Survival Sailing

Techniques, Tactics and Equipment

By Evans Starzinger

As weather conditions get progressively more severe, there is a line that is eventually crossed. On one side of that line is “Heavy Weather Sailing”, where you are still racing or passage making, still trying to make course and keep up speed. On the other side of that line is “Survival Sailing” where your priority and focus has shifted to preserving the vessel and crew. This article will focus on what to do when you have crossed that line and are in preservation and survival mode. It will also focus on mainstream and reasonably modern sailing vessels, and not get into the distinctive traits and requirements of more niche vessels (such as full keelers, multihulls, motorsailors and sport boats).

Survival Conditions

Fortunately survival conditions are quite rare. The last serious dose in the racing world was the ’98 Hobart race, although some would say the 2011 Mac race should have been treated as a survival situation. On the buoy 150nm East of Cape Hatteras , there are winds greater than 33kts only about half a percent of the time. Unfortunately this also means that there is extremely limited experience and knowledge in the fleet at dealing with such conditions.

So, what are survival conditions? Typically they are defined by the waves much more than the wind. Relatively small (say 15’) breaking waves can cause enormous damage, as a cubic yard of salt water weighs about one ton, while even very strong winds in flattish water will do little damage to a competent boat. However, extremely severe, unpredictable and shifty white squall wind conditions can also force one into survival mode.

The exact point where one shifts to preservation and survival mode will obviously depend on the vessel (depending primarily on its size) and crew experience. But generally, as a reference point, when the waves are as high as the beam is wide, and they start to break - not just white cap crests but breaking jets that thump the hull – then you are nearing the line. These kinds of waves will occur in much less wind when you are in current or over shallow water, and require more wind and fetch when you are in the deep open ocean. Again only as a general reference point, typically 50kts sustain (with higher gusts) is getting toward the line.

Photo: Strong winds can be hard to judge but at 60kts there is a very visible and distinctive ‘phase change’, as the surface of the water starts to smoke:

Operationally, if (after balancing the sail plan as well as you can) you are having sustained trouble steering a straight track, or are getting repeatedly thumped hard by waves you are nearing the line.

Courses to Sail

The first action to take when you are crossing the survival line is to NOT sail a course with the waves on the beam (say not between 65 degrees and 120 degrees from the bow). You want the waves either near the bow or near the stern. This bow or stern orientation is MUCH more knock-down resistant (perhaps 3 or 4 times more resistant) than a beam on orientation. Thus, if your ‘proper course’ was with the waves near the beam you need to decide whether to come up to a ‘bow on’ course or go down to a ‘stern on’ orientation.

Photo: Cresting wave near the beam. Time to start thinking about altering what we are doing:

There are typically three factors to think about when making this decision:

1. Which direction will take you out of the severe conditions the fastest. If you are in an ocean current, or near the edge of a continental shelf, one direction will often get you much more quickly out of the big breaking waves than the other.

2. Some boats tend to be much happier and more stable in one orientation rather than the other. You want the vessel to be 'happy', able to maintain a relatively consistent speed with little tendency to stall, or round up, or broach. This is entirely specific vessel dependant and hard to provide general advice on. If you are uncertain, try one orientation to the waves, and if the vessel is not "happy" then try the other orientation.

3. Which way is closest to your destination or the nearest harbor. In priority, this should be considered only after the above two factors, as you need to pick the best course to survive first and foremost, but if it's a toss-up, heading toward your destination or safe harbor can be valuable, if only for psychological reasons.

There are basically three tactics available in both the "bow on" and "stern on" orientations. Let's call them "fast/active", "medium/semi-active", and "slow/passive". Typically you will pick the faster techniques if you have strong helmsmen and the slower ones if you have fewer/less competent helmsmen.

Bow on (sailing with waves and apparent wind closer than about 65 degrees)

1. Fast/Active: This is sailing the boat on a close reach (say 50-60 apparent wind angle) across the back of the waves and coming up to close hauled when punching thru the crests, and attempting to weave around the biggest breakers. You want to have as much sail power and as much speed as you can while keeping the boat under control. You want the sails balanced so that you have a respectable amount of weather helm, so the bow will turn up into the waves if the boat is knocked over. Either a heavily reefed main alone, or a small jib on an inner stay is often the right sail plan, but this is wind and vessel dependant. Unfortunately, the typical trysail is usually both too big and not efficient enough close hauled for this tactic. To accomplish this tactic you need: (a) a rotation of strong helmsmen, (b) excellent sails, and (c) a vessel that has been well shaken down with no weak points to break when it is driven extremely hard. This approach was very successfully used in the 1998 Hobart race thru atrocious conditions.

The key break point determining when you have to give up this technique is when your helmsmen are getting too fatigued to anticipate the waves and vessel motion and able to weave up into the crests, around the breakers, and not dropping the boat off the back of the waves.

2. Medium/Semi-active: This is typically called "forereaching". The aim is to drive upwind, at a much closer angle than the above 'fast/active' technique' (perhaps at the vessels upwind vmg angle or even a little closer), and at as slow a speed as still allows you to punch thru the crests and not get knocked beam on. You want to set the sails so that the vessel essentially self-steers this course, with just some human input to help stop wandering in lulls and gusts. Some vessels will do this with a lashed wheel and no helm input at all, and many will do it with autopilot (on wind angle) or wind vane. Usually the sail plan is just a heavily reefed mainsail. This technique does not require the rotation of strong helmsmen,

and preserves the crew more, than the 'fast/active' approach. It does run a little more risk that the boat will not punch thru a crest and get stalled and turned beam on. On some boats, motor sailing is effective in this technique, to stabilize the course and maintain momentum and punch thru the crests, but we suggest you only turn on the motor it if feels necessary, as it can cause its own headaches (potential for ropes around the moving prop, extra noise is distracting and fatiguing, potential for engine to die from debris churned up from the bottom of the fuel tank, etc) . This "medium" technique is also a little more suitable for larger and heavier vessels that have more momentum to punch thru the crests.

3. Slow/Passive: This is typically called "heaving to". The aim is to come as close as possible to stopping the boat with the bow pointing at about 45 degrees (or a bit closer) to the waves. The aim is a slow drift downwind, but usually some small amount (a kt or so) of forward motion is impossible to avoid. How to accomplish this varies by vessel, but often you balance a small backed staysail against a deeply reefed main with a bit of upwind rudder (to drive the boat back upwind if it starts accelerating). This usually worked quite well with traditional vessels, but typically does not work so well with more modern designs – it is usually very difficult to achieve a stable attitude with modern designs. They will fall off and accelerate rapidly and then the rudder will turn them up quickly and they will go into irons and then repeat, which is neither comfortable nor safe.

To help stabilize more modern designs there have been experiments with running drag devices (para-anchors) off the bow. These experiments have tended to work better on smaller vessels than larger ones. When hit by a breaking wave, they can impose quite large loads (up to the vessels full displacement) on whatever deck hardware the drag device is attached to. And, unless very carefully and completely protected, the rode tends to chafe quite quickly wherever it goes out across the deck edge. All in all, this 'hove-to with bow drag device' is a tricky technique, with a relatively high failure rate. We do not recommend it as a primary technique, however, as discussed below, in the specific case of a close lee shore it may be the technique of last resort.

The general recommendation is NOT to use this 'slow/passive' approach if there is any way to sail toward better wave conditions. This is particularly the case when in ocean currents or shallow water, or the edge of a continental shelf, or in the track of a storm with a very intense core or wall . . . . very often in these situation the worst waves are confined to a relatively small band (often only 20 or 30 miles wide). If you use the slow/passive approach you will just sit in those bad waves until the weather system moves away, while if you take any of the faster approaches you can exit the area of bad waves much more quickly.

There is a debate among 'the experts' about whether there is a maximum wind or wave height for the slow/passive technique. We had a boat that executed this tactic extremely well (a centerboard ketch), and our personal experience would suggest it was not a matter of wind strength or wave height or even wave steepness, but rather a level of wave confusion that most often makes the technique unstable. If you have significant wave patterns from several directions, the vessel might be perfectly "hove-to" into one of those patterns but then slammed from a different direction by another of those patterns. We have seen this sort of wave confusion both in the gulf stream and in a southern ocean pattern with several fast moving lows close together.

Stern On (sailing with the waves and apparent wind aft of about 120 degrees)

1. Fast/Active: This is sailing downwind as fast as your helmsmen can keep up with. The faster you go the less impact the waves will have when they hit the vessel. You want to set the sail plan so there is the minimum possible tendency to round up. Usually this is headsail alone with the main entirely down. On most vessels, you should NOT do this with mainsail alone. That will tend to cause the vessel to round up on wave faces and to potentially cause the boom to dig in the water and snap.

When it's going well, this is by far the most comfortable ride, and it can sail you out of the worst conditions quite rapidly. However, if it goes wrong it can be the worst case. If you lose helm control and round up at the wrong moment on a wave face you can have the vessel's speed and momentum converted into an extremely violent roll . So, the four keys to this technique are (a) know how to set the vessel up so she is as balanced as possible and has as little tendency as possible to round up, (b) a rotation of excellent downwind helmsmen, and (c) have the experience and judgment to know when there is a risk of losing helm control and to then be ready to move to the next technique. (d) Active fatigue management is critical to this technique, as fatigue can lead both to bad decisions and poor helming . This means both managing the situation to get all the crew as much rest as possible (helm rotation, and using self-steering as much as possible in lulls), and on ongoing very blunt, honest and objective assessment of fatigue levels and willingness to change to the next technique if fatigue starts to get too high.

Photos from bow and stern: Mainsail carefully put away, running under storm jib

2. Medium/Semi-active: This is similar to the above technique but with the speed reduced (sqt of waterline length is often a good target speed), and usually towing either a warp or a drogue. These two elements (reduced speed and drogue) will dramatically reduce the tendency to round up and also reduce the momentum and damage if you do. An autopilot will usually be able to steer this technique perfectly, and many vessels will steer it with a lashed wheel. In the worst conditions you may have some waves break into the cockpit, but usually their impact is minimal.

In both the above two approaches (Fast & Medium) there is a decision to be made about what specific angle to take the waves. Absolutely square to the waves is often best if you are sailing bare poles or headsail only. This is true for two reasons: (a) Most hulls are most balanced, with the least tendency to round up, when sailed as flat as possible, as you are when dead downwind , and (b) you will present the smallest profile and have the least wave impact when absolutely square to the waves. However, if when sailing square your bow is burying in the wave trough (which is rare but can happen in particularly steep waves), or if you have some mainsail up (NOT recommended because of the possibility of an accidental gybe), then it will be best to take the waves at an angle. The optimal angle will depend on the skill of your helmsmen and hull balance and waves, but perhaps 15-20 degrees with just headsails or 20-30 degrees with some mainsail.

If you are taking the waves at an angle, you have the choice of port or starboard gybe. If there are multiple wave trains or an anticipated wind shift, you want to pick the gybe which splits the wave trains on the stern (favoring the most dangerous one further aft) and the one which will cause the wind to go aft in the shift.

3. Slow/Passive: This is again similar to the above, but even slower (2 or 3 kts is typical). Usually this set-up is bare poles with a series drogue off the stern, although often you need a bit of storm jib to stabilize the vessel if the winds are not extreme. You just lash the wheel (on center) and there is no need for a human helm. As you are going slower, the waves will hit harder and you will have more water breaking into and over the cockpit, but the series drogue will pull you stern first thru them with little tendency to roll or get knocked down.

Lee Shore

The above descriptions assume you have relatively open ocean and can choose which way to go and at what speed. However, if you are quite close to a lee shore you have greatly reduced options. You essentially want to try the Bow-On options in sequence. First try to sail off away from the shore using the fast technique, and then medium (including using the motor), and then slow.

If you get to the slow technique, and your boat just will not heave-to, and you don't have para-anchor gear (parachute and rode) on board, then (a) if you are still in deep water, put a spinnaker in the water with three sheets attached. As we all know that will definitely slow your drift. Just make very sure you don't get any of it in your prop or around your rudder. And (b) if you are drifting into shallower water (let's say under 100' depth), put out your anchors (all of them) on as long a rode as you can tie together (double fishermen knots are the best choice for joining rodes together). 500' of rode is not too much for offshore anchoring. However, if you are drifting toward a lee shore in a survival storm, these slow techniques probably will not save you (unless you are a long way off) . They will probably only give you extra time to figure out how to sail off, or plan a soft beach landing, or possibly get a tow (but that is unlikely in a true survival situation).

At Night

Once your eyes are night adapted, you can see surprisingly well even with heavy overcast storm clouds. The white wave crests in particular usually stand out quite clearly. However, add in a hard driving rain to

the night darkness and you may not be able to see anything, not even the instruments. It's a bit easier to helm the 'stern on' techniques in a hard driving rain, than to have the rain right in your face with the 'bow on' techniques.

In poor visibility it is useful to have someone looking aft and calling the waves to the helmsman, and this can be useful even during the days. It can also be useful to have someone calling the wind angle off the instruments when they get near some agreed boundaries (too deep or too close). At night it is obviously important to protect the night vision of the helmsman. No bright lights should be in the cockpit, or shinning out of the companionway. It takes about 45 minutes to regain night adaption once lost.

Some very excellent helmsmen can steer well with just minimal visual clues, using the boat heel angle, rudder feedback, wind on the neck and noise of approaching waves. But it is no doubt that darkness and driving rain add significantly to the difficulty of helming the fast/active techniques. If you feel blind, not in touch with the waves, and getting unexpectedly thumped by waves, then you should probably switch down to one of the slower techniques.

Most dangerous Techniques

The above techniques have good track records. There are three other specific 'techniques' which quite commonly get boats into trouble, and which we recommend you avoid.

1. Running off with mainsail alone. This is acceptable in brief squalls, say perhaps for up to 30 minutes. But on most boats it creates poor balance and difficult helm control, and too much speed and momentum for that unstable steering control. Doing it for any length of time accumulates risk that the helm will lose concentration or a wave jet will hit the transom at the wrong moment, and the boat will violently spin up and roll. This is perhaps the most common heavy weather tactical error and accident.

2. Lying ahull (eg with all sails down, and no steering, just letting the boat takes its natural attitude). This does in fact work (except for being uncomfortable) if there are no (or only very small) breaking waves, so can be used in 'heavy weather' rather than 'survival situation'. However even in that case it is very uncomfortable (lots of boat motion) and stressful (lots of wave thumping on the hull). In breaking wave 'survival conditions' conditions this approach puts most boats into the 'beam on' attitude which is the single most vulnerable orientation and most likely to being rolled.

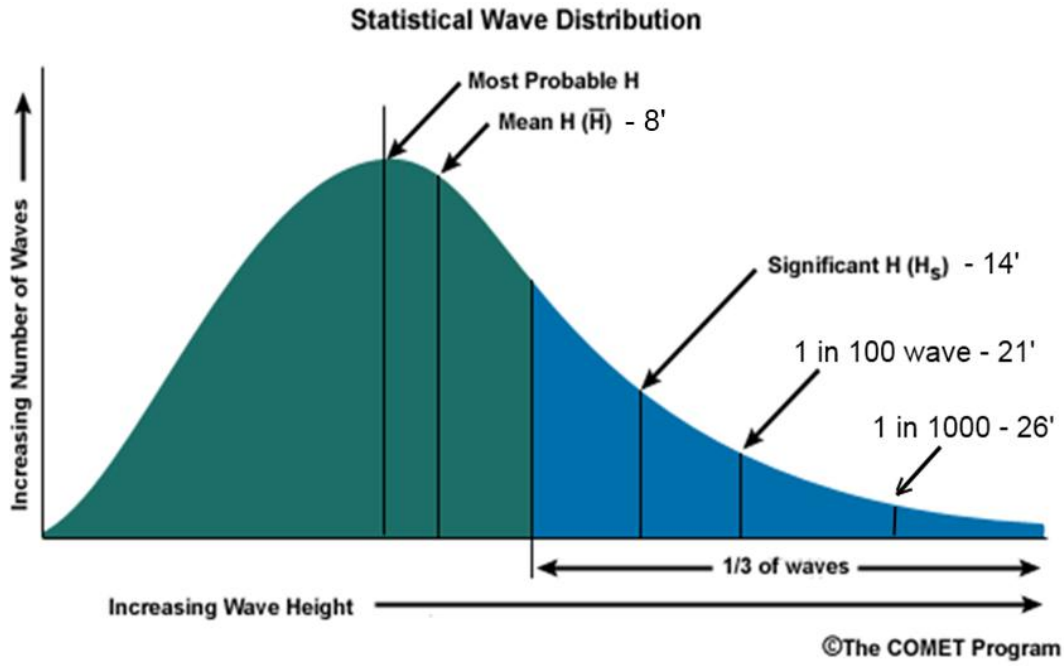
3. Going below and waiting for the storm to end. Your boat does need you, to check on chafe and things coming loose. But even more importantly, it is extremely valuable to monitor the situation and adjust your tactics as the storm develops. A surprisingly high number of boats get rolled near the end of a storm, as the wind drops and shifts direction. The boat may then wallow a little, the waves are coming from a different direction, and you can end up beam on and rolled unless you are paying close attention.

Waves

When deciding what tactic to use and determining if the boat 'feels right', it is critical to understand that at any given time in a storm the waves come in a relatively predictable range of different sizes (the Rayleigh probability distribution for those interested in statistics). Roughly 1 in 1000 waves is going to be 1. 8x the significant height and 1 in 4000 waves is going to be 2 times bigger than the 'significant

wave height' (significant wave height is the average height of the tallest 1/3 of waves. "Significant wave height" was developed as the closest measurement to what people actually judge the wave height to be by visual observation, and is the standard meteorological wave metric) and 3 times bigger than the mean wave. With a 15 second wave period you will statistically get one of the 1 in 4000 waves about every 12 hours. So, you have to anticipate these big waves. They are out there and will hit you. Luck does play a role in exactly if, where and how these big waves break, but their existence is foreseeable and anticipatable and should be factored into your decision making and tactics and not just become 'bad luck'.

As a concrete example, below is a graph showing the wave distribution during the *Low Speed Chase* accident, when the mean waves were 8' and the significant waves were 14'. The important point is that in this case 1 in 100 waves is 21' and 1 in 1000 is 26'. The vessel was handling the 14' waves just fine but was rolled and 5 people died by one of the 1 in 1000 waves.



There are three complicating factors which make the extra big waves both less frequent than suggested above but also more damaging when they do occur. The first is that the wave heights are not truly random and independent. Waves in fact travel in sets or trains, where 3 or more waves of roughly the same height and speed travel together. This means that the big waves may be spaced apart in time much more than suggested above, perhaps more like every 36 hours rather than 12, but when you get one you may get 3 in quick succession. Second, there is a dynamic where one severe breaking wave forces the water up again to generate another wave. And this second wave may break again. That can put you in a rapid spin cycle of multiple breaking waves. Finally, there is data from hurricane hunter planes and satellite measurement that in true hurricane conditions the big waves

(more than 2x significant height) may be much more common than in common gale and storm conditions.

Again, the key point here is that you need to anticipate and prepare for the full wave distribution and not just what you have at the moment. This means that you need to hold some margin of safety and stability in reserve for when one of these 1 in 1000 waves comes thru.

Trisails

Trisails are useful for four reasons:

First, and the primary reason a trysail is required by the offshore special regulations, is if you break your boom, your mainsail is probably entirely out of action, while you can still fly a trysail (because sheets to the quarters rather than the boom). It is sometimes possible to sheet a mainsail to the quarters if the boom breaks, by sheeting to the first reef clew but tensioning the second reef tack. But it is (a) difficult to get right when messing around in storm force winds, (b) almost impossible to do with full battens, and (c) creates a sloppy sail with a big bunt that will flog around in strong winds, (d) and is usually too big.

Second, using the trysail in select situations will save the mainsail from a lot of hard wear and tear. There is often quite a bit of leach flutter when hove-to or forereaching which can damage a mainsail. It is preferred to come thru and out of a storm, in the middle of the ocean, with the mainsail still intact and in good shape and keep all that wear and potential leach damage on the trysail.

Third, we have twice had mainsail slide/cars damaged at sea, and been able to hoist the trysail as sort of a 'spare mainsail' to keep the boat moving and stable while fixing the mainsail.

Fourth, (primarily for a bigger boat) on say 25-30kt daysails we often hoist the trysail rather than the main, because it is more than enough sail area, and is easier to flake and put away at the end of the day.



However, many people who have trisails don’t use them. There are a few tips and tricks to make them more user friendly and useful:

We carry a trysail and have a separate track for it (which runs down to the deck so we can work on it sitting down rather than standing up), but we learned early on that we would simply not use it if the trisail was stowed down below in a bag. We just were not going to sit on deck at the mast in a storm and fiddle all the slides onto the mast while the trysail was trying to blow around - instead we would either go with the deepest mainsail reef or drop the mainsail all together and go with just the staysail/storm jib. We would only use it if it was already hanked on the track, and bagged there, at the start of the passage, and thus ready to hoist just by putting the halyard on. If we did not have a separate track, as many boats do not, I can't imagine we would even consider trying to take off the mainsail and feed in the trysail. So, if you are going to get much practical use from a trysail, you probably need a separate track and to hank it on and bag it before you leave the dock.

There are two typical ways to rig the sheets for a trysail - two sheets to snatch blocks on the quarters and not connected at all to the boom, or one sheet to the end of the boom. The first method is the 'traditional' way, and it is good for sailing close hauled or forereaching but it gives terrible shape for broad reaching or running. The second method (sheet to the end of the boom) gives much better shape control for reaching and running, but obviously causes a problem if you have broken the boom in a knock down and also potentially causes some increases danger in a gybe. It would be nice to have a trysail that was cut to allow either/both, but the sail makers typically don't think about this.

The ORC recommended size trysail is a terrific size for perhaps 40-50 kts (depend on the boat stability) but it is perhaps a bit big for more than wind than that. It would be interesting to see a 'reefable' trysail.

Trisails are typically not very efficiently shaped and are typically of stretchy cloth, so they are typically not very good options for the 'fast/active' close reaching option described above. A higher aspect, better cut, lower stretch, deep third reef is usually better for this tactic.

I have always felt there is a lot of room for a sailmaker to rethink and redesign the basic trysail (which seems to have not been rethought or redesigned in almost 100 years). But unfortunately most sail makers (and the vast majority of customers) have not actually used one in storm conditions, and don't think much about them.

Drogue Specifics

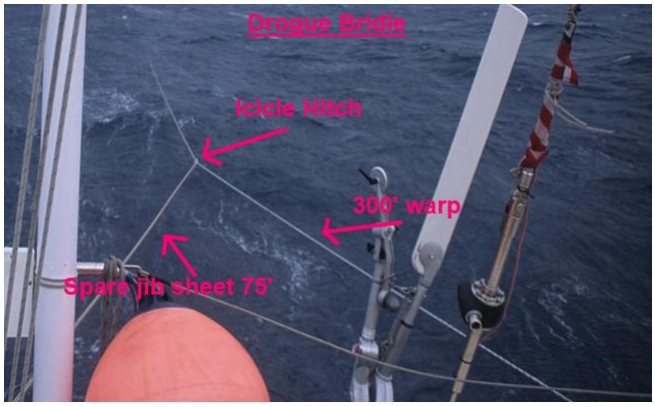
There are two quite different types of drogues:

(a) The 'single element' drogue (usually one large cone or webbing basket), which is used in the medium/semi-passive downwind technique. It is designed to stabilize the vessel track and hold the stern into the waves and maintain a 'medium' speed (about sqrt waterline). This is the smallest and lightest of the drag devices options and also the one that puts the least shock loads on its rode and the vessel attachment. The single biggest weakness of this gear is that in extremely steep waves it can pop out of the wave face and allow the vessel to accelerate until it digs back in. This is rare, but it does happen.

You can minimize this 'popping out' by adjusting the rode length. Some "experts" suggest the drogue should be 2 wave back, but in the real world this is difficult to execute both because the wave lengths are quite different even within a 10 minute period in a storm, and because in some big storms the wave length can be +400 ft long. We tend to set the drogue out at about 150' and see how the boat feels, and let out more if the drogue seems at all unstable. In the northern hemisphere we have never felt the need for more than 300'. However, in particularly big southern ocean patterns we often found 600' was perfect.

(b) The 'series drogue' (a series of usually more than a hundred little cones woven into a warp) is used in the slow/passive downwind technique. This is designed exactly to avoid the 'popping out of the wave face' problem with the single element drogue, as you have the drag spread out over hundreds of cones. The two drawbacks of this equipment is that it will slow the boat down more, allowing the waves to hit the cockpit and companionway harder, and it is rather harder and more work to recover.

Both types of drogues like to be set from a bridle so that they are pulling from the center of the transom rather than from one corner. If you set them just from one side they will both jerk the boat in wave hits and try to steer the boat.



Leadership

As is true in almost all emergency situations, even if you have all the equipment and tools and training, leadership will almost always be the single critical difference between success and failure, between life and death. This is too big a topic to cover adequately here, but four particular aspects stand out as especially critical in survival sailing.

The first is anticipation and judgment. If the storm is well forecast in advance (as most are) you want to get as much rest as you can ahead of it and prepare the boat. Then, as the storm develops, you want to switch to preservation mode and survival sailing a short while BEFORE you feel you could or might get hammered by a breaking wave. You do not want to be reacting to bad events, but anticipating and ahead of them. Then you need to continue to monitor conditions and your helmsmen fatigue/skill level and change tactics if necessary before a bad mistake is made rather than after one. This requires a good feel both for the boat (and when she is 'happy') and for the weather and wave development.

The second is to take action in a calm and methodical fashion. Even in horrible conditions, for most of the time, the boat will be able to look after itself just fine. You can often do more harm than good with a panicked overreaction. Just for example, people often get into trouble taking down too much sail after getting hit hard by a wave and then they wallow in the waves and get beam on and then truly rolled.

The third is to be willing to experiment and try different things until you find one that feels right. Don't be married to one technique. Different ones work better in different conditions, and different ones may be best early as a storm develops than later when the wave pattern has fully developed. Often the waves are shorter but steeper at the beginning and get bigger but longer as it goes on, which may suggest you evolve your technique during the storm.

The fourth is to always be active and aware and involved in the vessel. Even with the "slow/passive" techniques its absolutely wrong to simple go below and lock the hatch and hope it all goes away. You need to be aware of how the waves are developing and alert to potential chafe or lashings or shackles coming loose.

Summary

Weather forecasting and weather routing has improved, but it is still an uncertain science with metrological “bombs, and extreme squalls developing unexpectedly. If you are going more than 2 days offshore, or overnight coastal sailing in an area of potentially extreme fast moving squalls, you should be knowledgeable about when and how to switch to “preservation mode”.