angle of 135 degrees, we could slow the boat down enough to control the speed.

On this heading we'd be doing 7 or 8 knots—fast enough for good steering control. Then, after the wave had passed, we'd go back to a heading of around 170 degrees to the true wind and waves. When we'd hear, or feel, a big wave coming we'd head her back up to the 135 degree true wind angle.

We went on this way from midnight until daybreak and then the wind started to back off. We continued set up this way until noon to give everyone a chance to relax, and then resumed sailing.

In a more modern, powerful cat this blow would probably not rate more than a raised eyebrow at the yacht club bar. But back in the early 1980s, it was serious weather for this type of design. You can be sure that the guys onboard were being very careful not make a mistake.

The technique they adopted is similar to that described in the heavy-weather multihull section (page 393)—taking the seas on the diagonal, so they were not flying uncontrollably into the abyss, while maintaining maximum stability relative to the waves.

A few years later we find Gino aboard a 60-foot (18.4) racing cat of his design. Region Picardy was one of the first times the French had gone outside their borders for a race boat design, and this 36- foot (11m) wide, 10,000-pound (4,500kg) cat was not only powerful but fast.

La Baule-Dakar Race

The day of the race it was blowing 65 knots, way too hard to even get the boats out of the harbor, so they delayed the start. The next day the wind was down to 40 knots out of the southwest, dropping and swinging to the northwest.

As soon as the breeze was far enough behind us, we had the chute up on *Region Picardy* and were charging along across the Bay of Biscay.

About the time we were off the Azores, we hit something metal—it may have been a container but I'm not sure—and crushed the bow back 2 1/2 feet (0.75m). There was a crash box of course, so the hull stayed watertight, but we had to slow way down.

We limped into Sao Miguel in the Azores and did a quick fix. Within 10 hours, we were back sailing.

Between the Azores and Cape Verde Islands the breeze began to build quickly from the northeast as we broad reached South on port jibe in 25 knots of wind.

During the day the wind built up to the 45- to 50-knot range with breaking seas—and we shortened sail accordingly until we were down to triple-reefed mainsail, dragging a series of warps over the stern.

We had the warps set up so we could adjust them to help optimize our speed. The wind was not the problem; it was the seas we worried about.

Of course this was taking place at night, and you could not see the breaking waves. You could hear and feel them, and we adopted the same tactic as before, taking the biggest seas on the diagonal at 135 to 140 degrees, so we were slowed down to 16 or 17 knots and not surfing wildly down the wave face. (If we let the boat have her head she'd be doing 30 plus knots, headed down the trough.)

By morning the breeze was down and we were back to sailing at full speed.

Was this a conservative approach to storm tactics?

"We were racing, and so was everyone else. We were probably less than prudent, because we didn't want to give up any more distance than necessary. The boat felt very comfortable at the 16- to 17-knot speed. But this approach did take careful helming."

John Neal

John and Amanda take their students offshore to show them how things work in the real world. Their teaching cruises typically cover areas where others rarely go—like back and forth between Cape Horn (shown in the background of the photo above) and Antarctica, or an annual run between New Zealand and the Austral Islands south of Tahiti.

John & Amanda Neal

John and Amanda Neal may be the most experienced professional cruising couple afloat. For years they've made it their mission (and their career) to teach aspiring sailors about handling yachts offshore—and with a combined 300,000 sea miles, they know whereof they speak.

As professional sailors and teachers, they go out looking for challenging situations, and then instruct their students in the fine art of heaving to, choosing and setting storm canvas, steering in big seas, and using gear such as drogues and parachute anchors. As a result, they have a lot more real-world experience in the use of this equipment and in heavy weather than other professionals, who try to avoid inclement weather. John's comments follow:

Heavy-Weather Strategies

Unlike what some people claim, I do not believe there is one absolute best storm tactic for all types of sailboats. Larger, faster, deeper-draft boats of modest beam generally handle storm conditions best. Centerboarders or boats with excessive beam may tend to roll much sooner and tend to stay inverted once rolled.

If you are sailing a 30-foot (9m) boat in storm conditions there is a much higher chance you will need to heave to or employ storm tactics than if you are on a 50-foot (15m) boat.

During the Queen's Birthday storm we found that with a crew of six on our Halberg Rassey 42, we were able to run off before the storm with a storm jib, hand steering at 180 miles per day. If we hadn't had a full crew, we would have chosen to heave to or tow warps or a drogue to reduce speed.

When reducing sail, you need to keep enough area up to maintain 5 to 6 knots. Otherwise, the motion is difficult to live with and you increase the chance of being rolled. This is the time to look at your options. If you don't have enough sea room, start heading offshore.

When you are running or reaching off, you need sufficient sea room. Modern boats handle running off-the-wind boatspeed more safely, and are generally easier to steer than full-keeled traditional designs. The danger is pitchpoling or broaching and rolling because of excessive speed. Another danger, as conditions deteriorate, is rogue waves coming in from a different angle than the predominant pattern. If you are hand-steering and alert, you must quickly square the stern or stern quarter around to these rogue waves. If you are relying on the autopilot or windvane in these conditions, and the seas are large enough, you may be knocked down or rolled.

John Neal

More fun and much more instructive than reading books at home—learning to steer in breaking seas while running off during the Queen's Birthday storm.

We feel that heaving to is one of the safest storm tactics that doesn't require constant hand steering. By keeping the boat moving at 1 to 3 knots, the chance of a broach or pitchpole is eliminated. Compared to heaving to with a sea anchor you have the ability to move out of the way of other vessels, a smoother motion, and no chance of tangling lines around keel, rudder, or prop.

Lying ahull is the fastest way possible to get rolled and dismasted in breaking sea conditions. Don't do it!

Drogues and Sea Anchors

Warps towed in a bight are okay for moderate conditions. However, they usually do not have the drag necessary to really slow you down in heavy going and breaking seas. A drogue like the Galerider is more efficient at reducing speed. I have tested the Galerider dozens of times and find it easy to deploy and retrieve. Caution: You must monitor sea and wind conditions and be ready to recover the drogue, set storm sails, and heave to if conditions warrant. Parachute anchors are useful for multihulls, powerboats or lightweight boats where heaving to is not a safe option. However, these are far more difficult for two people to retrieve than you could imagine. Reduced maneuverability and chafe are additional problems.

Andy Burton

Andy Burton has been a professional skipper, charter captain, and instructor since 1972. With hundreds of trips on both coasts and more than 50 trips back and forth from the Caribbean, in more than 200,000 miles of sailing, you'd expect him to have had his share of bad weather.

But his response to the question is similar to that of other professionals we've interviewed. In all of this time at sea, Andy has been in four days of dangerous weather—involving two storms in the 70-knot wind range with gusts into the 80s. In addition, he's been in three or four dozen gale-strength blows (over 34 knots) with maybe 10 or 12 of these blowing up to 50 knots or so.

When you consider that a majority of Andy's deliveries are on the East Coast of the US during the spring or fall equinoctial gale season, this is in reality a very low figure.

Andy Burton on parachute anchors:

"I cannot conceive of a time when I would carry a sea anchor off the bow, for the simple reason that it puts too much strain on the rudder. If it were bridled so the boat lay at an angle with a bit of sail up, maybe—but I've never done that.

"There are a couple of problems I see with this approach: First, this is a rather difficult set-up and not one you want to be doing in extreme conditions. Yet, it's something you wouldn't want to do early either. Second, by the time you need to set the sea anchor, the crew is probably exhausted. Finally, when you are hove to the boat is making a knot or two to leeway and can give to the waves. The parachute stops that.

"I try to anticipate the weather, and we usually have enough notice to say 'Whoops, maybe I'll wait here till this goes away or press on before it gets too awful.' If I am somewhere I don't want to be, like in the Gulf Stream, I'll do my best to get out of there as quickly as possible."

Adventure Sailing

Part of what Andy does is run a company called Adventure Sailing, started in 1991. Andy takes sailors offshore, typically between the East Coast and West Indies, on a variety of Swan charter yachts. This provides an excellent opportunity to get your feet wet, with a professional seaman along to teach you the ropes, and a high probability of a gale or two in the learning process.

About 50 people a year take Andy's offshore sailing course.

Heavy-Weather Philosophy

We asked Andy about his general approach to heavy-weather management:

If it starts to blow up to the 30- or 35-knot range, and our destination is upwind, I always heave to. There's no sense in beating the boat and the crew up when you can stop, wait for a day or so, and have the wind die down or shift, and then proceed.

A lot of times if the crew is a little nervous we'll heave to just to show them how things calm down. We put a pot of tea on the stove and pretty soon folks are saying, "Hey, we can deal with this," because the motion is down. Of course, if we are heading to Aruba from Panama, and I know it's going to be blowing hard on the nose for the next five years, we just shorten down and keep going.

Running off is how I handle most extreme conditions—almost always. If the wind is blowing from where I want to go I'll heave to for a longer period before running off. On the other hand, if we're running towards our destination and the crew is exhausted, and if conditions are not too extreme, I'll heave to and let them relax and catch up on sleep.

There is no ultimate tactic—it is never black-and-white. What you do depends on the conditions encountered.

Nirvana

We started out by saying that Andy had only been in two dangerous blows in all of his time at sea. The most recent of these experiences was on a delivery trip between Newport, Rhode Island and Bermuda in the fall.

The vessel in question was an early 1950s John Alden design, *Nirvana*. At 65 feet (20m) overall length, she had a long keel, cutaway forefoot, and had the rudder attached on the aft end of the keel. *Nirvana* represented the archetype of the Alden school of design based on the best characteristics of the commercial-fishing schooners of the early part of the 20th century.

These designs are modest in beam and have reasonably balanced lines—something that is a necessity for good control given the keel and rudder configuration. We must confess Steve has a soft spot in his heart for John Alden, having grown up on two of his designs.

On board with Andy were the owner, the skipper, and three other crewmembers. Andy's narrative begins just before Thanksgiving, November 20, 1997:

What we look for when it is time to leave is to make sure that there are no cold fronts closer than Tennessee. This normally gives us time to get across the Gulf Stream and most of the way to Bermuda before anything serious hits.

We left on the second day after a cold front had passed through. It was a gorgeous day, with a northwest wind, and we were running and reaching in 20 to 25 knots of wind. Although the situation had looked clear inland when we left, pretty soon we started to hear gale warnings on the forecasts, and Herb Hilgenberg (an amateur radio operator, who fills Atlantic sailors in on the latest data) was talking about a lot worse than a gale.

There was no way we could turn around and make it back straight upwind to port before the feces hit the propeller, so we kept pushing as hard as we could to get across the Gulf Stream.

By the time we'd crossed the Stream, it really started to get bad. We were running under bare poles, towing 300 feet (90m) of 1 1/4-inch (32mm) three-strand nylon line. We were doing 6 to 8 knots and still seeing puffs of 70 knots on the anemometer. I'm pretty conservative in wave height and the seas were at 30 feet (9m) plus.

At one point I was on the helm, my harness wrapped around the mizzen mast, with breaking seas periodically pooping us—washing right over me at the helm.

All of this was taking place in an incredibly clear sky, brilliant sunny conditions, with snow-capped mountains all around us—a little on the scary side.

The breeze was from the north-northwest, and it just kept blowing all the way to Bermuda. Once the breeze calmed down to 50 knots, we hove to so everyone could get a rest.

We brought in the warps and *Nirvana* lay to the waves at a 60-degree angle with no sail up. There seemed to be enough windage in the mizzen mast to keep her close enough to the wind.

I'm not an advocate of lying ahull, but this was basically the equivalent of being hove to with sail set, and the boat was quiet and comfortable. However, if had been blowing really hard I think we would have laid more in the trough, more abeam to the seas, and this would have been really dangerous.

By the next morning the breeze was down to 35 knots, still in the north-northwest. As we started to get underway again we found that the steering wasn't working correctly. The bronze keyway between the quadrant and stainless rudder stock had sheared. We could steer if the wheel was turned slowly.

We set the staysail, and then made a drogue from two crossed fenderboards, weighed down with 30 feet (9 m) of chain. With the drogue keeping the stern to the waves, by steering carefully and anticipating the needed course corrections, we were able to stay on course.

On heaving to:

"Some boats won't lie at an ideal angle when hove to. You need to be at least within 60 degrees of the sea angle. Otherwise, the risk of being rolled is too high.

"I am always thinking about the weather, and if the boat might be happier on the other tack. Sometimes the wind will shift and you need to heave to on the other tack. You always want to have the bow pointing as close to the waves as possible.

"One of the things I watch is the leeward rail. If I see waves picking up the boat and pushing the leeward rail under, that is a warning sign that you are not presenting the best angle to the seas and are at risk of being rolled. It is a sign that it is time to run with the storm."

On running off:

"If the least competent helmsman aboard is having trouble keeping the stern to the waves, or we are surfing fast enough to catch up with the waves in front of me, that's a good sign to slow down—time to use a drogue or warp.

"We rarely have special drogues aboard; we just make up one from what we've got. I favor big stuff—hell, you've got the anchor and chain, they work well off the stern. A sail bag tied in the middle also works well, as do tires weighted down and towed well astern. A bight of line off the stern also helps to slow things down and make steering easier."

Adam Bailey

Adam Bailey is a professional seaman, who has spent countless hundreds of thousands of miles on commercial ships and large yachts. Now married, he has retired to the more laid back profession of flying helicopters out and back to North Sea oil platforms—so he still gets to see plenty of heavy weather.

Adam's perspective is from a much larger platform than many of the others in this section. What is interesting is that in the context of heavy weather, the tactics are essentially the same.

> "On a smaller, relatively fast reacting motor yacht (in coastal/offshore areas) I would turn and run, if there was a destination within range—but running before a big breaking sea on a power yacht requires a great deal of concentration and effort from the driver. Almost constant use of the throttles is required to keep the vessel facing in the desired direction. Generally the rudders are very small, and are consequently of little or no use in a breaking sea moving with the vessel. If possible, I try to stay out of the broken portion of the waves, but this depends upon the length of the seas. If they are short and steep, there is a good chance of accelerating into the back of the wave ahead, not a pleasant option!"

Design Issues

Most of my answers, which follow, are based on trans-oceanic motor yachts I have driven.

As far as I am aware, I have yet to go aboard a motor vessel other than custom-designed rescue craft that will survive a severe knockdown or capsize. (Most seem to have the point of vanishing stability at around 70 degrees—of course this is a generalization.) All that heavy engine room equipment starts to come loose and fall about at very high angles of heel, not to mention fuel tanks and the like generating free surface effect, and overflowing.

To avoid the problem is easy. Don't go out in rough weather. The boss won't enjoy it, so why do it? Long sea passages are generally limited to deliveries at the beginning and end of a cruising season and can therefore be timed and routed to miss the worst weather areas.

The only yachts that really travel into the higher latitudes or generally into the area of possible/probable storm weather are commercial conversions. On these vessels, the best method for handling foul weather is take it on the nose, and throttle back to a minimum headway speed. It gives the easiest motion for the crew, least stress on the equipment, and puts the toughest point of the vessel towards the seas. A solution that I would generally recommend to anyone unfortunate enough to get caught in serious weather.

For the larger trans-oceanic mid- to heavy-displacement vessel I think I would simply try to keep head to sea. The stern of these vessels is generally not the type you would wish to have a breaking sea roll over. Too many fancy glass doors and other non-watertight openings on the average motor yacht. For the lighter, faster variety, they either get shipped over or pick a weather window and zip over.

When running square, a quartering breaking sea is: a.) very uncomfortable; b.) very hard to hold a heading through.

Judicious use of the throttles should prevent pitchpole. Again the motor yacht is more likely to be unable to maintain heading, fall off and get broached, rather than pitchpoling.

UK to Norway

We did a small (75-foot/22.9m) power-yacht delivery from the UK to Norway in September. Having passed through the Straits of Dover, one enters the nasty shallow "bottom" of the North sea, an area of very strong tides, short steep seas, and fog!

We were heading into a moderate gale, Force 6/7, very much throttled back. Due to the shortness of the seas, we were pounding fairly hard. The fridge/freezer broke free and started chasing me around the helm station. That, combined with a worsening forecast, caused me to decide to turn and run for Dover.

It must have taken me about half an hour to find the right gap in the waves to turn around, and I used every bit of power in both engines, one ahead, one astern, to turn us, but even so we rolled to around 60 degrees. Once running downwind, I was using the throttles to steer. I know that I was not using the rudders because Steve Lloyd (who is interviewed on page 514) was hiding under the main bunk cushions claiming the steering gear had come undone! He spent the best part of four hours trying to reconnect the rams to the rudder head.

Parachute anchors:

"I have never been on a motor yacht equipped with one, and I doubt that many of the yachts of any size actually have a suitably placed/sized set of bits or fairleads. The deck crews are also generally not abounding in the seamanship required to perform that sort of maneuver. In my opinion, I have never been in a situation on a motor vessel where I would feel the need or wish to set one."

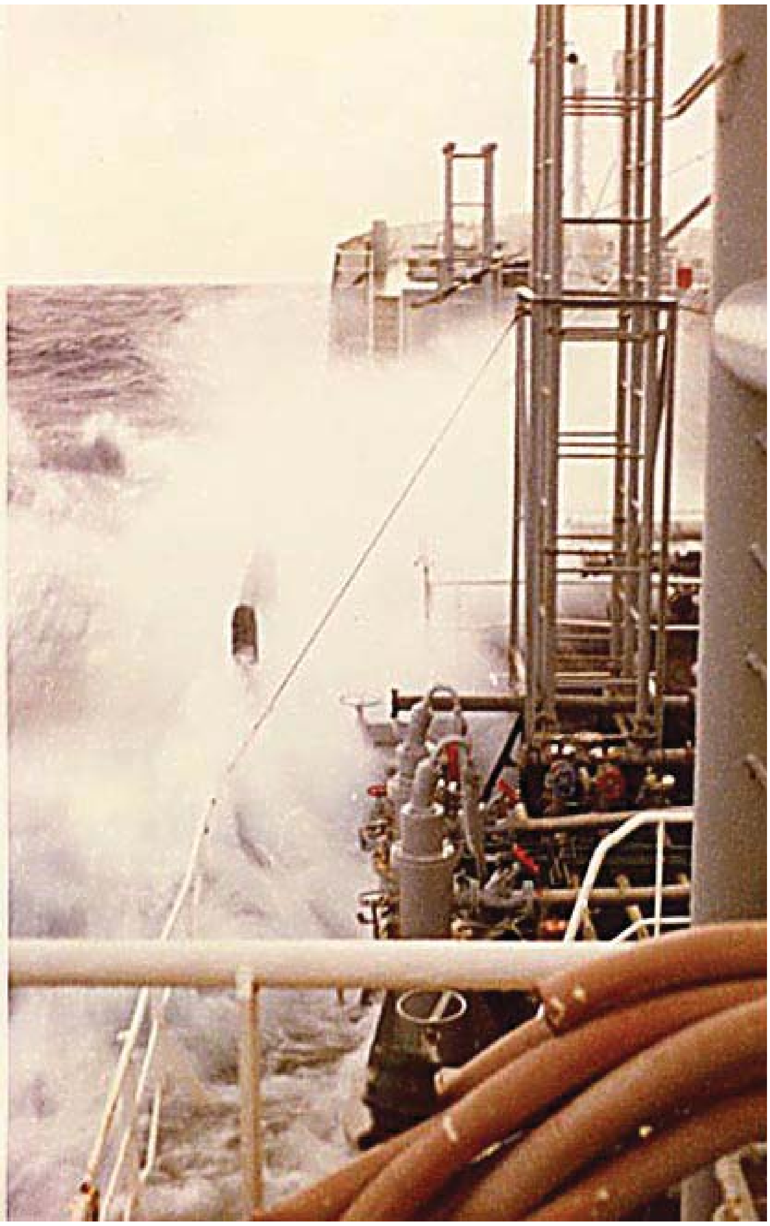
Commercial Stories

One hazard of putting the bow into the weather: I was second mate on a 100,000 plus ton bulk carrier—a sistership to the bulk carrier *Derbyshire* that went down in the same typhoon. We were 23 hours behind her, loaded the same way, and got the entire foredeck set down 18 inches (0.46m) by breaking seas coming over the bow. We were going full ahead just to hold our position at the bottom edge of the South China Sea, the bit with all the shallows. We used up all our fuel reserves, plus the bit in the chief's pocket!

On *La Quinta*—a small chemical carrier (5,000 tons), at one point we lost both motors due to water going down the chimney in Hurricane Allen. That kept the engineers quite busy for a while! The top of the funnel was measured at a little over 90 feet (28m) above the waterline. We also had one of our life boats washed out of its davits, and the maindeck swept clear of all the piping—8-inch (203mm) stainless steel, welded to the deck! My

Adam Bailey

The view from the bridge of a 100,000- ton bulk carrier can be impressive—even intimidating at times.


Adam Bailey

Heavy going in a 5,000-ton chemical carrier. In Hurricane Allen she took water down her 90-foot (27.6m) exhaust stack.

watchman had to have ten stitches in his head where the bridge typewriter hit him as it left its mounting by the chart table.

Another time we were caught in a severe typhoon in the South China seas, aboard a fully loaded bulk carrier, (iron ore I seem to remember) bound for Japan. With nowhere to run, we headed into the big seas. In order to simply maintain position, we were going full ahead. There were some very large, green seas coming over the bow. We took a particularly large one, and upon later investigation the center 12 square meters of foredeck was discovered to have been uniformly pushed down by about 12 to 18 inches (0.3 to 0.5m). The deck was supported by 4- or 6-inch (102 or 152mm) diameter columns, these simply bent under the force of the water. Sometime later we went into dry dock, and they cut off the damaged sections and replaced them.

All three of these "big" ships took a fair amount of damage from heading into the sea, but all survived. The fast, small boat option of running away was not open to us.

All the Atlantic crossings I have done on various power yachts have only involved "regular" storms, where you simply tie everything down and fix whatever breaks.

There I was, lashed to the wheel...My crews aboard the powerboats spend way too much time tied up polishing windows rather than being at sea, mainly because that is very largely what the job is all about.

Construction and engine condition would play a very major part in any decision I made to go offshore in heavy weather. I would be very uncomfortable on the cheaper Taiwanese Hatteras replicas, but have had little worry moving a dutch built steel 60-footer (18m) around northern Europe, mid-winter.

Basically if the hull & engines are sound, and the crew capable, I would feel "comfortable." I would qualify that by saying that if I think I might have trouble I always have a professional engineer, and one member of the deck crew that I know and trust.

CAM LEWIS

Cam Lewis

Cam Lewis is one of the few Americans to break into the field of maxi-catamaran racing with the French (who dominate the sport). He has by now crewed on many of the top French boats, including an incredible 79-day trip around the world on *Commodore Explorer*. At 42, Cam's resume reads like the who's who of multihull racing.

He began his multihull racing career in 1985 with the Worrell 1,000, sailing with SAIL Magazine editor Tom Linsky. This is a grueling race—1,000 miles in length—sailed in small cats along the Eastern Seaboard of the US. Cam then moved to the Formula 40 circuit crewing for Randy Smyth, and was soon racing aboard the big French cats and trimarans.

Cruising Considerations

While Cam has raced over 100,000 miles aboard big multihulls, his cruising experience is limited. Still, much of what he has learned is applicable across the board. As someone who has seen the ocean at its worst and returned to tell the tale, his comments on what makes for a good cruising multihull are worth listening to:

I'd say the minimum size for an offshore multihull is 40 feet (12.2m), but you would probably be better off larger in really bad weather.

Wing clearance is a major issue. On a cat, the higher off the water the beams are, the smoother the ride will be, and the better chance you will have for a fast, fun ride.

You need to be very careful with weight. Most people are not, and their boats end up being overloaded with stuff. In heavy air, boats that are overloaded do not perform well. You don't do well with storm sails and don't maneuver well. If the boat is sitting below its load waterline, it's less safe. In a multihull in storm conditions, the light boat doesn't get pounded as hard by the seas—if a sea hits, you have a better chance of sliding off to leeward. You are sliding through the water, not glued to it.

Most of the production cats are built for island-hopping in the charter trade. They are too heavy and do not have enough wing clearance to go offshore. In survival conditions I'd be especially wary of the designs with fixed keels, as they don't give when hit by a wave.

As Cam has sailed on both large racing trimarans and cats, we were curious if he had a preference between the two in heavy weather:

I don't know if it really matters much, as long as the wing areas between the hulls on the tri are open (with netting). If they are decked over solid, then you have a lot more area for the waves and wind to work on, and that can be a problem.

Cam Lewis

Commodore Explorer

During the Northern Hemisphere winter of 1995, Cam was aboard *Commodore Explorer*, along with Skipper Bruno Peyron and three other crew, as she started out to sail around the world—the goal being to do this in under 80 days.

Commodore Explorer is not your average cat. At 86 feet (26.4m) overall with a beam of 42 feet (12.9m), she is large enough to play a game of tennis aboard. Yet she weighs in at just 10 tons. The canoe body draws 18 inches (450mm), while the wing mast towers 110 feet (33.7m) above the deck. All of the accommodations are in the hulls—with an intercom between, so the crew can communicate when necessary.

This 27,372-mile circumnavigation was going to take them into the Southern Ocean and around the great Capes—a region of the world noted for extreme weather. They crossed the equator in nine days and by the 17th day of the trip, in mid-February, they were at 37 S, 25 W. Working their way around the southwest corner of the South Atlantic high, they were just getting into the westerlies, which they hoped would take them all the way across the South Atlantic, Indian, and South Pacific Oceans.

We'll let Cam pick up the story:

We were basically just getting into the rhythm of the trip. We'd left in a hurry with only five or six days to get used to the boat. We'd been averaging 16 knots, and were getting ready for the Southern Ocean.

The forecast was for 25 to 30 knots, but as you know, paper lies. The barometer was taking a dive and the seas were getting bigger.

The wind built to where it was blowing a steady 40 to 45 knots. And we dropped down to a third reef in the mainsail with nothing forward.

Everything was under control—when you are going that fast the true windspeed doesn't seem that strong, and our wind instruments were not that good.

The wind continued to build into the mid-50s. Bruno was driving, with Marc Vallin shooting video. I was down below cooking up some cornbread with an extra dose of safflower oil—to build up our bodies with extra fat for the Southern Ocean—holding a mug of hot chocolate between my legs.

The boat took off on a big wave—all I remember is the feeling of dropping into space, and then flying against the forward bulkhead.

As the boat came over the wave there was nothing but a huge hole below us and she dropped into it—her starboard bow hitting first.

We went from 20 plus knots to zero in a matter of a second, burying the bow right to the main beam. The rudders came clear of the water and we hung there.

"The risk of a quick deceleration is why we always sleep feet forward—so our feet rather than heads take the shock loading."

Why we didn't go over nobody knows. When you consider that we had 85 feet (26m) of boat buried almost halfway, with rudders well clear of the water, that will give you an idea of how steep that trough was.

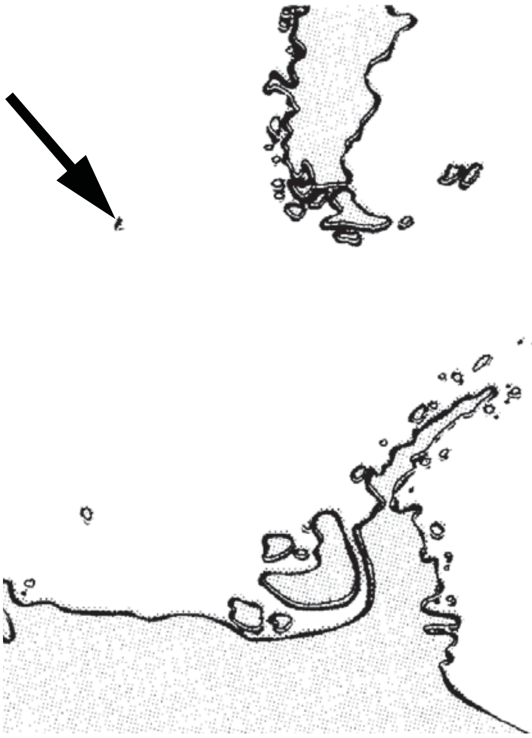
I poked my head up on deck to see what was going on and Bruno was wrapped around the wheel looking white like a ghost. Marc had flown forward and hit his head on the instruments. The other two guys, asleep below, were okay (the risk of a quick deceleration is why we always sleep feet forward—so our feet rather than head take the shock loading.)At this point we dropped all sail and ran off under bare poles. At the same time we brought all the loose gear and sails aboard aft to the rear beam to give the bows more freeboard.

I was curious to see if Cam felt that there was anything that could have been done differently to avoid the problem. Sometimes adjusting your course to windward as you come over the top of the wave avoids the quick drop and slows the boat down more gradually:

Bruno is probably the most experienced big cat driver in the world, and there was just nowhere for him to go. He has enough experience to know to head right or left as conditions dictate, but in this case there was no right answer. We had plenty of daylight, too—Bruno just ran out of options.

We could have slowed down to the speed of the waves. Going faster than the seas can get you into trouble (like this time!).

I think one of the reasons we didn't capsize is that we did not have roller-furling headsails. This reduced our weight aloft, as well as the momentum that would have continued to pull the rig forward as the boat stopped.



Commodore Explorer was located at 55 S, 82 W, roughly 600 miles west of Cape Horn (at the position marked on the chart above), when they encountered their big blow.

Cape Horn

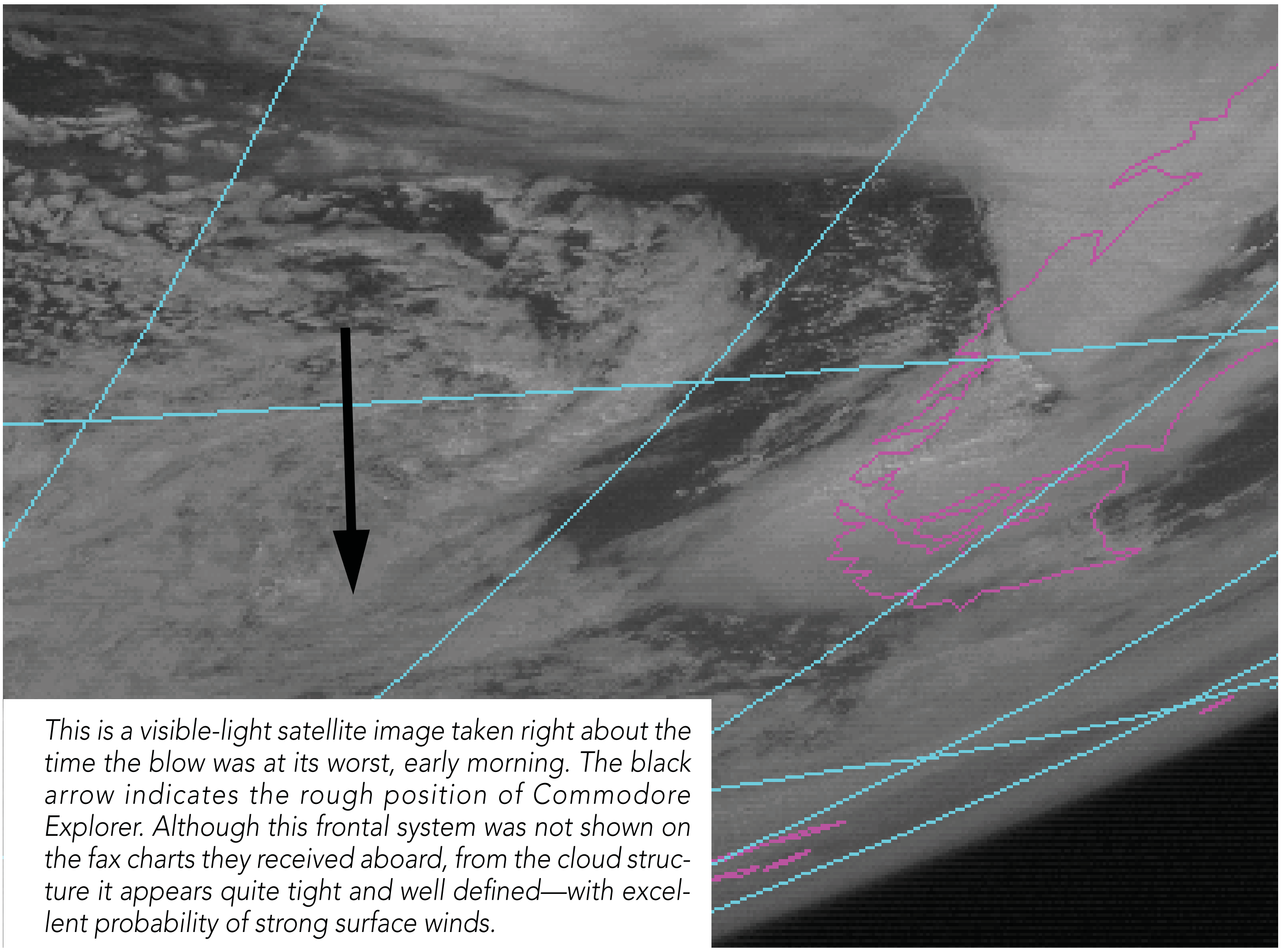
Five weeks later *Commodore Explorer* was 300 miles west of Cape Horn when they ran into a real blow:

I was on the 2000/2300 watch reaching in moderate conditions with a full main and Solent jib (100 percent), doing an easy 20 to 25 knots. The forecast was for 8 to 10 knots of wind the next day. But the wind started to build so we took a reef in the main. A little later it was blowing harder so we dropped the Solent, put two reefs in the main and set our staysail.

On the next watch as the wind built to 35 knots, the guys reefed the staysail and put a third reef in the main. The boat was still doing 20 to 25 knots.

By the time I came back up on deck for the 0200/0500 watch, it was blowing 55 to 60 and the barometer was still diving. The seas were huge, and the seabirds were gone—always a sign that things are going to get nasty.

Bruno was talking to the Chileans, the Argentinians, the Met, guys in France, and nobody had this depression on their charts.



This is a visible-light satellite image taken right about the time the blow was at its worst, early morning. The black arrow indicates the rough position of Commodore Explorer. Although this frontal system was not shown on the fax charts they received aboard, from the cloud structure it appears quite tight and well defined—with excellent probability of strong surface winds.

The weather continued to deteriorate until we were seeing 80 knots on our anemometer, which was mounted on a stern pole, just 15 feet (4.5m) off the water. We were doing 20 knots plus at the time just on the wing mast—centered to minimize its effectiveness. The seas were huge—40 to 50 feet (12 to 15m)—and breaking.

Bruno wanted to get the boat set up to where we could take the seas more on the quarter to slow us down some and not head so steeply into the troughs, with minimum resistance to wave impact. We had daggerboards with elliptical tips, which hung down below the hull when the boards were fully raised. To get rid of this resistance we rigged halyards to the tops of the boards and hoisted them even higher, so only the hull bottom and rudders were in the water.

We lashed the helm so the boat would sail at 150 to 160 degrees to the wind and waves while we waited below. This reduced boatspeed so we were going slower than the waves. This way there was less chance of falling into a big hole and capsizing, and the boat wouldn't trip on itself and capsize. Nobody wanted to be on deck steering. It was too dangerous.

We all prepared to survive in capsized mode.

Everyone had on their survival suits, and we secured everything below so that if we capsized, we would not have a mess. I secured all the glass jars in the galley so we wouldn't be walking on broken glass, if the worst came to pass. Each crewmember had a waterproof bag with papers, flashlights, and other gear close by.

The scariest part of this whole situation was when we turned the boat to port to bring the seas on the quarter. We didn't know if it was going to work, or if we'd flip.

We had two Galeriders aboard, one big and one medium-sized, but we had not practiced with them before. We were afraid if we deployed them we'd slow down too much and the waves would have too great an impact. Even slowed down like we were, our boatspeed was in the 6- to 10-knot range.

When one of the waves would hit us the boat would slip sideways. We might have tried to slow down with warps or the Galeriders but the waves were so big it was really scary. I don't know if this was the right or wrong tactic, but we're here to talk about it!

At one point one of the daggerboards dropped down a bit and then we got hit by a huge wave. The boat was really slammed and the forces were enormous. I don't think the boat would have survived for long with the boards down.

The wind continued to blow for 24 hours, then it began to taper off. It wasn't until the following morning, when the wind fell to 45 knots, that we had the cojones to put up a storm jib. We added the staysail a little while later and rounded the Horn with this double-head rig.

We asked Cam what he would have done in a smaller, heavier multihull in the same conditions:

"With a long-keeled production cat, I think the only thing you could have done was to try a parachute anchor off the bow. But the problem would be the windows and ports. They are probably not strong enough on most of these boats to take breaking seas, and if one of them went, you'd be flooded quickly.

"You couldn't hang by the stern, because the aft windows and doors are even more vulnerable."

Bill Biewenga

Since the late 1950s, when multihulls first started to arrive on the cruising and racing scene, there has been a controversy about if they are safe offshore.

When this subject is debated ashore, at the yacht club bar or along the docks at a boat show, mistakes in logic do not have consequences. But when the debate is acted out offshore, with Mother nature as a participant, the stakes can become quite high.

If you are evaluating the purchase of one type or another, or thinking about making a potentially dangerous passage, we feel that it is of vital importance to realistically consider all the issues affecting the safety of the vessel in question.

Chief among these is crew experience. This applies to sailing and weather forecasting skills. The design of the vessel in question and its structural capability are another factor. Finally, you have to look at the region to be traversed, the time of year, weather cycle, and perils associated therewith.

There are good arguments to be made for and against both monohulls and multihulls in heavy weather. It is not unusual for proponents to come from one camp and have tunnel vision on the subject.

So when you have a chance to talk to someone who has worked both sides of the fence, in the worst weather on earth, it's worth listening to what they have to say.

Bill Biewenga has a vast amount of both monohull and multihull experience. He has sailed offshore on multihulls for well over 35,000 miles, including a record-breaking trip with Rich Wilson (interviewed on page **552**) aboard *Great American II* ("Rich wanted me aboard as a weather hostage for the second trip around the Horn!") and the Transatlantic Race aboard *Sebago* with Phil Steggall (see page **502**).

Bill's monohull credentials are even more impressive: 200,000-plus miles offshore including four Whitbread Races and 18 Transatlantics (in addition to his two aboard multihulls).

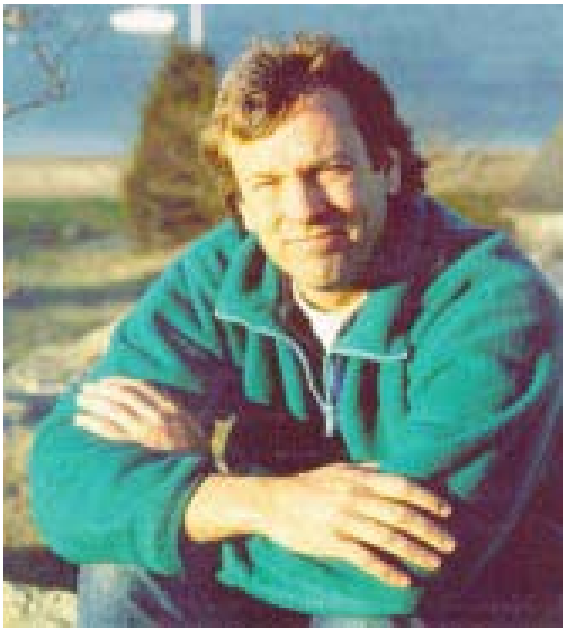
Bill, who with Bob Rice founded Weather Window, provides routing services for cruisers and racers. He's a marine consultant, writer, and professional skipper.

The Variables

There are all sorts of variables involved in vessel choice and heavy-weather tactics. Since Bill is asked to participate in Safety at Sea and Heavy Weather seminars all the time, he has a chance to interface with a lot of interested sailors—and answer lots of thought provoking questions. His comments follow:

Whether you're choosing a multihull or monohull there are a variety of criteria to consider. You have to look at the crew, their experience, their ability to understand and solve problems, and their physical fitness. First and foremost, the crew is either an asset or a liability.

Next comes the vessel in question, and last the conditions in which you are sailing.



Even if you have a really sound vessel, with an inexperienced crew you can have problems.

When you are sailing a monohull with too much sail up you heel over, the wind spills, and you realize there is a problem.

With a multihull, because there is so much form stability, you don't heel over. The boat just keeps going faster and digging the lee hull into the waves. The fact is that you do not know the boat is overpressed unless you are watching the leeward hull or float. It will continue to press until you go too far, and then it will pitchpole or capsize suddenly—so the crew must know what the hell they are doing with the multihull. Your safety on a multihull is far more dependent on wind, sails, and sea state. It's a more subtle thing you are looking for than with a monohull.

Multihull Considerations

With a multihull everybody's concern is that it stay upright Anything that has a bottom hatch in it so you can get back aboard if it flips while you are in the cockpit has to raise some red flags!

Most multihulls are buoyant and have watertight compartments. Even if you hit something, damage a hull and pitchpole, they will stay afloat. In a sense they appear more dangerous than a monohull because they have upside-down stability, but you are still afloat, and they are a hell of a lot better than a life raft.

In fact, a *fast* multihull may be safer than a monohull because of this unsinkability added to the ability to stay out of dirty weather.

When you are in the floating-condo-type of cat, these are usually under-rigged because they don't want you to capsize or pitchpole from the wind. By design there is relatively little sail area for that particular configuration compared to a racing tri or cat. While this doesn't by itself save you from the waves, it does make it less likely you'll get in trouble with too much sail up.

The problem with heavy boats is that they are slow in moderate weather, so it is more difficult to avoid bad conditions by using pure speed.

With the heavier cruising cats it is not usually the sail area you are worried about. It is the sea state, and you have to carefully manage boatspeed for the conditions.

The question becomes, how do you slow down the multihull? That becomes your constraint. And, at what point do you slow down? This is the skill set you really need to develop in order to be safe.

In the past few stories, you've seen an emphasis on professional sailors sailing in some of the more perilous regions of the world. Severe weather is an expected part of the game where they go. And there are lessons in their experiences from which we can all learn.

But when the time comes to discuss monohulls versus multihulls, the debate needs to be framed in the context in which the boats are going to be used.

For most of us, this means mainly tradewind sailing, typically short-handed, in cruising configuration (which means a lot of cruising gear aboard).

Weather exposure, while not great—typically limited to passages into and out of the tropics—is still a possibility that must be considered.

Now we get to the critical question. For the average sailor, just starting out in cruising, is one type of boat better than the other in heavy weather in Bill Biewenga's opinion?

"For the inexperienced cruiser, I'd rather see him or her in a monohull, because of the fail-safe factors, which come with the keel. It is easier to get a monohull to go safely in heavy weather, and you don't need as much experience.

"So many of the cruising multihulls tend to be floating condos. People look at all that space and want to fill it up with stuff. The weight adds up, reduces wing clearance, slows the boat down, and makes it more difficult to get out of trouble. The space is great for parties, but leave it open the rest of the time."

Warps, drogues, and sea anchors all have a place in the equation, depending on conditions. And you need to have plenty of strong attachment points bow and stern.

Another factor is the fixed keel-versus-daggerboard question. So many production boats have fixed keels, and we wondered what Bill would say about this design feature:

With multihulls you can go so fast that you need to be cognizant of the structural loads on the daggerboards, so you don't break them.

With a keel you lose flexibility; you don't have the ability to take it up any more. You want to slip a little sideways. It is always better to slip than to flip!

Tactics

I prefer not to stop the boat altogether in heavy weather. If you are moving, the waves have less impact. I think towing warps is the first step. Then, if the wind and sea continue to build, you go to a drogue of some sort. My preference is to tie this gear off the back to slow down so you don't pitchpole.

A lot of cruising cats have sliding doors on the back end. I love them at the dock or at anchor. But now we have this 50-foot (15m) breaking wave coming at us from behind—because that's the best way to deal with the seas—and these sliding doors are not going to be able to cope. If the wave gets through those doors, you have a big problem. So, you need to eliminate the door, or have some form of structurally sound storm shutter, so that if you are caught in breaking waves, you are not defenseless.

Extreme weather is what separates the issues.We have seen that big multihulls can survive incredible conditions, if used intelligently by experienced crews. But what about the situation with smaller boats crewed by folks with less experience?

If you are in an ultimate situation, blowing like hell, with big breaking seas, you are in a bad situation with either type of vessel. The reasons for being in trouble will be different in each case—it is really a case of apples and oranges, and it's hard to say which is the least bad in this situation.

But with the monohull you have more options tactically. With the multihull, once you've slowed down you've played your last card, and you hit this point sooner than in a monohull.

With the monohull, you will have drogues or warps out and perhaps a storm jib set for some directional stability.

The problems come when a breaking wave knocks you down. If the boat is structurally sound you are okay. But if a window goes while you are capsized, you may be going to the bottom—so good structure is even more important than on a multihull, which will remain afloat after a capsize.

John Jordane

This is the mental image that most of us have of the type of weather the professional sailors deal with—especially those who do the Whitbread Race. However, the reality is that things are a lot more moderate most of the time. Even in the Whitbread, if you subtract the cold of the high latitudes (in which much of the race is sailed) for the most part, conditions are benign. In fact, when Whitbread- and BOC-type boats are designed, they are typically optimized for light airs—because this is where the races are won and lost—and there is a lot of light air with which to contend.

Small Cats

Before we leave the subject of multihulls in heavy weather, we want to give you a little history on our own involvement with these types of boats.

Prior to getting involved in cruising offshore in "lead mines" (single-hulled sailboats with keels!), we spent many years designing, building, and racing various types of catamarans.

These boats were all "powered up" as they say (at least for their era) and required a close watch on wind, wave, boatspeed, and the sheets—or you'd suddenly find yourself sitting on an upside-down hull waiting for help.

In spite of sailing in the odd blow over the years (as defined from the trampoline of a small cat), except for two occasions we were always able to remain upright. The first exception took place one spring afternoon during a Santa Ana gale in Newport, California. This offshore wind was making wonderful high-speed reaches possible, with the beach a breakwater to weather—so there were no waves to impede progress.

Steve was sailing his 17-foot (5m) Wildcat (one of the first production cats in the US) at the time and at some point it dawned on him that if he capsized he'd float out to sea before anyone missed him. Good sense overcame adrenaline and he beat back into the channel, into a breeze now gusting to the low 40-knot range. He made one small error with a windshift—didn't feather quickly enough—and before you could say "boo" the mast was stuck in the mud. At least he wasn't offshore.

Beowulf III, a 25-foot (7.7m) cat before her "rescue," during which she was severely damaged (opposite page photo).

The second incident held more potential danger. This was many years later and we were racing a C-class cat in the *Yachting Magazine* One-of-a Kind Regatta on Lake Michigan. On this particular day, a northeaster had kicked up and it was blowing a steady 25 knots, gusting a little higher.

No big deal really, but enough so that *Yachting* cancelled all classes except for keelboats and multihulls. The issue was the sea state—the waves were very steep, although they were not breaking.

On our way out, we broke one of the daggerboards and decided to sail back to get a spare. We tacked around with great care and started heading back towards the Belmont Harbor breakwater on a broad reach, with the rig fully feathered, trying to hold our speed down.

As we neared the entrance, the sea became quite chaotic from waves reflecting back to windward off the shoreline, but we were negotiating the waves with care and had the situation under control.

About a minute from the safety of the breakwater the wind shifted 25 degrees, flow on the rig attached, and we accelerated to 25 knots. We became airborne as we drove over a wave crest, and cartwheeled head over heels a number of times. The boat was pretty much broken up in the rescue process, but we were safe, which was the main issue.

We were sailing conservatively, using all the skill at our disposal to bring the situation to a successful conclusion, and the elements simply caught us. There was nothing we could have done that would have made a difference.

Both situations would have been a piece of cake for a large, cruising multihull, conservatively sailed. But I have included them here because a 25- or 40-knot blow to one of these small boats is like at 60- or 70-knot storm to a larger, heavier boat—and in both cases operator error lead to capsize.

1971 Ensenada Race

It had been our practice for many years to "escort" the entrants in the annual Ensenada Race down the coast of Southern California from Newport Beach to Mexico. Some of the official entities were not happy about this, but we felt it our civic duty to make sure conditions down the race course were safe for 500 to 600 boats behind us in the race. We'd typically start a few minutes after the Ocean Racing Catamaran Association (ORCA) cat class, and work our way through the fleet by mid-afternoon. We wanted to get to Ensenada early enough to make sure the pubs were ready for the "official" boats when they finished the race.

The first year we took *Beowulf V* down was 1971. This was her first bluewater test (well, graywater would be more accurate). *Beowulf V* was a 32-foot (9.8m) D-class cat. She was 16 feet (4.9m) wide and weighed 702 pounds (318kg) in full cruising trim (including ground tackle and tools!).

For many years the two of us raced a series of high-performance cats as husband and wife, with occasional crew if we expected heavier winds. However, in the Ensenada Race Linda would drive down, while Steve sailed with a friend.

The following narrative is from Steve's perspective.

Beowulf V powered up and out ahead of the "official" fleet. We would normally be sailing from double trapezes, but offshore like this, we stayed on the hull to reduce structural loading on the beams and hulls.

Weather "Analysis"

Weather forecasting in those days was pretty basic. We'd call the desert airports to check the pressure gradient so we'd know to if it was better to sail on the beach or offshore at night.

The morning of the race dawned with a low overcast and 8 to10 knots of wind out of the south. None of this was unusual, although we'd have preferred clear skies and southwesterly breeze (which would have guaranteed a fast reach down the coast).

The weather looked like a normal "Catalina eddy," and the odds were that we'd be beating by the time we got to San Diego. If we'd watched a barometer during the day, we might have made plans to go to Disneyland for the afternoon.

The race started in the normal chaotic fashion—we were being careful to avoid being run down by the "turkeys," but eventually we were clear of the starting area in hot pursuit of the big ocean-racing cats.

ORCA

In the olden days, the ruling body for offshore catamaran racing in Southern California was called the Ocean Racing Catamaran Association or ORCA. The rules this body promulgated were ostensibly to promote safety. The reality was that they existed to protect the status quo—the "dinosaurs" as we affectionately called them.

The ORCA boats were slow and it wasn't long before we'd overtaken the lead boats and had them hull down on horizon.

Working down the Southern California coastline, the breeze remained fresh from the south with a tendency in the puffs to go southwest.

Rick Taylor, a sailmaker and good friend, was crew, and we were thinking that this might be the year we covered the 125 miles to Ensenada before dark.

We were sailing conservatively, not using our trapezes, ripping down the coast. By 1700 we were off Point Loma, the entrance to San Diego and halfway to Ensenada.

Unfortunately the breeze started to go back to the south and then southeast, dropping in velocity, and we were faced with a beat in light, sloppy conditions.

The issue at this point became one of positioning for the night. Do we go inside and work the beach, or do we head offshore and look for southwest-to-west winds?

Working the Beach

Previous experience dictated working the beach, where we might find a downslope wind in the late evening and early morning hours.

The sky remained overcast, which was not unusual for what we thought was a Catalina eddy condition.

By 2300 we'd worked our way past San Diego and were into Mexico, about 20 miles beyond Rosarita Beach.

Rick had been on the helm, playing the shifts at the edge of the surf. We were making good time for the conditions, and figured we'd be in Ensenada by first light.

I took over so he could refresh himself with a peanut butter and jelly sandwich, and immediately picked up a little puff of wind, this time with more south than east in it.

This was most unusual as the evening downslope winds normally came from off the land. I worked the puff a few hundred yards offshore to see if there was more where it came from.

Weather Front

Boy, was there! Within ten minutes it was blowing like stink. I'm not sure how hard, as it was pitch black and we had no instruments. But it was an easy 35 to 40 knots or more. Rick and I looked at each other and at our big mainsail and figured it was already blowing too hard to do anything in the way of reefing. We'd just have to feather through this squall or whatever it was.

If it had been daylight, or if we'd been offshore, we wouldn't have worried. But in the dark there was no way to know when the hull came out of the water—there was no horizon to check. The only way we could tell was the extra-long tiller extension, normally used for sailing from the trapeze, would begin to drag in the water.

When we felt the drag we'd shove the helm to leeward and bring the bow further into the wind.

Capsizing the boat would not have been a big deal—after all there were 500 plus boats behind us—but we were just to weather of the surfline, and this was a very inhospitable stretch of coast.

Interspersed with the wind were frequent rain squalls, which stung our eyes with such force that we had to look away.

To keep *Beowulf V* on her feet, we feathered the rig on starboard tack with the mast over-rotated to flatten the mainsail, and the traveler all the way down. If we got the bow too far into the wind she'd start to make sternway and I'd push the tiller to leeward, to get the bow to fall off going in reverse.

When she'd start to accelerate forward, I'd push the tiller more to leeward to get her to head up into the wind. It was an interesting dance.

During this period Rick and I didn't talk a lot, but we both knew the situation was serious. We were both afraid of the consequences of an error.

In the occasional lulls Rick would pull in the traveler so we'd be able to work a bit off the beach.

Eventually the front or line squall or combination of these two passed us by and by 0200 we were reaching down the coast in a fresh southwester which eventually went back to the west.

Now I should tell you that both Rick and I were very experienced in monohulls and cats at this point, and we'd both seen some blows before. As the sail down the coast progressed, we both came to the conclusion this wasn't such a big deal.

We decided that it had not actually been blowing that hard; but rather, we had been spooked by the quick increase in breeze and the fact that it had caught us so near the surf line.

By 0400 we were passing close by the committee boat. A startled race committee member, a friend of Rick's, shined a light on our sail and asked "How was it out there?"

Rick's reply was "Not too bad, but a little slow south of Rosarita beach. Then we caught a nice breeze and picked up some time."

That was how we looked at things. But the race committee had been monitoring the radio. As the front moved through the fleet behind us the racing boats were decimated. Sails were lost, rigs were dropped, and two of the officially sanctified ORCA cats capsized. 40- to 50-knot winds were reported by those with anemometers.

After anchoring *Beowulf* and catching a ride ashore, Rick and I were too tired to perform our official duties (checking the bars), so we headed for a motel situated on shore just north of the harbor. We awoke about 1100 to see the first of the official boats finishing.

Mickey Muñoz

Further up the coast, an even smaller cat was battling the storm system. Our old friend and surfing guru, Mickey Muñoz, was sailing a Super Hobie 16 in the unofficial race. A stock Hobie 16 was not the most stable platform, but the Super 16 had a third more sail, carried a huge fractional drifter, and had been widened to 12 feet (3.6m).

Mickey was then (and still is) one of the best small cat sailors in the world. He was about 30 miles behind us off the Coronado Islands, reaching south in light airs with the big drifter when he says:

> The hair on the back of my neck began to stand on end—and the sky turned black. We pulled down the reacher and before we could get fully secured it was blowing 25 to 30.

Mickey had the advantage of being well offshore, and he and his crew were wearing dry suits. But a capsize would put them in need of rescue—no certain thing.

> We fought the wind all night, pretty much feathering the boat as best we could. By morning, still being afloat, we continued sailing down the coast. The wind stayed out of the south and we were still beating. The wind picked up again and by afternoon it was really howling. There was a Columbia 50 ahead of us with a tiny jib and triple-reefed main, and they were almost putting their spreaders in the water. They told us later their anemometer was reading 45 to 50 knots at times. In hindsight, I can't believe we survived!

Mickey eventually got the boat ashore through the beach surf and found his way to Ensenada where a wake was being held in his honor by friends who assumed he'd been lost at sea.


Mickey Muñoz

The Hobie Super 16 en route to Ensenada. Check out the rig— 32-foot (10m) tall mast (on a 16-foot/5m boat!), 180-square-foot reacher, and a huge mainsail. To sail this boat through the gale and keep it afloat was an amazing feat.

Post Mortem

The fact that we and Mickey survived the storm indicates just how much you can accomplish by staying alert and engaged in the battle. If either of us had made one mistake due to lack of attention, or if we'd had any sort of mechanical problem, the sea would have won.

Rick and I discussed the race many times in the ensuing months. We obviously survived, but I suspect it was by a combination of skill and luck. As I said, one error on the helm or sheet and we'd have been upside-down and into the surf.

Our biggest problem was the failure to get the main reefed quickly. Had we taken immediate action, we would have been much safer. By the time we had waited ten minutes to analyze things, it would have been too dangerous to move Rick's weight off the weather rail.

These conditions were certainly a survival storm for the size and type of boats we were sailing in, but many other vessels would cope with ease, and with a lot more margin for error.

For someone in a more forgiving multihull, the wind might climb to 60 knots before survival was at stake. The key is to remember that, when the survival point comes, being prepared to take an active part in the battle with Mother Nature can significantly increase the level of conditions you can endure.

Around Alone Race

The Around Alone Race provides one of the best heavy-weather tactics laboratories on the planet. Single-handers on a variety of boats tackle the toughest oceans on earth, getting hammered by storm systems and frontal passages.

You'd think that since this is a race, the skippers would be prone to take chances. However, many of the boats are high-strung and require care in heavier going to avoid damage. If they break, they don't finish; and to win, you have to finish.

In the 1998-99 running of the race, Alan Nebauer was acting as shore manager for skipper Brad Van Liew. At the last stop before the finish, after the boats had sailed three quarters of the way around the world, Alan was kind enough to interview eight of the nine remaining competitors for us.

With everyone rushing to get their boats prepared (Alan included) for the final dash to the finish, you can imagine what a difficult chore this must have been.

The boats represent a wide cross-section of yacht design. There are the super-light-displacement, heavily water-ballasted hot rods, and a number of conventional boats. What is so interesting is that in spite of the design differences, all reported essentially the same approaches in many areas.

Single-Handed Storm Tactics

Each of the eight competitors reported consistent tactics. No one hove to, towed warps, lay to a sea anchor, or used any other strategy except for running at speed.

The speed varied, as you would expect, based on boat design and speed potential. Soldini in a Finot 60 ran at 14 knots, while Garside and Mouligne in smaller Finot 50s, and Van Liew in his Adams 50 ran at 10 to 12 knots (Mike Garside says "go as fast as you can go and keep control!").

Victor Yazykov in his 40-foot (12.3m) *Wind of Change* also ran in the 10- to 12-knot range.

In the smaller, heavier boats with less speed potential, the approach is similar, but the speeds are slower. Hunter, Petersen, and Saito all report slowing down to the best speed to maintain control—typically 6 to 8 knots.

Weather Analysis

Race Headquarters provides detailed weather data from Ken Campbell's Commander's Weather. In addition, the competitors were fitted with Inmarsat C telex receivers and could receive weather updates every six hours.

All reported that the general weather patterns as forecast by Commander's Weather were accurate, but that it often did not apply to their localized patterns. They also indicated that the EGC weather reports over Inmarsat C (which are free) were very helpful.

Each boat was fitted with a barometer. All these sailors used windspeed, direction, cloud progression, and barometric pressure. To predict their position relative to the depression center, and when to expect a frontal passage, they relied on the same techniques which have been in use by mariners for the last 250 years.

Most Dangerous Period

As you would expect, all of the men in this group reported that the most dangerous period was just after the frontal passage, with the wind shifting from northwest to southwest (remember, these blows are in the Southern Hemisphere).

In moderate storms all relied upon self-steering—either vane or pilot. But in the really strong storms, they felt it was important to steer manually, either by controlling the pilot or vane, or hand-steering. With no crew this puts an obvious premium on getting as much rest as possible before the frontal passage—something that applies to crews aboard cruising yachts as well.

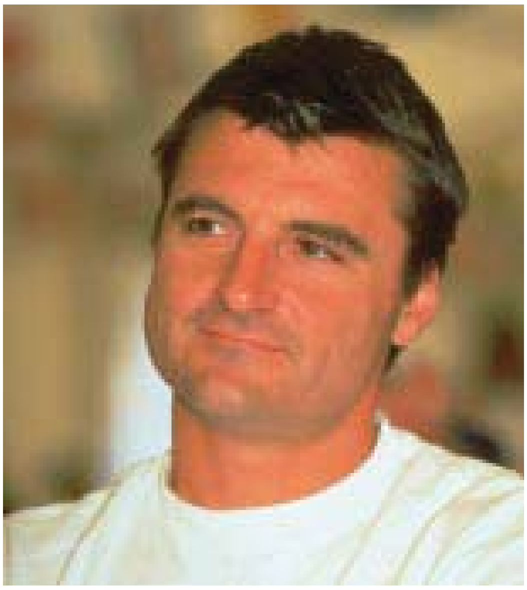
Lets hear from the competitors themselves now:

All photos this section by Billy Black courtesy Around Alone Race

Giovanni Soldini

`It is very important not to be tired when the cold front passes, so as to be able to hand-steer if necessary and handle the confused seas associated with the frontal passage. My sail configuration is dependent on wind strength and sea state. I do whatever is necessary to maintain control. My best speed is 14 knots in big seas. Not a crazy speed, but never slow.`

`The worst storm I have been in was the last race aboard` *Kodak* `(a 50-footer/15.3m). In the Indian Ocean, just after passing Kerguelen Island, 65-foot (20m) seas and 70 knots of wind. Typical Southern Ocean scenario—a very deep depression. No sail for two or three days, or down to just storm jib. Steering was by pilot as it was definitely too dangerous to be on deck. I suffered several knockdowns—it was pretty much a survival situation.`



J.P. Mouligne

When picking the right speed for running, the key is to adapt to the sea conditions. If you are going too fast you can bury the bows and maybe pitchpole. To slow and you get the full force of the breaking wave on board.

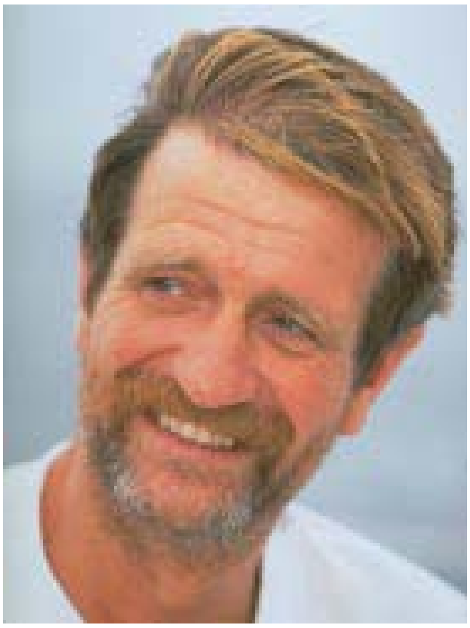
I am always on the autopilot. It steers plus or minus 10 degrees, and I watch the wind and waves and steer from below.

I like to go as fast as possible, then regulate sail area to maintain appropriate speed for conditions. It is best to go slightly slower than the waves in dangerous conditions. If seas are manageable, I go flat out; in 45 to 50 knots, three reefs in the main and staysail. If the wind is at 120 degrees apparent, and 50 knots, the main is down, and I use just headsails for control.

The worst blow I've been in was during the 1992 OSTAR single-handed race across the Atlantic. I was on my Frers 45, on the Grand Banks, and a very fast-moving front caught me with winds in the high 60s. Pooped severely, I was swept to the end of my tether—everything went over the side and I ended up towing warps accidentally!

Details are what matter most. In heavy weather it is hard to sleep, and simple things become extremely difficult (for example, try putting a sail tie around the boom in 60 knots of wind). Temperature has a big effect on how much you can take.

When the wind and sea shift after a front passes, you have to remain vigilant. You really need to pay attention to steering then, even though you are tired.



Mike Garside

Boatspeed is the key to staying out of trouble—just go! I never had occasion to take the helm in bad weather. The pilot always dealt with it, but would not have done so without the fast reaction time of the gyro compass. The faster we went, the straighter the course the boat steered.

I often sailed in heavy air at 17 knots—with bursts to the high 20s. No control problems, and I sleep okay.

In 35 knots of wind, I carry two reefs in the main and partially rolled genoa. In 40 knots, three reefs and just a bit of genoa. Above 45 knots, three reefs in the main and no headsail.

I never felt in danger during this race. The max wind was only 50 knots. The most memorable day was day four or five after Cape Town, South Africa. It was a good blow, seas began to flatten out due to the force of the wind. A real white-out. Clearly a low was coming with a falling barometer. I went as fast as possible, with true wind at 150 degrees, and apparent wind at 90.

The weather supplied by Ken Campbell of Commander's Weather Service was 60 percent accurate. The big picture was okay, but local was not very close. The Sat C EGC weather was more accurate for a given region. Weatherfaxes were only good from South Africa and New Zealand (they were excellent).

Brad Van Liew

In heavy weather I pick a speed which gives me good control and then adjust the sails in and out to suit.

At 10 to 12 knots I feel pretty comfortable and controlled in heavy weather.

I keep the boat on a broad reach, apparent wind at 150 degrees, and sail to the wind and waves from the new, fresh wind (as theoretically the older waves are diminishing).

In 30 to 35 knots of wind I have three reefs in the main and the furling staysail set. Above 50 knots of wind I put the main away and stay with roller-furled headsails. And then regulate the size as appropriate for control.

The most dangerous time is with cross seas when the wind begins to drop off. You are potentially undercanvassed (going too slow—hard to steer).

The biggest blow for me came a couple of days before the Horn. On February 19th the barometer starting dropping—1000, 980, 975 and finally 970. Then the winds started picking up. Forty, 45, 50 sustained and stronger in the gusts. By early evening it was 50 to 60 from the northwest and the seas were building.

By the 21st I was down to bare poles, being forced to run further south than I wanted. The boom was down on deck and there were extra ties on the main. The 22nd and the wind was blowing steady 60, gusting much higher. The wind shifted and the seas became horrific—40-foot seas (12.3m) from the northwest crossed the new seas from the southeast and hit the boat from two directions at once. Everything was white—snow, foam, hail all blowing across the deck. By the next day it was almost calm and I was playing Mr. Fix-It.

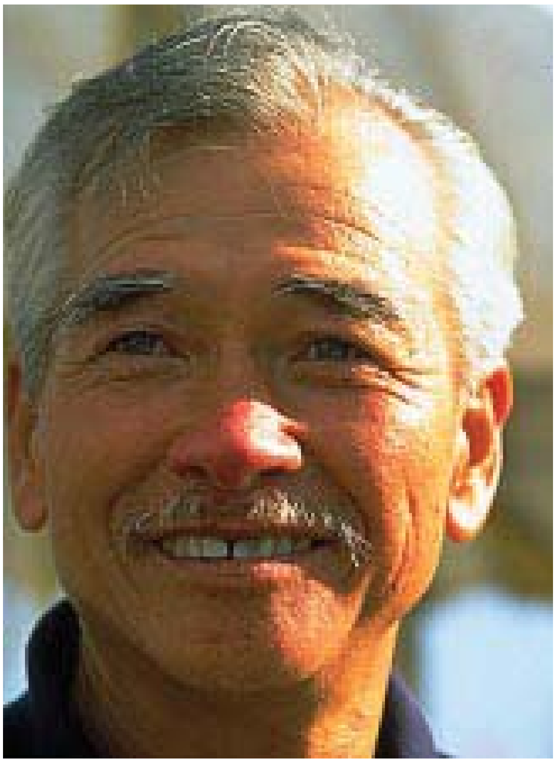
Victor Yazykov

Victor Yazykov had what may be the most interesting boat in the race. A super-simple, ultra-light displacement 40-footer (12.3m) that could give the larger Class II rivals a run for their money in some conditions. Like many of the other boats *Winds of Change* had a canting keel, forward, angled daggerboards, and twin rudders. However, the keel was well aft on the boat and Victor found that in some conditions, even broad reaching, she could steer herself quite well without pilot or vane, sometimes for days at a time.

His comments follow:

I go as fast as possible all of the time. As much as the sails can handle. My wind instruments have not been working, but anything less than 10 knots in a storm is too slow. I like to be at 12 knots.

The most dangerous period in the storm depends upon the sea state. Cross seas are what hurt you. The rest—wind, etc. is not so important.



Minuro Saito

Minuro Saito is the old man of the race. At 65 years of age, he has just completed his third solo Around the World race. He has sailed his Adams 50 (15.2m) more than 170,000 miles.

Yet with all of this mileage, much of it in areas capable of producing extreme weather he says he has never hove to and never runs with warps. As you can see in the photo, this is much more of a cruising-style yacht than the boats we've been looking at previously. While they are stripped out, minimum weight, minimum freeboard flying machines, Minuro's yacht, from a design standpoint, would fit well into anyone's cruising plans

When Minuro is running off before big storms he lets the autopilot handle the steering chores in less than 60 knots of wind. Once the breeze gets over this, he handsteers.

When it comes to the correct boatspeed, he lets the boat find a natural groove, letting her go at her own pace. As with the other competitors he says the worst conditions are caused by the waves coming from the side after a frontal passage.

Neil Petersen

The Around Alone Race was really divided into two sections—the hot rods designed especially for the race, and the adapted traditional cruiser-racers. Neil Petersen was right in the middle of the latter, and while these boats could not compete with the specialists, they still made seamanlike passages around the world. Neil's comments follow:

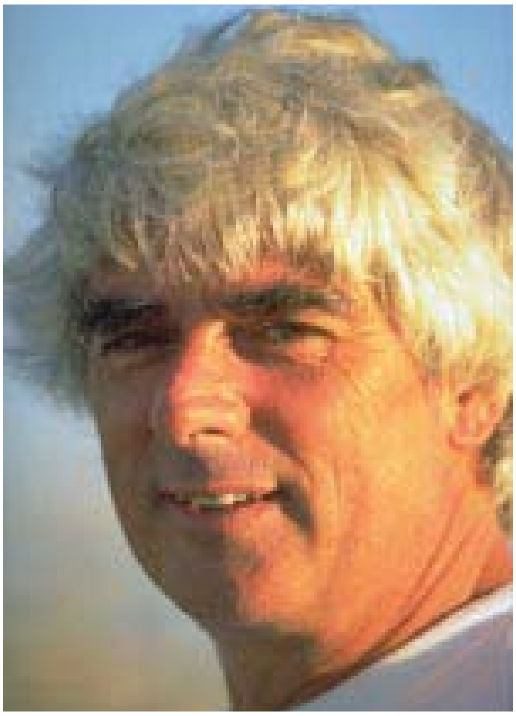
I watch the barometer, cloud cover, and in particular the sea changes and wind strength and direction to get a feel for what is coming. To find the low center I start with the forecast, and then use the barometer to update the forecast for timing the approach of the low.

I don't like to heave to—I prefer running with the storm. I do not like sea anchors, but I have tried warps with some sail on to steady the boat.

When it starts to blow I drop the main very early and go with headsails, using the Monitor windvane to steer. I drop the main at 40 to 45 knots, and go with half to one-third genoa. In 45 to 50 the genoa is down to 20 to 25 percent. At 55 I am down to bare poles.I try to keep the speed between 6 and 8 knots.

The most wind I've seen is 77 knots and this approach seemed to work well. With bare poles there is enough windage so we go fast enough for steering control. I try to pick an angle which will get me out of the storm as quickly as possible.

The worst blow was in April 1999, 300 miles west-northwest from Cape Horn. From 0100 to 0600 the winds were 60 gusting 70, low clouds and rain. The storm was not forecast. It was pitch black at night and very large seas. The windvane could not really handle and I hand-steered much of the night. I was surfing at 14 to 16 knots under bare poles. I got so cold that I had to let the windvane steer and during this time we broached and were knocked down a number of times. I was quite frightened, but suffered no damage. The seas calmed down quickly once the winds died off.



Neil Hunter

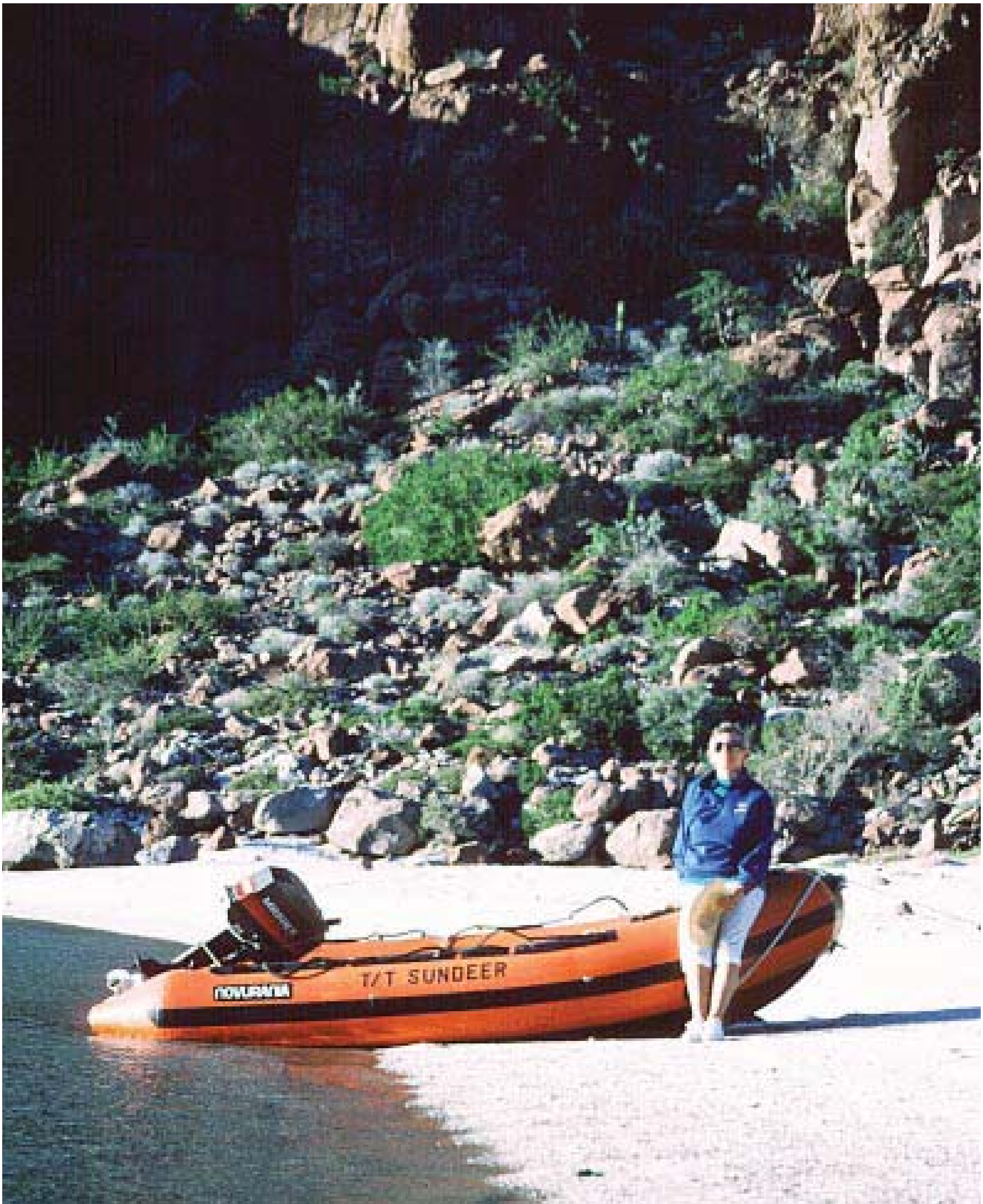
The weather forecasts we have received in all have been very unreliable. They tend to predict the worst scenarios just in case it might happen rather than what is most likely to happen.The best signs of approaching weather have been clouds and the barometer, and occasionally large ocean swells.

In the strongest winds so far I have just dropped the mainsail, rolled the genoa, and gone with the storm staysail. I have a sea anchor and drogue aboard but have never as yet had to use them.

When I run before big winds I use both the Monitor windvane and autopilot. With the vane I keep the wind at 60 degrees to remove the risk of crash jibing—or rather reduce the risk (in all the races to date I have had five to ten).

Cross seas after the passage of the front are annoying and there are often a lot of wave thumps. I prefer to slow the boat down in big winds to prevent crash jibes which with this fractional rig and runners can be nasty.

The biggest blow in the race for me was just after leaving Cape Town, South Africa. I was down around 38 to 40 degrees South, big seas and 40 to 50 knots of wind. Ran before it with triple-reefed main and hand-steered for a while. Touched 16 knots boatspeed! After dropping the main and putting up the storm staysail the pilot handled the steering very comfortably.



Obviously the singe-handed racers love what they are doing, otherwise they wouldn't do it. However, we prefer to take our solitude in quiet anchorages, where it is warm, and there's a beach nearby to explore.

PPL

Rick Tomlinson

When Help Is Required

There is a long tradition of sailors helping other sailors in distress. There is also a tradition of governments mounting major rescue efforts for stranded mariners. This all makes for interesting stories in the media.

The focus of the story is typically on the boat and crew in trouble. They are at risk of course, but so are the rescuers—whether a ship passing by, a Coast Guard helicopter on an over-water flight, or the crew of a search-and-rescue fixed-wing aircraft.

In our opinion the rescuers recieve too little commendation in the media, and in many cases, far too little consideration from those who request their help.

The modern yacht is an amazingly strong structure, able to withstand huge amounts of punishment from the sea—typically more than the crew can take. In most cases, when folks request rescue or take to their life rafts, their boats are later found intact.

There are many cases, some of which we've discussed already, where the occupants of the life raft are lost, and the yacht is later found intact.

The final issue is the risk of the rescue itself. If the rescue is taking place in heavy weather, the risks to rescuee and rescuer increase exponentially.

The point we are trying to make here is that the decision to request outside assistance carries a huge responsibility—to those on board the boat in trouble, as well as to those being called upon to render assistance.

It is often more prudent to sit tight, work through the current difficulties, and make the physical and mental effort required to keep your boat afloat. In many cases this will entail less risk for yourself than a helicopter winch-off, or a transfer to another vessel.

In the following section we will go into some of the practical issues to be faced when making such a decision. You will find a number of stories about boats requiring help and how they coped. Their lessons are hard-won—take them to heart.

Top photo: A British Coast Guard rescue vessel heads out on a mission. These little ships are designed for the worst Mother Nature can dish out, and are manned by some of the best seamen in the world. They are capable of rolling 360 degrees and coming back right-side up. If anything could get you back, it would be one of these vessels—but their dispatch is not without risk, as the long honor roll of those who have given their all to save fellow mariners will attest.

Left photo: Thierry Dubois on the upturned hull of Pour Amnesty International in the Southern Ocean.

Rich Wilson

Many people consider the west-to-east passage around the Horn the "easy" route. Certainly in the days of square-rigged sailing ships, this was the case. But a weatherly vessel making the east-to-west passage has the advantage of being able to hang out to leeward of the Horn, on the east side of South America, in the lee of the land and mountains, and choose the time to venture into the Pacific.

When you take the west-to-east route you are travelling with the weather, but are also at its mercy. Under your lee is the inhospitable shore of Chile, and every decision you make is colored by its proximity—even when shore is hundreds of miles to leeward.

We want to start this section about heavy weather rescue with one of the most incredible sea stories we've ever heard.

It is a tale of seamanship of the highest order, quick and clear thinking under duress, and an amazing confluence of fortuitous events—without which there would be no one left to tell this tale.

This saga is about an attempt to break the extreme clipper *Northern Lights*' 76-day, six-hour record between San Francisco and Boston.

During 1989, five boats took a crack at the New York-to-San Francisco passage. The east-to-west record finally fell to Warren Luhrs and his monohull *Thursday's Child*. Before the dust had settled, the 60-foot (18.4m) Shuttleworth trimaran, *Great American*, had set a new record. Aboard for the passage was Steve Pettengill.

Rich Wilson had been dreaming about clipper ships and Cape Horn since childhood. He had gotten into the multihull game in 1986 with a 35-foot (10.7m) Newick trimaran, which he sailed back and forth across the Atlantic, winning his class in the OSTAR Race in 1988.

Rich had a background in education. While serving as trustee for two marine-oriented educational foundations, Rich conceived an idea to mate his two interests—why not take a crack at the clipper ship record, and involve school kids from around the world in the voyage? This hands-on approach would allow school children to vicariously experience some of the wonders of being at sea—the heavens at night, dolphins diving in the bow wave, geography, meteorology, and navigation. This could be a great learning experience for the kids back home.

Travecrest Seaway, now *Great American*, was what we would term a second-generation trimaran. Her floats (amas) were narrow and v-shaped by today's standards. She had a modest 40-foot (12.3m) beam and sported a 72-foot (22m) fixed aluminum spar, conservative in both section and sail area. At 8 tons she was stoutly built.

Rich acquired the boat and in the bargain got Steve Pettengill to stay aboard to update her gear, and then to help sail her back to Boston in the record attempt. Considering Steve had just sailed 15,000 miles around the Horn in the opposite direction, you could construe this as a vote of confidence in the boat.

The "Easy" Way Around

Rich and Steve left San Francisco on October 22, 1990. Rich picks up the story from here:

We got down to the equator very quickly, and kept the boat moving until we were well into the South Pacific. We were running pretty much straight down from San Francisco, along 126 West longitude.

About 2,000 miles from Cape Horn, we were flying the spinnaker and starting to align our approach for the Horn. The breeze started to pick up from the northwest and we got a brutal spinnaker wrap around the headstay. It took three hours to get it cleaned up. This was on a Friday.

Throughout the weekend the breeze continued to increase: 25 knots, 30, 35 through Saturday. By Sunday it was blowing 35 to 40 knots, and the seas were 15 to 20 feet (4.6 to 6m). The wind was still in the northwest, and the barometer was holding pretty steady.

Monday morning, the breeze was now blowing 40 to 45 knots from the west-northwest, and we were down to four reefs in the mainsail and just a little bit of the staysail peeking out. We were heading dead downwind, east-southeast. I remember that morning we surged up to 19 knots on one wave, and then we put the main away entirely.

Our bow had a lot of buoyancy, and I had pretty good confidence that we weren't going to pitchpole forward. However, the deck was flat (not curved like the modern boats), and we were worried that if we stuffed into a wave, the deck would work like a shovel and just keep going.

So we started to drag warps off the stern. Initially we streamed halyards and extra sheets—five pieces, each about 120 feet (37m) long, straight behind the boat. This didn't have much impact, so we brought them in and tied figure-eight knots every 10 to 15 feet (3 to 4.6m).

The knots helped a little bit. We added three more lines for a total of eight, and it seemed like we had reached a critical mass. The boat really slowed down and became quite docile. We'd do 12 knots down the waves and 8 knots when climbing the backs.

The lines were all tied on different pieces of deck gear, so no single piece of equipment was excessively loaded.

We altered our course to a waypoint 60 miles south of Cape Horn, off the continental shelf so the sea state would be moderated. This put the wind 5 to 10 degrees on the starboard quarter.

Weather Data

We were getting weatherfaxes from Buenos Aires, Argentina, showing benign conditions. Bob Rice and Bill Biewenga were doing our weather routing and they weren't saying anything either.

The usual necklace of lows around Antarctica were in place, but none showed that they would have any impact on us.

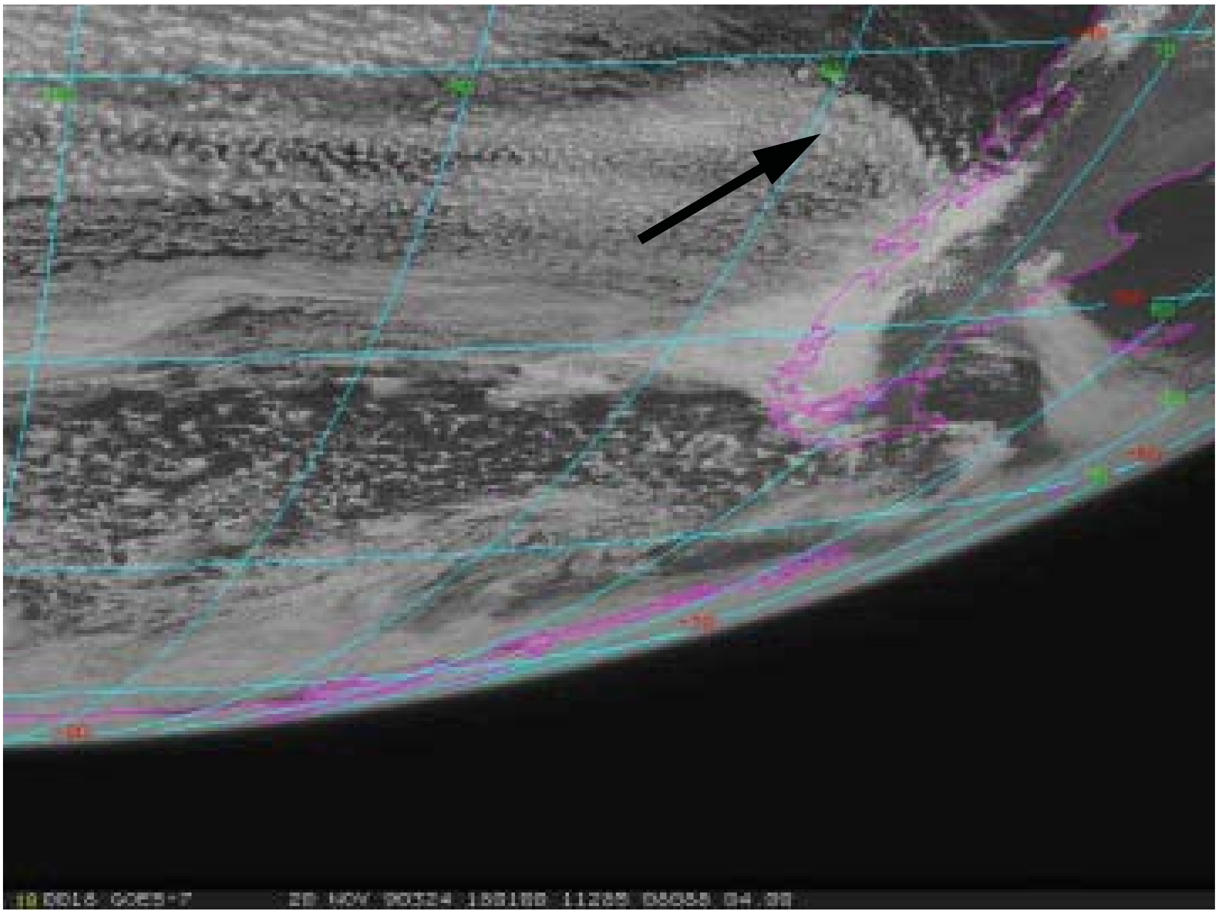
Monday night the wind was still blowing hard, but we got through the night without anything horrible happening.

We had a Robertson A300 pilot driving our big spade rudder and it was doing a good job. The v'd hulls were tracking nicely. We were trying to stretch the boat between the warps off the stern and had a little bit of staysail unfurled on the bow.

Tuesday the barograph was still pretty steady, but the seas were building. Tuesday night we got sideways on a wave, and the tip of the daggerboard dug in and the boat really lurched. We had the board up as far as it would go with our cockpit control lines. With the boat still running in 40 to 45 knots of wind, I went forward to put a halyard on the daggerboard so we could raise it further.

Wave after wave came surging past the boat, and you could really see the white crests in the dark. It was scary, and I was very cautious.

About midnight the barograph started to go down at a 45-degree angle and the wind began to build.



Here is the Tuesday satellite view of Cape Horn and the bottom of South America. The black arrow denotes the approximate position of Great American. The long horizontal cloud cover indicates "zonal" flow at upper-levels. Zonal flow is unstable, and typically breaks down to vigorous upper level troughing, which creates strong surface depressions. Today this process is better understood than a decade ago, when Rich and Steve were making this passage.

Wednesday morning we got sideways to another wave—only this time, the board didn't dig in and the boat slipped sideways nicely. It was pretty wild outside. Our upper spreaders were 52.5(16m) feet off the deck and the waves were even with them at times.

Wednesday afternoon the wind was up to 70 knots on our masthead anemometer, still in the west-northwest.

Wednesday evening the barograph was still going down—only now it was off the chart and the needle was dragging on the bottom of the drum. The wind was relentless. That evening, a little after dinner time, we saw 85 knots. There was never a lull—it just kept blowing.

Our speed was up to 12 to 14 knots, so Steve added six more lines bringing the total to 14, and our speed dropped off again to the 8- to 12-knot range.

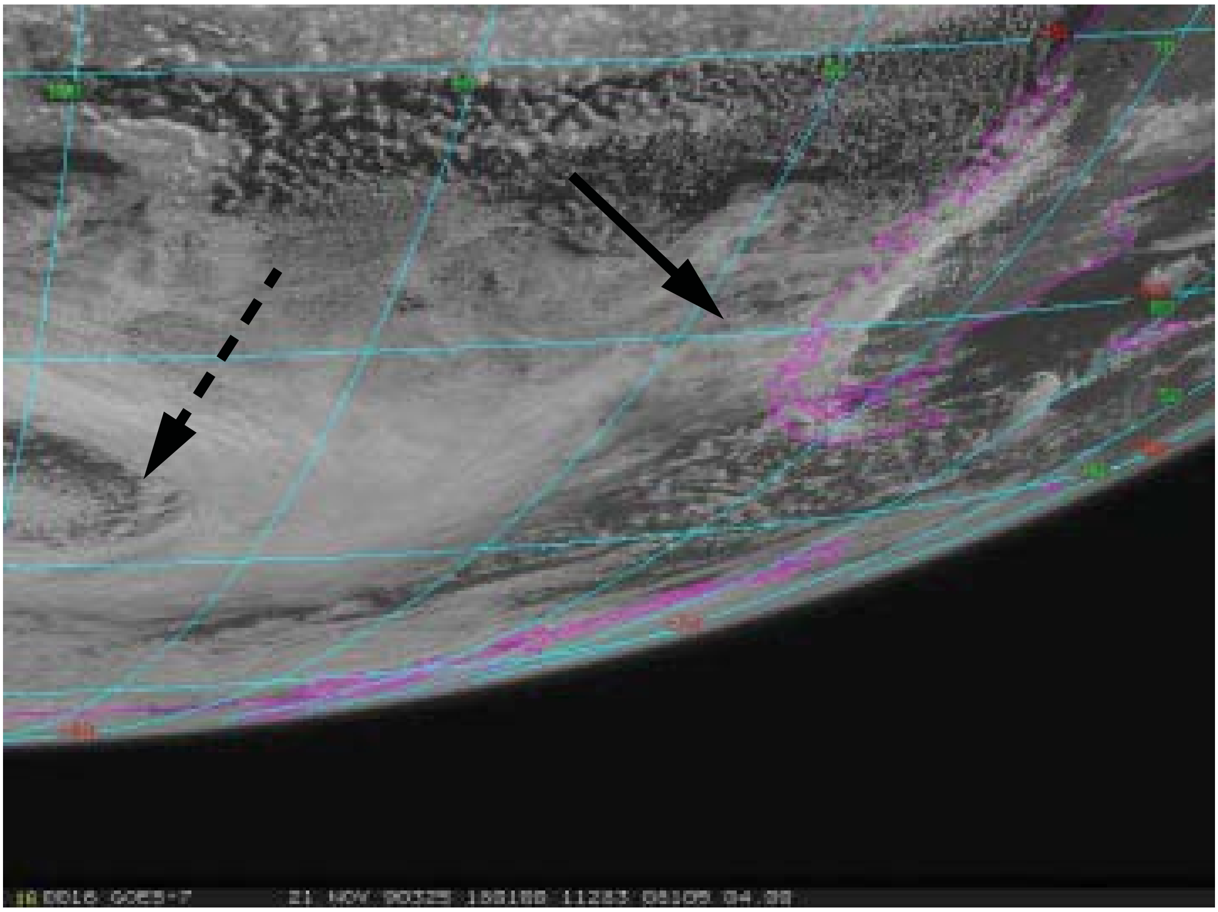
Sea State

The seas kept building; seas 6 or 8 feet (1.8 to 2.4m) behind us were towering 18 feet (5.5m) over our heads.

We were making just about the right speed—fast enough for good steerage and so as not to get pooped, but not so fast that we'd bury the bow. Despite the hellacious conditions, we were doing okay.

The boat was going along straight, only now the waves were 60 to 70 feet (18.4 to 21.4m) high, with an 18- to 20-second period.

Thursday morning, Thanksgiving day, and the barograph needle was still dragging on the lip of the barograph. We were about 400 miles west of Cape Horn, and 300 miles from the coast of



Chile to leeward. We were taking the seas on the starboard quarter, still at a 10- to 15-degree angle. We didn't want to run off further because we'd be on the coast of Chile within a day at this speed.

Bill Biewenga said we were going to have a 50- to 55-knot blow tomorrow. We told him it had been blowing 75 to 80. It would be nice to know what's going on!

About 1030 we got pooped by a breaking wave. It carried away the blades of the wind chargers and the SSB antenna.

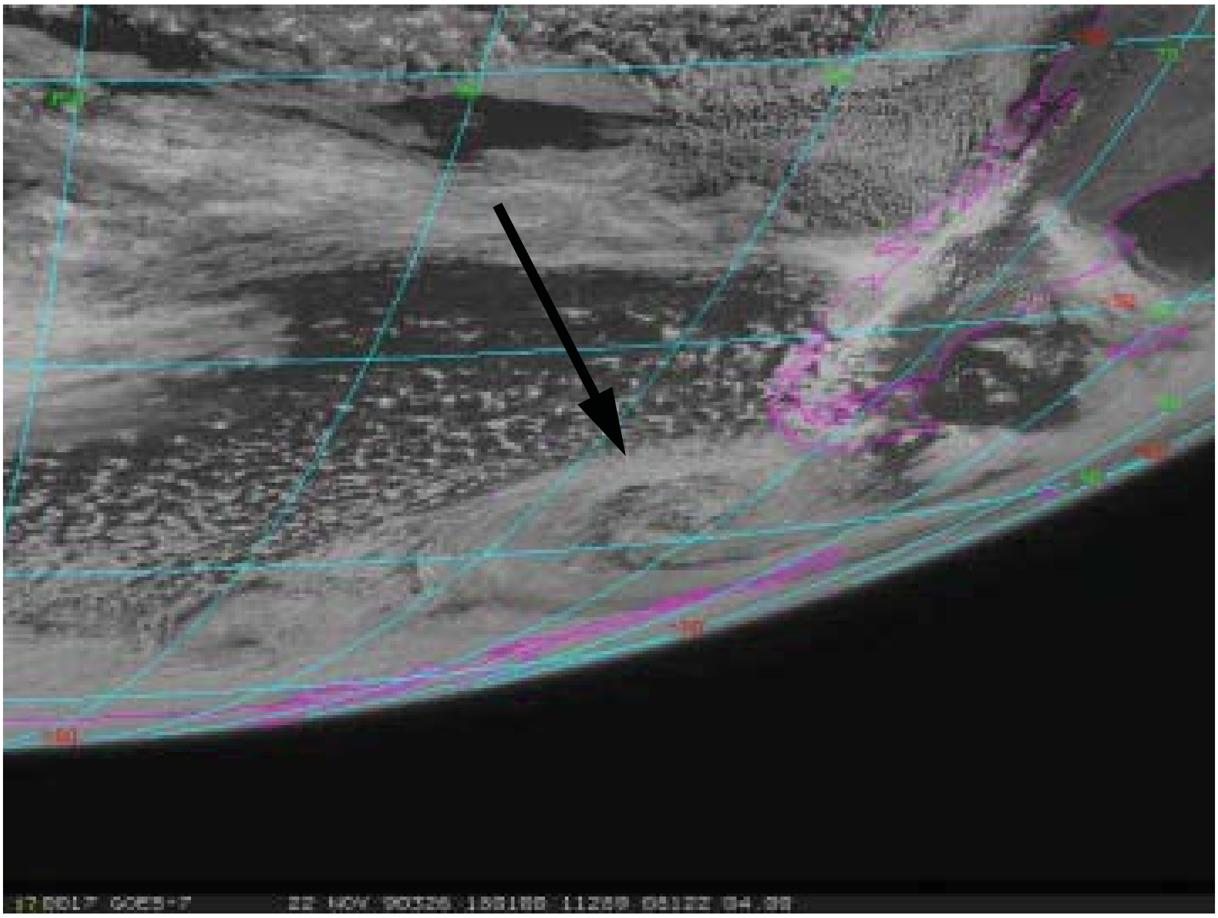
During the middle of the morning, we had a couple of sleet storms and ice on deck. Water temperature was 41 degrees Fahrenheit (5 degrees Celsius), air temperature was 40 degrees Fahrenheit (4.5 degrees Celsius) and the wind chill was 5 degrees Fahrenheit (minus 15 degrees Celsius).

A pin in the trim tab at the back end of the rudder worked loose. Steve went out to fix it and could work for only three minutes before his hands went numb.I went out and finished the job in another three minutes, after which my hands were also numb.

By early afternoon the wind switched to the southwest, and cross seas started to build. At this point we were at roughly 55 S, 79 W.

Looking at the barograph I got an idea to reset the needle, so we could see movement in the barometric pressure. We didn't need to know the absolute pressure at this point, just the rate of change. But I was tired, cold, scared, and didn't act.

Wednesday, 24 hours later, and off to the west (dashed arrow) we have what appears to be a large trough. We now know that well downwind (east) of an upper level trough is where depressions develop. So far there is nothing to indicate that this is going to be anything other than a "normal" Cape Horn storm.



Thursday, and the trough that we saw forming off to the west has moved at a 35- to 40-knot clip, developing all the while, and the depression center is now located southwest of the approximate position of Great American. At high latitudes this tight spiral is indicative of a baroclinic depression (what we call a bent back warm front). This is the most vigorous type of depression structure—one fully capable of developing winds in the 60- to 80-knot wind range over a wide area.

Low Pressure Tactics

At this point Rich and Steve were in a really difficult situation. With the swing to the southwest they knew that the low pressure center had passed them by.

The new wave train crossing the primary northwest wave system was creating unstable, breaking sea conditions—far more dangerous than what they had so far endured.

Ideally, they would like to run off more to the east, to get the seas and wind more on the stern. But because they did not know what was happening with the barometric pressure—remember, the needle was dragging on the bottom of the cylinder—they could not tell if it was safe to run off towards the coast of Chile.

If the breeze was going to drop off shortly, as often happens, giving up this ground to leeward may be the best choice of a poor lot. On the other hand, if the pressure was going to stay low, that would indicate a large depression and continued southwest storm-force winds, in which case sea room becomes an extremely valuable commodity.

Let's go back aboard *Great American* and let Rich continue with his story:

A wave came along and knocked the stern sideways. It was a cross sea knocking the stern over, and it left us lying abeam of the seas. Before we got straightened we got lifted up on another wave face, and then started to go over really slowly.

I was at the chart table and just grabbed on. We could feel the boat at the point of no return. It paused there, then we went gently upside down.

Stock Newport

Great American on her way towards the Horn. She does not look like a lot of boat to be tackling what is potentially the worst weather on the planet—off the pitch of Cape Horn.

Capsized

We were both standing on the ceiling—neither of us was hurt. Water was coming in the companionway and was about shin deep inside the cabin.

Our survival suits were right there along with the 406 EPIRB. We helped each other into the survival suits and then were sitting there looking out through the escape hatch on the starboad side and could see the starboard float was intact. It also looked like the rig was okay. And we thought "Hey, we've got a problem here!"

As the waves were surging into the companionway they acted like a piston compressing the air in the cabin, and our ears were popping. It was like going up and down really fast in an elevator.

We were now knee deep in water and trying to get ourselves composed a little bit—we were just sitting there trying to get over being stunned.

We picked through the debris trying to figure out what we might need later on.

About an hour later a second wave hit.

Steve had been a truck driver in an earlier existence, and he described the sound as ten tractor trailers piling up on the highway. I didn't hear a thing. I got launched upwards, was knocked out, and came to underwater. I was flailing away with my arms and legs; then I pushed off, and found I was still in the boat with the ceiling in the correct place-the wave had flipped us back right-side up.

I didn't know if the boat was going down or not. Steve was on deck yelling for me. I had to go through a bulkhead to get to him. The cockpit and decks were awash. The mast was in three pieces and the boom, which had been lashed on top of the house was also in three pieces.

At this point we were able to look around at the rest of the boat. We had ten watertight compartments, three in each hull. Each hull and cross arm was intact as far as we could see.

On the bulkhead amidships, under the mast, we found the ARGOS transmitter and triggered the distress switch.

We took it and some flares forward and lashed a sailbag over the hole in the deck where the mast had been.

Steve went to look for the wire cutters to get rid of the rig, and I began to pump out the forward sail locker because that's where we figured we'd stay.

We put the EPIRB on a food crate in the locker, and lashed the ARGOS transmitter with its solar cell to the mast stump.

At this point it was pretty late in the afternoon. We were both cold and tired, hunkered down in the locker room with the life raft, a crate of food and 6 gallons of water.

We had our survival suits on, but peeled them down to our waists, so our heads and chests were unprotected. We blew up our inflatable life jackets, which provided some insulation and warmth.

We figured we could last three days pretty easily. But if we didn't see anyone within a week, we were in big trouble.

Ships in this area transit around the Horn about once a week. If we'd just missed one it might be two weeks before the next was in a position to rescue us.

When you think about the conditions that Rich and Steve had been through in the past week, and then top it off with a capsize, leaving them alive but on a platform with virtually no freeboard, you have to wonder why they didn't give up.

We think most folks would have just sat back and accepted what the fates had dished out. Rather than trying to make a semi-dry and secure place, they would have given themselves up to the gods.

But not these two:

We were sitting there in the sail locker, hunkered down for the night. Steve was actually sleeping. We weren't worried about sinking. Flipping again was the real danger.

Our plan for the next day was to get the rig over the side, clean up the lines and sails, and then hang some sails over the bow to try to get it into the wind and protect the companionway. Then we could work on getting the hull bailed out and some sort of jury rig to get us back. We still had juice in the gel cell batteries to work pumps too.

About 0230 in the morning, I heard a strange noise—a low and steady pitch. At first I thought was the mast sawing on itself below us, and then I realized it must be man-made.

New Zealand Pacific

I popped my head up through the hatch and saw a ship about a half mile away. We figured okay, this is the second ship we've seen in 31 days, and here we are off the Horn. They might not know anyone was alive so we better contact them somehow.

We tried a pocket flare first and it didn't work. Then I got one of the larger handheld flares and ignited it to leeward.

The seas were still running 45 to 50 feet (13.8 to 5.3m) and we knew they couldn't put a boat over the side. Gradually we began to pick out the bow and stern and realized this was a very big ship. We figured they'd wait til things subsided.

Seeing the name and realizing it was a New Zealand ship gave us some confidence, just to know there were real seamen aboard.

We then noticed the ship coming towards us and that they were going to try to take us off.

A pilot door opened in the side of the ship, and we could see men rigging stanchions and lifelines—we knew these guys were not fooling around.

The ship was on our starboard quarter, with its bow pointed into the seas. It was coming towards us—the captain was triangulating the wind and seas perfectly—and the pilot door stayed exactly abeam of us.

The distance was decreasing—300 yards, 250 yards, 200 yards. Every once in awhile we could see the pilot door disappear. We learned later that the ship was rolling through 60 degrees and that solid water was coming in over the heads of the crew standing there.

We could see guys on deck, and there was one fellow in the bow, who we later learned was dumping oil on the sea to try making a local calm slick.

They'd shut down their starboard engine, so if we missed and drifted aft we wouldn't get sucked into the prop.

Steve and I discussed whether to wear our survival suits (which were hard to maneuver in) or our foulies. With the survival suits, if we missed and fell in we'd have a chance—if that happened with the foulies we'd be dead. We kept our survival suits.

Thirty yards and someone threw lines to us. They were thrown perfectly and snaked right across the main hull. I went for the far one and Steve got the closer one. We both tied the lines around our waists—an attachment point on the survival suit would have been a lot better. We worked our way over to the starboard pontoon. They had hung a ladder from the pilot door and netting from the rail.

Fifteen yards, 10 yards, 5 yards—the ship was handled perfectly. They just kissed the starboard hull right next to the pilot door. The boat touched once, we bounced away, and then came back again. There was no time to think.

I jumped for the ladder and Steve went scrambling up the netting. We scrambled like mad, as we knew there was only 20 seconds before the ship would roll the pilot door under again.

We turned around for a last look at the trimaran. The ship had a light shining on the deck. The stern was down but the bow was high and proud. She had defended us through two somersaults and was still intact.

The Captain went ahead on the engines and the trimaran started to drift away. We watched her go and that was the last we ever saw of her (she was found a year later, ashore on South Georgia Island, 1400 miles from where we'd capsized).

The chief mate asked if we were hurt and we told him no. He then said "You're on your way to Holland with us."

Rich and Steve found that their rescuer was the largest container ship afloat. She was 815-feet (250m) long, a Panama Canal-maximum 105 feet (32m) wide, grossing 62,000 tons.

Captain David Watt had maneuvered this huge vessel to within 6 inches (150mm) of where she needed to be in hurricane-force winds and seas.

The master and his mates told Rich and Steve that prior to this passage, they had been around the Horn 12 times and thought its reputation was undeserved. They'd seen much worse in the Tasman Sea between New Zealand and Australia—until this voyage.

Captain Watt said that in 40 years at sea, this was the worst weather he had ever seen. At one point, they had been travelling downwind at 21 knots and had been pooped by a sea, ruining a row of containers on the stern, which were 43 feet (13m) off the water. The ship's log indicated Force 12 winds, with 65-foot (20m) seas.

Rescue Cycle

An interesting part of this sea story was the nature of the distress communications, and what had to come together for Rich and Steve to be saved.

First, the 406 EPIRB had not been properly registered. Somehow it had gotten into the computer as an aircraft. When the distress message came down from the satellite it was sent to the air force control which looked at the position, said "this must be a mistake" and promptly forgot about it.

The ARGOS data got to the Search-and-Rescue division of the US Coast Guard. The looked up the closest ship on the AMVER (Automated Mutual Assistance Vessel Rescue) network, the *New Zealand Pacific*, and then contacted them on their Inmarsat A telephone.

Had the ship only had SSB, maintaining daily contact, they might not have gotten the call until they were 400 or more miles away.

As it was they were about 100 miles to the southwest, and immediately altered course.

When they reached the ARGOS position for *Great American* they could not see any sign of the boat.

They made another large circle and still didn't see anything. At this point one of the crew was getting a bite to eat in the mess and thought he saw something. He called another crewman over and stated "Look over there." The crew looked out, and the first man said "No, not out there, down there!" *Great American* was not 100 feet to leeward of the big ship.

They ran up to the bridge, notified the captain, and the rest is history.

Epilogue

Rich has some interesting thoughts on heavy weather tactics. The first is about the right type of boat. "I don't think any monohull would have survived the storm we were in. They would have been rolled many, many times."

The next issue is the right tactics:

I don't think we could have used a drogue in the conditions we were in. I don't know what we would have tied it to, and besides, there is no adjustment with a drogue. The knotted warps gave us the ability to add drag as we needed it.

We covered 700 miles in 60 hours with that 1200 feet (368m) of line off the stern and only got sideways four times.

The whole concept of the sea anchor is a touchy one as well. If you are in conditions where you would have to consider one of these, trying to get the boat turned around and headed into the sea would be very dangerous.

If I had taken the time to adjust the barometer, so we could see what the pressure was doing, we'd have known the low had passed us by and that things would be moderating. We then could have taken the decision to run in towards shore, bringing the seas more on the stern. Perhaps then we wouldn't have been caught by that cross sea which turned us broadside to the waves.

You will be interested to know that in January of 1993, Rich was back at it again, this time with *Great American II*. This time he made the trip from New York to San Francisco in 69 days, breaking the clipper ship record in the process.

PPL

ABANDONING SHIP

Rich Wilson and Steve Pettingill has no choice but to abandon *Great American*, considering where they were located. Had they been in any other part of the world, where conditions were bound to be more benign, after being flipped upright they could have easily pumped out the boat, tidied her up, and made some sort of a jury rig—indeed, as we have seen, they were contemplating such as they did not expect to be rescued so quickly.

A decade or two ago this would have been the reaction of most cruisers around the world. Stay with the boat, jury-rig it, nurse it home somehow. Part of this was due to a lack of insurance, perhaps a greater degree of self-reliance, and no secure means of communicating distress and position. Perhaps the best example we have of this in the book is the battle by the Smeetons and John Guzzwell to save *Tzu Hang*—and themselves.

When emergency locating beacons became available, the self-sufficient approach seemed to come to an abrupt halt. This change may have been due to less experience in the sailors—the "new sailor" came on the scene about the same time as the first generation of satellite navigators—while in the past, celestial navigation had always seemed to keep people from going cruising until they were well prepared. Or, perhaps sailors lost their drive for self-sufficiency once help was theoretically a push-button away.

Whichever, it seems that more people are giving up their boats these days in conditions where this would not have been the case a few decades ago.

Raphael Dinelli awaits rescue aboard the Vendee Globe racer Algimouss. He is 1,200 miles southwest of Australia and 1,000 miles north of Antarctica. He has broken his mast in a rollover during a major storm and the spar has pierced the cabin top. His activated EPIRB has brought an Australian P3 Orion SAR aircraft on the scene, from which this photo was taken. They have dropped him a pair of rafts (his was lost upon inflation during the storm). Minutes after he climbs into the raft the boat sinks.

Staying Aboard

As we've discussed briefly before, and shown in some of the examples mentioned (*Salacia*, *Winston Churchill*) going into a rescue procedure or stepping into a life raft from a vessel which is not in immediate danger of sinking carries with it numerous risks. Most of the people who died in the 1979 Fastnet Race (see page 604) did so in the "security" of their life rafts—and their yachts were later found afloat. A number of the boats abandoned during the Queen's Birthday storm in 1994 (see page 585) were later found floating or washed ashore many miles from where they were abandoned. In addition, if you are awaiting rescue, it is much easier to see a large boat than a small raft from the air or the deck of a ship.

What we are trying to say here is that the old saying "always step up into the raft" is correct. As long as there is hope of salvaging your boat, you are much better off working to the limit of your strength to achieve this goal, rather than to abandon ship and hunker down in the life raft. The odds, based on historical data, are much less in your favor on the life raft.

Twelve hours after getting into the raft, in the midst of the most desolate ocean on earth, Dinelli is rescued by English sailor Pete Gross, who has been diverted to look for him by Vendee Globe Race officials. Sailing solo and finding a raft in the middle of the ocean is an incredible act of seamanship.

Both photos PPL

Reducing Rollover Risk inside the Boat

In the 1979 Fastnet, and other heavy-weather scenarios where people abandoned their boats—or seriously considered this action—fear of additional rolling (after the first event) has been a major factor in the decision-making process.

Often this is because of injuries sustained in the first rollover. We've discussed in our preparation section (page **106**) the concept of securing the interior for a knockdown or rollover, and it might be worthwhile to go back and re-read this. You have a much better chance of coming through unscathed if the stove, batteries, chain, floorboards, fridge door, and other heavy gear stay in place while you and the boat are doing a 360.

Avoid the need to use the life raft in heavy weather by:
- ❑ Reducing rollover risks to crew in the interior.
- ❑ Maintaining alignment with the waves by active steering, or use of drogues.

Equally important is a place to stay where your body is protected, or at least movement is limited, during a rollover. Tight pilot berths with strong leecloths make the ideal cocoon in this situation. Of course this needs to be addressed well before leaving port (see page **630** for more data on interior safety and design).

Alignment with the Waves

The first rollover is typically caused by a combination of a larger-than-normal breaking sea, and misalignment with the wave. If you are maintaining a heading which keeps you at right angles to the waves, the odds of a wave with enough power to roll you are substantially reduced—probably by an order of magnitude or more. If you are beam-on to the seas, lying ahull, the probability of being in the wrong place at the wrong time increases dramatically.

Since the initial severe knockdown or rollover may have compromised rig or other critical systems, the very first order of business needs to be getting the boat re-aligned with the waves. If the rig is over the side, and the steering and/or engine are functional, then the rig should be cut away ASAP and the engine/steering used to head into the seas or downwind.

If controlling the boat is not possible and there is a parachute anchor or drogue aboard, then rigging one of these devices must be the first order of business.

Without this gear, the rig should be left attached by the backstay or headstay to help keep the boat into the waves and wind.

Raft Launching Considerations

We've heard numerous stories of rafts launched in heavy weather being torn from their painters and drifting off before the crew has time to get in. If you consider the drag on the painter of a towed dinghy, and then multiply this many times for the round shape of a raft and add for ballast bag drag, you can see how the forces are high. Throw in some wave action and it becomes apparent that the raft and distressed vessel will not long stay tied in heavy going.

Hypothermia is a major risk once aboard the raft. The combination of mental or physical shock, wind, water from waves, and ambient temperature can conspire to rob your body core of precious heat. This leads to slowed mental processes, poor decision making, and is often directly or indirectly the main factor in whether or not you survive.

There are two ways to combat this problem. The first is by staying dry, a difficult-to-impossible task in heavy weather in any small vessel, let alone a raft.

The second is to assume the worst and prepare for it. Some form of survival suit or immersion suit (which can be worn on deck as foul weather gear) will make a huge difference in the odds of making it back to dry land.

We think the approach taken by the crew of *Winston Churchill* (see page **169**) makes a lot of sense—not launching the rafts until just before they are required, when the vessel is settling into the water. As it floods, the mother ship's speed is reduced, and there is much less drag on the raft during the time it is attached by painter.

Soft-pack rafts stored below have a history of beginning their inflation process before they are through the companionway and on deck. This is probably because the raft painter, the means by which the inflation mechanism is triggered, becomes tangled and is then accidently pulled.

If you have a soft pack raft stored below, take care with the painter on the way up to the deck.

Abandon-Ship Bag

Most vessels have an abandon-ship bag or bags ready to go. These are as critical to your survival as are the contents of the raft itself. Assume that the raft is going to be capsized and the contents thrown about—and prepare in advance for this eventuality.

The very first order of business once the raft is launched is to securely tie all of the accompanying gear into the raft.

To assist in this process it is very helpful if the abandon-ship bag and other items all have lanyards attached, ready to be put into use.

Raft Capsize Risks

You already know that most life rafts are subject to repeated capsizes in moderate breaking waves, let alone what is found in survival storms. There are only two options. One is to utilize a raft with a toroidal buoyancy chamber, like the Givens or Switlik offshore models. The other is to have a strongly made and well secured para-anchor or drogue, to which the raft is attached.

However, most of the stories we've heard about raft drogues indicate they typically do not stand up to the load placed on them.

Righting a Capsized Raft

You need to know how to right your capsized raft, in the dark, in horrendous conditions. Attending a safety at sea seminar, with in the water demonstrations of this process, is a step in the right direction.

Staying with the Raft

The need to stay with the raft seems axiomatic. However, if the raft is being capsized, this is easier said than done. Handholds are typically not abundant on the inside of the raft, and the raft is often capsized with little or no warning.

For this reason it seems prudent to us to grab your safety harness as you are abandoning ship, then clip the tether to something stout on the raft.

This way, if you are tossed out during a rollover, at least you will still be with the raft.

Green Hornet

Situations requiring rapid abandonment of a vessel are rare. There is usually a substantial amount of time to prepare. But what happens when the time isn't available—when the boat is rapidly going down and you have to react quickly, running on instinct as much as anything?

Jim Lott, the Marine Safety Officer in New Zealand who helped us ferret out details for some of the sections in the beginning of the book, was kind enough to forward the following data on *Green Hornet*.

The story starts with Kiwi sailor Brian Murray and the 1999 Melbourne-Osaka Two-Handed Race. The boat was his 36-foot (11m) Paul Whiting design, *Green Hornet*. Co-skipper and crew was Gordon Mann, an old friend of Murray's and an experienced offshore sailor.

The following account starts five days after the start of the race from Melbourne, Australia. They are sailing in the Tasman Sea, headed north.

Running with a Gale

Gordon Mann picks up the story:

We had the wind up the bum (stern), three reefs in the main, and were still surfing down the waves. I'd buried the bow up to the mast and we'd slewed around. I was washed out of the cockpit, hanging on by my harness and broke a shackle. I didn't know if my arm was broken or just badly bruised. After that we lashed the helm and lay ahull, but we were still doing about 2 or 3 knots. Brian brought the life raft back to the cockpit and secured it to an eyebolt by the companionway. Prior to that it had been tied securely up by the mast under sails—because you're not going to need it, are you?

Overnight, the spinnaker sheet must have worked loose and formed a big loop under the boat, which got caught round the prop. We couldn't start the motor, so the sheet must have caught one of the propeller blades. We decided to wait until morning to sort it out.

Early the next day (April 23, 1999) we were hearing on the radio that other boats were having problems. One had retired, some were getting knocked down, so we decided to head into Sydney, get the engine checked, and see how bad my arm was. If it was broken, we couldn't keep on racing, but if it was just bruised, we'd go on.

We were the most easterly boat and closest to the low, so going away from it had to be good. We sent out a Security to let people know what we were doing. I estimated the waves at about 40 feet (12.3m), but we were fine.

Brian Murray:

Any sail up was too much sail; we'd had storm jib and trysail, but even the trysail alone was too much. We were still doing about 5 1/2 to 7 1/2, to sometimes 8 1/2 knots and it was too fast. Four knots motoring would have been about right.

Gordon was down below off-watch, sleeping on the sails on the floor. I was on the helm; I'd put my wet-weather gear on without a second jersey underneath and was cold. I decided to let Gordon rest as he was coming up on watch soon, but I should have put more clothes on straight away.

Knockdown

About 0900 this huge wave, a 70-foot-high (21.5m) vertical wall of water, came in the midst of all the other waves. It was huge—the sky was blanked out. It was just this perpendicular monster. It threw me off the bloody tiller, I was flying through the air at the extent of my harness, and I watched from above as the boat was thrown about 30 feet (9.2m) through the air. We were moving at about 40 miles an hour. I saw the boat go ker-smack! into the trough. It took out the starboard bulkhead and most of the cabin top. I came crashing down on the boom. That's when I took a big chunk out of my shin and broke four ribs. I was absolutely dazed.

Gordon Mann continues:

I was sleeping down below on the sails. I'd left my wet weather gear and harness on which is unusual for me—I always, always take them off. There was a terrific crash. I thought we'd been knocked down. I've done about 26,000 offshore miles—you know it's eventually going to happen. The boat was half full of water, so I was looking for a bucket to start bailing.

Murray:

After the initial impact, it was Gordon standing there yelling at me that got my attention. I was dazed. I hadn't hit my head, but I had the wind knocked out of me. I was like a stunned mullet. He looked terrible; his arm was hanging by his side all bent and it looked about the right shape for something you'd clean a toilet with. He had a deep gash on his forehead going right back; I thought he had split his skull, and he had this huge hematoma sticking out the side of his head the size of a tennis ball.

It was a broken boat. Every time she rolled she was a big scoop just taking in half a ton of water. I thought, "Shit, I've got about two minutes before she sinks."

Mann:

Brian told me to send a Mayday, but I couldn't see the radio. The cabin side was all pushed in, then I saw the radio through the window—outside the boat. I didn't even bother trying to get to it. The water was pouring over the gunwale into the boat like it pours into a submerged bucket. Brian handed me the ARGOS beacon from the back of the boat and started inflating the life raft. He told me to grab the EPIRB and the grab bag and I said, "I can't, I'm injured." I really thought about it. I was literally about 3 feet (1m) from the 406 EPIRB. I thought, "If I put down the ARGOS, get in behind the leeward bunk, get the EPIRB out of the bracket, grab it—what if I can't get it and then I've lost the ARGOS as well?" The EPIRB would have been better because it's a continuous signal, whereas the ARGOS only gives off a signal every six hours, but they would still find us. It was just going to be slower, that's all.

Murray:

I knew I had to get the life raft inflated; it took ages. Then I had to get Gordon in the life raft. I just threw him in; I was going to get the 406 EPIRB from down below, but the water was already lapping at the engine cover. The life jackets were down under the water too, and the bag with all the flares in it. I thought, "Shall I get it? No...Yes..." Then, "Nah, f___ it." The grab bag was under a cushion and a locker, with all the flares in it and food and water. There was no way I could get it.

The life raft was drifting away from the boat and I thought, "I'm going to drown here." So I swam along the tether rope to the life raft. We had both seen a documentary on the Sydney-Hobart Race, and one thing that really came out of it was the emphasis on wearing a safety harness, so we both had harnesses on and we attached ourselves as soon as we got into the life raft. We tied the ARGOS beacon to Gordon.

The boat was floating nose up (due to the watertight bulkhead installed in the bow before the race), floating as far back as the mast. She stayed afloat for a while, but it was obvious that the vessel was going to go down.

About five minutes after we got in the raft, we got rolled and had to right it. I got trapped underneath it. I got ropes tangled around my feet. That was the only time I really felt conscious of panic.

I decided I wasn't going to tell Gordon what he looked like. Obviously he knew about his hand, but he didn't know how bad the gash on his head was. He never mentioned his injuries once, not even once.

We went like that for about an hour when all of a sudden we heard this tremendous roar and got rolled again. We had opened the bag of emergency supplies, flares and water, but when we got rolled, we lost most of it.

That time the wave took off half the canopy so we were really exposed. I was so cold, because I only had light gear on under my wet-weather jacket. We got rolled about three times altogether I think.

Mann:

In the afternoon, I got some biscuits out of the emergency rations. I broke one in half, but Brian said he couldn't even chew it, it was so hard. It tasted like cardboard but I said, "Look, it's in the life raft, it must be good for you." I thought it might be easier if I soaked it, so I did and it swelled up—it was a sponge for bailing! We had a good laugh about that.

Rescue Procedure

The emergency signal from ARGOS beacon was picked up around 0400 GMT on April 23. CLS ARGOS in Toulouse, France phoned Sandringham Yacht Club about an hour later, 1400 local time, who later confirmed *Green Hornet* had not checked in for the sched at 1800 that evening and alerted Australia SAR in Canberra.

Murray:

We saw a plane late that day and we had one flare out of the pack in the life raft, but it came apart in my hand in the dark and there was no way to put it back together.

Mann:

The plane had latitude and longitude from the ARGOS and found us on the second turn. It let off a siren, waggled its wings, and flashed its lights on and off. It just stooged around keeping an eye on us, saving fuel—they weren't doing a search pattern.

Lessons:

- ❑ Even though most situations requiring one to take to a life raft involve significant amounts of time in which to think and react, there are occasions when things happen fast. Having an abandon-ship plan worked out in advance will pay big dividends if you are ever in a position to put it to work.
- ❑ Even though *Green Hornet's* crew were in the South Australian Current, a relatively warm body of water, they were extremely cold. Gordon Murray had on foul weather gear, but just light clothing beneath it. This makes a good case for storing thermal clothing, which is efficient when wet, in the abandon-ship bag.
- ❑ As with many other stories, the crew in the raft were capsized by waves—further proof that if you are headed into breaking seas and want a good raft, it is better have a toroidal-style ballast chamber.
- ❑ Wearing a safety harness while in the raft, and keeping it attached, will pay dividends.

Righting a capsized life raft:

- ❑ Most rafts have a capsize strap, similar to that used with small catamarans, which is used to pull the raft right-side-up from a capsize.
- ❑ When righting the raft, place your feet on the side containing the inflation bottle. This way you are not fighting the weight of the bottle, and you are not at risk of being hit on the head as the raft drops back right side up.
- ❑ Do not climb on top of the raft—this creates a vacuum between the raft and water surface, which makes it difficult to right the raft.

Gordon Murray:

"I look back on it and there isn't anything I would have done differently at the time...(The only regrets were that) I didn't have the 406 EPIRB in the companionway because I didn't like the look of it there, and I would rather make the grab bag more accessible. I always thought the boat would hold up through anything. The only thing I was scared of was it being picked up and dumped on its side, and that's exactly what happened."

We never got seasick. I never thought I was going to die. I'm a project manager and I like solving problems. It was just a series of problems that had to be solved. My arm couldn't be solved so there was no point talking about it. We weren't going to die of thirst, we weren't going to drown. If we got washed out of the life raft, we never got any further away than the length of our tethers. We were getting into our own strategies. We looked after each other. Every time we got dumped on by a wave it took about an hour to bail out, but it was important to keep as dry as possible. I breathed down inside my jacket to keep up the warmth of my body. The ARGOS has a "man alive" button which I pushed every hour, dit-dit, to show there were two of us alive. We tried to make a radar reflector from some aluminum wrapping around a food pack.

Murray:

We talked a bit. We gave each other a hug occasionally for reassurance and for warmth. About 0400 I was shaking with cold and we were singing songs from *Pirates of Penzance* to help keep us warm. We called it Opera in the Raft.

Finally we saw another plane about 0700. We'd been in the life raft about 21 hours.

Mann:

These enormous waves would roar past us like an express train, it was like being in a shooting gallery. About a quarter of an hour after we saw the second plane, I heard voices. I knew I wasn't delirious. There was so much noise: the fabric flapping, the waves, the wind...We pulled the canopy aside and there was the 143-foot (44m) *HMS Warmambool* just sitting there. It was like magic.

Murray:

It looked like the *Queen Mary*. Getting on it was another story. One minute we were looking at the keel, and the next at the deck.

Mann:

I told the crewman I couldn't climb, so he dropped down a collar and Brian grabbed the monkey's fist. They must have been playing it like a fishing line, because the raft was going up and down but there was never any danger of letting go the collar. They pulled me up on deck. I put my feet down and burst into tears.

Murray:

When we got onto the ship, the guy who had the job of medic had just finished his first aid course two weeks ago and about the worst thing he'd ever seen was his mate's cut finger. When we had a look at us, he didn't know what the hell to think, but he looked after us. He's resigned from his role of medic since. We went down and saw them afterwards, gave them ten cases of beer and some champagne. They saved our lives.

ALLEZ CAT

Let's turn now to a different sort of a story. This one involves many of the elements we've been discussing—heavy weather, problems brought on by structural defects and/or lack of maintenance, and abandoning ship.

We've been familiar with *Allez Cat* since her launching. In the olden days when we raced multihulls, *Allez Cat* was a regular competitor of ours. Interestingly, at one point in our sailing careers we were bringing a similar CSK-designed cat back from Mexico, in adverse conditions, and suffered similar structural problems—although with less severe results.

Phil Schlund picks up the story from here:

It was in October 1992, when my partner Silvia and I, having looked around in European yacht harbors without much success, traveled to California in search of our ideal sailing craft. We were looking for a fast, seaworthy cruising catamaran, to sail across the Pacific and Indian Oceans to the Maldives, where I had been working as manager of a dive shop. Earlier, I had skippered some monohulls across the Atlantic Ocean, and I had a fairly good idea of what my ideal cruiser should look like. We found it in L.A.'s Marina Del Rey, and it's name was *Allez Cat* It was love at first sight! Built 1963 in Hawaii by the famous multihull designer Rudy Choy and CSK as a blue water racing-cruiser for the 1964 Transpac Race, the 43-foot by 18-foot (13.2m by 5.5m) catamaran combined beautiful lines, a sloop rig with a 55-foot (17m) mast, and all the accommodations you need when sailing for long periods offshore—and last, but not least, we could afford it.

Phil and Silvia made their way along the usual route through Mexico, to French Polynesia, across the Pacific, and then to New Zealand. After flying back to Switzerland to replenish the cruising kitty, Phil returned to New Zealand to work on the boat while Silvia stayed at work in Switzerland.

After two months of long hours, *Allez Cat* was looking very spiffy, ready to go to sea with a new coat of paint and upgraded systems and interior.

Putting to Sea

Phil picks up the story again, leaving Auckland for Australia. He is sailing with another crew while Sylvia remains in Zurich.

The weather was fine and we did quite well at the beginning, leaving the Hauraki Gulf between some islands of the Hen and Chicken Group. We were still quite close to the North Island, heading straight north, with the wind blowing from about west. Heading north is a great thing when you are so close to the Antarctic, and we could hardly wait to be back in the tropics. During the first 25 hours we covered 220 miles, and I was very happy about the boat's performance.

The second day surprised us with a moderate 20 knots from the northwest, increasing. When the headwind freshened up to 30 knots, I decided to give our brand-new Para-Tech sea anchor a go. What a great thing to have! It's easy to deploy: a little fiddling around with tether, chain, floating line and chute, and your boat swims steady with the bow in the wind, riding the waves.

Northwest winds in this part of the world indicate you are downwind of and below the center of a low pressure system. If the low is moving towards you, and if you are not in is direct path, the wind will gradually back to the southwest.

However, if the wind stays in the same direction, as it did here, there are two possibilities: one is that you are directly in the path of the center. The second is that a compression zone has developed, with a high pressure system below your position.

You can identify the situation with the barometer. A steady barometer indicates a compression zone. One which is dropping, as in this case, means the low center is moving towards you. In either situation the wind can build, as it did here.

We repeated the game twice in the next few days. The wind was mostly north to northwest. Slowly but steadily we made our way to the north.

For some wicked reason I was unable to receive the weather comments of the Keri Keri Radio Net, but I hoped to pick up John's Net when coming closer to Norfolk Island. In the meantime, the northwesterly gale grew stronger, building up some nasty cross seas with the prevailing westerly swell. On the fourth day, the deteriorating conditions caused me to abandon the idea of sailing straight to Australia. Remembering the good time Silvia and I had spent at Vav'au, I altered course for Tonga, intending to sail from there in the tradewind-belt westwards for the Torres Strait. I still think that this was a good plan, but unfortunately it made no difference with regard to the end of our journey.

Storm-Force Winds

On July 13, because of very confused seas and strong north-northwesterly winds, we had to deploy the sea anchor once more. The steep, and at that time "only" 13-foot (4m) high seas pounding on the wingdeck were causing some delaminating, but that was no major drama yet. A little repair session at Tonga and 2 pounds (1 kg) of epoxy would take care of that, we thought. But first we had to get there! The barometer was falling, not very fast, but it was unambiguously falling. We had been hanging on the sea anchor for about 55 hours, when the northwesterly storm increased to 60 knots while the seas were growing up to a towering 20 feet (6m). By that time, our wingdeck was badly smashed, and I was really getting worried. No multihull likes 20-foot (6m) confused, breaking cross seas! But in a way, I was still hoping for the promised, nice 25 knots from the south.

Then, suddenly, it happened; the port tiller-bracket came off the rudderstock! It was Saturday, July 15, at 1000 NZST, position 29-29 S,176-26 E. Without the tiller on, the rudder slid out and was hit by a huge wave, when it was halfway out. The hull was not strong enough to withstand the resulting extreme physical forces, and the 1.8-inch (45mm) stainless steel shaft broke out of the boat, tearing a leak of about 1 foot by 4 inches (30cm by 10cm) in the port hull, naturally below the waterline.

Now the situation was really alarming. Olaf was pumping frantically, whilst I was trying to plug the leak with towels—without success. Sixty knot winds and 20-foot (6m) monster waves are a bad scenario for repairing a leak anyway. The port hull was flooded within 10 minutes. I had no intention of abandoning ship, but we inflated our dinghy (10-foot model with roll-up aluminum floor) just for safety's sake, loading it with the already activated EPIRB, food, water, handheld VHF, GPS, compass and covers, not forgetting the container with the cash, documents and papers. For buoyancy and warmth, we had put on our diving suits.

Allez Cat's sterns were completely submerged by now and the boat, still hanging on the sea anchor, was offering the waves the already badly damaged wingdeck. I shall never forget those nasty, crackling noises! When it became obvious from the boat's movements that *Allez Cat* was going to capsize very soon, we launched the dinghy, intending to fasten it to the back of *Allez Cat* in such a way that if she capsized or broke apart we and the dinghy were safe and would be able to return to the yacht once things began calming down. The maneuver was interrupted by a gigantic, clear blue mass of water that I would not call a wave, which washed the dinghy with Olaf and myself out into nowhere. We capsized several times, losing most of our equipment—except, luckily, the EPIRB, some food, and the watermaker. *Allez Cat* had disappeared—we never saw her again. Good-bye, *Allez Cat!*

"I never had the intention to abandon ship. The basic idea was to tie up the dinghy with crew on *Allez Cat*'s stern and avoid damage during the inevitable capsize of the yacht. We lost contact to *Allez Cat* because of the chaotic situation in the cockpit while the waves buried the flooded port hull. Once we were in the water without a line to *Allez Cat* there was no chance to swim back, since *Allez Cat* was still on the parachute sea anchor."

In the Dinghy

It took us quite awhile to realize what had happened, to stabilize our drift, and to learn how to surf the "big ones" with our small craft. We had no means of sending a Mayday, but fortunately the EPIRB distress-signal was picked up by an Australian station in Canberra, about 1,300 nautical miles away. They informed the New Zealand authorities, and an aircraft of the NZ Air Force found us at about 1400 NZST—after approximately four hours. Neither of us will ever forget that magic moment when we saw the airplane, flying very low and waggling the wings to show us that they had seen us! Then the crew dropped a five-person life raft—providing better shelter from the cold wind—so accurately that we could reach it quickly with just some paddling. I wish I could thank the pilot and his crew personally for the magnificent and risky job they did, most probably saving our lives. For the moment, I thank them here and now. God bless you, boys! And that goes for the chaps in Canberra, too.

Our position was about 500 miles from New Zealand, and I figured that we might have to hold out in that black-and-orange, cold, wet plastic thing for quite a while. We still had some food and water and some of those pills that make you so sleepy and your stomach so calm, but when the night fell, we were really freezing in our wet diving suits. It was terribly stormy and lonely out there in the dark, but we hoped that the aircraft might have been able to contact some ship in the vicinity that could rescue us. And really, somebody up there must have held both thumbs up: at about midnight, we were picked up by the Red-Chinese freighter *Shou Chang Hai*, which had been plowing through the heavy seas of the South Fiji Basin, somewhere to the north. It was another of those unforgettable, miraculous moments when we noticed the lights of the approaching vessel. Captain and crew of the freighter took good care of the shipwrecked sailors—it was a marvellous feeling to know that we had survived thanks to the efforts of those unknown seamen. *Shou Chang Hai* took us to the Australian port of Newcastle, about 1,200 nautical miles to the west, where we disembarked on Friday, July 21st, 1995, after 12 days of an incredible adventure. We had saved nothing but our lives and the diving suits we wore. No passport, no money—just nothing.

The Next Time

Phil is now back in Switzerland, working with high-performance racing cars on the Formula One circuit. Via e-mail we asked him what he'd do differently the next time, and to clarify a number of issues:

"We stabilized the dinghy with our weight, and surfed the waves with our weight in the stern. The dinghy capsized instantly when beam-on.

"Capsizing was not such a problem but we lost equipment with every capsize of the dinghy (the survival gear was tied up in the dinghy but not well enough), and submerged for approximately 90 seconds. In the water, dinghy and we both spun around and we had to hold our breath until the buoyancy of the dinghy and our Neoprene wet suits brought us to the surface. Righting the dinghy was easy."

We took with us into the dinghy EPIRB; GPS; VHF (handheld); hand-operated watermaker; emergency container with fishing gear; medic first aid; signal mirror; bailer; food in plastic containers (from the fridge); money; and documents. It was difficult to secure the equipment in the dinghy when capsizing in the big breaking waves and we lost the money and the documents, VHF and GPS. The EPIRB was secured to my body and we both were secured to the dinghy with safety harnesses.

We used 7mm Neoprene wet suits (water temperature was about 59 to 64 degrees Fahrenheit/15 to 18 degrees Celsius). The wet suits with the Neoprene boots, gloves and hood were sufficient. The only problem was that we lost the boots, gloves and hood.

The pilot of the aircraft dropped the life raft very accurately but the sea conditions and the wind made it very difficult to paddle to the life raft, to get in, and to transfer our equipment. The plastic of the life raft was orange at the outside but black inside. It was possible to bail out the life raft but there was always a little water inside so we were wet and cold all the time. The wind protection was very comfortable.

There was no risk to capsize in the life raft due to the water ballast underneath and a drogue. We were four hours in the dinghy and eight hours in the life raft.

For my next boat I think I will have kick-up rudders to avoid damage on the rudder system when using the parachute, as well as a better emergency container with special attachment brackets in the dinghy.

Generally, I still think that a life raft is too heavy on a multihull and that this weight jeopardizes the yacht's safety. Since a multihull should not sink even when the boat is turned over, the yacht itself is a far better life raft then any plastic inflatable tent. *Allez Cat* was not well prepared enough for an emergency situation and escape hatches, non-skid paint, and safety lines underneath the wingdeck must be fitted on any multihull.

Wingdeck clearance must be as high as possible and is far more important than headroom in the cabin. Modern high-modulus composite materials like pre-preg carbon fibers, Dyneema or Kevlar with honeycomb cores are making a big difference in the construction and design of fast multihulls.

I'm looking forward to going offshore with a fast catamaran one of these days but before: Work, work, work......

Calling for Help

We've seen now how there is frequently little time in which to call for help. As key crew may be tied up on deck it makes sense to have several crewmembers skilled in operating the SSB, VHF, and EPIRB. (Recall that on page **472** *Wandering Star* was rolled because Birch Kelly had to leave the boat on windvane while he called the Coast Guard—nobody else on the boat could operate the SSB radio.)

When you get in touch, the very first piece of data to communicate is the vessel's position. Coordinates should be given with latitude first, then longitude, with the north-south and east-west at the end ("We are at 33 degrees 41 minutes North, 110 degrees 16 minutes West").

If in extreme danger, it works best to call "Mayday" three times, then give the vessel name, followed by the position: ("Mayday, Mayday, Mayday. This is the sailing vessel XXX, at position YYY.")

After calling, it is necessary to stop the broadcast and listen for a couple of minutes. If nothing is heard, begin again. It is absolutely necessary to stop transmitting so that others can contact you—there are lots of examples where panicked sailors call over and over, blocking the frequency or channel so that no one can respond.

We've seen so many instances of difficulty in communicating between rescuers and stricken vessels that by now it must be axiomatic that a waterproof, portable VHF, with a good supply of high-quality batteries, is essential. We feel there should be one easily accessible on the boat, and a second in the abandon-ship bag.

What Is Your Position?

With GPS we take for granted knowing where we are down to a fraction of a mile. But what happens if you lose all electronics? The first issue is to make sure you keep a periodic written record of your position. This way, if a crisis arises, and you don't have an electronic positioning system operational, you have a written record of where you recently were. We always make an hourly record in our log—just in case.

Most people today carry a portable GPS or two for emergencies. However, some of the heavy weather we've been discussing comes with intense lightning storms. If you happen to take a direct (or even a near) hit, all electronics may be lost—including portable gear.

Which leaves you with a sextant and a nautical almanac. The almanac is best kept in a waterproof bag.

There are several simple methods of drying electronics gear. One is using alcohol which evaporates, taking water with it. However, alcohol has smelly fumes, and can promote seasickness.

An alternative is one of the many commercial aerosol cans of drying chemicals. If your electronics ever get a good soaking, two or three of these cans (stored in a sealed bag so they don't rust out) will be worth their weight in EPIRBs.

Using SSB

Using an SSB or ham radio requires a degree of familiarity. Many sets have antenna adjustments, frequency selections, and a host of other adjustments. If you don't use this gear on a frequent enough basis that its operation is second nature, the odds of operating it properly under stressful conditions are remote. As with anything else, you need to be familiar with how it works.

Using VHF

VHF, of course, is a much simpler form of communication. Select channel 16, make your call, and wait for a reply. But VHF has limited range, typically a maximum of 60 miles (although with atmospheric ducting, we've communicated 400 miles).

Is your EPIRB properly registered? If not, valuable time will be wasted once the signal is received.

When you purchase the unit, it comes with a registration card, which must be filled out and returned to your national authority. Most countries require a periodic update of boat data. If the boat (and EPIRB) change ownership, a new form must be submitted.

Robert Patton is Chief of Operations for US Mission Control Center for COSPAS-SARSAT—the folks who are responsible for this process in the US.

Robert says you can register online by going to www.sarsat.noaa.gov

Or in the US call (301) 457-5430, or fax (301) 457-5406.

It pays to check periodically to see that the data is correct. You can do this at the numbers above by giving your EPIRB identification number. If you don't have that, give the vessel name or the name of the owner.

Losing Radio Antennae

Since many calls for help originate with a severe knockdown or rollover, there is a good chance that radio antenna will be lost. Preparation for this eventuality should be a part of getting the boat ready to head offshore. SSB radios work quite well with a "dipole" antenna, without the use of a special tuner, if the dipole is simply laid out on deck. A dipole should be in the emergency kit for the boat, set up for the most reliable frequency in your area.

Spare VHF antennae are not a bad idea either, and if the rig is lost, the VHF whip antenna with coax attached can be lashed to a stanchion, then plugged directly into the back of the VHF transceiver.

Even if you don't have specialty gear for use as a backup antenna, you can make an SSB antenna from spare wire if the length is correct. Check with your local electronics technician for suggested for antenna length (and/or for several dipoles).

Keeping Electronics Dry

We've seen over and over again cases in which boats have had their radios and other electronics put out of action by saltwater. Sometimes the culprit is the mere proximity to the companionway or a port. At other times it's the water rolling around in the interior after a severe knockdown.

Several things can be done to mitigate these risks. The first is to avoid mounting critical electronics where they are likely to be dripped on, or where spray can get to them. While this seems like common sense, you need to think about it in the context of the discussion we've been having—extreme weather. Very few boats are set up this way. Opening ports—which are always subject to leaking or damage—should also be avoided.

Think about the water which finds its way below during a rollover. Gravity keeps the water low in the boat, and the rolling motion of the boat will have the water sloshing up the hull sides. To avoid getting wet, mount key electronics (i.e. communications gear) as close to the centerline as possible. If you are laying out an athwartships nav table have the SSB radio at the inboard edge. Put "weather-resistant" gear outboard.

EPIRBs

EPIRBs are wonderful devices, especially the 406 models, and now the even more precise 406-with-GPS. For these to operate properly they must not be washed overboard, should have a fresh battery, and must be registered correctly. Given the example we've seen of an improper paper trail at a government bureaucracy with *Freya*, it probably makes sense to follow up with the proper authorities to make sure your unit is correctly registered.

Queen's Birthday Storm

We want to turn now to the Queen's Birthday storm of 1994. The meteorology of this blow is covered in detail in *Mariner's Weather Handbook* (starting on page 229). What we'll be discussing here are some seamanship lessons that can be learned from the blow. (For additional information, the drama of this event has been chronicled in detail in Tony Farrington's *Rescue in the Pacific*. The tactical details have been addressed in Kim Taylor's *1994 Pacific Storm Survey.*)

To recap briefly, a fleet of 35 yachts was making the annual late fall/early winter migration from New Zealand to Tonga and Fiji in the tropics. A small tropical low formed, then moved south by southeast as an upper level trough moved in across the Tasman Sea. The circulation pattern of the trough was such that it brought cold, dry air in from the high latitudes to the south, which when combined with the damp, warm air of the low, formed a "bomb." This was a classic baroclinic/bent-back-warm-front type of depression, complete with lightning displays, extremely squally weather, and a central eye.

A number of issues led the official forecast bureaus in New Zealand and Fiji to under-forecast the event.

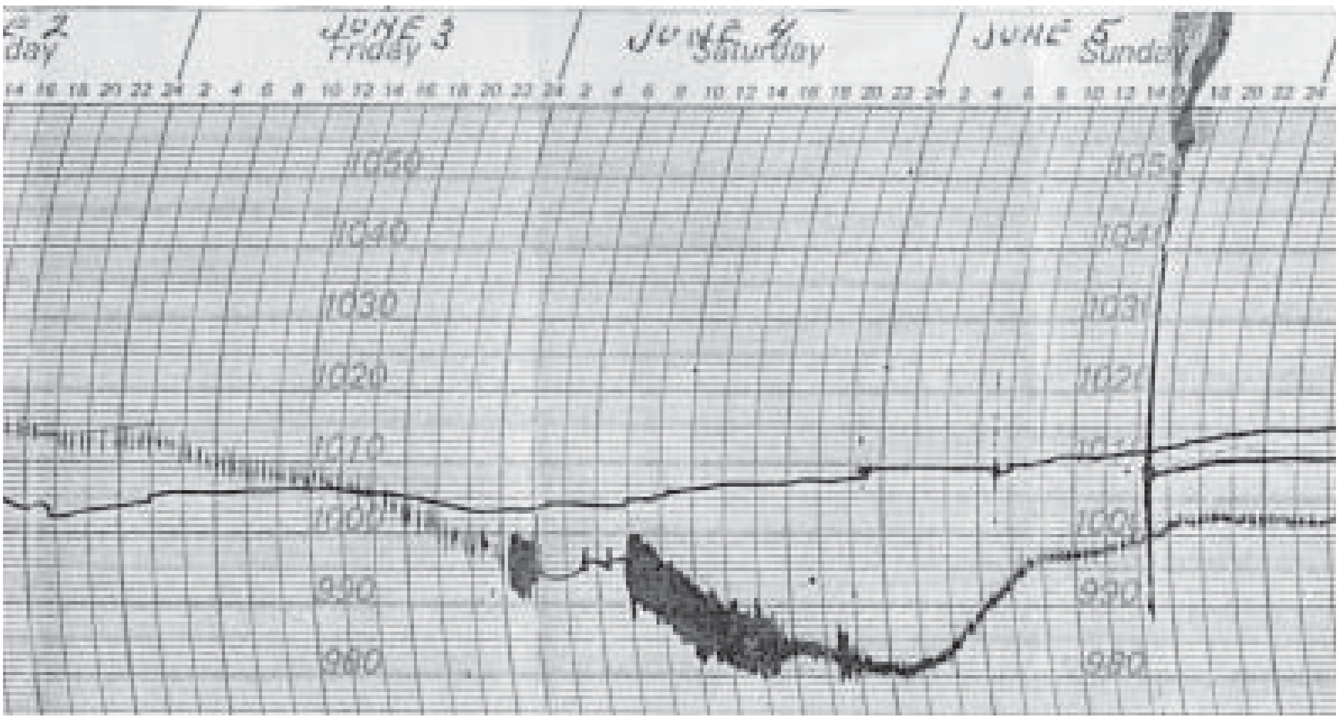
Of the 25 to 30 yachts in the area, seven required rescue and an eighth was lost.

Relying on Official Sources

Some of the popular press and survivor accounts gave the impression that the storm was a special event, and that nothing could have been done to avoid this system.

We feel strongly that this was not the case. There were numerous warning signs that the risk of a major event was there—you just never know when one of these systems will hit full stride and develop its potential (which is fortunately a rare occurrence).

The barograph trace (below) is from the New Zealand survey vessel Monowai for the period during the Queen's Birthday storm. The thin line (on top for Saturday, June 4) is from the previous week. The thick line (below) is for the storm. The thickness is the result of the ship's being hammered by seas—common on yacht barographs, but not something one would expect to see on a ship!



Royal New Zealand Navy

Almost all of the boats relied on two basic sources of information. One was the official forecasts, broadcast by fax and over SSB. There was a period during which boundary forecast areas between Fiji and New Zealand kept the storm from being adequately reported. However, between the tropical development to the north, and the high building over and to the east of New Zealand, there was plenty of data hinting that a major blow could unfold.

Jim Corenmen was in the fleet headed for Tonga aboard *Heart of Gold*. His comments:

"The advice (from Keri Keri Radio) was well-meaning but inappropriate. It was clear to us (from the fax charts) that the high was stalled over NZ, that the south side of the low would be the bad side in spite of the usual rule, and we needed to get our asses north. I am not sure why they advised staying put. But they were mostly donating their time, were not professional meteorologists, and did not have anything more than the fax charts that all the boats (should have) had. So the message that we take home is not that Keri Keri did a bad job, they tried their best; but rather that it is essential for everyone to take responsibility for their own weather forecast, to get the fax charts and forecasts and spend the time to learn what it all means."

We don't want to belabor the point, but as we've said before, official forecasts must always be taken with a grain of salt. They can be reasonably accurate on a large-scale basis; but for your own patch of ocean, they can be significantly off. This is why it is so important to understand the basics of forecasting. With this skill, the sailors could have recognized what was happening and taken early evasive action.

The second source of data came from Keri Keri Radio, in the Bay of Islands. A wonderful service for cruisers making the annual passage back and forth between the tropics and temperate latitudes, it had been run on a volunteer basis for many years. The couple who ran Keri Keri Radio collected position and weather reports from traveling yachts, and passed along the official forecasts to those unable to receive them directly.

These folks were not trained meteorologists, but had some feel for the weather based on years of talking to yachties making passages. (They've since retired.)

In the video *Rescue in the Pacific* you can hear yachts calling in and asking for advice and being responded to by Keri Keri Radio. Unfortunately, from our perspective, much of the tactical advice was wrong—dead wrong.

We don't say this to criticize those who were trying their best to help. What we want to point out is that you should make your own decisions based on the abilities of your crew, vessel, and on your local weather.

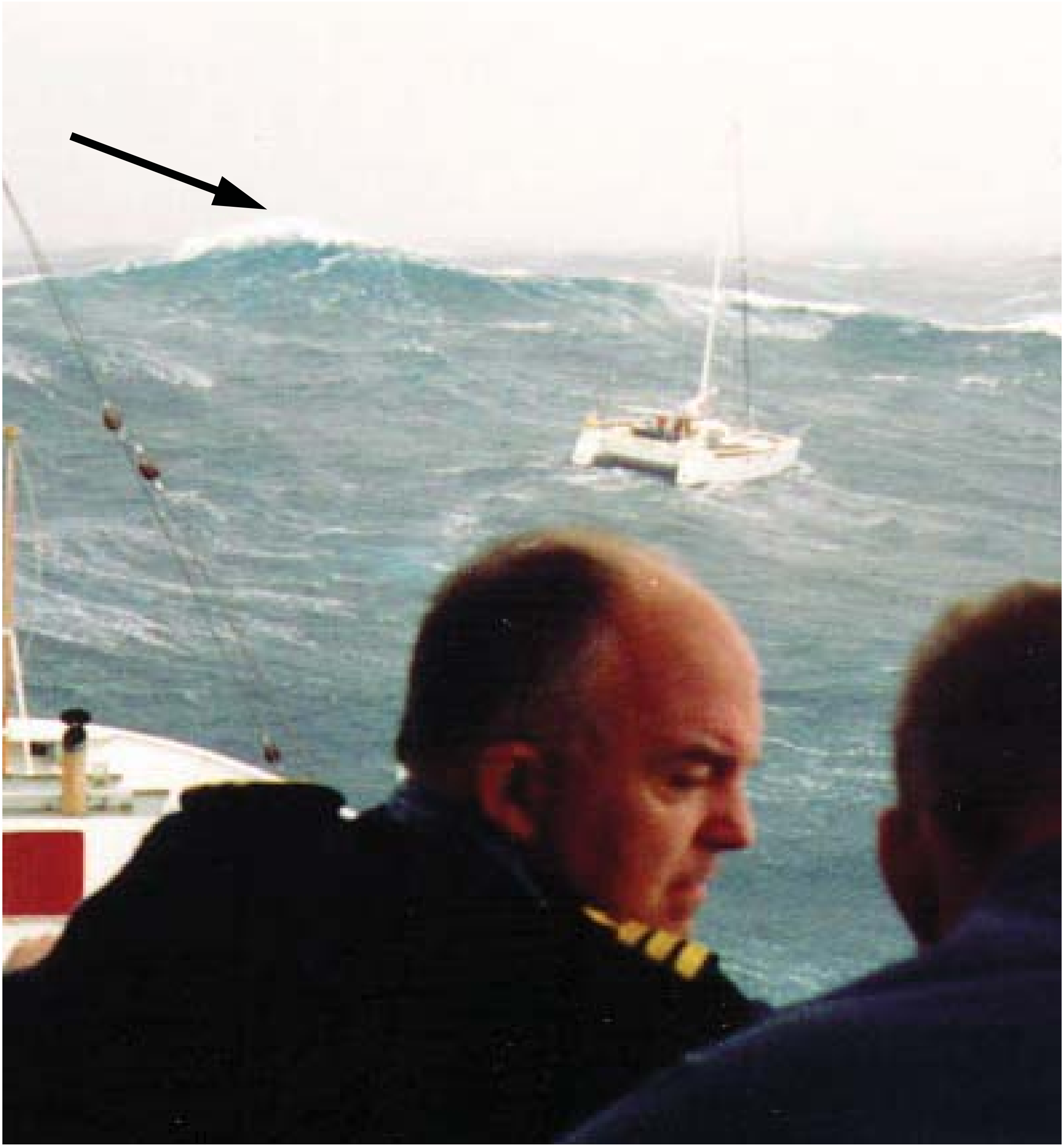
Relying on outside experts, even when they really are expert, can get you into deep trouble. We need only recall *Great American* with Rich Wilson and Steve Pettingill, who had two of the finest forecasters in the world working for them, to see that even the best can be off at times.

Ramtha

We've touched briefly on the story of *Ramtha* at the end of the section on multihull-specific tactics (page 399). We want to show you more of these photos and discuss the decision to abandon her and the risks this entailed for her crew. We hope you will bear with us for another batch of photos—we are using so many because severe-weather photos are hard to come by. The value of this group of photos, taken over a short period of time, is that by studying the sea state carefully, you can learn a great deal—the easy way, without getting your feet wet.

As you examine these photos, keep in mind that they are taken from a height of 36 feet (11m). In addition, the camera lens tends to flatten things. These are shot from the bridge of the New Zealand survey vessel *Monowai*.

Ramtha is a 38-foot (11.7m) Roger Simpson-designed cat on which Australians Robyn and Bill Forbes had been cruising for seven years.



Lindsay Turvey

View from the bridge as Monowai closes with Ramtha. Check out the sea (arrow), which has just passed Ramtha.

They had been hand-steering for four days, keeping a careful watch on the waves. They did not have the power to punch into the seas, and running off had them going too fast, so they were reaching across the seas, trying to dodge the breaking crests. They had been sailing with a triple-reefed mainsail and no jib. However, the main had blown out so they were down to bare poles—which of course reduced maneuverability.

On several occasions, as waves broke close to the boat, they almost flipped. When they heard the *Monowai* calling on the VHF and they were debating whether or not to get off the boat, a wave broke right over them—then their steering failed. This had happened many times before, including the second day out from New Zealand.

All photos Lindsay Turvey

These photographs offer a real feel for the chaotic conditions that existed during the height of this storm.

It is always difficult to second-guess what gets you into a situation like this, but two things are certain. If there had been an easily used trysail aboard, and if the steering had not failed, the Forbes probably would not have considered rescue.

Lindsay Turvey, a very experienced sailor who took most of these photos, has this to say: "The June storm was bad in that the large waves were much higher than average, a result of the confused sea. The wind came in gusts like squalls that lasted several minutes. That's when the tops came off the waves and caused all the problems. Those that managed to miss the squalls didn't get such a fright. I suspect the pockets of strong wind were quite isolated. Those that got rolled or scared out of their wits were unlucky to get in one of these pockets of increased activity. The photos don't do the sea state justice."

"In short, (these are) probably the worst seas I've seen, but it's really hard to tell as my perspective on Monowai is nothing like being on a yacht. Being on a yacht is probably less awe-inspiring, because I just tend to get on with the job and stay focused on the things that really matter. That doesn't leave many useful memories, unless you sensationalize it a bit by filling in the gaps. On the ship you see a bigger picture."

Lindsay Turvey

We are looking almost directly upwind in this photo. Ramtha is drifting with her bows downwind, about 120 degrees to the wind and seas. The Forbes are in the water, (arrow) being pulled across to Monowai. They are wearing wet suits, life jackets, and safety harnesses, and are tethered together on the line to Monowai.

Things to consider for an in-the-water transfer:

- ❑ Ability to keep your mouth above the water so you can breathe.
- ❑ Protection from scrapes and bangs while being hauled up the side of the rescue vessel.
- ❑ Control of the transfer line as seas and wind push you and the rescue vessel apart.
- ❑ Positioning yourself so that no injuries occur if you are jerked off the boat, before you are ready, by wave or wind action tightening the transfer line.

The decision to abandon *Ramtha* was not an easy one. Aside from it being their home, there was an extremely risky transfer to *Monowai* to consider. It was far too rough for *Monowai* to consider launching their big RIB (rigid-bottom inflatable). The only possible way to make this rescue happen was for the *Monowai* to fire a line between the two boats, then pull the Forbes through the sea from *Ramtha* to *Monowai*, and hoist them aboard.

With *Ramtha* almost out of control, and *Monowai* having difficulty maneuvering in the huge seas, it took several passes before they could get close enough to attempt a line transfer. After numerous failures, a connection was finally established and the Forbes were almost ready to go. They were wearing wet suits and life vests.

They slipped into the collars on the end of the transfer line and made ready to jump overboard. However, before they had a chance to jump, *Monowai* rolled away from them, the line tightened, and they were dragged into the sea.

You know by now that they were pulled to *Monowai* then hoisted aboard in amazingly good shape—a remarkable outcome. It bears repeating that *Ramtha* was found several days later in good shape and towed to Tonga.


Royal New Zealand Navy

Here is another view, taken just a minute or so later in the transfer. The Forbes are at the bottom center of the photo above (white arrow), and you can just make out the tow line. That they survived this transfer unharmed is amazing.

Alternate Approaches

Now let's consider the alternatives. If the Forbes had a drogue system on board, they could have deployed it off the stern, adjusting the bridle so that they were angled with the seas on the diagonal, or keeping the seas directly astern, whichever seemed to work best. This would have controlled the boat, keeping it from surfing too fast on the wave crests, and if on the diagonal, maintaining maximum stability versus the waves.

Based on the data we've collected on parachute anchors, it is doubtful that a standard parachute system would have worked under the loads encountered in this sort of sea state.

And if the worst occurred and they were capsized? Assuming they had survival suits aboard, equipped with strong harness points, they could have tethered themselves on the wing of the upturned boat.

Faced with the same decision as the Forbes, either of these approaches would have been more palatable to us than taking the risks associated with the transfer to *Monowai*.

Multihull preparations for the best odds in worst-case scenarios:

- ❑ Several types of drogues and/or parachutes so a selection can be made of what is best for current conditions.
- ❑ Experience using this gear.
- ❑ Survival suits with strong tether points.
- ❑ Assortment of padeyes on underside of hull/wingdeck for attaching tethers in the best location to minimize breaking-wave impact.

Royal New Zealand Navy

Silver Shadow heading towards her rendezvous with Monowai. Compare these photos to those of Ramtha on the previous page and you can see how much the sea has died down. Yet the Monowai's RIB was damaged and almost lost during this rescue.

Silver Shadow

Silver Shadow was a 42-foot (12.9m) sloop designed by David Warrington. At just under 8 tons displacement she would be considered light-to-moderate for a cruising boat. The experienced crew was led by Peter O'Neil, a Kiwi with considerably more offshore experience than most of the sailors in this group of yachts.

They had left from Wellington, at the bottom of the North Island, and so were behind the majority of the yachts. However, they were pressing along quite quickly and soon had caught up with the fleet.

During the evening of June 4th they listened to the evening check-ins with Keri Keri Radio, amazed at what they heard going on with some of the other boats. The reported conditions did not seem to jive with what they were experiencing themselves, although it was blowing in the 50-knot range, and the seas were quite large. They were pressing hard to the west trying to get past the storm track, under deeply reefed main and storm jib, making about 8 knots.

Later that evening they were severely knocked down by a breaking sea. The rig came down, and the crew quickly got to work cutting it clear. Working on deck in the darkness in the breaking seas must have been extremely difficult. The crew tied the bolt cutters and other tools to themselves, so that they could drop the tools and hang on with both hands when a wave was about to hit the boat.

The SSB had been given a thorough dunking so even with their emergency aerial they could not transmit. The boat lay ahull, abeam of the breaking seas and during the night they were repeatedly knocked down—eventually doing a violent 360-degree roll, during which O'Neil broke his shoulder.

In an effort to get the boat to lie in line with the seas, the crew took a sail, tied the three corners together, and, after rolling it tightly together to keep the wind from getting to it before it hit the water, deployed it off the stern. However, it failed to keep the boat aligned and she continued to lie abeam.

They then took a line from the sail to the bow, and this worked a little bit better. But each time the line went slack, the bow would fall off.

Lindsay Turvey

Monowai's RIB (under arrow) moves in to pick up the crew. The sea state doesn't look that bad, but there are still plenty of waves out there in excess of 20 feet (6m), and the typical post-storm confused pattern making things very difficult.

The RIB is maneuvered to leeward of Silver Shadow. The keel and rudder on Silver Shadow will keep her from drifting to leeward as fast as the RIB, which allows the RIB driver more flexibility in coming alongside. If he backs off the power, he blows away from Silver Shadow, so he has more control of the overall situation in this position.

The transfer of Peter O'Neil is complicated by the fact that he is immobile and cannot assist in any way. The lifelines are bent out of the way and he ends up being dropped into the bottom of the RIB—an excruciatingly painful experience with a broken shoulder.

Royal New Zealand Navy

Lindsay Turvey

Peter O'Neil is hoisted aboard Monowai from the RIB (arrow). With Monowai rolling heavily, this was an extremely delicate not to say difficult hoist.

Eventually they made a jury mizzen mast out of a reaching strut lashed to the pushpit astern. From this they flew a piece of jib angled forward to the rail, and with this riding sail providing some after w indage, *Silver Shadow* settled into a more-or-less bow-on mode—with less frequent journeys to the seas-abeam position.

The crew discussed what would be necessary to jury-rig the boat and sail her to Fiji, and plans were being made toward that goal—they had gear for a stub mast aboard, and plenty of fuel to get them to within a day or so sail of the islands—once the weather abated. However, the injury to Peter O'Neil's shoulder was serious and he needed medical attention as soon as possible.

A C-130 Hercules search-and-rescue plane from New Zealand spotted them, and they had a one-way dialogue as at the time the VHF was not working; except that *Silver Shadow's* crew communicated with microphone clicks. The Hercules asked how bad things were and when the crew responded they were coping, the C-130 flew off to search for other vessels.

The following day the C-130 was back to check on *Silver Shadow* and advise them that *Monowai* was steaming towards them. It appeared that the rendezvous would take place after dark, and since *Silver Shadow* still had an intact engine, they proceeded to power on a reciprocal course to shorten the time interval.

When contact was eventually made, *Monowai* launched their 20-foot RIB, a very tricky operation in the huge leftover seas. The RIB picked up the crew, but the transfer of Peter O'Neil was difficult and painful. When the RIB returned to *Monowai* they had extreme difficulty maneuvering, trying to get passengers and crew off, while avoiding being crushed by *Monowai's* hull. In the end, they pulled it off, but not before the RIB suffered severe damage.

Silver Shadow floated ashore some months later.

Lessons

This was a well-prepared and experienced crew. They understood the importance of keeping the boat aligned with the waves, and made every effort to do so, given the tools at hand.

They were moving west to get away from the storm's track as quickly as possible—the correct tactic in our opinion. With the benefit of hindsight, you could argue that they were moving too fast for the conditions, which is why they were knocked down and lost their rig. However, given the situation, we probably would have adopted the same approach ourselves.

When it comes to weather risks, we would suggest that in an equinoctial gale season, where the risks of meteorological bombs are higher, one should make earlier decisions to mitigate weather risk. In this case abandoning Tonga as a primary landfall, heading west as soon as the low started to form until well past its potential track, and then heading to Fiji, a destination which would be easier to make after giving up a lot of distance to leeward (*vis a vis* the trades).

Another factor here is the time it took to cut the rig away, and the conditions under which this took place. Obviously, if the boat had suffered a roll or severe knockdown with crew on deck, it could have been serious. Large bolt cutters are difficult to use when cutting rigging wire on a dock, let alone on a heaving deck. A better approach is a hydraulic cutter (see page 260 of *Offshore Cruising Encyclopedia*). These are much easier and faster to use. Finally, it is obvious that if help had not been available, Peter O'Neil and crew would have gotten *Silver Shadow* safely to the islands. Given the risks (and pain) of the transfer, we wonder if he would make the decision to abandon *Silver Shadow* again?

Monowai

To put things into perspective let's take a look now at *Monowai*, under the con of Commander Larry Robbins. *Monowai* was a moderate-sized ship of 4,000 tons, accustomed to the weather in this part of the world.

Before she received her call from the New Zealand Navy to assist in rescue efforts, she had been steaming slowly in the storm, rolling as far as 48 degrees from the vertical—that is 96 degrees of total arc. Winds had been recorded at 50 knots, gusting higher. Commander Robbins altered course to the northwest and reduced speed. During the initial stages of the blow, three sailors had been injured, and gear on deck had been damaged or lost to boarding seas.

Monowai has twin screws, was underpowered for good maneuverability in the existing conditions, and her port engine was acting up. Unlike more modern vessels, she was not fitted with a bow thruster.

All things considered, there was considerable difficulty in maneuvering the boat into position for the various rescues—and a significant amount of risk to crew from boarding seas and waves rolling the boat.

We point this out because one often assumes that big ships are immune to the effects of a storm at sea; but pure size is no guarantor of safety, as we've heard in the comments of Steve Lloyd and Adam Bailey. In fact, in many cases we feel the argument can be made that a well-prepared moderate sized-sailboat will do better in large seas than many ships.

Throughout the rest of the fleet, similar dramas were unfolding for an additional six yachts, five of which were rescued. One, *Quartermaster*, reported being rolled to Keri Keri radio, and then was never heard from again. An inflated life raft without occupants was sighted some days later.

What happened to the other vessels after being abandoned is of interest:

- ❑ *Destiny*: rescued by container ship *Tui Cakau* (skipper was severely injured in a pitchpole). Hull later washed ashore.
- ❑ *Sofia*: rescued from inflatable by French Navy vessel *Jacques Cartier*. Vessel recovered at sea six months later.
- ❑ *Waikiwi II*: rescued by 30,000-ton bulk carrier *Nomadic Duchess* and sunk while under tow.
- ❑ *Pilot*: rescued by *Monowai*. *Pilot* was deliberately sunk by *Monowai* so she would not be a hazard to navigation.
- ❑ *Heart Light*: rescued by fishing vessel *San Te Maru 18* and then rammed and sunk at request of owners.

Richard Bennett

RESCUE CONSIDERATIONS

The photo above shows VC Stand Aside signaling with a smoke flare, awaiting rescue. The shot is straight down after they have been sighted. Without the smoke flare, even in clear conditions, they would be difficult to spot at more than a fraction of a mile.

We've discussed in some detail the fact that calling for a rescue entails risks to the potential saviors, as well as those asking for rescue. Let's now switch gears to discuss the process itself, and what can be done to make it more efficient.

Being Seen

Even with a 406 EPIRB broadcasting your position, sighting is not guaranteed. The degree of precision in the position is fine for good visibility conditions, but in heavy weather the odds are that between sea state and weather (frequently low clouds and rain) you will be very difficult to spot from the air. We need only to go back to the story of the Burmans and *Freya* (page 69) to see how much difficulty the search-and-rescue (SAR) teams had in spotting them. Even when the SAR aircraft are equipped with infrared sensing, like the Orion looking for *Freya*, it can be extremely difficult for the crew of an aircraft—let alone that of a ship—to make contact.

And if it is this hard to see you aboard your vessel, think how much more difficult it is to find a life raft a fraction of the size of the mother ship.

The highest quality SOLAS parachute flares should be aboard and easily accessible for such emergencies. Keep some in the raft as well. Smoke flares help tremendously during the day, as do packets of dye in certain conditions.

Perhaps the most important part of this equation is the ability to communicate with the searchers—and of staying alert for the sounds of aircraft in your vicinity. If you hear them and can communicate via VHF, between their ability to home in on your VHF signal, and your ability to see them flying, the odds improve substantially.

HELICOPTER RES-

Helicopter rescue may seem at first to be pretty straightforward, and perhaps this is the case in relatively calm conditions. However, in heavy weather the situation is quite fluid, and flying can be extremely difficult and dangerous.

From the pilot's perspective, he or she has to maintain a position relative to a drifting vessel, stay clear of the vessel's rigging if it is still intact, make allowances for constant changes in wind gusts, wind direction, up-and-down drafts—and we haven't even mentioned maneuvering around and between huge seas.

Then you have the pilot's view of the situation below. In some cases the co-pilot or winch operator must talk the pilot into position and tell him or her when to dodge waves.

PPL

A rescue swimmer and victim are winched aboard a British Coast Guard helicopter. If the victim were to raise his arms he could fall out of the lifting strop. The U.S. Coast Guard swimmers usually put their legs outside of your arms to avoid this possibility.

Lifting off the Deck

Helicopters rescue procedure varies with local standards, ambient conditions at the rescue site, the abilities of the helicopter and its crew, and the state of the ship's rigging. It may be necessary to get into the water (but only if told to do so by the helicopter crew).

Getting into the water means thermal shock and the risk of hypothermia if things don't go well the first time—and they may not. You should be wearing some form of thermal protection, depending on water temperature. Wet suits are a minimum.

Eendracht

The 105-foot (32.2m) Dutch sail-training ship, *Eendracht*, suffered engine failure just after leaving Newhaven Harbor in the UK during a Force 8 gale. She was driven hard onto a sandbank, beam-on to the seas, and was being continuously assaulted by the waves. There were 51 people aboard at the time.

After a commercial tug failed in its efforts to free her, the decision was made to try to winch the sail-training cadets and permanent crew of 17 off the forward deck, using Coast Guard helicopters from two nearby bases.

There were two choppers involved in the rescue, which took turns hovering over the foredeck while they winched off the passengers and crew.

The spars of the *Eendracht* were oscillating wildly back and forth, making maneuverability extremely difficult for the helicopters.

With all of this going on at the chopper level, on the deck of the distressed vessel there's plenty to be concerned with as well. First is communicating with the rescuers. Assuming you have a working handheld waterproof VHF, the noise on deck from the chopper will be deafening—not to mention the noise of the wind and the sea. So, it is probably better to communicate from below where ambient noise will not be as loud. Even better, is to have a headset, which will plug directly into many handhelds, and blank out some of the external noise.

Rescue of the crew of Eendracht. This is the most difficult situation for a chopper. The vessel is being battered by seas (she's aground), the rig is intact, and the flying conditions are extremely hazardous.

All photos PPL

In the first 2 1/2 hours, the 33 trainees were lifted off. The helicopters then returned to base for fuel, after which they completed the rescue without incident—a remarkable demonstration of flying skill.

The Dutch captain of the vessel was the last to leave.

One member of the chopper crew, winchman John Spencer, was working on the deck of *Eendracht*. "There were times when the ship shuddered on the ground. At one point the boat keeled right over and waves were coming over my head and I thought. If this thing goes, where am I going to?"

The *Eendracht* was towed off on the next high tide and taken back to Newhaven to undergo repairs. Considering the risks involved in being lifted off the deck, among the waving spars, perhaps everyone would have been better off left aboard.

The Pilot's Perspective

It is probably useful to understand what is happening on the helicopter from the pilot's perspective. This will vary, of course, with the weather and the aircraft being flown. The sophistication of the positioning systems, autopilot controls, and even the size of the helicopter all have an impact. In the end, however, it comes down to the pilot sitting in that right seat, flying pretty much by the seat of his or her pants.

To get a feel for this, we got in touch with Commander Dan Abel at the US Coast Guard. Dan has been flying Search-and-Rescue missions for ten years with over 300 recoveries.

We asked him for his comments on what a mariner in distress can do to make his job easier:

During the day anything you can do to make yourself stand out from the whitecaps is helpful. Smoke flares work well as do simple signaling mirrors. At night, flares and nav or flood lights show up if it is clear, but if the conditions are poor they are hard for us to see.

We always hover into the wind. I'm flying from the right seat The ideal position for the boat is to be 35 to 45 degrees to the right of the windline. For example, if the wind is from the north, the boat should be steering 035 to 045. This way we

can hover into the wind, and I can move up or back a little as required to keep clear and see what is going on from the right side of the aircraft.

The flight mechanic (winch operator) is also on the right side and he, the co-pilot, the rescue swimmer, and I will discuss the situation, and decide if a hoist is necessary given the risks and urgency, and assess what we think is going to be the best way to get the people off.

If you see us hovering like we are waiting for something to happen, it's because we're discussing the situation—looking over our options. We've had people jump into the water when they see us hovering like this—exactly what we don't want to have happen.

It's hard enough to find the boat—seeing the head of a person in the water is almost impossible. So, stay on the boat until we tell you otherwise.

At night we usually fly an "instrument" approach to the vessel once we've found it. We come in heading downwind and fly over the boat. Then we make a procedure turn into the wind, either on the flight computer or manually. We have to be careful with the turns in these conditions so as not to set ourselves up for vertigo.

Top photo—crew wrestle with the hi-line from the helicopter while other crew await their turn at attachment in the lee of the bulwarks.

Bottom photo—two of the crew are lifted away from the boat toward the helicopter.

Things to be aware of:

- There is extreme wind and noise under the hovering helicopter. This is not as much of an issue when you are aboard the boat as if you are in a raft or in the water where the down-wash of the rotors can cause major problems.
- If you see the helicopter hovering behind you, the odds are the crew is discussing the situation. Do not take any action, such as getting into the water, until so instructed.
- If the chopper sends down a trail (orange) line, watch the winch operator for instructions. The odds are that the basket is attached to the line and they want you to pull the basket to you. This is done when rigging makes a vertical delivery of the basket too hazardous.
- Do not, repeat, do not attach the trail line to anything on the boat.
- Once the you have the trail line the helicopter will back off and remain in a low hover.

In smooth water, we can use the radar altimeter for maintaining hover, but in big waves we use the barometric pressure altimeter. This way we can maintain a steady altitude, while the swells sweep under us.

As soon as we are in position, we'll go to open mic with the flight mechanic, where his microphone is on all the time. He then cons me in, continuing to talk as I fly. He'll say forward and right 40, forward right 30, giving positioning commands as well as advisories such as basket is half-way down, basket is 3 feet (0.9m) from water. In the H65 I cannot see the basket and generally cannot see the boat when I'm in close—the flight mechanic is my eyes and ears.

If it is necessary the preferred method to deploy the rescue swimmer is like Spiderman, drop him down on the cable to the boat—if there's a clear spot, or into the water. However, in some daytime cases, we'll go into a low hover, 15 feet (4.6m) off the water, and he'll jump.

We maintain a stable hover, with the swells coming up and down below the helicopter. The hoist mechanic raises and lowers the swimmer as required. When a swell comes up, it drops him onto the deck or into the water, and then pays out slack on the cable as fast as possible as the wave is dropping out from underneath us, so as not to yank the swimmer back up off the boat.

As soon as the swimmer is down, or we've got a line onto the boat, I move back and to the left, and probably drop down to a lower hover position.

If there is no contact with the vessel on the radio, we'll try to lower a VHF down via a line. This is usually an orange line with a bag of shot at the end to help weigh it down. We sometimes send down a message block.

There will be a static discharge between this line, or anything connected to the helicopter and ground. It won't kill you, but it will give you a jolt. It is best to wait until the receive device has been in the water or touched some metal on the boat, before handling it.

Rescue Swimmer's Perspective

In most cases the helicopter crew will try to put a rescue swimmer onto the boat, or in the water nearby. The only time they do not do this is when conditions are simply too dangerous—it's a tough call.

To get a handle on the the rescue swimmer's perspective, we spoke with Scott Dyer, an Aviation Survival Technical Chief. Scott has participated in several hundred rescues.

Scott had a lot of interesting comments about what to expect in a rescue situation—data that is better to think about now, rather than when your heart is racing in the midst of a rescue.

Commonsense is the number one thing we need from people. It is a very noisy environment, and it is difficult to communicate. It is best if you have on some form of ear protection—ear plugs at least.

You will want to have clothing covering your body, arms and legs included. There are cables, and all sort of metal stuff on which you can get cut. If you have a wet suit, get into it. Avoid

USCG

A survivor being lifted in a basket. Keep hands and feet inside of the basket at all times.

heavy clothes, like wool sweaters, which absorb water and make it difficult to move because of their weight.

Some form of head protection, like a kayaker's helmet or a wetsuit hood is also a good idea.

If the rig is down, and there's a space for me to land on deck, the best thing the crew of the boat can do is to clear an open space, removing as much debris as possible.

Don't try to help me in any way until I am on the boat and disconnected from the helicopter. Once I am on the deck, if there is a lot of motion, I might want some help, but while I'm connected to the helicopter it is best to keep clear.

When I'm down on the deck, I'll give a brief heads-up to the boat's crew.

I normally use hand signals to communicate with the flight mechanic, although I do have a waterproof VHF radio.

With civilian rescues our primary device is the rescue basket. If you are using a basket make sure you keep your arms and legs inside at all times. Do not reach out and try to grab anything or try and help. The forces are too great and you can be badly hurt, complicating our rescue further.

When the basket arrives at the helicopter, the flight mechanic—who is held in with a safety belt—will bring the basket into the ship. Do not do anything until he tells you to. When you get out of the basket, move aft to the location he specifies and stay there, out of the way.

If there's a radio at the end of the trail line, use it to communicate. After the radio is passed the helo crew will probably drop the line into the water, which means you can toss your end too.

If they don't drop it, it is because they want you to haul across the rescue basket.

The weighted bag at the end of the line is just to help position it in the wind.

Key factors to keep in mind during a helicopter rescue:

- ❑ Maintain course 35 to 45 degrees to the right of the wind, moving slowly forward.
- ❑ If you are drifting, try to get the bow or stern into the wind with some form of drogue.
- ❑ Do not touch any lines from the helicopter until they've been in the water or hit metal on your vessel.
- ❑ Never attach any cable or lines from the helicopter to any part of the boat.
- ❑ Do not get into the water until told to do so by the rescue crew.
- ❑ Clear a space on deck for the rescue swimmer.
- ❑ Do not assist the rescue swimmer unless he asks for help.
- ❑ Wear ear protection.
- ❑ Wear a helmet or wetsuit hood if possible.
- ❑ Wear a wetsuit, or at least cover your entire body.
- ❑ Put on a life jacket.
- ❑ If you have on a safety harness get rid of tethers as soon as possible. These could tangle in winch machinery in the helicopter.
- ❑ Have wallet, papers, glasses ready to go when the rescue swimmer arrives.
- ❑ Follow directions when boarding helicopter.

The other device we use is a quick strop. This is a harness, which goes around your chest and under your arms. If the person is unconscious. we'll use a crotch strap. Otherwise, just around the chest.

With the quick strop you have to keep your arms down. If you raise them, you fall out. You will be hanging below a foot lower than the rescue swimmer, your face on his chest. We usually put our legs around the arms of the person we're being hoisted with, so they can't accidently raise them.

When we reach the helicopter, the winchmen will pull us in, and we'll fall to the floor. I'll be on top for a moment, until I can get my feet under me.

If there's an injured person aboard (I'm a trained emergency medical technician) we'll bring them up in a Stokes Litter.

We take injured personnel off first. This way, if the helicopter has to leave for some reason, they will get care as soon as possible. We take women and children next, and then the men.

There are some situations where you have to get in the water—when the rig is still up and it is too rough to get the helicopter close enough to the boat. In this case it is best to wear something which helps us to see you. Reflective tapes on shoulders show up well at night under our lights. We use international orange wet or dry suits. Black is one of the worst colors—almost impossible for us to see you in the water then.

A bright colored wet suit or jacket is the best.

If you are in the water and there are large waves, there is going to be a lot of herky jerky with the winch cable. There may be a lot of slack, and then it gets jerked tight as the wave passed underneath.

Make sure you never step in the bite of the cable or a trail line, and never connect the trail line to anything on the boat.

Reg Ellwood's Comments

In preparing this section of the book we went back and chatted with Reg Ellwood, the pilot that rescued the Burmans (page 71). His comments follow:

Bruce Burman asked if they should try to get in the water after we had trouble getting Trevor (the rescue swimmer) to the boat initially. I replied emphatically no.I believe we would have been in real danger of losing people in the water.

If the rig had still been up I would have still attempted a hi line to the bow even though this would have been more dangerous and difficult.I think we would have managed this somehow. If, as a last resort, they had to go into the water we would have had Trevor in the water close by and had them enter one at a time and retrieved them one by one.

If in these sorts of conditions you have to have people go into the water, everything possible must be done to control their movement and keep track of them. We had a very difficult time finding *Freya* and actually lost sight of her again momentarily 320 feet (100m) away. A person in the water could be swept away in a moment and lost to view.

We always put down a winchman or rescue swimmer to assist people on a vessel or in the water and to make sure they know what to do on the spot. As we did with Bruce Burman, we attempt to give a hi line brief before lowering down the line to a boat. The crew on board can make it considerably easier for us if they do the right thing.

A few details to keep in mind, just in case. Top photo is the standard rescue basket. The floats on each end provide buoyancy. Do not reach out to grab anything. Keep hands and feet inside the basket at all time. Let the winch operator get you inside the helicopter. Do not try to help him.

It takes a huge amount of effort on the part of the flight crew to get a trail line down to you. If they are hoisting survivors, maintain control of the line at all times. You will need it to pull the basket back to you for the next survivor.

The Stokes litter, used for injured survivors. Flotation is provided, and, as you can see, the injured person is strapped in. You will probably have to help get the litter to a position where it can be lifted. Most rescue swimmers are trained emergency medical technicians.

The quick strop (lower two photos) is really just a simple harness, with padding to provide some flotation. It goes around your chest. Keep your arms down at your side so it cannot slip off.

USCG rescue swimmers will lock their legs around your arms to hold them down. Other countries do not use this approach (see photo on the first page of this chapter).

All photos USCG

Rescue by Ship

As sailors and pilots, we think the helicopter rescue sounds a little hairy—it is far more than a simple pick-up and deliver. But while that may be nerve-racking, rescue by ship is even more difficult.

Risks

Remember, we're talking about heavy weather here. The same waves tossing you around are making the ship roll through huge arcs. When you and the ship are close together, the odds are the two vessels will be in contact. If your rig is standing when the ship first comes by, it will not be once the ship passes.

There is almost certain to be structural damage to your vessel from the ship. The odds are contact will open the hull-to-deck joint, or crush some of the hull itself.

As you drift down the side of the ship, there is a good chance you may be caught under the stern. If the stern is coming down on a wave while you're coming up, the game is over.

If you don't get off the boat on the first pass, you're certainly going to have to make it the second time.

We raise these issues not to be alarmist, but because the decision to bring two vessels together in this sort of situation is fraught with danger. This is a life-or-death situation. If someone makes a mistake, or the vessels collide the wrong way, you will be in the water (or crushed) with no way of getting back aboard either vessel.

So, think long and hard before abandoning the relative security of your own boat for a transition like we are talking about here. And keep in mind that almost all of the rescue stories we've related have ended with the abandoned vessels later being found afloat.

Relative Positions

You will want to hold station into the wind if possible. This allows the ship to come up into the wind, and gives them the most maneuverability. The ship will typically position itself to windward, providing some lee from wind and waves. But it will still be rolling heavily, even if the bow is only 30 degrees or so off the wind.

Remember that big ships do not maneuver well at slow speeds—that's why they use tugs in port. And even with twin screws and thrusters it takes immense skill and a substantial portion of luck to make something like this happen.

The odds of pulling off a rescue like that of the crew of *Great American* are unlikely. The skill shown by the crew, as well as that demonstrated by the rescuers aboard the *Monowai*, is exemplary. But you cannot always expect such a high level of seamanship. In fact, this is probably the exception rather than the rule.

Climbing Nets

There are really only three options for making the transfer. The first is by using climbing nets. The crew will place one of these nets over the side and as you come into contact with the ship, or close enough thereto to make the transition, you jump, and then hold on and climb for you life.

You have to avoid falling into the water where you could be crushed or drowned. You have to climb fast enough so that when the ship rolls your side down into the waves, you are not pulled off, or crushed by your own boat which will probably be rising relative to your position on the ship.

Watch the roll of the ship and note the period of time it takes to go through one complete cycle. This is likely to be a consistent time period. Try to time your transition when the ship is on the downward roll relative to you. This gives you a head start up the net, and gives you the maximum time period in which to get up before the next downward roll.

Breaches Buoy

If you are being picked up by a military vessel or a Coast Guard ship, it may be equipped with a Breaches buoy, as *Monowai* used when they rescued the Forbes from *Ramtha*.

They will fire a line with a weighted end—sometimes an actual rescue strop of some form. Stay out of the path of the projectile (recognizing that it's difficult to aim with both vessels in constant motion).

If you get the line aboard, act fast. It is not strong enough to act as a tow line or painter, and the odds are you will be drifting apart rapidly. Be prepared in advance to hook on, and wear a wetsuit or survival suit and life jacket.

Life Rings

If you are alongside the ship and they throw down a life ring, remember that these are hard to stay in. Recall what happened with the crew of *Salacia* (page 79). Julie Black slipped out of her life ring, never to be found again, and Mike Fritz slipped out, falling back to the water, and then got a second chance. Keep your arms down. Better yet, wear your safety harness and connect it to the hoisting line.

Small -Boat Transfer

If the rescue ship has a small boat aboard and the sea state has started to moderate (you're not dealing with survival conditions), the small boat might ferry you to the ship. The transfer is still risky relative to the sea state, but not nearly as much as coming alongside the big ship yourselves.

Stay out of the way, listen for and follow orders of the rescuing crew, and keep your hands and arms in the boat when you come alongside the mother ship. The transfer up the ship's side, or the lifting of the small boat, is tricky. Stay alert.

The conundrum designers, builders and owners face is clearly illustrated by these two photos. Above (Beowulf anchored at Hanavave Bay, Fatu Hiva, in the Marquesas Islands), you have the way boats are used 99 percent of the time. Below, conditions which probably not one out 1,000 boats will ever come close to seeing in their lifetime. Do you play the odds and hope one of your boats will never get caught, or do you go the conservative route and design, build, and prepare for the worst?

Lindsay Turvey

Design & Construction

We want to spend some time now talking about naval architecture and construction scantlings as they relate to heavy weather.

Thousands of factors go into designing and producing a small boat. Everything the designer and builder do affects something else in the package. You push a little here and the boat bulges somewhere else. The design process is long, detailed, and involves literally thousands of trade-offs—and proper construction is no less arduous.

Most successful designers start out with a concept. Sometimes it is his or her own; at other times it comes from the client. Frequently it is a blend of the client's dreams and the realities of naval architecture brought home by the designer.

Much of the information on this subject applies across the board for all type of vessels—power and sail, monohull and multihull. We'll cover the universal themes first, after which we'll get into the type-specific data.

The design concept is what guides the trade-off process. If you are going to be using a boat for coastal cruising, primarily for day trips, you will go in one direction. If the boat is to be used for some offshore work, but the passages are short with little exposure to severe weather, other considerations come into play.

If a client comes to you and says "I want the safest boat I can get, and I expect at some time to experience storm-force and above winds," a different approach is taken.

The same holds true for the builder. Very few boats leave their marina berths more than a few times a year. Of those that do venture forth, a tiny percentage actually head offshore. These are facts of life to which builders, designers, and their marketing "experts" respond. Boats, which look good at the dock sell—and if they are not suitable for heavy offshore work, well they probably aren't going to be used that way in any event. So the marine industry ends up building for the most part what we call "percentage" boats. These are boats built under the philosophy that such a tiny percentage of the end product ends up exposed to serious weather that those risks can be ignored. The boat is designed for the way it is used most of the time. This works fine, unless you happen to be caught offshore in a real storm.

When the time comes to buy a new or used vessel, or evaluate one that you already own, with an eye to how it would do in a real blow, you might not have been privy to the design concept. The trade-offs that were made will not be readily apparent.

Still, there are many basic factors that affect how boats perform, and it is to those that we will now introduce you.

We want to start this section with a discussion of the 1979 Fastnet Race. This race, and the situations that arose during it, caused a significant amount of thinking to be done throughout the sailing community. Those lessons are still valuable today.

JOHN ROUSMANIERE—1979 FASTNET

The 1979 Fastnet Race led to changes in thinking by race organizers about offshore risks, and what sort of design parameters were acceptable.

The tragic results of this race also brought into focus the issue of capsize mechanics, and what could be done to improve a boat's chances of avoiding such an event—something that had previously not been given much thought.

There are several seminal storms in the annals of heavy weather tactics and yacht design. These blows are probably not any more severe or even in the same category as major storms, which individual yachts have endured, but because they were encountered by large fleets of small boats, there was extensive damage, which highlighted shortcomings in tactics, design, forecasting, and shoreside response.

While the events themselves had tragic consequences for some of the participants, they provided an invaluable pool of knowledge for the rest of us—so that we could learn from what went wrong and avoid making the same mistakes in the future.

The 1998 Sydney-Hobart Race, which we discussed at length earlier is one such event. But *the* heavy weather event as far as sailors are concerned was the 1979 Fastnet Race.

We first heard about this blow in the Southern Hemisphere spring of 1979, when we reached Durban, South Africa during our circumnavigation. There were all sorts of rumors afloat about what had happened and why. Eventually the racing authorities in both the UK and the US issued detailed reports and made changes in the screening formula used to determine who was eligible to race offshore.

But the very best account of the race was written by John Rousmaniere, the dean of all yachting writers. John was there, sailing aboard the Swan 47 (14.4m) *Toscana*, with his publisher, Eric Swenson. *Fastnet, Force 10,* John's book about the race, has been through numerous editions over the last 20 years and has been reprinted in six languages. If you are interested in learning about heavy weather, read *Fastnet Force 10.*

In researching this book. we asked John for his thoughts on the 1979 Fastnet.

Background

The fatal storm that swept across Ireland, Wales, and England on August 13 and 14, 1979, is known as the Fastnet storm because it heavily pounded the 303 boats and 2,000-odd sailors who were sailing in that year's Fastnet Race, sponsored by the Royal Ocean Racing Club. Fifteen of those sailors died, 24 boats were abandoned, and 5 boats were sunk. As unprecedented and shocking as this event was, Fastnet had a constructive result. Because the many accidents were well reported at the time and thoroughly analyzed later on (thanks to a questionnaire sent out by the Royal Ocean Racing Club), it became a watershed in the history of yachting seamanship.

I sailed in the race and wrote a book about the storm, and I am often asked to explain why the catastrophe occurred. The answer is straightforward: An unusually rough and volatile storm swept across a tricky body of water and surprised a large fleet of relatively small boats, some of which were not suited to handle these tough conditions.

Here I'd like to flesh out this summary and point to a few lessons learned.

First, an important caution is in order. In examining these

Photos and art work courtesy John Rousmaniere

John Rousmaniere at the helm of Toscana during the Fastnet gale.

events, we must be careful to avoid making unsympathetic or ahistorical judgments. If we are not humane in our evaluation of people's actions that occurred a generation ago, we set ourselves up to be harshly and unreasonably second-guessed a generation hence. Today we have the Fastnet experience to guide us. In 1979 the paradigm was a very different one, and many modern-day techniques of weather forecasting, boat design and construction, and storm seamanship were not known then.

Weather

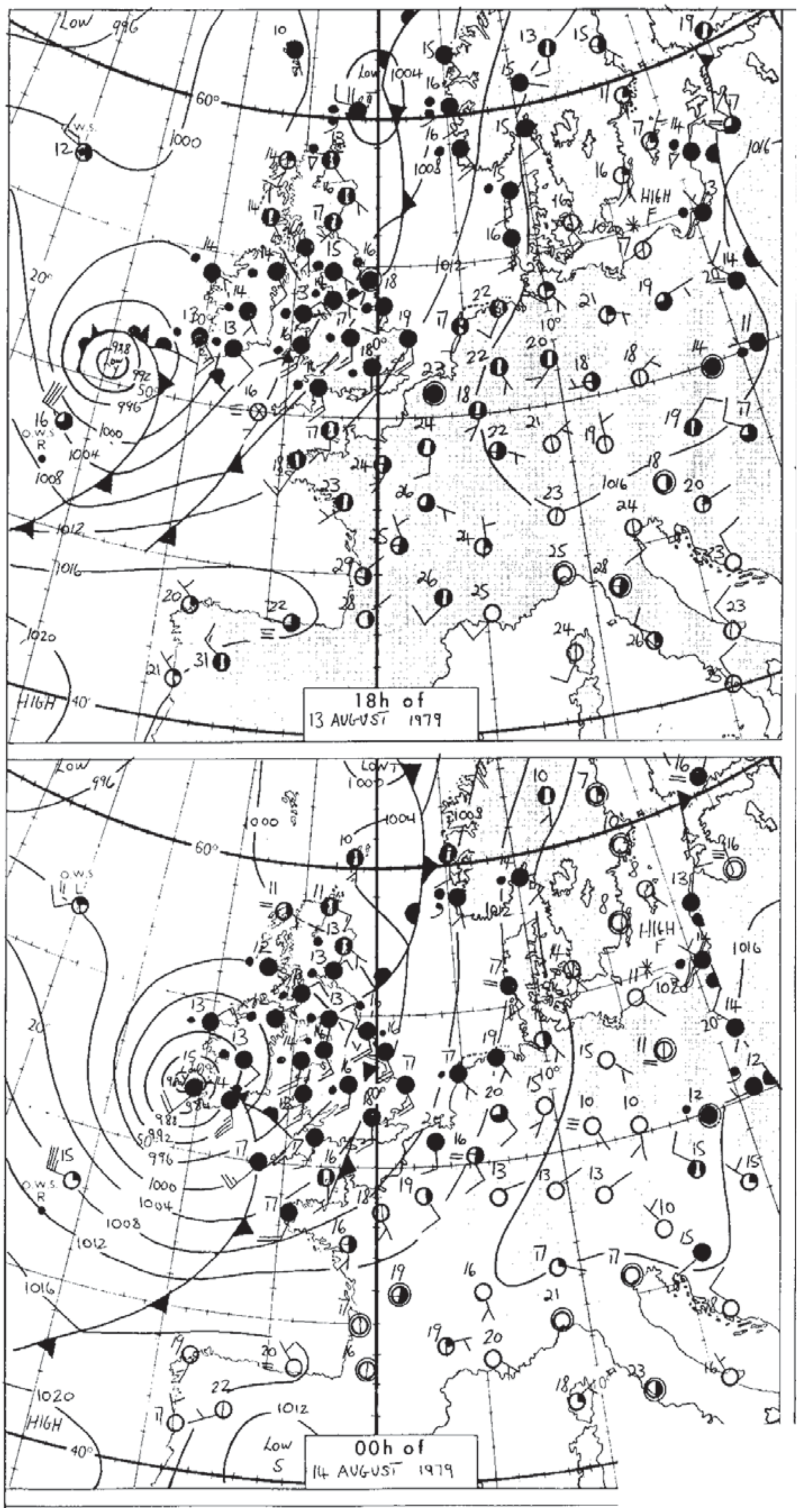
The story must begin with the gale itself. It was a winter-like storm—deep, volatile, fast-moving, opportunistic—that was tossed by chance and the earth's spin smack into the middle of a huge summer regatta.

Its violence, like its path, was unpredicted. Long before today's ubiquitous, split-second weather forecasts and broadcasts, few satellites were in orbit for non-military use, and offshore storms often were tracked in the traditional way, using radioed reports from the decks of ships. In Europe and Britain, met broadcasts came at intervals of several hours. Weatherfaxes were rare. We had a primitive weatherfax in *Toscana*, the Swan 47 (14.4m), in which I sailed the race; but we did not think of using it, in part (I believe) because the racing rules barred its use as "outside assistance." In any case, we were too distracted and excited by the seamanship prob-

"My rough-weather experience to date included hard gales in such places as the Gulf of Tehuantepec, the western Caribbean, and several portions of the Gulf Stream, including one in company with the tail of a hurricane. Yet nothing came near to matching the Fastnet gale."

lems at hand to remember to turn it on. (For the same reason, I never even considered taking my camera out of its case.) In any case, the weatherfax would have told us nothing of timely value, although a printout would have made a valued souvenir of surviving what turned out to be the storm of a lifetime.

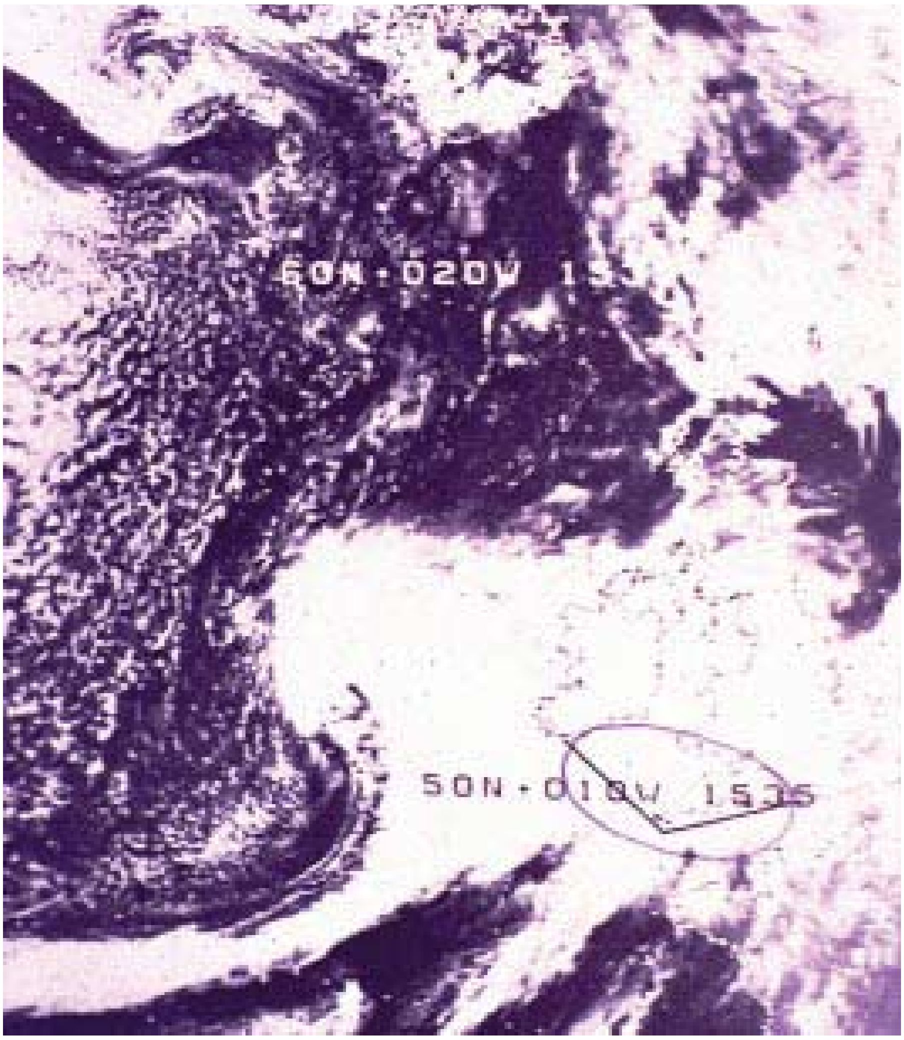
And that was what this storm was for me.



Surface synoptic charts for the day before and the day of the Fastnet gale.

The nasty Fastnet storm had a fascinating and instructive history. It was born 6,000 miles to the west in the northern prairies around the U.S-Canada border—that spawning ground of twisters. So tightly wound was the depression that, on its way to Ireland, it occasionally disappeared from the synoptic weather maps that I studied while writing the book. It had unusual power for August. Racing east, it dropped 2 inches of rain on Minneapolis, blew the roof off a toll booth on the New Jersey Turnpike, killed a walker in Central Park with a shorn tree limb, capsized several keel boats off Newport, Rhode Island, and dragged uncounted anchors in New England harbors. One experienced sailor in Newport mistook the gale's black scud for the telltales of a hurricane.

On August 11 the cell bolted into the Atlantic at a speed of 50 knots. It was pooping out a day later, just east of Newfoundland, when it was re-energized by two new factors—heat and cold. An



area of unusually warm air and water, up to 5 degrees above normal, had been left behind by another depression that had passed this way two days earlier. After the low passed over this hot spot, cold air was pumped into it by an enormous older low to the northeast that was moving slowly from Greenland to Iceland.

Heat plus cold plus humidity plus the depression's original power plus its high velocity all made for an explosive mix. The barometric pressure plummeted in a pattern that, a year later, meteorologists would label a "bomb": a pressure drop at a rate of 1 millibar an hour for 24 hours. (In fact, the Fastnet storm came to be pointed at as a prime example of this newly identified phenomenon, widely known today but unknown in 1979.)

The depression to the north, called the primary low, also created an eastbound superhighway upon which our low—"secondary" in name but not force—drove east. It would have fetched up in the Bay of Biscay, on France's west coast, had the primary kept pace. But the primary stalled near Iceland. Overtaking it at about noon on the 13th, the secondary followed the curve of the isobars, altered course to the northeast, and charged off straight for Ireland. Its dangerous quadrant would sweep across the Western Approaches, the 170-mile-wide body of water between the southwest corners of England and Ireland.

The Race

The race had started on August 11 off Cowes, the Isle of Wight, under a forecast for, at worst, a small gale. That did not scare British sailors, who are used to a good blow, or their American, European, and Asian guests. Unfortunately, the pas de deux between the primary and secondary lows, barely a dot on forecasters' consciousness at the time of the start, turned out to be perfectly timed (assuming that weather has timing and a frightful battering of more than 2,000 souls may be called perfect).

"According to the English meteorologist Alan Watts, this harsh, maddening variability was the symptom of a chaos of cells of extreme low barometric pressure. Think of these cells as small local gales, each with its own depth and direction, blowing along what Watts has called 'corridors of extremely strong winds' that were the Fastnet storm's arterial system. Now add the storm's rapid speed of advance, the prevailing southwest swell, and (arguably) eddies caused by millions of tons of water sloshing around the sink-shaped Western Approaches, with only a tiny drain up near the Irish Sea."

"On almost any other day except August 13 or 14, 1979, nobody but a few cruisers and fishermen would have known about the storm. But the Western Approaches were filled with the huge Fastnet Race fleet that was crossing from Land's End to round Fastnet Rock, off the Irish coast, and then turn back toward the finish at Plymouth."

From 2200 on the 13th until about 1400 on the 14th, the Fastnet fleet endured conditions ranging from Force 8 to Force 12, hurricane strength. The danger lay in the strength but even more so in the extraordinary instability of the storm. The wind had the feel of a shifty blow of a frontal northwesterly blowing from the American East Coast or of a Santa Ana gusting from Southern California. I know this because I spent several hours wrestling with the shifts and the helm on the night of the 13th as we beat toward Fastnet Rock under deeply reefed mainsail and the forestaysail, set on the headstay. (Strangely, storm sails were not required for the race.) As is usual in such a situation, the air was filled with heavy spray and a roar like a freight engine's, but the wind and sea never did settle down to a predictable pattern. Irregular breakers were big and everywhere. "Every sea was different," reported one veteran of the race, Chris Bouzaid, talking about the sail back with the wind astern. "Some of them we would square away and run down the front of. Others were just far too steep to do this." Pilots of rescue helicopters later reported that when hovering over distressed boats, they had to rise up as far as 50 feet (15.2m) in order to keep salt spray from breaking waves out of their engines.

Obviously, such mixed conditions pose a considerable challenge in the area of storm tactics, which concern the choice of point of sail to ride out bad weather. As for storm strategy—whether to find a haven ashore or ride out the blow—it was already settled upon. When the telltale mackerel sky and diving barometer first announced the storm's imminence late on the afternoon of the 13th (hours before the first gloomy radio Met. forecast), almost all the boats in the race were far too many miles out in the Western Approaches to make a successful run for shelter.

That does not mean that all the boats kept racing. We did in our sturdy 47-footer (14.4m), and so did another 80-odd boats. But most of the entries were simply too little or too light for these conditions, and their priorities immediately switched to tactics for survival. Of the 303 entries, 180 were 38 feet (11.7m) or shorter in overall length and had light or moderate displacement. Most of them were unable to make way to windward toward Fastnet Rock. Many of the larger boats, like *Toscana*, banged into it under heavily reduced canvas with various degrees of success. We made about 6 knots of headway and 2 knots of leeway.

Many Americans later were surprised to learn that boats as small as 30 feet (9.2m) were allowed to go out there. But over half the Fastnet Race is sailed within sight of land, and Brits have a long tradition of sailing in smaller boats. In any case, the real issue is not length but power and stability, and here the Fastnet fleet suffered from recent trends in yacht design.

Design Issues

Until the 1970s, the typical stock racer-cruiser was not much different from the typical stock cruiser. Both types were bulky, narrow, and heavy with a range of positive stability over

130 degrees (meaning that if knocked over until her mast was under water, a boat still has enough stability to pop back upright). But in the 1970s the intensification of competition and the tweaking of the International Offshore Rule (IOR) by clever designers for ambitious owners produced a new breed of boat that was little more than a big dinghy. A 30- to 35-footer (9.2 to 10.7m) like this was very fast, beamy, light, and tippy, with a stability range as low as 90 degrees. Put one of them over on its side, and it can flip over completely, like a Laser or a catamaran.

Bigger boats can get away with dinghy-like features because of their displacement and inertia. But the smaller ones of the new type were not so fortunate in the Fastnet. Where a handful of the old-fashioned smaller breed slogged around the course, their lighter cousins were beaten up pretty badly. Of the 85 boats that finished the race, only 13 were smaller than 38 feet (11.7m). Of the 24 boats that were abandoned, all but one were 38-feet (11.7m) or smaller. All the 15 sailors who died were from this large population of smaller boats. The bigger boats did not escape unscathed (6 entries larger than 44 feet/13.5m were rolled over), yet the weight of the storm lay heaviest on the people in the smaller yachts.

"One clear lesson from Fastnet is that for offshore sailing given a choice between boats of different sizes, take the larger boat. (This is assuming that her beam and displacement are not extreme in width and lightness, and also assuming that she is strongly built and rigged)."

So much has been written about yacht design for offshore sailing that it would be fruitless for me to say more other than to suggest some reading. Steve Dashew argues a strong case for lighter, narrower boats in (among other publications) *Offshore Cruising Encyclopedia*. The argument for somewhat heavier displacement is made by Olin Stephens and others in a book that I edited and that was written by members of the Cruising Club of America, *Desirable and Undesirable Characteristics of Offshore Yachts* (1986). And C.A. Marchaj offers the case for still heavier boats in his *Seamanship* (1996).

All these writers draw on the 1979 Fastnet experience, the RORC survey, and books like mine. These studies also focused the international sailing community's attention on further understanding and improving design features, personal and boat safety equipment, and seamanship tactics that would minimize the danger of a storm. If many racing boats continued to look and perform like big dinghies, they at least have been taken offshore far less frequently than two decades ago. This is in part because they are so uncomfortable that few sane people will sail in them overnight.

This extensive work on safety and seamanship has not eliminated all risk. You can minimize the danger, not end it. Perfect protection is impossible. The high technology and refined seamanship tactics that have appeared since 1979 will never be able to save every boat. Under the right combination of conditions and some bad luck, a storm of the Fastnet's power and volatility will disable and perhaps even wreck well-built and well-sailed vessels. The conceit that new machinery always reduces the odds of accident only invites the arrogance that causes more accidents.

> "Even in a steady prevailing wind, the sea changes shape and develops anomalies such as rogue waves. In time, the steep, square, breaking waves typical of a new storm gradually lengthen until they reach something longer, smoother, and closer to the smooth parabolic shape predicted by oceanographers. Yet the anomalies continue; incoming waves from distant storms appear to kick up rogues."

Life Raft Lessons

Fastnet taught some seamanship lessons, two of which I would like to discuss here. The first concerns abandoning ship; the second, tactics for survival.

In the 1979 storm, two dozen boats were abandoned for life rafts, and of them only four sank immediately (one went down while under tow). Those crews were later ferociously second-guessed for leaving vessels that turned out to be buoyant. To be fair, we should look more closely.

That life rafts save lives is obvious today, as it was then. The greatest sea story of the 1970s concerned a family that had survived a sinking and grueling, long exposure to the elements in life rafts and other small boats. *Survive the Savage Sea*, the first-person account of this feat by Dougal Robertson, is one of the epics of survival at sea, standing only a rung or two lower than *Men Against the Sea*, Nordhoff and Hall's account of Captain Bligh's amazing voyage in a life boat after the mutiny aboard the *Bounty*.

By 1979, these and other books had taught generations of sailors that if the boat threatens your life, you are free to abandon it. That was the governing paradigm for the sailors in the 1979 Fastnet Race. Some 80 boats were rolled over completely, or 180 degrees, and about 115 were knocked over at least 90 degrees. Some boats capsized more than once, the second time after losing the mast in the first rollover. (Research has demonstrated how a mast provides stability through inertia.)

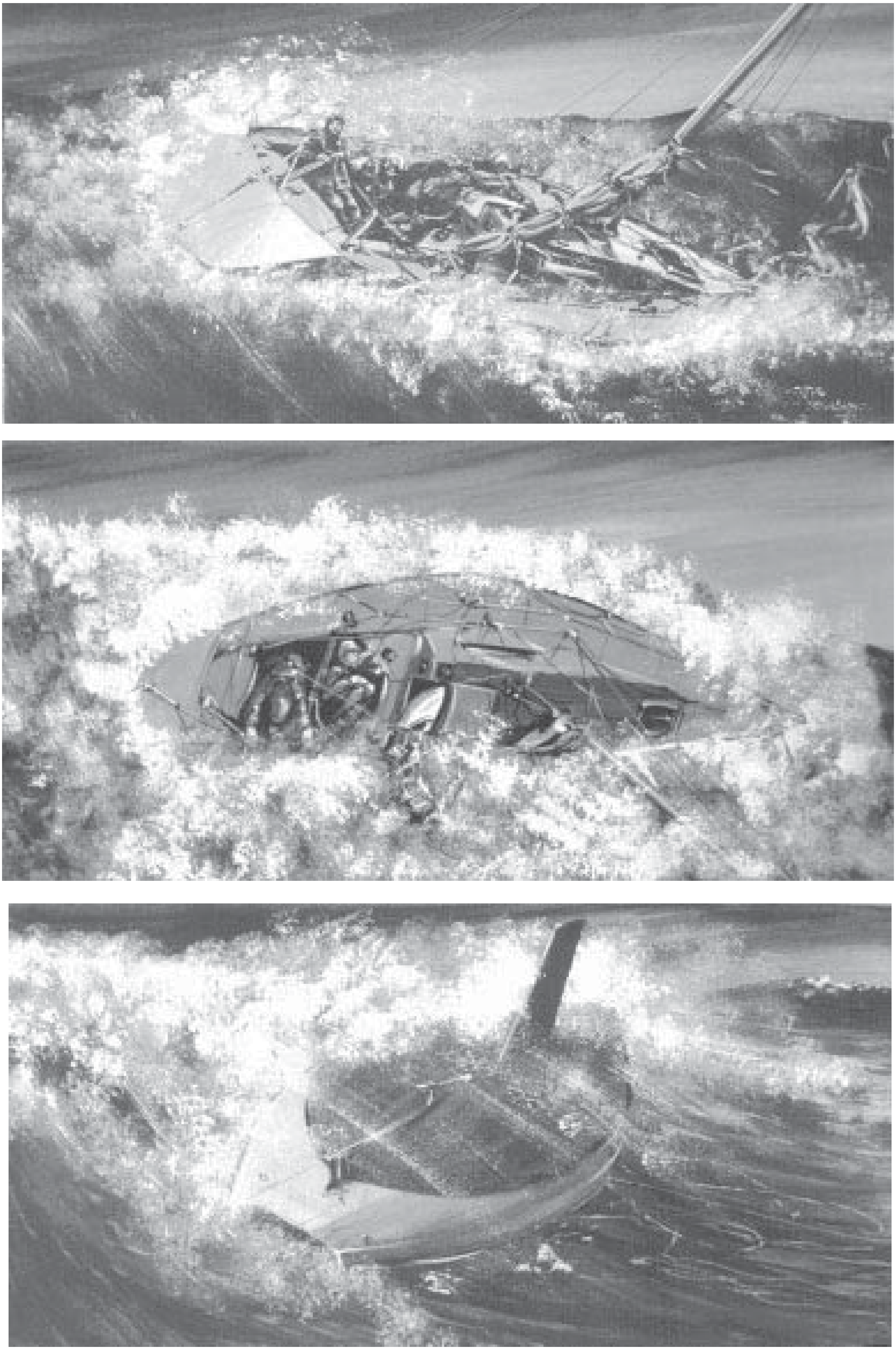
The consequences of these knockdowns and capsizes were grim. Boats shipped huge quantities of water through broken rudder posts and ports, and their interiors were smashed completely, in some cases causing severe injuries to the crew. Therefore, many sailors, reasonably fearing for their lives, followed the old paradigm and took to the life rafts, a few of which capsized or broke up in the rough seas. Some of these sailors died near or in the rafts, but a total of 74 sailors were rescued from rafts, the water, or the decks of boats by Royal Navy helicopters.

Yet the large number of abandoned yachts that remained afloat (19 in all) changed the paradigm. Today the rule of thumb is "Don't get in one until you have to step up." The boat may be the safest place to be until she actually goes under.

Storm Tactics Debate

Besides the abandon-ship debate, there have been many arguments over the past 20 years about storm tactics. Even without a Fastnet, the options as to what to do in bad weather are constantly being discussed, often heatedly, around cabin tables and yacht club bars.

The problem with most of these arguments is that they usually assume a fiction: that the sea is uniform and in a steady state. But a seaway is always changing, though perhaps not as violently as it did in the Western Approaches in August 1979.



Richard Everitt - *Fastnet Force 10*

The practical lessons for hands-on seamanship in this story are clear.

- ❑ Start out with the right boat.
- ❑ If you are overtaken by a blow, choose the right storm tactic for the conditions at hand.
- ❑ Control the boat's speed.
- ❑ Put the best person on the helm.
- ❑ Carry plenty of buckets.

Once designers started to exploit "loopholes" in the IOR handicap rule, some very unhealthy design characteristics came into play.

Wide beam aft, with very narrow bows created unbalanced hulls which were extremely difficult to steer—especially when pressed downwind in heavy going.

As John indicates in his comments, this lack of steering control was responsible for many of the capsizes.

Chris Bouzaid, whom I quoted earlier on the Fastnet sea, laid out the difference between the ideal and the reality this way: "One imagines a sea to be a long sausage-like piece of water moving across the ocean. However, this was not the case at all as these seas had too many breaks in them and were not uniform."

Practically speaking, what this means is that passive tactics (heaving to under storm sails or lying ahull under bare poles) may not work early in the storm. Then, the boat probably would be safer running before the storm under bare poles with active steering, sailing fast enough to stay ahead of breakers and prevent being pooped, but not so fast that the boat broaches or pitchpoles.

Later on, as the crests spread out, the passive tactics may work. By then, running before it may well have worn out the boat's steerers. Even the best sailors lose their quick-trigger reactions over time, and few situations are more demanding than negotiating down the face of a wave without broaching. As a Fastnet sailor said, "We found that if she was carried off really fast on the face of a wave and the helmsman made a mistake, we were really done."

Not surprisingly, the typical capsize in the 1979 Fastnet followed instantly on a high-speed broach on the face of one of the ubiquitous steep, irregular breaking seas we had to deal with that night and the following day. The boat usually was surfing too fast until she yawed; then was whipped to one side; then lay beam-to; then was overwhelmed by a breaking wave as much as two or three times her weight; and then was whiplashed over on her side and her top. The keel was left pointing up; her mast (if it survived), pointing down. Unless the violent capsize tossed them clear, the crew were trapped in the cabin or under the cockpit for two or three minutes until the next wave smacked the keel and brought the boat back upright.

Storm tactics, therefore, are never certain. The choice depends on the situation. The crew must be flexible and also determined. This is one of those cases where a strong will and good judgment can more than compensate for short experience and modest skills.

In my book on the Fastnet storm there is a story that illustrates the state of mind needed in all conditions like this.

Windswept

Windswept, a beamy, light-displacement 34-footer (10.4m) of the new breed, was down to her storm jib until, with 60 knots on the anemometer, she began to be badly battered. The crew doused the headsail and tried to lie ahull. It worked well at first, as the experienced skipper, George Tinley, recalled: "We were just lying there like a little duck, going up and down, which is just what all the books say should happen." Then a rogue wave threw her on her beam's ends, tossing the crew on deck the length of the tethers of their safety harnesses. (Incidentally, the greatest effect that studying the Fastnet had on my own sailing was that I became a true believer in safety harnesses. My faith in them has not lapsed.)

The boat righted. Though Tinley's nose was smashed, he retained command and tried the tactic of riding to a sea anchor improvised by putting an anchor in a sail bag and letting it off the bow at the end of a mooring line. Once the boat came up against the sea anchor and her bow was dead into the seas, her motion steadied and the forces eased. Tinley lashed the helm, moved the crew below, and issued them life jackets. Sitting in the messy but warm cabin, they sent a watch on deck every few minutes.

But a series of waves shoved the bow to one side, putting *Windswept* on a reach. Tinley started the engine and was sticking the bow back into the wind's eye when a line fouled on the propeller. With the waves on her side, the yacht almost immediately was turned over completely. She remained turtled for over half a minute while somebody shouted encouragement: "Never mind, it will come up again in a minute." When the boat finally came upright, there were footprints on the inside of the cabin coachroof.

In this capsize George Tinley broke his wrist and was knocked unconscious. With the boat apparently full of bloody water, they decided to abandon ship. However, the life raft's inflation system broke. Then the crew unsuccessfully tried to attract the attention of a nearby boat with flares, only some of which fired off. Facing the fact that they would have to make do on their own, they bailed out much of the water with buckets (the pump handle was lost during the rollover) and turned the stern to the wind and sea. This time the sea anchor became a drogue towed astern with some additional equipment to provide resistance, including a bottle of water. It worked; the boat immediately slowed, steadied, and became much more manageable.

At the helm Tinley assigned a young sailor who had sailed very little offshore but had considerable experience racing small boats, which fully prepared him for steering a boat in these difficult circumstances. He steered skillfully for several hours while the crew bailed and huddled together on the sole of the now-destroyed cabin to generate body heat. They were lucky that one shipmate, a Frenchwoman whom Tinley nicknamed "the good Sophie," volunteered to blow warmth down the others' shirt fronts. As the storm dropped and then died, *Windswept* slowly sailed to the Irish coast and land.

The brave sailors of the aptly named *Windswept* also teach us some more abstract though equally valuable rules of thumb. As miserable, bloodied, cold, wet, and terrified as they were, they neither panicked nor gave up trying new techniques. The best storm tactic is often a steady application of human intelligence and spirit.

The crew of *Windswept* did an excellent job of getting the boat sorted out. However, there were several additional things they could have done to help the boat stay end-on to the seas:

- ❑ Adding a second weighted sail bag off the bow.
- ❑ Creating more windage aft, by jury-rigging a sail using a piece of mast, boom, or reaching strut tied to the pushpit.

Richard Bennett

The ultimate photographic example of steering control. Wild Thing planing downwind in 50 knots of wind, gusting 70. She's carrying more sail than would be the case if she were cruising, but is under control. In fact, light boats with good steering characteristics in heavy weather typically do best when kept at speed. They become sluggish, like heavier designs when they're slowed down by too little sail or lulls in the wind.

Design Factors

Many factors determine how a sail or power yacht will behave in heavy-weather conditions. As with anything to do with the sea, there are a lot of divergent opinions on this subject.

Since we've made a living designing and building large sailing yachts, we do have some strong opinions on the subject, not always shared by others in the industry. (If you're interested in more detail on this subject, a large section in *Offshore Cruising Encyclopedia* is devoted to yacht design, starting on page 461.)

Steering Control

Of all the factors impacting your heavy weather tactics in sail and power, nothing is more important than steering control.

It is steering control that affects how fast you can go downwind. It is steering control that affects when the boat begins to broach when running, and how much speed you need to maintain heading into the seas.

Steering control also determines the use of the autopilot, and how the crew does when it becomes necessary to take over helming duties.


Rick Tomlinson

A couple of decades ago, when the first Whitbread Race took place, the IOR boats were so cranky (hard to steer) in heavy going down wind that a 265-mile-day was considered really good—on a maxi. With the (fortunate) demise of the IOR rule and its replacement by the IMS and Whitbread 60 rules generating boats, which are easily controlled at high speeds. Four-hundred-mile days in the Southern Ocean are now common. Without good steering control, this could never happen.

Hull Balance

One of the biggest factors in steering control is hull balance. If hull lines are drawn so that they maintain their distribution of volume evenly with heel, there is little tendency for the boat to round up when heeled over.

Vessels with unbalanced lines—and this means almost all motor yachts and many modern cruising sailboats—tend to round up into the wind when heeled by the wind or a wave slap.

In either case a lack of hull balance increases the risk of a broach, severe knockdown, or worse.

Beam-to-Length Ratios

With power and sail, the narrower a boat for a given length, the more directionally stable it will be. It is also easier to draw hull lines which balance when heeled with narrower beam yachts (although this can be done with fat boats too, if the designer is careful).

In designing our sailing yachts we maintain a minimum length-to-beam ratio of at least four-to-one.

Keels

Here's where things get a little argumentative. It is our feeling, based on many designs and probably over a million miles of client experience, that keels play a very small part in the steering equation.

Long keel or short keel, if the boat is beamy with unbalanced lines, it will be a pig to steer. On the other hand, if the boat has a favorable beam-to-length ratio with balanced lines, it will steer easily—with either a long or short keel.

Centerboard yacht designs have benefits and negatives.

On the plus side, in heavy going they can pull up their boards, reducing lateral resistance, and allowing the boat to skid more easily.

However, they tend to be beamier and have a higher center of gravity, so they roll over more easily and take longer to come back upright.

The reason the "traditional" yachts of earlier in this century steered so well has nothing to do with their long keels. Rather, it was their very narrow beams and beautifully balanced lines.

For most designs, the shorter the keel, the easier it is to turn the boat. All of our larger yacht designs have what would be considered very short keels, typically less than a quarter of waterline length, and these boats steer like a dream going downwind in heavy conditions.

Another design consideration with keels is what we refer to as "tripability." With some extremely deep and/or long keels, in a severe wave-induced knockdown, the keel can exacerbate the rolling of the boat. We feel it is far better to have a keel that loses its that loses its grip at modest heel angles so that the boat can slip sideways (we'll discuss this in more detail a little later).

Rudders

The best rudder is also a somewhat controversial issue. Our experience, and that of all modern race boat drivers, is that the spade rudder delivers the most steering effect for the lowest input of force—from autopilot, wind vane, or helmsman.

In the early days, there were some structural problems with spade rudders, but these were solved a long time ago. There are upwards of 50 of our larger yachts crossing the oceans on a regular basis, and as far as we know, none has lost a rudder to the ocean.

If you have any doubt about small keels working in severe conditions, go back and look at the drawing of *Bin Rouge* on page **268**. Without the extreme maneuverability provided by the combination of light displacement, small fin keel, and large spade rudder, they never would have been able to steer around the breaking seas in the 1998 Sydney-Hobart Race.

Yachts with a skeg-mounted rudders steer less efficiently, requiring greater power.

The worst-case scenario is when you have a rudder attached on the back end of the keel. Here the rudder is really more like a wing flap than a rudder, and has limited usefulness.

When you consider how you will do running off at speed, the rudder is obviously going to be a major factor.

It goes without saying that the larger the rudder in any given situation, the better job it will do when the chips are down.

Rudder/Propeller Relationship

If you are using your engine to help hold a position (usually head-to-wind or shy beating), the relationship between the rudder and propeller is important.

The closer the prop to the rudder, the more flow over the rudder to help it steer.

With a lot of separation between prop and rudder, as on some sailboats, the rudder can only develop turning force by moving through the water—so you need boatspeed from the sails and engine.

But if the rudder and prop are close together, you can be held almost dead in the water by strong winds, with the prop turning at slow-to-medium speed, and have really good steering control from the prop wash. All of our yachts are designed with the propeller close to the leading edge of the rudder—sometimes as close as half a propeller diameter.

PPL

Oops! This is what happens when the limit of positive stability gets too low, and the inverted stability too high—even with monohulls.

Limit of Positive Stability

Limit of positive stability (LPS) is the point at which a boat will no longer come back from a knockdown and remains upside down.

This is a function of how the boat floats and the center of gravity of all of the weights.

High freeboard, cabin structure, narrow beam, and a low center of gravity all promote a good LPS.

Wide beam, low freeboard, and a high center of gravity are negatives.

The appropriate LPS is the subject of debate and varies with boat size. Generally speaking, the larger the boat, the better it will tolerate a lower LPS.

Another part of the LPS situation is the instability of an inverted vessel. Ideally, you want to have as unstable a situation as possible when inverted, so the boat comes back upright quickly.

Our boats, for example, typically have LPSs between 120 and 135 degrees (for 60-80ft/18.3-24.4m designs).

For smaller boats, you want even more LPS. Many power yachts will capsize at 70 degrees or thereabouts without righting themselves. If you are offshore in one of these boats, be very careful with your tactics.

Polar moments is a term used to describe how weight is distributed around your hull. The further the weight is from the center of things, the higher the polar moment. Distance is a third-power function in this equation.

It takes energy to upset the balance of the polar moments, so when a wave slaps the side of your hull, the energy imparted (to make you heel and roll) must overcome your polar moments. The higher these are, the more energy the wave has to get into your hull to do a given job.

Where things get a little tricky is with the sailboat's mast and rigging. Because they are tall, that third-power function kicks in, really increasing polar moments. At the same time, the vertical center of gravity increases, which is a negative for LPS.

However, the fact that boats that have been dismasted seem to be at much higher risk of rollover seems to indicate that polar moments are a critical factor.

Skidding vs. Tripping

If the boat can skid off the leeward and absorb the wave energy over time (typically a second or so), as opposed to being held in place by the topsides and keel, it has a much better chance of staying upright. We have comments on this subject from many of the monohull and multihull sailors we've interviewed. This is a key factor in the ability of a given design to deal with survival conditions.

As already mentioned, keel shape has a big impact on whether a boat will skid. If the keel breaks free early as the boat heels, there is less in the water to keep the boat from sliding with the wave.

Another factor is how the deck edge behaves with heel. The more heel a design can tolerate before the deck edge digs in, the better it will skid to leeward.

Factors that promote skidding are small keels, shallow keels, narrow beam, and high freeboard. Factors which tend to hold a boat in place are wide beam, low freeboard (both of which dig the deck edge in more quickly), and large keels.

Cockpit Layout

Ideally a heavy-weather cockpit will be deep and secure, with easy-to-grab bits of hardware or actual handrails to aid moving from the companionway aft. Where dodgers or other protective coverings are in use, having inside and outside handrails makes life ever so much more pleasant (and safer).

You should be able to move from the aft end of the dodger to the wheel by going from handhold to handhold (usually the end of the dodger frame with handhold cut-outs to a safety bar ahead of the steering wheel).

The ideal cockpit will be deep enough to give your legs good support when standing up—typically about 20 inches (450mm). This can be uncomfortable for sitting by the time you add sea cushions, but most people sit with their legs up, so it is not a big issue.

The smaller the boat, the more important this becomes, as a smaller boat will have more motion.

On the other hand, the cockpit should not be so large that when flooded, it adversely affects the vessel's trim.

Also, the companionway entrance should be up one step, so the first washboard is well above the cockpit sole. This reduces the annoyance of leaks below when the cockpit fills.

Cockpit Drains

Cockpit drains should be much larger than anyone imagines necessary. On the average medium-size sailboat cockpit, we like to see drains 2 inches (50mm) in diameter. Ideally, these will exit through the transom, well above the waterline. If the cockpit is large, the drains should be in the 3-inch (75mm) range.

If you have grills over your cockpit drains, remove these before the onset of heavy weather, as they will reduce the rate of drainage by 50 percent or more.

Heeled Flotation

All hatches, vents, and companionways should be analyzed in the context of a full knockdown, and how the boat floats when heeled at various angles.

Check with your designer to see how the boat will float when heeled in a full knockdown (typically about 60 degrees), then see what's inside and outside of the flotation line—with an allowance for wave action.

Companionways should obviously be on the center. The same goes for deck hatches and dorade vents.

Cockpit lockers, which empty into the interior will leak, and if you are taking breaking waves on deck, you will collect lots of water through these hatches.

They should be stoutly made, with have good seals and positive locks. If you lose a cockpit-seat lid in a knockdown or rollover, it may cost you your boat.

Knockdown Mechanics Recap

As we stated earlier in the book, a wave-induced knockdown or capsize has far different mechanics than one brought on by carrying too much sail. When a yacht tips from wind pressure, the angle of heel is a function of the wind's force acting against the boat's natural tendency to remain upright. You continue to heel over until a point of equilibrium is reached. Most yachts will heel no more than 70 degrees from wind pressure alone. When this occurs, the crew has two options: change course or ease sheets.

But a wave-induced roll is something else. Here we have a "jet" or breaking crest of water striking the hull and imparting a force, which the hull absorbs and begins to dissipate as it heels over. In this case the forces imparted to the hull act much faster than the wind, and the crew can do little besides brace themselves and hold on. The yacht then rolls with the breaker. At some point the energy of the sea is dissipated and the yacht begins to right herself. Regardless of size or steepness, if the wave isn't breaking, there's nothing to fear.

A great deal of the reaction of your yacht to a breaking sea has to do with the wave's angle of attack and the amount of hull area impacted. If heading into or away from a breaking crest, the energy can be absorbed and dissipated longitudinally as well as in the athwartships plane. The odds are that only a portion of the crest will catch you. Most of us have experienced a mild broach from a slap on the stern quarter, or felt a breaking sea all but stop forward progress.

Taken beam-on, however, there is more hull structure exposed and less stability available to deal with the forces of the breaking sea. That's why lying ahull, beam-on in breaking seas can be such a dangerous tactic.

Sorcery

It was in the noisy confines of Papeete Harbor on the island of Tahiti in 1977 that we got our first impressions of the rollover of the C&C 61 *Sorcery*, from Ted George. He'd been at *Sorcery's* wheel running before a Force 10 gale in the North Pacific with just a trysail and storm jib set. *Sorcery* had been in the blow for the better part of three days, keeping the wind on the quarter—about 150 degrees apparent wind angle—traveling at 8 knots.

The seas were enormous. A Coast Guard cutter 300 miles away from the severest part of the storm, (where *Sorcery* sailed), estimated the waves at 45 feet (13.8m). From the vantage point of the crew aboard *Sorcery*, they were considerably larger. But the basic wind-driven seas were not breaking, and so held little danger.

Swells from earlier blows were occasionally colliding with the wind-driven waves. Every now and then the resulting confused sea, (sometimes a small breaker), would catch *Sorcery* from a different angle and give her a good wallop.

It was just after midnight, when Ted heard something that made him turn and look over his shoulder to windward. Against the overcast night sky he could just make out the outline of white water as a large breaking sea with a crest perhaps 10 to 15 feet (3 to 4.6m) high rolled down on *Sorcery*.

Ray Hays, a frequent crewmember aboard *Sorcery*, was just getting ready to come on watch when the crest rumbled aboard. Ray estimates that *Sorcery* was rolled through 360 degrees in less than five seconds.

Rushing up, the crew from below found chaos on deck. The rig was gone, and the deck had been swept clean of gear. But *Sorcery* was still watertight and afloat, with little other damage.

Ted, however, had not fared so well. He was nowhere to be seen. His faint cries were finally traced to the stern where he had been thrown when his harness failed. Ray and owner Jake Woods struggled to get Ted back aboard, but in the heaving seas and wild motion of the sparless yacht, the two men could not hoist Ted. Finally, a third crewmember arrived to lend a hand and he was pulled back into the cockpit.

Galaway Blazer

Peter Crowther was on his way around the world single-handed, in the westerlies, when he encountered a series of severe depressions 200 miles south of the Cape of Good Hope, aboard the 40-foot (12.27m) junk-rigged *Galaway Blazer*. A damaged foresail had made it necessary for Peter to lie ahull (the mainsail, even reefed to the first panel, was too large for sailing in the prevailing weather).

Peter felt *Galaway Blazer* was doing fine in the early part of the gale. His yacht would bob buoyantly as the onrushing seas ran under the hull. Down below, in the tight confines of his narrow yacht, he felt safe and secure. There was no doubt in his mind, however, that he would have been better off running before the storm. But as Peter says, "Dealing with the elements on a less-than-ideal basis is sometimes required at sea."

During the second day of the gale, *Galaway Blazer* was rolled. Peter was below and didn't see the wave, but felt it must have been a pretty good-size breaker to overcome him. He was left with decks clean and both free-standing spars broken off just above the deck. Shorn of the roll stability from its spars, *Galaway Blazer*'s motion became extremely violent. During the balance of the storm, she was rolled two more times. When the storm abated, Peter was able to make his way to Cape Town under power for re-rigging which is why we discussed his impressions.

These two examples show totally different types of yachts in distinctly different situations. In the case of *Sorcery*, we have a moderate-displacement, medium-freeboard, deep-keeled design broad reaching and under control.

Galaway Blazer was designed with a specific orientation to these dangers, and had a gently rounded deck edge to prevent tripping and to improve re-righting characteristics. She was a light design, with substantial freeboard for her displacement, and a low center of gravity. Both yachts were well-rigged.

Absorbing Wave Impact

Let's review for a moment the factors which enhance your ability to absorb wave impact.

We feel the most important is the skid factor discussed previously—a design feature over which you have little control.

Next would be polar moments, (the weight away from the center of the boat) which resists the acceleration of the boat to a knockdown as the hull absorbs the energy of the breaking wave.

Finally we have the limit of positive stability. This is a design function and is related in some ways to both polar moments and skid factors.

This is also an area where you have some control, as a very important part of LPS is your vertical center of gravity.

Improving Your Odds

There are some simple ways to improve your effective, or "sailing" vertical center of gravity. These have to do with payload, and how it is stored. We've covered this in the section on preparation (page **107**) but it's worth going through briefly again.

The image evoked by a salty-looking bluewater cruiser, decks festooned with extra jerry jugs full of water and fuel, outboard motor on the pushpit, and dive gear lashed in a deck box, is absolutely wrong for any sort of a passage and can be particularly dangerous in a severe blow. That gear, carried high above the center of gravity, reduces the range of stability and the safety factors associated therewith. This gear belongs below, as low as possible under the floorboards, where it contributes to stability. The same goes for anchors, chain, rodes, docklines, inflatables, and any other loose gear on deck.

Storage in a Knockdown

The second aspect of storage is making sure everything stays put if you do suffer a severe knockdown or rollover. This means inspecting each piece of gear and equipment to be certain that it will stay where stowed, if the boat is inverted. Particular care must be taken with stoves, batteries, refrigerator tops, and floorboards. If you've stowed supplies and spares under bunks and settees, be sure the lids will stay in place with all that weight pressing down, should your yacht invert. One of the main reasons given by the 1979 Fastnet Race crews for abandoning their yachts for the apparent (although illusory) safety of life rafts was the dangerous condition of their interiors.

Cape Hatteras Storm

Before we go further into this subject we'd like you to join us aboard *Intermezzo II* on a fall passage south around Cape Hatteras.

This was a seminal experience for us from a design perspective, as it gave us a first hand look at a variety of modern design characteristics in a severe storm in the Gulf Stream. Every design, with which we've since been involved, reflects the experience we gained in this blow. For this passage Steve made the trip with two catamaran-racing friends as crew. (Linda stayed ashore with Elyse and Sarah).

Intermezzo II

As the great capes go, it isn't much to look at—a low, sandy beach in the form of a lazy "V" pointing southeast. It doesn't have the grandeur of a massive headland like Cape Aghulas, at the bottom of Africa, nor the impressive physical characteristics of Point Conception, California's version of Cape Horn. Yet, with the exception of Cape of Good Hope and Cape Horn, no piece of waterfront real estate on our globe generates as much respect from seasoned mariners as Cape Hatteras.

A combination of environmental characteristics gives Hatteras its fearsome reputation. Let's begin with the "Hatteras low," a small depression that is permanently moored in the vicinity. As frontal systems sweep across the continent, they sometimes hook up with this cell and intensify the local pressure gradient. This means wind. Then there's the Gulf Stream. While professional meteorologists ponder the effect of its warm-water temperature on swiftly moving cold fronts, those who have been caught in the "stream" when a cold front passes know that rapidly escalating winds are the result. Add to these factors the Gulf Stream current, which accelerates as it makes its bend to the east-northeast right off the cape, and a shallow seabed with a steep drop-off, you now have all the ingredients for a good story.

There were three of us aboard *Intermezzo II* that evening as we motorsailed down the Chesapeake toward Norfolk. Sean Holland and Lorraine Reid had hailed us from the dock in Annapolis. Old multihull-sailing buddies from our West Coast days, we had an interesting evening remembering past lives and friends.

Norfolk, Virginia

The plan was to wait in Norfolk, Virginia, at the mouth of the Chesapeake until the weather forecaster announced a good-sized front with storm-strength winds. I was hoping to test our new *Intermezzo II* in heavy downwind going. Her 55-foot (16.9m) waterline and lightish displacement should be at their best in steep seas off the wind. The major questions in my mind dealt with how hard she would be to steer, and if her storm canvas and sail-handling gear were adequate for Linda and myself to manage on our own.

I should probably digress a moment and tell you that at this point in time *Intermezzo II* represented our view of the ideal short-handed cruising boat. She had been built in Cape Town, South Africa, to a design Angelo Lavara-

Intermezzo II at speed with jib top, staysail, and full main. This 62-foot (19m) design was considered radical when she first debuted, but in reality was extremely conservative. The primary focus of her design was dealing with heavy weather.

nos and I had worked up. Between Angelo's experience with the waters around South Africa and our desire for a conservative boat (*Intermezzo II* represented our house money!) you would expect she'd do okay in nasty going.

Since Linda and I had been cruising and living aboard her for the past year, we'd seen nothing more than 35 knots of breeze—hardly a test at all. Now we had a chance to really wring the boat out and learn something.

None of us was really enjoying the cold November sailing conditions, but the hot bath in the forward head that awaited each of us after the hook was down in Hampton Roads helped improve our outlook. After a convivial evening meal, we deemed it prudent to have a listen to the NOAA weather forecast. Unfortunately, or so it seemed at the time, it looked like clear weather for the next few days. The morning broadcast was similar, and, with a schedule to keep, we decided to forge ahead. Our testing would have to take place another day.

Beating South

As we sailed southward in the moderate south-by-southwest wind I ruminated on this sad state of affairs. We were beating upwind against the Gulf Stream Current and it was cold, with a steady barometer of 1,023mb, indicating no immediate change in the weather.

Spirits were somewhat improved by the afternoon forecast of a mild frontal passage later that evening with an attendant wind shift.

The crew bunked down, while I kept an eye on our progress toward Diamond Shoals light. *Intermezzo II* was making good time under her double-head rig on starboard tack. The breeze was gradually swinging around, first to the southwest, and then west-southwest. The barometer was up a tick at 1,024mb.

My blood, thinned by the tropics, was feeling the effects of the mid-30-degree temperature despite long woolen underwear, heavy sailing pants and shirt, sweaters, watch jacket, wool cap, and foul-weather gear (not to mention gloves and two pairs of socks).

Frontal Band on the Radar

The frontal system we saw on radar was probably not that strong as it crossed the land mass to windward of our position.

But once it hit the warm, damp Gulf Stream, extra fuel was provided to help it "bomb."

This tends to be especially true when the sector of the weather system trailing the cold front comes into contact with the Gulf Stream.

Warming up for a few minutes below, I was checking our distance off the beach on radar when, at the edge of the screen, I watched a heavy band of rain clouds come into view. That would be the frontal passage NOAA had mentioned. I considered shortening sail, but then we were only expecting 25 to 35 knots—nothing to get overly excited about. The breeze was now down to 15 knots, with a stable barometer, and had clocked further to the west.

Judging by the size and density of the cloud target, the wind should reach us in about 30 minutes. That left a moment for a cup of coffee before I had to ease sheets.

Not more than two minutes later I noticed the barometer had jumped 3mb. While I was trying to ponder the significance of this event we were laid neatly on our side, spreaders kissing the wave tops as our front announced its arrival.

Adrenaline flowing, I scrambled horizontally on deck. I eased the main traveler, which allowed us to straighten up. We ran off to the south, with the headsails blanketed in the lee of the main. By the time Sean and Lorraine had bestirred themselves, the yankee and staysail were secured on the foredeck.

Working the Beach

We were flying downwind under mainsail only, now with the wind clocked all the way to the northwest. After the squall line passed us, we could decide what to put up for the duration. An hour later we were still moving well. Sean went below to take a radar fix on the beach. Staying in close kept us out of the current, but there were limits. This was before the era of the cheap GPS or Satnav, and we relied on sextant, fathometer, and radar as primary navigation tools.

With a strained voice, Sean hollered up, "How hard do you guys think it's blowing?"

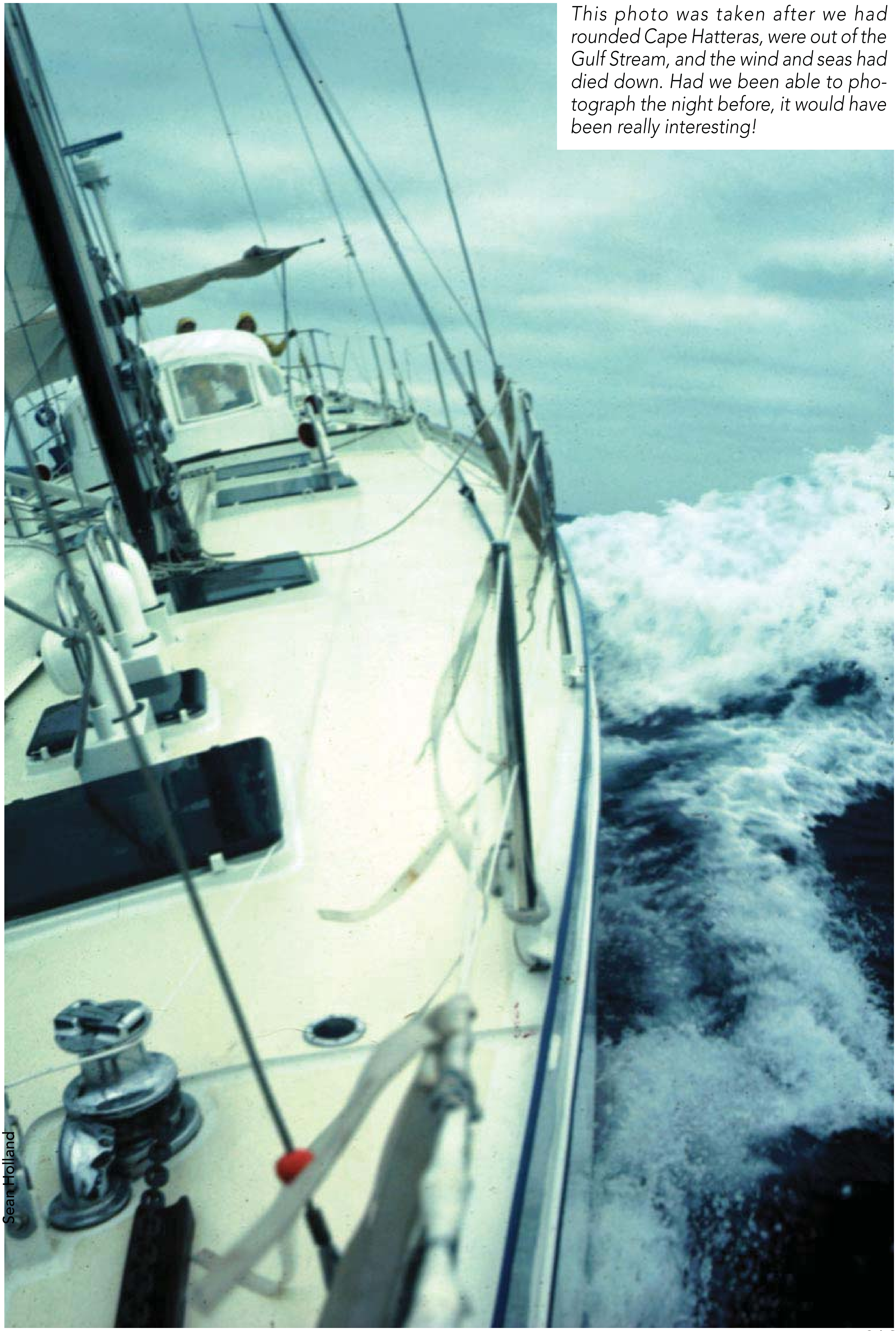
Lorraine and I looked at each other and I said, "Maybe 35 to 40?"

"Guess again. It's 55 on the anemometer and we're averaging 13 to 14 knots!"

Allow for the opposing Gulf Stream current and this adds up to 67 knots true windspeed before the puffs. This is not what you would expect from a frontal passage from this sort of system, unless you throw in the warm-water effect of the Gulf Stream.

Although the sea state didn't yet show the effects of so much wind, we knew it wouldn't be long before the Gulf Stream opposing this northeasterly breeze would have the sea breaking.

Even though we were comfortable bare-headed, a deep reef in the main seemed prudent given the conditions. It was accomplished with more ease than I had reason to hope, and our ride slowed somewhat.



This photo was taken after we had rounded Cape Hatteras, were out of the Gulf Stream, and the wind and seas had died down. Had we been able to photograph the night before, it would have been really interesting!

In the next eight hours, as we neared Cape Hatteras, the seas began to build, while the barometer climbed at the rate of almost 3/4mb per hour.

Within a short period of time, the waves were running 8 to 10 feet (2.4 to 3m), the top half breaking in a welter of white water. As each foaming crest approached our stern, we accelerated down its face. *Intermezzo II*, as always a perfect lady, could be steered with two fingers.

With a few hours more to mature, the seas had reached the 20- to 25-foot (6.1 to 7.6m) and above range. Nothing to write home about if it wasn't for their shape—very close to vertical, with less than three boat lengths between crests. Yet we continued to enjoy our incredible sail. *Intermezzo II* could be maneuvered at will, the helmsman carving out her best angle of attack across the seas. She was regularly hitting speeds in the high teens and low 20s while surfing down the wave faces.

Steering Technique

The steering technique was much the same as one would use when aggressively steering the boat downwind under spinnaker.

I would feel the oncoming sea begin to lift the stern. The combination of more wind on top of the wave than in the trough, and with the crest slapping the stern, would begin to round the boat to windward.

The key for the helmsman was to react ahead of that slap. I would put the helm down to leeward aggressively before she had time to get the bit in her teeth and start reaching across the wave face.

Once we had accelerated and were surfing down the wave, sometimes surrounded by the crest and at other times ahead of it, I would begin to bring the helm back to neutral.

At the bottom of the wave I would pull the bow up to windward 15 or 20 degrees, to avoid burying her nose in the steep back of the wave crest ahead.

As long as our speed held above 11 or 12 knots, the boat reacted fast enough to her helm so that you could be a little tardy on the initial downwind corrections at the top of the wave.

Knockdown

The only problem came in the lulls. When the wind dropped for a few moments into the 50s (35 to 40 apparent), we were under-canvassed with deeply reefed main and had to be most careful on the helm. With the boat slowed into the 7- to 8-knot range you had to anticipate the steering needs. The instant you felt a gust or the stern began to lift, the helm had to be cranked to leeward. If you were even two seconds late, the crest would have you spun around.

The combination of cold, post-adrenaline drowsiness, and inattention by the skipper during a momentary lull, allowed *Intermezzo II* to get herself sideways on a breaking wave.

We were picked up, thrown down sideways, and skidded on our topsides—showing no tendency to trip. It was so much fun that by the time we reached the light and headed southwest we had done it two more times.

Putting Diamond Shoals Light astern that November night was a happy occasion, all the more so for the calmer lee that the shoals afforded us as we turned southwest toward Cape Fear. Running out of the Gulf Stream with the bottom dropping away, the seas became docile by our new standards.

The next day, with the wind now in the 40s and a number two yankee poled out, we were still flying. The barometer was steady at 1,031mb, and the wind had veered all the way to the north-northeast.

Lessons for the Future

The rest of the trip was uneventful, if slow. The breeze tapered off in due course and our progress was impeded by headwinds.

This gave me plenty of time to ponder our experience in the recent blow. Several factors stood out.

First was the boat's ability to skid on her topsides when caught by a breaking crest. Rather than tripping on her keel, the skidding allowed her to dissipate the wave's energy over time. If the boat had been designed with less freeboard and a deeper, larger keel, she could have been easily knocked down past horizontal by the sea state.

The second issue was steering control. We felt that we had plenty of rudder in all conditions except for the lulls. And in the lulls we were definitely under-canvassed.

We knew we could carry more sail area. Our storm jib or heavy staysail would have been perfect. But running pretty much square downwind did not allow us to use a headsail unless it was boomed out. The spinnaker pole was 25 feet long (7.7m) and a bit intimidating to handle under the existing conditions. A reaching strut would have worked beautifully.

We were fortunate in being able to stay out of the major axis of the Gulf Stream, so we had only 1 1/2 or 2 knots of opposing current. Had we been further offshore, even just another 25 miles, that current would have been running at 3 to 4 knots, in which case the seas would have been far more dangerous.

We had no choice but to hand-steer as the Wagner S50 pilot on board did not have a chance of handling the boat in those conditions. This forced us to stand at the wheel, exposed to the elements, where the cold quickly took its toll on stamina and concentration.

Recognizing how important it is to have a pilot that can steer aggressively in storm conditions, we subsequently fitted far more powerful systems to all of our clients' and our own boats.

It was obvious to all crew that with a vessel like *Intermezzo II,* we had a new range of storm tactics available. Running fast enough to keep from broaching would not have been possible in our older, heavier *Intermezzo*. Nor would Sean have been able to use this approach on his 38-foot (11.7m) C&C design.

With both boats, we'd have been forced to slow way down, counting on some form of drogue device off the transom to keep us aligned with the waves. Given the steepness of the seas, a parachute anchor would have been out of the question.

Michael Popcock

We met Michael and Pat Popcock in the Sea of Cortez in the mid 1980s. They were on their way to the South Pacific, aboard *Blackjack* (and subsequently completed a circumnavigation).

Michael was a yacht designer, surveyor, and marine consultant. He began designing yachts in the mid 1970s, after working as a building architect.

It isn't often that designers have the time (or desire) to do serious cruising. So when we found one who did, we were intrigued with how his concept of a proper cruising yacht would look.

When we met he had designed a series of yachts from 58 feet(17.7m) down and, at that time, had just done a series of water-ballasted OSTAR/ TWOSTAR racers for the small end of the fleet.

Blackjack

Blackjack, aboard which we spent many interesting hours chatting with Michael and Pat was one of Michael's designs built for the TWOSTAR in 1981. He and Pat did the TWOSTAR together in 1986 (Pat described it as "not much fun until we got there, and then it was.")

As Michael puts it "it's horses for courses," and *Blackjack* was designed for the North Atlantic in early summer, meaning lots of beating in big seas with gales more often than calms.

She's 37 feet (11.3m) on deck, 30 feet(9.1m) on the waterline, has an 11-foot 1-inch (3.4m) beam, and a 7-foot 9-inch (2.4m) draft and 15,400-pound displacement in racing trim (with another 1,700 to 2,000 pounds added for cruising). All halyards and reefing controls lead aft. There are roller-furlers for the genoa and staysail, and a robust Aries vane sits on her transom (although the Autohelm 2,000 does most of the work downwind and in light air).

After the 1986 TWOSTAR, *Blackjack* cruised Iceland and has since sailed the Caribbean, Galapagos, to Hawaii (4,200 miles in 32 days), Alaska (Hawaii to Kodiak, Alaska; 2,200 miles in 16 days), and down to Victoria, British Columbia, where the boat wintered while the Popcocks flew home to see family and design boats. The following summer, they went back to Alaska, and then in the fall down the west coast of the US and into the Sea of Cortez, where we met them at Isla Partida. Keep in mind that with two seasons of cruising Alaska and one in Iceland behind them, Michael and Pat have yet to bother with installing a heating system aboard *Blackjack*. They have since completed their circumnavigation.

Talking to a designer with so many sea miles under his belt is a unique experience, and we were anxious to hear Michael's philosophy on proper cruising design. "My preoccupation has always been hull balance, and control" he told me, "That's the North Atlantic influence. The difficult part is getting a good upwind boat which isn't a dog off the wind."

When we pressed Michael on just how he achieved this, he went into an explanation of using a system of 45-degree diagonals that serve as the hull shape control. This gave him fair sections both forward *and* aft. "There are some tricks I play with the aft sections to give the boatspeed," he said with a conspiratorial air. We'd love to know what those tricks are but that gets into the realm of personal black art.

We asked Michael what he considered to be their ultimate cruising boat. He thought for just a moment, then said a boat with a maximum length of 40 feet (12.2m), although they were happy with *Blackjack*. "But," he continued, "we could easily go smaller just for the joy of being simple."

With all their high-latitude sailing, we figured that we had a treasure trove of heavy-weather experience anchored next to us.

What Heavy Weather?

"What sort of tactics do you use in heavy weather?" we asked.

Pat looked at Michael for a couple of seconds then replied, "We haven't really had any heavy weather!"

It's the old axiom; heavy weather is relative to boat size and experience. Still, with the miles this couple had covered, there must have at least been some fresh gales.

"When we did our qualifying miles for the TWOSTAR, we had a bit of a blow," Michael allowed. "We were off the Scilly Isles (in the United Kingdom) when a 50-knotter came through, on the nose, of course. It was March, a bit cold, and the seas were rather steep. *Blackjack* is designed to keep moving in conditions like that. We shortened down to the third reef, rolled the staysail in a bit and kept at it until we'd reached our turning point. Then we surfed home."

Roller-Furling

We were intrigued by Michael's comments on roller-furling. "We have Hood rollers on the bow and staysail stay. The sails have padded luffs to reduce draft, and if they are done right the sail sets reasonably well. But a sail for *all* weather doesn't exist."

Storm Canvas

Michael has some interesting comments on storm canvas as well. When asked about their lack of a separate trysail track he explained "It's rather difficult to get the track past the spreaders on this Kemp spar, so we make do with the third reef in the main. If the main is damaged, then we can go to the trysail." (It is IOR-sized, as are the storm jibs.) "I like the heavy staysail when the going gets a bit rough. This gets the sail area off the bow so the bow doesn't tend to blow off in the wave crests."

We asked Michael what he'd do with the trysail if he was getting a new mast. "Oh, then I'd have a good-sized one with its own track, and use it instead of the main in heavier going."

But with her present set up, as Pat puts it, "*Blackjack* can keep plugging along in just about anything, and we don't have to be on deck to help her do it."

Design Features

By now you must be asking yourself just what are these design features that allow *Blackjack* to keep on moving in such inclement weather. "Power with moderation, deep draft, high ballast ratio, and the ability to maintain hull balance at high angles of heel. And more than anything else," Michael added, "the boat has the ability to stand up to the rig, and the rig has the ability to stand up to any wind it meets."

Since Michael is a marine surveyor as well as a designer, his views on appropriate offshore boats are of interest. "It's a question of what you want to do, and where you're going. If you are going to do the ARC race to the West Indies and then sail the easy route home, most any design type will do. But if you're going to tackle the North Atlantic, you need a tough, rugged boat."

As a surveyor Michael likes the Contessa 26 (modified Folkboat), Virtue 25 (Laurent Giles-design), Nicholson 35 ("a super boat"), Contessa 32, Tartan 37, and Sparkman & Stephens-designed Swans (all carefully surveyed of course).

MULTIHULL HEAVY-WEATHER DESIGN

There is quite a debate among designers and users about what constitutes a good multihull design for heavy weather. We'll go to some of the designers who have wide experience in this field in a moment, but lets first hear the comments of some neophytes, getting their feet wet on a cruising multihull for the first time.

The Hermans

Most of the multihull sea stories we've discussed so far are from very experienced and/or professional sailors. But the majority of folks buying cruising multihulls are at the opposite end of the spectrum—they are just starting out, often with little or no bluewater experience.

That's more or less the case with Rich Herman, his wife Cindy, and their two teenage sons. They had sailed a PDQ 36 catamaran in the Virgin Islands together, and Rich had done a coastal and offshore sailing course—each a week-long aboard other boats—and they'd chartered out of St. Petersburg on Florida's West Coast a couple of times.

They had ordered a PDQ 36 catamaran (Mark lV version) for both personal use and to put it into the charter fleet in the West Indies.

This cat has an 18-foot (5.5m) beam, weighs 12,000 pounds (5,442kg) before cruising gear, has fixed keels, and less than 2 feet (600mm) of wing clearance.

The Hermans had allowed the company to exhibit the boat in the Miami Boat Show, and had expected that whatever "punch list" existed after the factory delivery would be taken care of before their arrival.

Towards the West Indies

Rich's plan had been to get to Miami with what he thought would be plenty of time to become acquainted with the boat, within the context of a schedule—both he and his wife are emergency-care physicians in Colorado and they had a definite date to be back at the hospital.

However, as so often happens with new boats, there were many things yet to be done to complete various installations and get the bugs out of others, and they were delayed in leaving.

Rich picks up their story:

Our plan was to sail the boat straight through the Bahamas via the Providence Channel; then, once out in the Atlantic, head due east along 24 N latitude until we reached 64 W, after which we'd drop straight south for the Virgin Islands.

We actually cut the corner a little bit, according to how the wind played, but were generally sticking to our plan.

A day and a half out, about 180 to 200 miles east of San Salvadore Island, at around 0500 we were hit by a southerly gale. We'd been sailing in 15 to 20 knots of wind—measured on our masthead anemometer—when all of a sudden the wind increased to 32 to 35 knots, gusting to 40.

With both wind and seas on the beam, we had the main double-reefed and the genoa rolled down to about 30 percent.

The wind blew this way for an hour or so, after which the conditions were getting really uncomfortable. Wave height was 18 to 20 feet (5.5 to 6m), and the tops were beginning to break. It was impossible to sleep. The waves would slam under the wing and we'd be thrown 4 inches (100mm) into the air off the mattress.

Eventually we decided to run off a bit and put the stern to the waves. We were starting to surf down some of the faces with the bows hitting in the troughs of the waves.

When she started this surfing business that's when I said "Okay, it's drogue time." It was 0600 on the 15th of March (1999) when we decided to slow down.

Using the Jordan Series Drogue

The Hermans have a Jordan series drogue made up from 308 feet (94m) of 3/4-inch (19mm), double-braid nylon line. There are 120 of the special cones, and the entire assembly is attached to the boat with an 80-foot (24.4m) bridle.

When the time came to set the drogue, they took down all canvas and headed directly downwind:

The drogue was really impressive. Not many products work as advertised. It really worked well. Everything settled down, the boat quit surfing. The faces of the waves passed benignly under the boat. Motion became easier.

We locked the helm amidships with the autopilot clutch and let the boat steer itself.

We did have some water breaking over the stern, but nothing the scuppers couldn't keep up with—and this was the exception. We still had the dinghy on davits and no water got into it.

Most of the time our knot meter was showing about half a knot. Sometimes it would surge up to a knot and a half.

Like many production cats today, the Herman's PDQ 36 has large sliding doors at the aft end of the house structure. With their stern to the breaking seas, these doors offer an area of vulnerability. The odds of them withstanding a large, breaking sea are slight.

So I was curious what Rich would have done if the wind had climbed to 50 or 60 knots, with larger, breaking seas.

I'm not sure what would happen with bigger seas. I'm just not that experienced. What I can say is that the water that came aboard had very little energy. It just sort of washed up into the cockpit.

It might make sense to hang by the bow if the seas were a lot bigger, but that might require a parachute anchor.

By 2330 on the 15th, the breeze had moderated and the Hermans were again on their way East. The breeze stayed in the South, which made for a nice reach to their waypoint at 64 West. Six days after the gale they were waiting to clear customs in Soper's Hole in the British Virgin Islands.

Looking back, I thought we had a beam reach with the wind—maybe we should have worked with it. But then we were a hell of a long way from any kind of help, so we played it safe and just drifted with it.

Multihull Design Issues

At the beginning of this discussion, we need to make a major distinction—we are talking about the design characteristics that are important in heavy weather of the severest form. The vast majority of multihulls built today are designed for the charter trade; some of these find their way into the cruising fleets.

By definition, the charter trade pre-supposes protected areas of water, short hops between ports, and moderate weather.

The design factors that work best for charter do not work as well when you are fighting the sea for your safety.

To get an update on current design thinking on this subject, we went back to two of the designers you've already heard from: Erik LeRouge and Gino Morrelli; and we've added a third, Angelo Lavaranos, because his boats have spent considerable time cruising around the Cape of Good Hope as well as in more temperate climes. Angelo, like the other two designers, has considerable offshore experience.

Size

Much more than with monohulls, size is a major factor with multihulls. Gino Morrelli suggests "45 feet (13.7m) or up for serious cruising, not including Cape Horn—within the 40 North to 40 South range." For every 10 degrees of additional latitude he suggests another 10 to 15 feet (3 to 4.5m) of boat length.

Erik LeRouge says "Many of my 38- to 40-foot (11.6 to 12.2m) cats with 21-foot (6.4m) beams have done lots of ocean crossings and been through heavy weather. However, I would not have felt safe in my Biscay gale (page **386**) in anything smaller than the 46-foot-long (14m) by 25-foot-wide (7.6m) *Freydis*. However, I would not go around Cape Horn with her."

A number of Angelo Lavaranos' multihull designs in the mid-40 range are cruising offshore as well.

What we seem to have here is a consensus of sorts—45 feet (13.7m) is a minimum for serious work, but for extreme conditions, more size is required.

Displacement

Displacement is a key factor in performance, maneuverability, the ability to absorb wave impact, and pounding. While we were not able to tease any specific numbers from our group of experts, there is a strong feeling that the boats should not be overloaded beyond the designed weight. This also holds true for monohulls, although there is a bit more latitude.

Wing Clearance

All multihulls pound their wing decks at some point. The question is how long you can defer this, and how to reduce the magnitude of the impacts.

Wing clearance has a major impact on comfort, the ability of the crew to rest, and your general ability to make progress up or downwind—which is important in getting away from the storm track.

You can probably say that there is no such thing as too much wing clearance. However, there are a whole series of design compromises, which make this ideal hard to attain.

Several proportional factors come into play. One is beam. As beam increases, so must wing clearance. Otherwise, you bang more than would a sistership with similar clearance and less beam.

Another is displacement and weight in the ends. As the overall weight of the boat goes up and the weight in the ends increase, there is more pitching which leads to more banging of the wing. Ideally, you would have light ends, modest displacement, and high clearance.

Angelo Lavaranos suggests that wing clearance should range from 1 foot (300mm) on a 25-foot (8m) cat to 4 feet (1.2m) for a 65-foot (20m) design.

Beam

Beam equals stability. As long as you have enough fore and aft stability to avoid pitchpoling, and sufficient wing clearance. Up to slightly over half the length in beam seems to work well.

Hull Buoyancy

All these designers favor high-prismatic hull shapes, with substantial buoyancy in the ends. This is important when running down wind at speed, and can be important if you are hove to under parachute anchor in breaking seas (where a lack of buoyancy can lead to a reverse pitchpole).

Erik LeRouge designs his forward sections so they provide dynamic lift, to help reduce the tendency to nose dive. He feels that a buoyant, streamlined forward cross beam provides the ultimate insurance in case of severely stuffing the bows.

Vertical Center of Gravity

Most people—including many builders and designers of multihulls—don't consider the vertical center of gravity a major issue as with single hulled designs. However, in an ultimate situation, where you're in danger of capsizing, a little less weight aloft—a lower VCG—can mean the difference between plopping back down onto the wave right-side-up, or going all the way over.

VCG also has a big impact on pitching and therefore wing and bow slamming. The less weight you have in the rig, the better you will do in ultimate conditions.

One way to improve on both VCG and windage is by removing roller-furled headsails, folding them, and storing them below.

If you want to see how important this is, try removing your ground tackle from the bow and stowing it centered in one of the hulls-do the same with roller-furled sails. Then go out with a sea running and a fresh breeze and check out the difference in motion. You will be amazed.

Lateral Plane

Angelo Lavaranos and Gino Morrelli both fit stub keels to many of their cruising designs. They are easier to build, avoid the maintenance problems of daggerboards, and do not interfere with the interior. However, they both say the added lateral plane these provide will reduce slippage, and that is a negative in severe weather. They do not say this is a safety issue, but we believe we have demonstrated conclusively that the ability to slip off to leeward is one of the primary defensive mechanisms for multihulls.

Powerboat Design

Powerboats have an inherent advantage in avoiding heavy weather. Passages are organized around the search for light air and smooth seas. Also, weather routing is easier because powerboats can maintain a consistent speed.

Hull Design Issues

You may be surprised to learn that most design parameters work the same under power as they do under sail.

For example, long boats with modest beams tend to steer more easily at sea than those which are beamier for their length.

The same goes for rudder shape and size. Large, deeply immersed rudders immediately behind the prop offer better steering control than smaller, shallower rudders.

Bow and stern shape and the "rocker" of the hull also affect handling. The more rocker—the more longitudinal curve in the hull—the easier the boat will be to turn.

Displacement and the ratio of boat in the water to that above the water is another important factor.

The more favorable this ratio, in other words, the more boat below—as opposed to above—the sea surface, the better it will react to breaking waves.

Limit of Stability

This brings us to the limit of positive stability or LPS. All vessels have a point beyond which they will no longer right themselves.

The key question then becomes what happens next. As we've previously discussed, with sailboats this happens at anywhere from 115 degrees of heel to 150 degrees—well past horizontal.

Most motor vessels, ships included, start to get close to their LPS in the 60-degree range.

How your gear is stowed affects stability in a substantial manner. Adding equipment up high—dinghies and jet skis, for example—raises the vertical center of gravity. This reduces the positive angle of stability working for you.

Tank levels are a major factor. The heavier you are down low, the better off you are. The combination of light tanks and a high VCG from gear on deck can be deadly.

While icing is not normally an issue with cruising yachts, it is something to keep in the back of your mind. Ice buildup on fishing vessels is a leading cause of capsizes.

When a sailboat capsizes, or exceeds its limit of positive stability, it continues on around and rights itself. Few motor vessels will do this (unless they are expressly designed for this purpose).

It is a good idea to know the LPS for your vessel in a variety of tank conditions and with various gear loadings.

Powering Capability

Your ability to deal with the elements depends almost totally upon powering capability. This usually means at slow speeds, plugging into large (perhaps breaking) waves, with lots of wind.

Various hull, prop, and engine combinations show different characteristics. Generally speaking, slow-speed designs, with lots of reserve power do best.

Stock Newport

High-speed yachts with smaller, faster-turning props are apt to have difficulty holding their bows up at slow speeds, and experience more problems with propeller cavitation.

Regardless of your configuration, the best thing to do is stick your nose out into some moderately nasty weather, with shelter close by, and experiment.

Watertight Integrity

What passes for watertight integrity in moderate seas will rarely get the job done when serious water is on deck.

Make sure you have adequate storm covers for exposed doors and windows. Fuel and water vents should be mounted high and be plumbed with shut-off valves.

If there are high bulwarks, it is necessary to have properly sized freeing ports, so that water accumulating on deck can be quickly dispersed before it compromises security.

Station Holding Systems

As we've discussed, a key heavy-weather powerboat tactic is holding station with the bow into or just a hair off the waves.

This requires the ability to go slow with varying amounts of engine thrust.

On motor vessels with powerful bow thrusters, it is not unusual to have the thruster operation connected to the autopilot. This way the thruster itself can keep the vessel head-to-wind in moderately heavy conditions, and then use an assist from the engine when it really starts to blow.

Interior Layout

There's a major conflict between what is ideal for an interior used at anchor and one that is optimized for heavy weather. Since even ardent offshore voyagers rarely see heavy weather it seems a pity to design for something so rarely encountered. However, many of the design issues affecting your safety in heavy weather make the boat more comfortable in general on passages.

How far you take this is very much a function of where you intend to voyage, the size of the vessel, and how quickly you can make your passages.

Smaller, slower boats are more apt to be caught, and they get knocked around more than their larger cousins, so they need more care in interior planning.

On the other hand, large yachts have bigger spaces, which can be problematic in really severe weather—there's more space in which to go flying.

If you have an existing vessel, beyond some minor improvements with handrails, fiddles, and leecloths, there is not much you can do. Still, it is important to make a reasoned analysis of the strengths and weaknesses of your vessel, as this may eventually impact on your thinking about when and where to voyage.

Moving About

A key issue is moving about in the interior. Ideally you will be able to do this as much as possible with your body braced by leaning to leeward, not even using your arm strength with a handhold.

Furniture, is ideal when it is hip-high, typically 36 inches (900mm). Even better is a longitudinal (fore-and-aft) bulkhead.

When you consider interior issues, look at the ergonomics of all crewmembers. Shorter, weaker crew need to be able to use handholds. And sometimes those on the overhead are out of reach.

One problem area is the companionway. In an ideal world you would have a bulkhead on each side of the stairs leading to the interior, so that you would be supported on each tack. This is rarely possible, so you need lots of good handholds, which should work on both tacks at large heel angles.

When you step off the ladder, there should be some furniture close by against which you can lean while you change handholds.

Using the Head

This may sound like a strange topic for a heavy-weather text, but it is important to maintain all bodily functions so you are at peak efficiency when your safety requires it.

Many boat heads are difficult to use at sea. Even in this enclosed space—which is frequently larger than it should be for use at sea—it may be difficult to function.

The best toilets face forward or aft, so your body can be braced while sitting on either tack by a bulkhead and furniture.

Head compartments located forward are going to be a lot harder to use than those in the middle or aft end of the boat.

Furniture Details

You will want to think carefully about where corners are placed and how they are built. The more generous the corner radius, the less it will bruise when you bump into it.

Avoid door hardware that projects into walkways (if on a longitudinal furniture front)—you will bang into it if you lose your balance.

Never use hardware that requires the insertion of a finger for operation. If you have your finger inside a door or drawer, and the boat gets popped by a wave, you'll do serious damage to that digit.

Solid fiddlerails are difficult to grab onto. Your hand has much better gripping power if it can close around an object. Often it makes sense to router occasional hand cut-outs into fiddlerails.

Navigation (which to us includes weather analysis) is a key element when the situation becomes really difficult. You may be tired, and the boat is being tossed around by the sea. Yet you still need to be able to function with some degree of efficiency in this environment.

The ideal nav station will allow you to wedge yourself in on one tack by leaning to leeward, while bracing yourself on the opposite tack with your feet against a properly-placed piece of furniture.

Knockdown and Rollover Issues

Severe knockdowns and rollovers are rare. But in extreme conditions it is best to have one place in the boat where you can sleep and not be thrown out of the bunk if the worst occurs.

Quarter berths and pilot berths, with strong leeboards or leecloths, are the best place to be in this situation.

Handholds

As you move around the interior, you should be able to walk from handhold to handhold anywhere your body is not braced by a bulkhead or furniture.

These handholds will see substantial loading if the boat is knocked down by a wave as they'll be carrying your body weight plus the acceleration force of several Gs.

We like to have vertical handrails on each side of bulkheads as well as along the deck head.

Remember, handholds need to be placed so they work on both tacks (it's usually easier to hang from a handrail than to brace your body in compression).

Keep in mind that you may require handrails to get on and off the toilet—again on both tacks.

Cooking

The best approach to cooking is to avoid it entirely, since anything to do with a stove in heavy weather entails some degree of danger.

Our approach is to have pre-cooked meals, as well as a thermos or two full of hot drink and sometimes soup.

If you do work in the galley it is imperative that all body parts be protected from hot debris should they fly off the stove. Ideally the galley will be laid out so your body is braced on both tacks and you can work the stove *without standing in front of it*. Remember, anything on the stove is liable to come flying off at some point.

If you do have to work in line with the stove, you'll want to be able to lean against a strongly secured, wide safety strap.

Pentow Marine

Even the big guys have structural problems in heavy going—which is why they have watertight bulkheads.

Above is a not-unusual occurrence in the Aghulas Current along the South African coast. This is the Tokal on her way to Cape Town for repairs, under tow by a Pentow Marine tug.

STRUCTURE

Discussing structure in the context of heavy weather is an unpleasant subject. But the issues surrounding this subject should provide the basis for every offshore yacht if the chance of heavy weather is to be found in its itinerary.

To design a yacht for normal offshore loads is a simple exercise in engineering. One look at the design database, or at a construction rule such as Lloyd's or the American Bureau of Shipping (ABS), and the resulting structure will take you safely offshore in moderate conditions—in all probability it will even deal with gales.

But when you meet truly dangerous weather with large, confused, breaking seas, the structural issues become far more difficult to anticipate.

Nobody really knows the true loads that occur during a rollover or when a yacht is slammed 20 feet (6m) from the crest of a wave into a trough. Many yachts survive these encounters structurally. Others find their watertight integrity has been breached.

Why not just make the structure incredibly strong—perhaps twice as strong as before? The problem is this increases the weight of the vessel, which causes all sorts of attendant design problems. It may now be harder to escape bad weather in the first place, or to deal with it (without a rollover or severe knockdown) if you're caught.

While there are no easy answers to these questions, there are some principles to be examined as well as design approaches that can reduce your risk without significantly increasing structural weight.

We want to start with a basic premise: In order to stay out of harm's way and deal efficiently with the weather if caught out, you must have a structurally sound boat. As long as the boat remains upright, the key issues become keel attachment, steering integrity, and keeping the rig standing.

Keel Attachment

PPL

Another oops! Exide Challenger, minus her keel in the Vendee Globe Race. At least she still floats. You might say that this would only happen on a highly refined over-stressed race-boat keel—and for the most part you'd be right. But if you hit something, if your keel structure is not strong enough for the impact, and if you miss the internal damage, the same could happen with a cruising yacht. So, make this area extra-strong to begin with, then keep a close eye on the floors, bolts, and the hull-to-keel joint if you hit something hard.

It seems axiomatic that the keel needs to be soundly attached—but every year vessels come to grief because of keel problems.

It is often the result of a previous grounding which may have weakened or loosened the structure.

There are several answers to this. Most preferable is to have a keel structure, which will withstand a severe grounding. If you do go aground, make sure you check around the perimeter of the keel underwater to look for movement, and check the keel bolts.

Have a means of tightening the keel bolts on board, and make sure you can use the tightening system (typically a large socket, extra-long extension, and huge "cheater" bar). Sometimes a quarter of a turn on a couple of keel bolts you didn't know were loose is enough to keep the entire structure from working apart even more.

In terms of engineering, over the years we've found that working to four times the ABS norm for keel bolts and keel floors allows enough leeway for most severe groundings and whale collisions.

On our yachts the norm is to design to twice ABS requirements for rudder structure and corresponding components. Over the years we've never had a spade rudder fail with these scantlings.

With keel bolts, and keel floors, we use four times ABS. This allows a factor of safety when grounding the keel.

Rudder Integrity

If you lose your steering system, or if it becomes loose and sloppy, making efficient speed will be difficult if not impossible. We've seen numerous examples in this book where a steering problem disabled a vessel and consequently led to serious difficulties. You don't want to be left to the mercy of the elements.

So the steering control system—cable or hydraulics—should be sturdy, well installed, and properly maintained. Obviously this goes as well for the rudder and related hardware.

Rudder Stop System

The rudder stop system limits how far the rudder can turn. When the boat is going forward, it never sees any load. But if you are hove to or sitting behind a sea anchor or parachute, and the boat is thrown aft by a large sea, the rudder may be thrown against its stop system, in which case loads are substantial.

If the stops are not tough enough, their failure will lead to other problems in the steering system.

Take a good look at your system. If in doubt, have the stops checked by a marine surveyor or the yacht's designer.

Emergency Tiller Loads

Emergency tillers can experience exceedingly high loads in storm conditions—especially if the boat is thrown backwards by a sea.

It is common for an emergency tiller to get crumpled in moderate gales (or less).

You want this piece of gear to be really strong. Hopefully, then, you will never need to use it. (See page 545 in *Offshore Cruising Encyclopedia*.)

Rig Integrity

Rig integrity is obviously a major factor in making a fast passage and in adopting different storm tactics.

The key is to make sure that all the various pieces in your system are inspected before each passage—and periodically pull the rig to thoroughly check tangs and other hard points. It is rare that a failure arrives without warning. Keep your eyes open, and you will see it coming.

A word on wire and fitting size. Sometimes riggers or owners will want to up-size standard rigging to give it a higher factor of safety. If the rigging is under-sized, this might make sense. But on many yachts rigging is correctly sized to begin with—if you increase size, you are also adding to weight aloft, raising the vertical center of gravity and reducing your limit of positive stability.

If considering this route, consult with the yacht's designer before adding that weight aloft.

Dropping off a Wave

In the olden days when boats were built of composite timber with lots of deck houses, dropping off a wave was the most common way boats were damaged in heavy weather. The usual result was a shifting or loss of the cabin structure and perhaps an opening of the garboard strake (the area around the keel). Both were major cause for concern.

Modern materials combined with lighter displacement make this less of a risk. In fact, I would say that this type of event is extremely rare nowadays—unless the drop is of extreme proportions, as were some in the 1998 Sydney-Hobart Race.

Still, to the extent that danger exists in a given situation, you will want the strongest hull-to-deck connection possible, extremely tough windows and ports, and a strong cabin structure.

Richard Bennett

If you look closely under the arrow, you will see VC Stand Aside planing off ahead of what is left of a breaking crest (she's minus her rig at this point, and the crew has been helicoptered off). Imagine the impact loads when hit by that wave, if you're tied to something like a sea anchor, or have a heavy-displacement long-keeled vessel, which won't skid off on the wave face.

Rollover Loads

It is very difficult to predict the loading during a rollover event. This may happen with incredible force and extreme speed, or the speed and loading may be more moderate.

There are plenty of stories about boats keeping everything structurally intact during a roll, while others have breached their deck structure and lost their rigs.

It is safe to assume that the odds are anything tied down on deck (including the life raft), will be swept away, unless the gear is well secured to extremely durable padeyes with backing plates on the inside of the deck to spread the load. (There are numerous stories of padeyes pulling bolts right through decks when backing plates are not used.)

Cockpit Structure

Consider how strongly the bottom of your hull is constructed and then look at the cockpit area. The cockpit carries the same load as the bottom, if the boat is upside down.

Cockpit openings in the form of seat lockers create discontinuity in the structure, which causes further weakening.

Indeed, the seat lids and their attachment hardware become fundamental weak points when a boat is severely knocked down or inverted.

If in doubt about your structure, one way to reduce stress levels is to install bulkheads between the cockpit laminate and the hull below.

The deck cannot be as strong as the bottom since this would make the boat top-heavy and more prone to capsize. Thus designers and builders compromise, putting as much structure into these areas as is practical, using every means possible to keep it light.

Companionways

Companionways are another weak point. The sliding hatch and its attaching structure along with the washboards and their tracks may see very high loads.

Some production boats use timber surrounds to retain slides and wash boards. These are attached with self-tapping screws into the laminate. This is fine 99 percent of the time, but when fighting for your life, you will want these retainers through-bolted.

Hatches and Windows

Hatches, ports, and windows are potential weak points. They should be constructed with metal frames, hopefully cast or forged rather than built from light extrusions or plastic, and should be through-bolted.

Where large expanses of windows are used, they must be installed in accordance with applicable structural codes (ABS Offshore as a minimum).

Many production boats do not meet these standards. If you want to be secure in a serious situation, sub-standard ports should be replaced.

You'll also need some form of storm shutter arrangement—one which is easily installed—and then make a practice of installing the storm shutters before you take off on a risky passage.

Light-weight fiberglass deck hatches frequently fail in a rollover as do composite timber and plastic frames, unless they are massively constructed with extra reinforcement for hardware attachment points and in the corners.

Any hardware used to attach deck hatches must be massive, and through-bolted with backing plates.

Boats are nothing but compromises, even in the structural area. If you build something too heavy, trying to make it strong, the loads go up—so the safety factor you were chasing remains elusive.

However, today there exist some wonderful materials that are enormously strong yet light in weight. Thanks to these, we can now build heavy-weather structures that are far better than a couple of decades ago.

Yet sometimes there just isn't enough budget to cover everything, and something has to give.

You should understand that when building a boat, the hull and deck structure and related internal components form less than a third of the total cost for most production boats, and less than a quarter for a custom yacht. For a very small overall increase in total cost, you can have a strong yet light structure. If you back off just a hair on the interior fit-out, and restrain yourself a little with electronics and/or systems, you can have this extra factor of safety in structure for the same overall price.

To us, it does not make sense to go to sea in a boat built any other way.

Ocean Madam

We started out this section with some comments about "percentage boats" and the concept of designing for the charter business. As an example of what can happen with this type of vessel in moderately heavy weather, we turn now to the case of *Ocean Madam*, a Beneteau Oceanus 390.

The following data is from the Marine Accident Investigation Branch (MAIB) of the British Government. Roger Brydges, the investigator and author of the report, was kind enough to supply us with a copy and answer a few questions.

Background

Ocean Madam was a 39-foot-long (11.3m) Beneteau sloop, with a beam of 12.5 feet (3.8m) and a draft of 6.5 feet (2m). She displaced 13.6 tons and had been built in 1989.

The owners engaged Robert Beggs, an experienced professional, to deliver the boat from Malta in the Mediterranean back to the UK. Beggs rounded up the services of Andrew Nurse and Ray Newton, two inexperienced sailors who were eager for some sea time, to accompany him on the sail.

Beggs and crew arrived in Malta on September 21, 1997, and met with the owner who explained the boat and its systems to them. The boat seemed to be well equipped and in good condition. The crew carried out a thorough inspection of rig, safety gear, and systems, then shoved off on September 22.

They headed directly for Gibraltar and, after a period of fair sailing, encountered head winds and moderately rough conditions. The crew settled in well enough, and as the autopilot could not handle the boat in such conditions, they had the opportunity to do a lot of hand-steering.

After stopping briefly for fuel along the Spanish coast, they made Gibraltar without incident. Two days later, with a fair forecast, they were off again. Sailing conditions north along the Iberian Coast of Spain were good but light. They decided to make a last stop in La Corona to top off the fuel tanks and make a couple of phone calls.

They picked up the forecast for Force 7 to 8 winds from the southwest.

Beggs had to juggle two issues about leaving La Corona. On one hand his crew was inexperienced, and he was about to cross the Bay of Biscay with its huge lee shore at the beginning of the equinoctial gale season. On the other hand, the later in the year he waited, the worse the weather was likely to become.

He chose to depart.

Biscay Gale

They left La Corona under full sail in a moderate south-southwest breeze, blowing Force 4 to 5. That evening they picked up the first BBC radio forecast to shipping, with a southwesterly gale Force 6 to 8 forecast and later Force 9 north of the area.

They shortened sail during the night and, by the next morning had breaking seas on the port quarter. They were broad reaching on port tack.

By now they had shortened down to just part of the roller-furling jib. The engine was running at low speed to provide additional steering control as they ran down the fronts of the seas.

Sea height was in excess of 26 feet (8m). The proximity of the continental shelf—about 40 miles from their position—may have had something to do with this. Roger Brydges' report follows:

At roughly 2130 a particularly large breaking sea knocked the boat down to starboard. She righted herself almost immediately. Water had entered below from deck vents and the companionway. Everything belowdecks broke loose, and the Zodiac inflatable dinghy, which was lashed to the transom, was washed away.

About 0230 a second large wave hit, inverting the boat. The capsize was so fast that the crew could not remember which way she went over.

Nurse was below at the time and recalls he ended up standing on the coach roof, with water pouring into the boat from the companionway. There is some conflict in the recollections as to what happened with the companionway sliders, but the end result is that they were not locked in, fell out during the inversion, and the boat began to flood rapidly.

Beggs and Newton were trapped beneath the cockpit, underwater. Beggs held his breath waiting for the boat to right. When it failed to do so, he unclipped and swam to the surface. Once clear, he reached the transom and grabbed the boarding ladder. He recalls seeing the propeller turning before it stopped.

The yacht eventually righted itself allowing Beggs to climb back aboard. The yacht was dismasted, and Newton was nowhere to be seen. However, his shouts could be heard from the sea.

"The inflated life raft became a major distraction and nuisance, interfering with any hope of recovering the crewman who was overboard and drifting away from the boat".

The life raft had inflated while the yacht was inverted and was in danger of being washed away (it was not fitted with a hydrostatic release—but had broken loose from its lashings to the deck and had probably inflated when the painter jerked tight). It was pitch-black out, very noisy, the seas were breaking all around them, and the engine had quit running. Beggs was trying to hold onto the raft and Newton went below to grab the EPIRB and activate it.

Nurse boarded the life raft in order to make it fast to *Ocean Madam*. Then Beggs joined to help. Shortly after another wave broke over the boat and the line connecting them to *Ocean Madam* broke.

The raft was capsized almost immediately and after attempts to right it failed, Beggs decided to cut through the bottom (which was now the roof) so they could remain out of the water by sitting on the bottom of the upturned raft.

The EPIRB alerted French search-and-rescue authorities and at about 0530 on October 9 they were picked up. A further search for Ray Newton was conducted but no trace was ever found. His life jacket was later found inflated. It is assumed that Newton slipped out of the life jacket (it had no crotch strap) or succumbed to hypothermia.

Ocean Madam was found afloat and upright. She was sunk by the French Navy as a hazard to navigation.

Range of Stability

Data provided to the MAIB indicates a limit of positive stability of 109 degrees, without taking into account the benefits of the coach roof, which may have added another 5 to 7 degrees. However, in our experience these calculations are often based on best-case scenarios—wishful thinking if you will. The actual number may have been less, although we have no knowledge of this one way or the other. We would consider this well under the range for an ocean-going vessel, especially one this size, with such a wide beam.

In addition, once the boat starts to flood, the water rushing inside would reduce the LPS even further. However, as with so many other cases on which we've reported, this vessel was found afloat after she'd been abandoned in favor of the life raft.

Weather Issues

In the context of the weather we've been discussing, a Force 9 gale (41 to 47 knots) does not seem to be that big a deal. Certainly not for a properly designed and built vessel of the size of *Ocean Madam.*

The sea state in Biscay is always a little tougher than elsewhere, with all sorts of currents, reflections off the shoreline if you're close to land, and the ever-present heave of different swell systems coming in from North Atlantic storms.

But still, this was only a Force 9 gale and the frontal wind shift had not yet occurred.

Survival

Beggs and Nurse reported that they were surprised at the ease with which the life raft flipped over (Beggs had previously attended a survival course and was grateful for having done so). He knew how to right the raft, but because there was no life line on the underside, he had no means to accomplish this feat. He also became frustrated by the seemingly ineffectiveness of the water ballast pouches which did not provide the necessary stability.

Beggs and Nurse experienced immense difficulties with the design and contents of the emergency pack. Finding the things they required was frustrated by the its long, thin shape. Everything they needed was at the far end of the bag and groping for them became extremely difficult. Attempts to insert batteries into the flashlight proved equally complicated. It became obvious that many simple tasks became almost impossible in the confines of a small life raft being tossed around in a severe gale.

Comments on the *Ocean Madam*

The MAIB report has this to say about the Beneteau 390:

This class is typical of its type with a high-volume, low-ballast ratio, light displacement and shallow hull form. It is highly suitable for most activities including charter work and has a good safety record. *It is not a suitable craft for crossing oceans in bad weather* (our emphasis).

Such craft are more susceptible to the effects of oceanic weather conditions and especially to heavy seas.

Lessons from *Ocean Madam:*

- ❑ Vessels of this design and construction are probably not suitable for severe weather conditions.
- ❑ Life rafts must be secured strongly enough to stay mounted during a rollover.
- ❑ If you are on deck when the boat rolls and fails to come upright, be sure to find something to grab onto before you drift away. On a short-handed, disabled boat the odds of recovery are remote.
- ❑ The life raft should have a proper ballast chamber to provide stability in breaking seas.
- ❑ Check emergency life raft supplies to make sure they're easy to access and use. Look at them in the context of a raft being buffeted by breaking seas.
- ❑ Once again we have a vessel found afloat after being abandoned. Do not abandon the boat until it is just about to sink from under you.

Ralph Naranjo

We've been friends with the Naranjos since we first met at the Yacht Club in Suva, Fiji in 1977 during our respective circumnavigations. Ralph, his wife Lenore, and their two children Eric and Tara sailed their Erickson 41 *Wind Shadow* in a very efficient and professional manner.

We found we had lots to chat about. This, combined with the fact that our children were contemporaries, had us meeting up whenever possible as we continued our journeys in a westerly direction.

When the Naranjos returned to the States, Ralph took over a full-service boatyard on Long Island Sound, and ended up running it for more than a decade. He went on to hold the Vanderstar Chair at the US Naval Academy, a job that includes overseeing safety and seamanship for the Academy's extensive sailing program. In addition, Ralph is the Technical Editor at *Cruising World Magazine*. He still makes long offshore passages on a regular basis.

Thanks to these jobs, Ralph has a wonderful view of what is happening in the marine industry. He spends time each year in many of the production and custom boatbuilding shops around the country, which keeps him up-to-date on the current practices in marine production. We are grateful to Ralph for the following comments:

In many of life's endeavors there's good reason for the obvious to be left unsaid. However, when it comes to crossing oceans, passagemakers must take a close look at all the essential facets of a voyage. Staying afloat is at the heart of every safe cruise. However, no sailboat made comes with an "it-will-get-you-there" guarantee.

A friend once said that, "many great voyages are completed despite the vessel they are made in, rather than because of it." This grim reminder is a sobering kick-off point for a close look at how boats are built and what to look for when you decide that extended ocean passagemaking is in your future.

I have found that not every sailboat dubbed a "real passagemaker" by boatshow sales teams has the structural integrity to cope with significant heavy-weather encounters. Before delving into the anatomy of sound seaworthy craft, I feel that I should share the basis for my opinions. The time I've spent sailing offshore and the diversity of technical experiences I've been fortunate to be involved in are the foundation for my sea-going skepticism, and why I advise every potential boat buyer to get to know the basic difference between the great boats that are just right for part-time coastal cruising, and a vessel ready to cross oceans.

Over two decades ago my interest in sailing lead to a family voyage around the world in a 41-foot (12.5m) production sailboat. The resulting memorable experiences caused me to develop a keen interest in the structural side of ocean passagemaking. The five-year voyage aboard *Wind Shadow* began what would turn into a 20-year field study of what goes into good boats. In the years that followed bluewater cruising, racing and family sailing *Wind Shadow* on two more extended cruises have been part of our lifestyle.

As *Cruising World Magazine*'s Technical Editor, I've had a chance to sail and get a very close look at a wide variety of new and used sailboats, traveling around the country to large and small, high-end as well as bargain boat builders, observing how they put their boats together. Each fall I join a team of judges evaluating new boats in *Cruising World*'s annual Boat of the Year Contest. It has become apparent to me that most builders know their client's profile and recognize that at-anchor/marina livability and creature comforts rank high among many buyers. They also know that most of their passagemaking is done in a daysail context via inshore or coastal routes, and that's what the majority of production boats do best.

Offshore Compromises

On the other hand, an ocean-going sailboat is a different set of compromises, one that never forgets the implications of heavy weather. It's a comprehensive project involving significant design and engineering challenges, all of which can make or break the success of the boat even before the hull is molded, welded or planked. Assuming that the right blend of stability, volume distribution, beam-to-length ratio, sail area-displacement harmony, ballast-displacement ratio and other vital statistics have been reached, the engineering side of the house must devise just how much material it takes to keep the water out and all the articulations (rudder-rig-keel) where they belong.

For example, the hull and deck scantlings appropriate for a vessel caught up in a heavy-weather encounter differ significantly from what it takes to handle average sailing forces. The point loads associated with breaking seas and a vessel falling into a wave trough are often hard to predict, as is the energy defined by wind and sea tormenting a hull and its appendages. The rig, rudder and keel also transmit forces to the hull skin creating stress hard spots that need to be structurally reinforced in order to cope with the increased loads. The keel stub, garboard, chainplate, rudder post, mast step, partners and hull-to-deck joint are focal points where a storm's energy readily makes itself known.

Repetition may be the best teacher, but in an engineering context it is also one of the most destructive concepts known in material science. Cyclic loading weakens metals and plastic alike, and its long-term impact can lead to a major reduction in the strength of a plate or laminate. Add to this the vulnerability of weak, under-sized and poorly reinforced structures, and you can see why a safety margin is so important to the passagemaker. The pure and simple reality of oscillating loads being the cadence of ocean crossing justifies the one-size-larger mindset of many voyagers.

Boatbuilding "Shortcuts"

Shortcuts in boatbuilding can take their toll. One builder I visited laminated chainplates to the inner skin of a cored hull which eventually delaminated under the tension load. Another buried welded stainless steel chainplates in fiberglass laminate hull skin that would eventually leak and become a sump for corrosion. Another builder saved a few dollars in the rudder by

Look closely at how the loads are spread in the vicinity of:

- ❑ Keel stub and garboard/keel bolts.
- ❑ Chainplates.
- ❑ Hull-deck joint.
- ❑ Mast partners.
- ❑ Mast step.
- ❑ Rudder post.
- ❑ Around big hatches.
- ❑ Rudder post.
- ❑ Skeg.
- ❑ Backing plates.
- ❑ How thick are the hull and deck laminates and what are they made of?
- ❑ Number of units—material type and size.
- ❑ Core material and laminating methodology.

Look for signs of:

- ❑ Too little material (skin prone to oil canning).
- ❑ Poor attention to detail (dry spots/pooled resin).
- ❑ Signs of chemical failure (soft resin/browning from hot batch).
- ❑ Delamination.
- ❑ Excess flex in deck or cockpit sole.

welding a mild steel plate to the stainless steel rudder stock, assuming that the blade would never leak.

One of the most common shortcomings is the habit of cutting holes in sandwich core materials and not back-filling the raw edge with a high-density filler or, better yet, actually laminating a denser material in such areas as around the perimeter of ports, hatches, and where hardware is fastened.

Cored hulls and decks can be just fine if they are properly built, and have enough laminate on each side of the sandwich structure.

Builder skills must increase as the strength-to-weight ratio increases.Conventional wet lay-up of mat and roving was never rocket science, and if the resin mix was right and the work crew wet out the laminate properly, carefully squeeging each layer, things tended to come out okay. High-modulus materials are another story, because they represent finesse rather than the brute force approach to boatbuilding, and they need to be handled more carefully. The premise is based upon doing more with less—or at least that's what happens when good attention to detail results in properly bonded and cured materials.

Problems can arise if the resin kicks before the vacuum bag squeezes down on the material in the mold, or if too much resin is pinched out of a key area. Although the marine industry has made great strides forward in the last decade, their approach to composite usage is not a sequel to the aerospace industry. To do so would mean aircraft laminating costs, kicking up already hefty price tags.

The nine-question boatshow survey:

- ❑ How far is the core cut back and replaced with solid laminate near the keel stub?
- ❑ How was the core bonded to the hull/deck GRP skin?
- ❑ How is the scoop transom stern bonded/fastened to the hull?
- ❑ Is there any mild steel inside the rudder/skeg?
- ❑ What kind of keel bolts are used and how are they held in the lead?
- ❑ Are there any welds in the chainplates that have been covered with GRP?
- ❑ How do you fasten and seal cabin ports against the inner floating liner?
- ❑ Do the bolts holding the toe rail go through or miss the deck element?
- ❑ Are there deck beams or additional structure around the big hatches and windows?

Non-Structural Liners and Pans

Another concern for the ocean passagemaker is the inordinate amount of laminate weight tied up in minimally structural internal pans and liners that hide the inner hull skin and contribute little to keeping the water out. This may be fine for boats that sail less volatile waters, but going to sea carries higher stakes. With better workmanship on the inner skin molding process, some builders are not so prone to hide their workmanship with liners. Some custom builders often make the valid pitch that more of the total weight of the hull and deck in their boats is actually structurally involved in keeping the water out of the boat, and less is spent compartmentalizing accommodations.

Another growing trend in boatbuilding is the use of welded stainless steel below the waterline, replacing more traditional, less galvanically reactive silicone bronze. It's not unusual to find welds corroding and stainless steel struts and rudder gudgeons breaking loose. Submerged metals need to be regularly checked for electrolysis as well as signs of deterioration caused by physical strain. Keel bolts do not have an infinite lifespan and boats that come with a galvanized mild steel version should be carefully inspected at or about the decade milepost. This means dropping the keel and looking closely at any pitting or reduction in diameter due to corrosion. Lead ballast and higher-quality Aquamet keel bolts are the preferred alternative.

Charley

Despite the best efforts of naval architects, builders and sailors, occasionally major structural problems do occur. These may be due to a design or building fault of some sort, or to loads from the sea which are simply too great for the boat to stand.

In this story the crew of *Charley* teach us a memorable lesson in perserverance as they overcome potentially terminal structural problems with their vessel.

Chuck Hawley, whose comments follow, is a long-time veteran in the marine business. He started out sailing as a kid and was one of the first employees at West Marine, back in the days when they had a single store. In 1980 he raced his Moore 24 (7.4m) to Hawaii, then did the same thing again in 1982. In 1983 he had the chance to be skipper aboard a radical new ULDB, *Charley*.

Chuck is now Vice President for Product Knowledge at West Marine—he's the guy who does the product testing, puts together the catalog, runs the web site, and moderates safety-at-sea seminars. He has sailed over 35,000 miles offshore.

Chuck Hawley

Leaving Hanalei

It was difficult to leave Hanalei Bay, but the time had come to depart the lush island of Kauai and head back to the mainland. We had had a wonderful time in the islands, due in no small part to the notoriety that *Charley* had received after winning the 1983 Transpac.

But now we had turned north, and were a day-and-a-half from Kauai. We had *Charley*'s jib up. Our five-person crew had settled into the routine of an ocean passage and was anxious to get *Charley* home to San Francisco safely.

Besides myself, there was Bill, my college roommate and close friend; "Atomic Bob," a glazier from L.A. who had befriended us; Lilly, from Christchurch, NZ, who had wandered down the docks one day; and Dana, a very experienced sailor from Long Beach.

Before departing, we had taken on 120 gallons of fuel since we intended to pass the Pacific High close by on the way back, and wanted to be able to power for several hundred miles if need be.

At 1600 on the second day we were 288 miles north of Kauai, with 12,000 feet (3,658m) of blue Pacific water below us. I was dozing in the leeward quarterberth, while Bill and Atomic Bob were standing watch. Without warning, *Charley* began humming loudly, then rolled over about 60 degrees. There was the inevitable sound of gear sliding off countertops; and Lilly, who was asleep on a weather berth, promptly fell onto the sole of the cabin. I shouted to the crew on deck, assuming that they were horsing around: "Hey, get this boat back on her feet!"

"Chuck, you'd better come on deck; something is really weird," was the panicked reply.

I scrambled out the companionway and looked at the two men standing on the sides of the cockpit. "The steering seems fine, but she won't respond to the helm. Look!"

Missing Keel

Bill spun the wheel and, indeed, the wheel seemed connected to the rudder but the boat did not change course. My mind raced to try to figure out what could have caused this condition. The first image that came to me was that the boat had run into a large fishing net, and that the keel had become stuck in the net, stopping our forward motion.

I scrambled to the high side of the deck, which felt as if it were 15 feet (4.6m) above the water. I looked over the side, half expecting to see a tangled mass of polypropylene netting wrapped around the keel and rudder.

Instead, I was shocked not so much by what I saw, but by what I didn't see: *Charley's* keel was missing. I looked in disbelief at the stainless-steel keel bolts that were glistening in the clear Pacific. Where there had recently been a 5.2-ton lead keel, which extended 10 1/2 feet (3.2m) into the water, there was now a stub of the keel containing no lead and extending about 12 inches (0.31m) below the hull. No wonder we had lost so much stability!

Anytime you are involved in something potentially this serious, it is a good idea to get a second opinion. So I asked Atomic Bob to come over and to verify that we had, in fact, lost the keel. He obliged, and stuck his entire body over the rail and stared at the remains of our keel. When he pulled himself back on deck, he confirmed that there was, in fact, no f*****g keel.

While Bill stayed at the helm (why, I am not sure, but it seemed like the right thing for at least one of us to do), Lilly, Dana, Bob, and I struck the sails. With the main and jib down, the boat righted herself from an angle of 50 degrees to one of 20 degrees, solely due to the pressure of the tradewinds on our bare rigging. I assigned jobs to the crew, and went below to radio the Coast Guard in Honolulu. I wasn't sure exactly what to say, but I wanted to let them know what had happened.

Calling the Coast Guard

The first miscommunication with the Coast Guard occurred when I tried to call them. You would think that the Coast Guard would be called "the Coast Guard" anywhere in the US. Not so in Hawaii. While I kept calling for "Coast Guard Honolulu," this guy kept on responding that "This is ComSta Honolulu, over." Well, I didn't want the ComSta (whatever that was), I wanted the guys in the white boats with orange stripes. Turns out the ComSta stands for Communications Station, and I was the only one in the Pacific Ocean that didn't know that they ARE the Coast Guard. Oh, well.

The second miscommunication was that they had never heard of someone losing a keel. Rudder? Yes. Mast? Yes. Crew? Yes. Keel? No. Each person I spoke to at the Search-and-Rescue Center needed to be told that, "Yes, we had lost our keel," and "No, I did not mean the rudder," and "Yes, the keel is that big lead thing under the boat," and "No, I can't explain why the boat has not capsized yet."

I quickly told them our position, and the color of the bottom of the hull, knowing that if they needed to search for us, the bottom was all they would see. I requested that if they did not hear from us on an hourly schedule, they should begin a search for our upside-down boat. Our ETA in Honolulu was about two days away. We agreed to call them every hour until we tied up in the Ala Wai.

We started the engine, which gave us a strange feeling of normalcy in an otherwise chaotic situation. We put the engine into forward, and threw the helm over so that we were headed for the west end of Oahu. *Charley* seemed most comfortable at 6 1/2 knots, slower than normal under power, but fine under the circumstances. The long trip back had begun, and my calculations showed that we had 49 hours of powering before we'd be back at Ala Wai Harbor again.

Improving Stability

Having never faced a keel loss before, I was a little unsure of how to increase the stability of *Charley*. We pulled the main boom to windward, and lashed it to keep it from swinging. Our delivery sails were stuffed in windward lockers, and spare water and provisions were loaded on top of the sail bags. We slept on the "high" side, and concentrated on not giving *Charley* any reason to roll over. We had no idea how far over she would go and still come back upright. At the time of the keel drop, we probably heeled over 50 degrees or so. Would 60 degrees be too far?

Life began to return to normal: standing watches, preparing meals, making logbook entries, cleaning up. Sleeping was difficult. What would it be like if *Charley* inverted while three of us were down below in the sack? Should we sleep on deck? Was that safer or more dangerous? Who would have the courage to swim into the upside-down hull to try to pull the rest of the crew to safety? We debated these questions for the next two days.

We had two Avon life rafts on board, each stored in a locker in the cockpit. They slid aft into the enclosure and fit snugly, and since they were buoyant, we weren't sure that we'd be able to wrest them from their lockers and get them to the surface if the boat were upside-down. Should we keep one on the transom, where it would be easier to deploy? We decided to leave them in place.

We also debated whether we should attempt to drop the mast. Charley's mast was more massive than that of today's typical sled. It measured 10 inches by 6 inches (254 by 152mm), was about 75 feet (23m) above the deck, and weighed about 1/2 ton. Just how would you remove such a mast? Hacksaws? Pull all the pins in the turnbuckles on one side and then tack? What if the mast punctured the hull? We decided to leave it in place.

Our hourly watch schedule with the Coast Guard went like clockwork, until they suggested that we change to a four-hour schedule. Evidently, they were getting a little tired of hearing from us, but it did us a world of good to know that they were tracking our progress.

Tropical Storm Bruce

We had been following the weather closely, and a small depression started to turn into Tropical Storm Bruce, with winds to 50 knots. Bruce was north of Molokai and heading west. It looked like we could avoid it, either by turning around and going north, or by being beamed to the Ala Wai via Scotty on board the *Enterprise*.

Tropical Storm Bruce was rapidly converging on us, and we did not know whether *Charley*, without her keel, could withstand 50 knots of breeze on the beam.

If we had had a sea anchor, I would have felt more confident, since we could have laid bow-to and probably stayed below for the entire storm. Our fuel supply was such that we had perhaps 50 miles more than enough to fetch Honolulu, but any large diversion would result in our running out of fuel. And sailing, you can well imagine, was out of the question due to our marginal stability.

We faced up to the fact that we would feather *Charley* into the breeze, but try to make progress back to safety in Honolulu. Sometime during the second morning, our apparent wind peaked at 42 knots.

I remember being below working on the engine. *Charley* had a large "propeller window" under the engine, where you could look to see if there was kelp hanging on the propeller. Since *Charley* had a v-drive, this window was 8 inches (203mm) across, and directly below the engine. I remember hearing someone in the cockpit yelling, "Brace yourselves, big wave!" shortly before I felt the impact of a large wave hitting the port side.

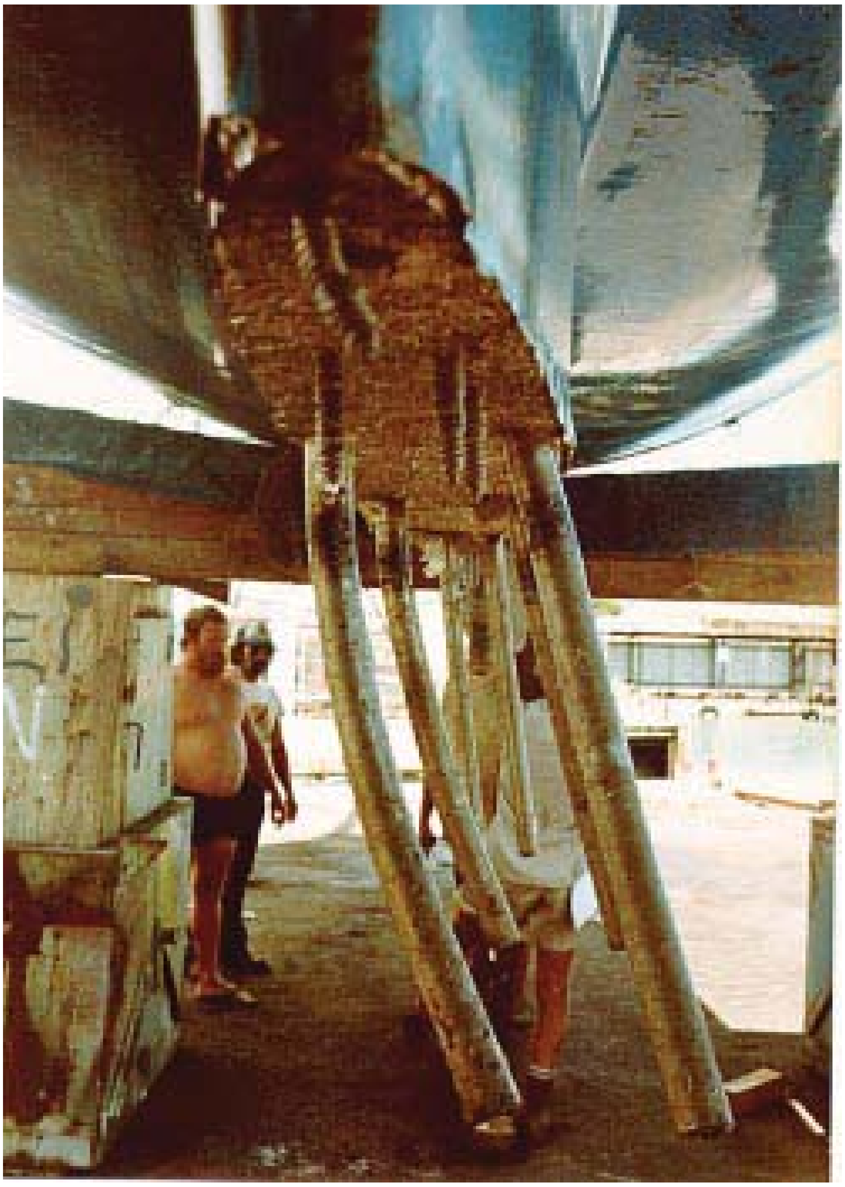
Charley shuddered and began rolling over. As clearly as I can remember anything, I recall seeing daylight through the propeller window, and a second glimpse of the waves that were rolling towards us. *Charley* had rolled over so far that the centerline of her hull had come out of the water for many seconds, before slowly righting herself and continuing south. Remember, this was a 67-foot (20.6m) boat, not a dinghy.

The winds gradually dropped back to the normal tradewinds of 15 knots, and sometime around noon we drew behind the lee of the west end of Oahu. The seas flattened out, the winds became more shifty, and everyone on board knew that the worst was over. We pushed the throttle forward to 8 knots, and began depleting a case of Heinekens that Bill had snuck on board. Barber Point soon passed by, and we turned east towards Waikiki and Ala Wai Harbor.

The atmosphere on board had lightened up for several hours as it became more clear that we would make it and not have to be

Chuck Hawley

"The crew after passing into the lee of Oahu, where we felt the trades diminishing and our spirits rising. We went through a case of beer by the time we reached Hawaii Yacht Club, probably the most dangerous part of the trip!"


Chuck Hawley

A close-up view of a potential nightmare for everyone—sailors, builders, and designers. Without getting into the issue of who is at fault, the fact that Chuck Hawley and his crew made it back to port sans keel is a remarkable testament to the seamanship employed, not to mention pure moxie. The next time a small difficulty is giving you grief, put it into perspective with a fresh look at this photo.

"Keel bolts were rod stock with a trivial weld at the tips, which broke when we torqued the nuts. We should have realized that the nuts never felt quite 'tight', and of course, the welds probably broke over time."

rescued. We cranked up the stereo and danced on deck. Dana, as was her wont, began scrubbing the boat so that it would be presentable when we docked. Bill and I transferred the last of our fuel from large rubber bladder tanks into the engine's tank.

By the time the five of us cleared the Ala Wai's jetty at 1700, the beer was gone, and we were intoxicated with the thought of getting off the boat.

The finger of land, where the Hawaii Yacht Club is located, was jammed with people. While we thought they were there to watch the Friday night race, many of them had heard that we were returning, *sans* keel, and they had come down to the harbor to see us. Somehow in our frantic attempt to tie up and GET OFF THE DAMN BOAT we managed to drop a bow hook and back up stern to the shore. Each of us walked down the sloping transom and did the only thing we could think of: We kissed the grass in front of the club, and thanked our respective gods for seeing us through.

In the years since *Charley* lost her keel, many racing sailboats have followed suit, including *Martela OF*, *Pandemonium*, *Coyote*, and some other lesser-known boats—obviously the result of engineering mistakes in the quest for pure speed.

It all gets down to the basic maxim of seamanship: Take the right boat, crew, and gear to sea for the particular voyage at hand. Don't take an inadequate boat, load it with gear, and try to cheat the odds. Your crew is too important, and you have to finish the race to win it.

GOING FORWARD

It has been over 20 years since we started researching the experiences of other sailors in heavy weather. In that time we've interviewed hundreds of amateur and professional mariners from all over the world.

Most of this research, together with our own (limited) firsthand experience, has formed the basis of the yachts we've designed and built for ourselves as well as for others.

We didn't really think of our past research in the context of a book until we started hearing about the November 1998 voyages from the tropics to New Zealand (discussed starting on page 22). Then we started to realize something that should have been evident for many years—sailors were making the same mistakes over and over again.

This applied to understanding the weather, the choice of vessels in which they voyaged, maintenance issues, tactics, as well as how boats and crew were prepared.

When we look back into the rusty interview notebooks in our library, the same themes are repeated time and again. Minor maintenance problems create a crushing chain of events as the weather deteriorates; or the storm was un-forecast or under-forecast; or this was the first time storm canvas or drag devices were used and more practice was required.

Yet our own experiences in well over 200,000 miles of sailing jive with those of the 33 professional sailors interviewed for this book. Weather is most unlikely to be dangerous if your vessel is well prepared and you use cautious seamanship.

We hope that the preceding pages of this book have made this self-evident.

The question, of course, is how do you get up to speed with the skills and equipment necessary to have the same results as the pros? Believe it or not, it's not that hard. You simply need to make this goal a priority. And, if you make all of your basic decisions based on how they impact your heavy-weather capabilities, day-to-day cruising will benefit greatly as well.

Passages will be faster and more comfortable. You will make longer, more adventurous, and rewarding cruises, because you are no longer afraid of heavy weather. Your mate and crew will sense this increased ability to deal with the elements efficiently—and the result will be a happier ship.

We want to close this book with the comments of two professional marine accident investigators who are also experienced small-boat sailors.

Their comments on the type of problems that crop up repeatedly are worth a close look. Following this, we'll recap our own thoughts on the subject of heavy weather.

Jim Lott

Jim Lott is a safety officer in the New Zealand Office of Maritime Safety. As such, he has interviewed survivors and written reports on all sorts of marine accidents. He is the relief master on the New Zealand sail training ship *Spirit of New Zealand* (250 tons) and has a square-rig master certificate. He is also a very experienced small-boat sailor with numerous trans-ocean passages under his belt.

We asked Jim what he would suggest to mariners interested in increasing their security when voyaging, and if there were any common problems which people could avoid:

To answer your questions as best I can, I must stress there are in my opinion no absolute answers. We can learn from survivors—and, by educated guesses, from those who didn't survive—about what may work.

Awareness of all this is probably the best defense.

Stress

I have a feeling that stress, both physical and mental, is a major factor. How often do we find that something we know we should go and do is left undone because of lethargy and tiredness? Short-handed sailing is typically a factor here, especially as we depart from the kind weather of the tropics to higher latitudes and frontal weather. Replacement of worn sails and equipment is certainly a factor, but the human element seems more important. A good man will often get a bad boat home but a bad crew won't get there even in a good boat. Maybe a good crew is the one that copes best with stress.

What is it that makes a sensible person who has spent maybe years and a small fortune preparing a boat, get off it after a couple of days of storm when a ship is available? All know of the danger that exists in trying to board a ship in a storm.

For example, the much-reported Queen's Birthday storm (covered starting on page 585) resulted in crews being rescued from boats. Of all rescued, except one boat whose mast eventually holed the hull, the boats either survived, or were deliberately sunk, or sunk accidentally by collision with the rescuing ship. Why would these persons whose boats were mostly uninsured and represented a lifetime savings, choose to abandon?

The stress, I feel, is a very significant factor. Perhaps a psychologist could help, but the noise factor of a gale at sea could be significant. I have tried ear plugs on a couple of occasions and have felt less apprehensive as a result. I know those who have tried drugs like Valium, but I think that is crazy. No doubt some use alcohol.

Knowledge and Preparation

Ultimately survival is to a great degree dependent on knowledge and preparation. Storm gear that is stowed where readily available is going to be used. So often it remains unused for years and buried beneath other gear, which is difficult to move, especially when it starts getting rough.

How often do life rafts get serviced? Often not for five years.

Design

There is no doubt that yachts that remain stable when inverted are dangerous.

My feelings are that a combination of factors applies. A yacht whose positive righting moment ceases at say 112 degrees may be safer than one with 120 degrees if the area beneath the stability curve is smaller. I also feel that a higher freeboard not only provides greater righting moments at moderate heel angles, but in addition it keeps the crew dryer and more comfortable. A deep keel is also a problem at times since a yacht can trip more easily rather than slide sideways when hit by a wave. In all designs a compromise occurs.

My gut feeling is that moderation in everything is probably best.

Preparation

How can anyone be totally prepared for conditions rarely encountered? Training is good in that it highlights areas that need attention—retrieving a cold person back on board, or finding how a yacht lies to a parachute or drogue in moderate weather. Perhaps *Janamarie* (see page 58) would have been carrying 2 or 3 tires had this been tested.

Mental preparation is as important as the boat. Visualizing situations is important and a written action plan for crew to learn for such things as abandoning ship is a must. Clearly we can learn from experience and most of us do. There are also those who simply benefit from the experience of others and this is the value of education.

We have had examples in the Southwest Pacific in recent times of yachts sailing into tropical cyclones. In one case a foreign going master sailed his yacht into an area where he was fully aware that a cyclone existed. When the cyclone moved in a likely direction, five people died. We know that tropical storms kill and yet well trained people still seem prepared to take a risk.

Rarely is a disaster the result of just one incident. Normally a series of happenings cause a problem, as well as a series of decisions which may start well before a voyage regarding sails, rudder, rigging and so on. *In hindsight most accidents are preventable*. It is up to us all to provide that hindsight to others if they want to hear.

A life raft provides no guarantee. It is great in case of fire or sinking after hitting something. bit if the yacht is overcome by bad weather the life raft probably will be also. Self-sufficiency is paramount, and if the mental preparation says "Outside the harbour there is no possibility of any rescue," preparation would often be better.

The crew of the *Green Hornet* survived because they wore harnesses in the life raft. On *Quartermaster* and *Winston Churchill* it is likely others would have survived in rafts had they worn a harness.

I really feel education is important, but eventually experience is the ultimate teacher.

Roger Brydges

Roger Brydges, the Administrative Manager at the Marine Accident Investigation Branch (MAIB) in the United Kingdom, is constantly reviewing marine accidents. His office receives reports of around 1,800 incidents each year, the more serious of which are fully investigated with reports published. Roger has sailed all his life in yachts and dinghies. He races and cruises in equal measure having sailed extensively offshore and around the cans in half and three-quarter tonners in the days of the IOR. He has (more recently) campaigned 505s and Wayfarers.

Before we get into Roger's comments, let's take a look at two examples he sent along.

Severe Gale in Needles Channel

A group of work colleagues chartered a seaworthy and well-equipped yacht for five days of coastal sailing on the South Coast of England in February. Their experience varied but was adequate for what they planned.

They sailed from the Solent to Poole and had hoped to extend westwards to Weymouth but forecast bad weather led to a change of plan. After a period alongside in Poole, they prepared for the return passage to the Solent. The forecast wind was southwest Force 7 to 9. On leaving Poole fairway, the skipper reduced sail for the prevailing conditions and headed east with the intention of approaching the Solent via the Needles Channel, which he knew well. No passage plan had been filed with the Coast Guard.

It was a rough passage, but the crew were confident they were in control until they confronted the first steep-sided seas at the seaward end of the Needles Channel. These were typical for this area when either the west-setting ebb tide meets strong southwesterly winds or, as in this case, heavy seas build up in the vicinity of the Shingles and the Bridge Bank.

Because some difficulty was encountered in identifying their precise position, the skipper altered course to the south as he feared he was too close to the Shingles. Moments later a particularly vicious sea capsized the yacht, throwing all four crew overboard. Three who were clipped on by safety harnesses managed to climb back aboard, but the skipper, *who had unclipped to go below to the chart table*, was lost.

A great deal of water had found its way below during the capsize through the open companionway and was over 3 feet (1m) deep in the cabin. One of the crew went below to make a Mayday call and during this time the yacht capsized again, this time being dismasted. The two crew on deck were washed overboard, one being swept away, the other trapped upside-down with his head below the water. By the time he was found by the one survivor, he was dead.

Only a fragment of the Mayday transmission was received. It is most likely that the radio had been damaged in the capsize and was only transmitting intermittently. The Mayday was received by HM Coast Guard and by another vessel in the Solent but no

This event took place aboard a Beneteau Oceanus 351. At 35 feet (10.7m) long, this Bermudan sloop is typical of the mass-production high-internal volume, relatively light-displacement designs so prevalent today. Roger did not supply us with the stability data but says, "It would be surprising if it was very different from that which we reproduced for the 390 *Ocean Madam* (see page 637). The builder, Beneteau, is the largest yacht builder in Europe—they produce about 3,000 vessels per year of all sizes.

"This capsize off the Needles was partly due to the skipper and crew underestimating the conditions likely to be encountered in what they regarded as 'home' waters. As with *Ocean Madam*, it wasn't the wind strength that caused the capsize but the sea state."

position was received, just an urgent request as to whether anyone could hear the signal. For want of any further information and lack of detail as to the origin or location of the vessel making the distress call, no search-and-rescue operation was mounted.

The yacht was eventually washed up on an Isle of Wight beach with the one survivor on board. The three remaining members of the crew were recovered, but all had been killed through drowning or hypothermia.

Lessons

Winter sailing with gales forecast demands a high degree of responsibility by skippers. The yacht on this occasion was well found. The experience of the crew appeared adequate for the conditions and the skipper had demonstrated sound judgement by abandoning an ambitious plan to sail further westwards.

In accordance with the MSA Code of Practice for Small Commercial Sailing Vessels, yacht charter firms are strongly advised to give appropriate guidance to charterers on the use of the craft, bearing in mind the declared experience of the skipper and crew, their knowledge of the boat, and the weather forecast.

No matter how short the passage, proper planning is essential. Given wind forecasts of Force 7 to 9, the skipper had the choice of remaining in Poole, taking the long route to his eventual destination by sailing south of the Isle of Wight, or making for the Solent via either the Needles Channel or the North Channel.

The indications are that because the tide was flooding, setting northeast, and with the wind, the skipper decided that the Needles Channel option was a safe choice.

The choice of which passage to adopt must always be the skipper's; but the responsibility must be taken after very careful consideration of the dangers and, if lacking in local knowledge, the advice of others. In this instance the skipper, having taken the decision to proceed to sea, appeared unaware of the grave dangers associated with entering the Needles Channel in strong south-southwest winds, especially in the early stages of the flood.

In bad weather conditions, safety harnesses should be attached to properly tested securing points at all times, and when fitted, the crotch strap of life jackets must be correctly fastened.

Conventional foul-weather clothing offers little protection from winter water temperatures (in this case 42 to 46 degrees Fahrenheit/6 to 8 degrees Celsius) and in breaking seas once the body is fully immersed. Survival time is measured in minutes.

One set of flares for emergency use must be kept readily available and separate from the main supply. It is recommended that the ready-to-use set is placed under cover and is easily accessible by the companionway.

Yachtsmen are encouraged to report their passage plans to HM Coast Guard especially in winter when bad weather is forecast.

Reflective tape on life rafts, life jackets, and foul-weather clothing stands a very good chance of being sighted at night

"A vessel with better stability characteristics would have stood a better chance of surviving the wave that capsized the 351. There can be genuinely horrible conditions there, but because they are so close to the sheltered waters of the Solent, the dangers are sometimes overlooked."

A number of interesting points are raised here, and are worth repeating:

- ❑ Make sure safety harnesses are always attached—even when going below (having a padeye at the companionway entrance, with a longer tether, will allow you to go from the cockpit to the navigation desk and back to the cockpit while remaining attached).
- ❑ Keep a supply of emergency flares separate from those used with the raft, where they are readily accessible.
- ❑ Consider adding reflective tape on the life raft to help the spotter and rescue teams at night.

when it is picked up by searchlight beams such as those used on Royal National Lifeboat Institution lifeboats.

Publishers of sailing directions, which offer advice on using the Needles Channel should highlight the dangers of breaking seas in the vicinity of the southwest Shingles and the Bridge Bank, especially in strong winds from the south round to west. The swell in such conditions tends to build up once the west-setting ebb has stopped. Around low water the seas at the seaward end of the Needles Channel can be particularly vicious.

Publishers of charts specifically designed for the small boat user should draw attention to potential dangers in high sea states. Areas for special consideration are sandbars at the entrances to harbors.

Despite having to sail close to a lee shore, the North Channel offers a viable and usually safer alternative to the Needles Channel when entering and leaving the Solent in adverse weather conditions even when the tide is favorable.

English Channel Gale

A 33-foot (10.15m) sailing yacht (a Westerly Storm, a UK-built Bermudan sloop with fairly high internal volume, but with moderate rather than light displacement) was bareboat-chartered for an intended voyage across the English Channel and back. She carried a crew of seven including the skipper. The last weather forecast obtained before sailing was for north-easterly winds of Force 5 to 7. It was considered that the wind would be coming from a favorable direction for the proposed cruise across the Channel.

The yacht sailed in the afternoon, but during the night, some difficulty was experienced in steering her and she made a number of uncontrolled jibes. As dawn broke it started raining, and the visibility became poor; the crew were cold and miserable, and some were seasick. It was decided that the best course of action was not to carry on to the proposed destination but to make for the nearest harbor. During the subsequent maneuver the sheets, which had been snap-shackled to the jib broke loose; the jib was furled and not used again. However, while making the presumed approach to the harbor, a west cardinal buoy marking shallows was seen very close to on the port bow and it was realized that the tidal stream had been setting to the east and not to the west as had been assumed.

"This report illustrates a case where the equipment to deal with rough weather was used incorrectly. Many yacht owners have all the right equipment on board, but if faced with having to rig, for example, a trysail, would be scratching their heads. In this case, the skipper set off across the English Channel with a marginal forecast and only one set of reefing pennants roven. When the wind and sea state began to take charge of the over-canvassed yacht, gear failure contributed to the eventual tragedy."

The yacht remained on course while one person checked the navigational chart. The eventual jibe back on to a westerly heading was not properly controlled, because of the increasing wave heights. The mainsail boom swung over very quickly, the mainsheet went taut and came away from the boom end.

While attempting to drop the mainsail, the yacht was struck by a huge wave, which washed four crewmembers overboard. All were attached to the yacht by harnesses, and two managed to get back on board. One of the other two remained attached, but it was not possible to pull him back on board, and he did not survive. He was not wearing a life jacket. The other person either slipped through his harness or removed it himself and was unable to get back on board; his body has not been found.

The remainder of the crew were rescued by a helicopter. The abandoned yacht eventually ran aground on the coast.

The yacht strayed off course and sailed the wrong side of the Pierre Noir buoy, which marks shallows about three miles north-east of the entrance to Cherbourg, northern France. Very strong currents—up to 5 knots—and a rapidly shallowing sea can produce dangerously steep, breaking waves. Bear in mind, though, that this vessel was off course, and should not have been where she was when the capsize occurred. Had she sailed on the correct side of the buoy she would would probably have made port.

Comment

Because only one mainsail reef of the three available was reeved, the skipper had insufficient control of the yacht's sail area in the worsening weather conditions.

Sheets with snap shackles should not be used for foresails; bowlines are preferable.

A boom preventer may have proved beneficial in this case.

Steering difficulties were caused by running dead downwind in a lumpy sea and becoming overpowered as the wind rose. The skipper was a competent helmsman, but the crew were not.

No proper passage plan was prepared before the start of the cruising voyage. The yacht's track was not monitored after altering course for the nearest harbor.

On sighting the west cardinal buoy and knowing that the danger lay to the east, the yacht should have jibed to the west immediately. It is possible that, if this had been done, the heavy breaking seas might have been avoided.

General Thoughts

In the average yachtsman's favor is a generally well developed safety culture, particularly when compared with, say, the fishing industry. Yachts are generally well equipped with a range of safety equipment, but the knowledge and ability to use it is sometimes limited. The yachting press in the UK has regular features on heavy-weather tactics and the deployment of equipment, informing the debate and raising the awareness. MAIB reports often appear in these features, which are a useful means for us to have safety messages spread wider.

There is much to be gained by being able to anticipate sea states from weather forecasts and understanding their effects. Also, when considering an ocean passage, an appraisal of your chosen vessel's stability characteristics is important. Stability curves are only now becoming generally available to buyers in the UK, but we believe they are not widely understood—hence our recommendation in *Ocean Madam* (upon which the Royal Yachting Association is acting—see page 639).

Surviving the Storm

By now you probably appreciate the complexity of heavy weather, with so many variables including boat design, wind, sea state, weather tactics, and navigation. In the following section, we'll try to bring it all into perspective.

Priorities

There is never enough time or money for everything that needs to be done when getting ready to shove off. This applies to a short summer cruise as well as a circumnavigation. The question then becomes one of priorities—where do you spend your time and budget?

Assuming that the goal is safe, enjoyable voyaging, we would submit that by eliminating the nagging fear about dealing with storms, you are on your way to passages that are more comfortable both mentally and physically.

And the best way to do this is to prepare yourself as well as your boat with an eye to heavy weather.

This means understanding the entire range of storm tactics we've been discussing, and how they apply specifically to your vessel. It means practicing boathandling on boisterous days and in gales. Reefing, heaving to, setting storm canvas, using drogues, and steering aggressively both upwind and down are skills that need to be developed on your boat, on the water.

This proficiency will stand you in good stead on the average passage and in serious conditions. You and your crew will feel better psychologically, and will therefore be more comfortable physically. The confidence that comes from knowing you have the expertise and equipment to deal with adverse weather brings with it a wonderful sense of well being—replacing that tingle of dread so many sailors carry in the back of their minds.

The odds are you will have to make choices on how your time is spent. Do you work on your seamanship skills, or spend time planning and installing sophisticated cruising amenities? If the choice is between knowing how to sail the boat upwind in a gale, or upgrading systems, go for the skills first. The new systems won't do you any good if you are stuck close to home, because you or the crew are unnecessarily worried about the prospect of storms at sea.

Take the same approach with equipment. Heavy-weather canvas, drogue or parachute systems, good weatherfax gear, and sound structure are far more important than inverters, televisions, laptop computers, or refrigeration. If there's not enough time and money to meet all equipment needs—and there usually isn't—heavy weather preparation should be a priority.

Staying Away from Storms

By now it will be clear that the best way to deal with extreme weather conditions is to avoid them entirely. This is not as difficult as it may seem.

If you combine a basic understanding of analysis and forecasting with the vast array of weather data available on the Internet, via weatherfax, and from on-shore routers, the odds of encountering serious weather will be reduced enormously.

However, no amount of external weather data, even from the very best routers in the world, can replace your own analysis based on local conditions.

Get to know how to use the 500mb fax charts. These hold the keys to almost all extratropical severe weather. Warning signs are often evident at the 500mb level long before they show up on surface forecasts.

Weather Tactics within Storms

Once you're in a gale or storm, there is always a favored direction to head in order to reduce the odds of encountering severe weather and to escape the existing conditions as fast as possible.

On the spot—with direct observation of wind direction and strength, swell direction and period, and barometric pressure—you are in the best position to formulate evasive tactics, much better than anyone on shore. If you're working with a professional forecaster, remember, the data he or she feeds you is only one part of the overall equation.

What you see firsthand in most cases provides the soundest basis for evasion tactics.

Maintenance

The vast majority of difficulties arising in heavy weather begin with minor maintenance problems that escalate when the weather deteriorates. A steering or rig problem in 20 or 30 knots of wind is merely an irritant. In 50 knots it can threaten the safety of vessel and crew.

Maintenance problems and structural failures in rig, hull, keel, and steering are rarely precipitous. There are typically small warning signs well in advance of catastrophic failure. Watch for these clues. Check the boat carefully before and during each passage, and deal with the minor problems immediately—while they are still minor. By doing this, you can eliminate the major difficulties.

Heavy-Weather Design

We've presented a brief overview of the design issues that we consider critical in heavy weather. Many of these factors—high polar moments, good range of stability, moderate beam, and balanced hulls—were present in abundance a couple of decades ago. But as the IOR racing rule evolved towards high-volume, light-displacement hulls, with limited range of positive stability, cruising boats followed suit.

Today, the vast majority of production yachts are simply not designed for heavy weather.

Yes, they have wonderful, livable interiors while in port. If your cruising is coastal in nature, with short hops between protected harbors, these boats are both cost-effective and fun to live aboard.

But when you head offshore, with a greater chance of encountering severe weather, these designs simply do not provide the range of tactical options necessary to deal with adverse sea states. They are less forgiving and require far higher skill levels to deal with a given set of conditions. The fact that these boats are typically purchased by neophytes compounds the problem.

So what do you do?

Our suggestion is to forgo the flash of the modern, beamy production boat and find a soundly built CCA or early IOR design. Or, find a yacht that is not influenced by racing rules, but instead designed to the rules of the sea. You will trade a stylish new interior for a longer, narrower, and heavier design, which is faster in difficult conditions, more comfortable, and much safer.

Those fancy, new, high-volume designs may look good at anchor—and if you aren't heading offshore, they may be just the ticket for you. But if you are planning to go to sea, the "retro" configurations we've been discussing leave you with a much higher chance for success in temperate as well as heavy-weather voyaging.

Boat Size

There is no denying the fact that between comparable designs, bigger is faster and safer in breaking seas. But we don't want to give the impression that only a large, expensive boat is comfortable or safe.

On the contrary, a well designed and properly handled small boat will be safer than a larger vessel that is unwieldy and has to adopt passive tactics because she cannot be steered, or whose crew does not have the required experience to deal with the conditions.

There are lots of 20-year-old $10,000 to $30,000 boats around in which we'd rather be caught out than most of the new builds costing over $100,000.

Don't be deterred by lack of size or budget. Just choose wisely, and conservatively. Spend your money first on waterline, second on good storm canvas and related gear, and if anything is left over, put it to work on the fancy upgrades.

Rollover Preparation

Any boat heading offshore should be prepared for a rollover. If interior gear and stores stay put, the odds are much better that you will work your way out of the situation. When the interior becomes a chaotic mess it makes everything to do with recovery harder.

Aside from risk to life and limb from flying fittings and stores, when the boat rights itself, you need clear bilges in order for the pumps to work; and emergency gear and charts must be dry and easy to find.

Storm Canvas

A proper inventory of storm canvas is crucial to giving you the flexibility necessary to deal with a variety of wind and sea states. Nothing is more important when the chips are down. If you have a single-stick rig, and don't lie smoothly at anchor when the wind is up, you will want to look closely at a back staysail to help hold your head into the wind and seas.

Trysails need to be set on their own track. Storm jibs must be flown on an inner forestay for most efficient use. Take a careful look at the size of your storm sails and make sure they are small enough for anticipated worst possible conditions. Practice using these sails.

Drogues and Parachutes

Drogues and parachutes are only one tool in the survival arsenal. For each boat and storm, optimal equipment will vary. We feel strongly that for the most part this class of gear should be looked at as a means of easing motion and gaining control while using passive tactics during intermediate-strength storms. However, in extreme conditions, active tactics—where the crew is aggressively sailing and steering—usually hold the highest chance of success.

We are particularly concerned with the concept of the parachute anchor for survival weather. For some multihulls this may be the only option. But for most boats our research indicates that the systems available today—parachutes, rodes, and attachment points on the boat—are simply not up to the structural demands in breaking seas. Yet as an intermediate-weather-range device, they appear to work well, if properly used.

Safety Harnesses

We've encountered a shocking number of stories of harness hardware and tethers failing, and of sailors slipping out of harnesses. This data is reinforced by the Seattle Sailing Foundation's in-the-water testing (see page 118).

We have now completely re-evaluated the harnesses and jackstay systems we use at sea on our own boat, and we hope you do the same.

Consider this gear being used in the worst possible circumstances—with crew overboard and unable to help themselves, perhaps unconscious—to see if it is suitable for offshore work.

Emergency Communications

Time and again we've heard about rolled or dismasted vessels that have been have been unable to communicate with their would-be rescuers. This problem is easily solved with a waterproof, hand-held VHF, extra antennae for the SSB, and the communications gear located where it can be protected from water as much as possible.

Each crewmember needs to be familiar with the use of VHF, SSB, and EPIRB.

EPIRBs

For emergency rescue, 406 MHz EPIRBs are wonderful devices. But they must be properly registered, and the registration must be updated biannually in most countries. Double-check that the registration data is correct. Have the EPIRB and battery checked annually to be sure you have full battery capacity and that the EPIRB transmits properly.

And remember that by triggering the EPIRB, you're asking search-and-rescue crews to risk their lives in order to help you.

Life Rafts

There are two key elements in the use of life rafts in heavy weather. First, if you are knocked down or rolled, you need the life raft to stay with the boat. This means extremely strong attachment hardware.

Second, conventional rafts, with small stability bags on the bottom, simply do not have the capability to withstand even small breaking waves. Some form of large ballast chamber such as the toroidal structure used by Switlik and Givens is a must.

A major loss of life from rafts in heavy weather is due to the occupants being tossed out when the raft is capsized. Wear your harness in the raft, and keep it attached to a hard spot. Make sure that all loose gear is well secured so that it is not lost in a rollover.

Finally, always step up into the raft from the sinking vessel.

Abandoning Ship

Evacuating to a helicopter or another ship entails huge risks. And these perils accrue not just to the "victims," but to the rescuers as well.

In the vast majority of cases it's safer to stay with the boat, fighting to save her (and yourselves)—especially when you consider that in roughly 80 percent of the cases we've studied, abandoned vessels are later washed ashore or found afloat.

Before you make the decision to get into a life raft remember that your yacht will be much easier to spot for would-be rescuers, and probably safer in breaking seas, than the tiny hull of the raft.

Alignment with the Waves

Aligning with the waves, keeping them close on the bow or stern, is the fundamental tenet of all successful storm tactics.

There are frequently waves from plus or minus 30 degrees, even from a single weather system. This means that when the waves are breaking, active steering is required so you can align your vessel to the current wave.

There is almost always a favored tack, where the worst waves are taken at the closest angle to the bow or stern. As the wind shifts with the passage of a front, stay alert to the change in sea state.

Which Storm Tactic?

No single storm tactic works for all boats in all conditions. The main issues revolve around wind and waves. How do you get away from the most dangerous part of the storm, and how do you deal with the breaking seas?

The tactics adopted will be based on the steering capability of the yacht in question, the wave shape, favored direction *vis-a-vis* the weather, and what the wind and waves allow you to do.

Often one tactic works for a while—perhaps running off at first—and then it becomes necessary to switch to beating, because you can no longer safely control the boat at speed heading downwind.

In many cases, beating or motorsailing to weather can offer the safest tactic. As with all aspects of heavy-weather preparation and seamanship, it's important to practice steering techniques and sail trim while conditions allow for mistakes.

Mental and Physical Conditioning

It is our feeling that the most important ingredient in safely dealing with survival storms is the mental attitude of the crew. This means being alert to the external situation, watching the wind and sea state, and being in tune with how the boat is reacting.

This also means forcing yourself to take action as soon as you detect the need to do so—even if that means moving from a snug, warm bunk to a howling wind and wave-swept deck to alter course or adjust sheets.

The time to act is when you first think about it. Don't procrastinate, or you may end up getting knocked down or rolled.

To remain mentally alert you need to be physically fit. If your body is in good shape, you will have more physical and mental endurance.

In the early part of a storm, conserve your energy, and sleep when possible. Maintain food and drink, and normal bodily functions.

That extra reserve of endurance salted away in this fashion may be what gets you through the last few hours of a 24-hour trick on the helm—and could save the boat and her crew.

Staying Ahead of the Sea

The majority of disasters that occur to small boats offshore happen because the crew gives up. They assume the elements are too powerful to deal with, perhaps even abandoning a vessel which wasn't sinking for the apparent security of a life raft. In most cases, had they been better prepared, continued the fight, and stayed on the yacht, they would have been far better off.

It bears repeating that the worse the conditions, the more important it is to remain alert to changes in wind and sea state and how your vessel is reacting to them.

You may be comfortably hove to, lying to a sea anchor, or with backed storm jib and trysail. When the front passes there will be a 90-degree windshift, and a new set of seas will start crossing the old system.

It may then be necessary to tack ship or start to run off rather than remain hove to. The crew must remain an active participant in this battle, staying ahead of the sea in the process. When something needs to be done, when action must be taken, do not let lethargy keep you in your bunk. Get up on deck and do what is necessary.

Recovering from Emergencies

Despite our best efforts, sometimes emergencies do occur. Perhaps a wave catches you at the wrong angle at the wrong time; maybe the steering fails, or the rig is compromised.

When this happens it is critical to prioritize the actions to be taken. If the boat is lying abeam of the seas, the first order of business will almost always be to get the boat end-on into the seas, either bow- or stern-to.

If the rig is over the side, the next order of business will be to cut it free. Having the proper tools to cut through standing rigging is a critical element in this process. This means wire cutters of the proper size. Even better, carry a hydraulic wire cutter which will make short work of even the largest wire. The crew should have experience in using these tools.

Often the engine will be used to help maintain position with the waves. Before engaging the prop, be certain it is clear of sheets, halyards, sails, and other debris.

If you work at it; don't give up hope; and make use of the gear aboard, almost any emergency can be dealt with well enough to get you through the storm and to the next port.

The Marine Industry

The majority of boats today are sold to customers who are new to sailing. Many of these buyers dream of sailing off into the sunset—a wonderful dream, and one in which we wish sailors everywhere success.

The problem comes with the marine industry's approach to the subject of heavy weather. Most boat brokers, dealers, and builders prefer to ignore the subject. And when people ask, "Is this boat safe in heavy weather?," they are sold a bill of goods.

Advertisements trumpet the various features, and indicate that the boat is built in accordance with a particular standard or other. However standards like ABS and ISO are woefully inadequate in how they deal with many of the details of design and construction that bear on safety when caught in storm-strength or worse conditions.

Another problem is that very few builders, designers, or marketing people ever actually go to sea. And of those few that do, a small percentage experience severe weather.

After a while the boats begin to reflect this lack of experience. Design is further influenced by the input of the marketing gurus after watching boat-show response to new models.

If you plan to do coastal cruising where weather is not a risk, and don't expect to make long passages, these boats are fine. But understand that they are not designed or built for heavy weather.

If in doubt, look at the photos in this book, and ask yourself if you would want to be caught offshore in a typical production boat. You might ask the boat salesman if he or she would want to be caught offshore as well.

Go For It Now

We want to close with some words of encouragement. The ocean is a wonderful environment on which to play and learn 99 percent of the time. Most passages are made without difficulty. If you are prepared for the worst, the worst probably won't happen.

Rather than waiting forever until you can afford the perfect boat with the ultimate equipment list, we would urge you to head off as soon as you have developed your skills of seamanship—in particular, heavy-weather boathandling and weather analysis. Go now, with only the basic equipment necessary for safe voyaging. Get some sea miles under your belt. Practice heavy-weather techniques whenever the opportunities arise. Then return to the land and use your new-found knowledge to decide which big-ticket items to buy for the boat.

But, by all means, go. We want to see more of you out there when we put our anchor down, and we want to have discussions about the techniques you've learned that work well in heavy going. In the end, as you build your skills and confidence in stormy weather, even the pleasant days of sailing will be more enjoyable.

We'll see you out there!

INDEX

Numerics

A

B

C

T