

PREPARING BOATS & MARINAS FOR HURRICANES



Boat owners from Maine to Texas have reason to become edgy in the late summer and fall: Each year, on average, two hurricanes will come ashore somewhere along the Gulf or Atlantic coast, destroying homes, sinking boats, and turning people's lives topsy-turvy for weeks, or even months. This year, who knows? Florida is struck almost twice as often, but every coastal state is a potential target.

Experts predict that as global temperatures rise, tropical storms will increase in strength and drop even more rainfall.

Experts also fear that after a number of storm-free years, people in some of the vulnerable areas will be less wary of a storm's potential fury. But to residents of Texas, crippled by Maria, and Florida, ravaged by Irma in 2017 (Irma was the strongest hurricane ever recorded in the Atlantic), the hurricane threat won't soon be forgotten.

Developing a Plan

If you own a boat, the first step in developing a preparation plan is to review your dock contract for language that may require you to take certain steps or

to leave the marina when a hurricane threatens. Ask the marina manager what hurricane plan the marina has in place.

Planning where your boat will best survive a storm, and what protective steps you need to take when a hurricane threatens, should begin before hurricane season. The BoatU.S. Marine Insurance claim files have shown that the probability of damage can be reduced considerably by choosing the most storm-worthy location possible and having your plan ready long before a hurricane warning is posted.

Knowing What to Expect

Preparing a Boat for a Hurricane Means Defending Against Wind, Rain, Waves, and High Water—All in Proportions Rarely Experienced by Boaters. Claim Files from Past Storms Show That Damage Is Usually Due to a Combination of These Factors.

>> SURGE

The damaging influence of high water, or storm surge, is often underestimated in preparing a boat for a storm. Storm surge raises the water level far above normal high tide, cutting off roads, forcing evacuation, and lifting boats above their docks and pilings. Surge accounts for major damage to boats because it puts docks and dockline arrangements underwater as the boat tries to float above. In 2012 Hurricane Sandy set a new surge record of 14 feet in parts of New York.

Surge is the result of several factors. Due to low barometric pressure, the ocean surface is drawn upward forming a mound about one foot higher than the surrounding ocean. Large swells generated by the storm reach land first, while storm winds drive water toward the coast. As the storm makes landfall, water levels over ten feet above normal high tide are possible. Surge is responsible for extensive flooding and much of the loss of life that accompanies a hurricane. Dangerous high tides can reach outward 20 to 50 miles from the storm's center. Surge makes extra length and positioning of docklines critical.

>> WIND

A hurricane, of course, brings high winds. Wind speeds of 70 to 130 mph are common; in 2017, Irma reached a record 185 mph. What may be less understood is the force created by such winds. When wind speed doubles, the wind pressure quadruples. To put it in practical terms, when the wind speed increases, the damage it causes increases at a much greater rate. This illustrates the importance of reducing the boat's



A storm surge during Hurricane Isabel combined with normal high tides to overcome this low-lying breakwater. The protected harbor then became an open bay and many of the boats in the harbor either sank or were badly damaged.

windage, which is the amount of area your boat presents to the wind, by removing as much rigging, canvas, and deck gear as possible, and facing the bow toward the greatest exposure.

>> WAVES

Waves in the ocean have tremendous energy and can reach mountainous heights. But even in relatively small harbors, bays, and lakes, waves can build to surprising heights. In a hurricane, it is not unusual for steep, breaking waves three to six feet high to pound normally peaceful harbors. Seawalls, barrier beaches, and other structures that normally protect docks and moorings are submerged by the storm surge. This has the effect of greatly extending the "fetch," or distance, over which the wind can generate waves.

>> RAINFALL

Rainfall of six to 12 inches within 24 hours is normal during a hurricane; hurricane Maria in 2017 dumped an all-time record of 60 inches of rain in parts of Texas. Boats that are spared the worst high water and wind still can be sunk by the torrential rain. Cockpit decks are seldom 100% watertight,

and the ability of a bilge pump and battery to handle rain accumulation is greatly overestimated. Deck drains and pump discharges located near the waterline can backflow when waves and rain put drains underwater.

>> TORNADOS

Tornadoes are sometimes spawned by hurricanes. Of the 46 people who died during Hurricane Carla in 1961, 11 were killed by tornadoes. Little can be done to protect a boat from a tornado. The possibility of a twister, however, is a strong reason for you, your family, and your boat, if it is trailerable, to be far from the coast when a hurricane makes landfall. ⚠️

Recommended Reading:

Chapman: Piloting, Seamanship, & Small Boat Handling, by Elbert Maloney. 632 pages. Hearst Marine Books.

The Complete Book of Anchoring and Mooring, Second Edition, by Earl Hinz. 331 pages. Cornell Maritime Press.

Seaworthy, by Bob Adriance. 268 Pages. International Marine/McGraw-Hill.

Where to Keep Your Boat

Securing a Boat Ashore

Going back as far as Hurricane Alicia in 1983, BoatU.S. Hurricane Catastrophe Team (CAT) members have spent thousands of hours working to identify and recover damaged boats. They have seen firsthand what works and what doesn't work when a boat is prepared for a hurricane. When asked where they would take their own boats if a hurricane warning were posted, most of said they would have it hauled ashore. For many boat owners and marinas, hauling boats is the foundation of their hurricane plan. Some farsighted marinas and yacht clubs have evacuation plans to pull as many boats out of the water as possible whenever a storm is approaching and secure the rest in the largest available slips. BoatU.S. marine insurance policies include Named Storm Haul-Out Coverage, which reimburses 50 percent of the cost (up to \$1,000) to professionally haul or protect your boat in preparation for a NOAA named storm in your area.

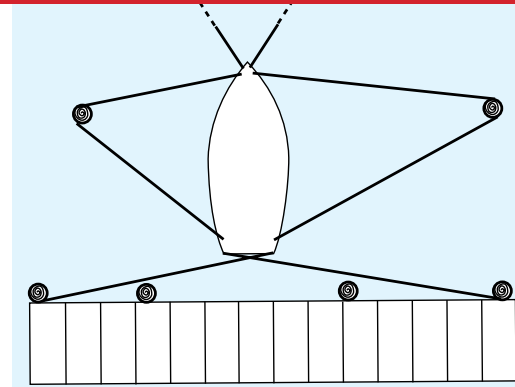
There are some types of boats that must be pulled if they are to have any chance of surviving. Smaller, open boats and high-performance powerboats with low freeboard, to use two examples, will almost always be overcome by waves, spray, and rain. This is true even if the boats have self-bailing cockpits. Fortunately, most of these boats can be placed on trailers and transported inland.

Boats ashore should be stored well above the anticipated storm surge, but even when

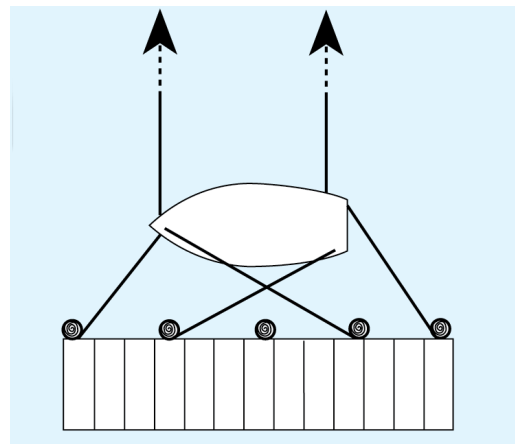
boats are tipped off jack stands and cradles by rising water, the damage they sustain in a storm tends to be less severe than the damage to boats left in the water.

Windage is also a consideration. If nothing else, reduce windage as much as possible (see "Critical Points") and make sure your boat has extra jack stands, at least three or four on each side for boats under 30' and five or six for larger boats. The jack stands must be supported by plywood and chained together. To reduce windage, some ambitious boat owners on the Gulf Coast have dug holes for their sailboat keels so that they present less windage. Smaller sailboats are laid on their sides.

One technique that has proven to be very effective involves strapping boats down to eyes imbedded in concrete (see cover photo). At least two marinas in Florida and one in Puerto Rico have used straps with excellent results. One of the Florida marinas strapped the boats to eyes imbedded in its concrete storage lot. The other Florida marina and the one in Puerto Rico built heavy concrete runners (similar to long, narrow concrete deadweight moorings) beneath the boats to anchor the straps (because it has less stretch, straps made with polyester work better than nylon). Even when the wind has been on the beam and water has come into the storage area, the straps held and boats have stayed upright. An alternative tried at other marinas has been to use earth augers screwed into the



A sample storm arrangement: note the spring lines, which were the longest lines, are now the shortest. Stern lines are extended one or two slips away. Additional bow lines lead across to the next dock or to storm anchors placed out from the slip.



On a face dock, position the boat farther (the farther, the better) than usual from the dock and add offshore lines to hold the boat away from the dock. Offshore lines can lead to distant pilings or trees, such as across a canal, or to anchors if the bottom provides adequate holding.

When to Take Action

"The time for taking all measures for a ship's safety is while still able to do so. Nothing is more dangerous than for a seaman to be grudging in taking precautions lest they turn out to have been unnecessary. Safety at sea for a thousand years has depended on exactly the opposite philosophy."

— Admiral Chester W. Nimitz

A hurricane "warning" advisory is posted when sustained winds of 74 mph or higher are expected within 24 hours or less—too late, in most situations, to head for the boat.

Securing the house, gathering emergency provisions, and evacuating the family will need attention at this point.

A hurricane "watch" is posted when hurricane conditions pose a threat to a specified coastal area, usually within 36 hours. Some hurricane observers believe waiting for a watch to be posted also may be too late to head for the marina or to move the boat to a safer location.

Even watching the barometer, which is helpful for some weather patterns, can't

tell you when to prepare for a hurricane. The extreme low pressure associated with a hurricane occurs close to the eye of the storm—too late to predict landfall.

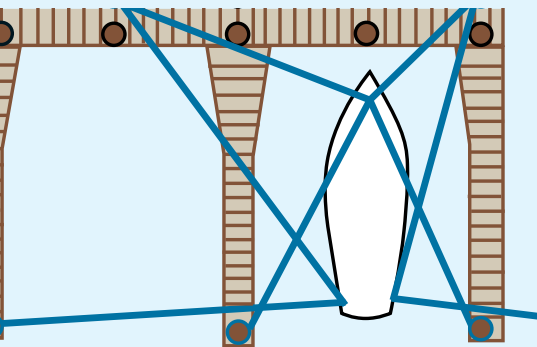
The best advice is to prepare or move your boat when a hurricane is a substantial possibility, even before a watch is issued. If you wait longer, and your plan includes relocating the boat, bridges may be locked down and the hurricane hole you choose may be inaccessible. Or, if you plan to have your boat weather the storm ashore, you may find the marina is too busy to haul your boat. ⚠️



Two problems with the storm-worthiness of this marina: First, the boat is exposed to far too much open water. Second, the condition of the pilings is abysmal. In the event of a hurricane, this boat would have to be moved.



Several years ago, the 6' pilings that anchored the floating docks at this Virginia marina were replaced with 18' pilings. When Hurricane Isabel came up the Potomac in 2004, all of the boats survived the 14' surge with no damage. Had the pilings not been replaced, damage at the marina would have been extensive.



The larger the slip, the better the chance that a boat will survive a hurricane. When a boat must be left at a dock, moving it to a larger slip (equally well protected) will be a decided advantage. Docklines (the more the better) should be arranged to minimize the chances of the boat coming in contact with the dock and pilings.

ground to secure the straps. Results with the latter technique have been mixed; some have held while others have been pulled out. All things considered, any attempt to anchor a boat on shore is worth the effort.

Securing a Boat in the Water

Any boat in the water should be secured in a snug harbor (don't even think about riding out the storm at sea unless you're the skipper of an aircraft carrier). The trick is deciding which harbors will still be snug if a hurricane comes ashore and which will be vulnerable. Storm surge—high water—is a major consideration. A storm surge of 10' or more is common in a hurricane, so a seawall or sandy spit that normally protects a harbor may not offer any protection in a hurricane.

Another consideration is rocks. Crowded, rock-strewn harbors are picturesque, but they are not a good place to keep your boat in a storm. Rocks are hard on boats, should yours break loose. If you plan to anchor, the best anchoring is usually in sand, followed by clay, hard mud, shells, broken shells, and soft mud. Also, water can sometimes be blown out of the harbor, leaving boats stranded briefly. If this happens, your boat would rather settle onto anything but rocks.

At a Dock

At a Fixed Dock. Members of the BoatU.S. Cat team estimate that as many as 50% of the boats damaged at fixed docks during hurricanes could have been saved by using better dock lines: lines that were longer, larger, arranged better, and/or protected against chafing. If you decide to leave your boat at a dock, you'll need to devise a docking plan that is liable to be far different than your normal docking arrangement. By the time preparations are completed, your boat should resemble a spider suspended in the center of a large web. This web will allow the boat to rise on the surge, be bounced around by the storm, and still remain in position.

Take a look at your boat slip and its relation to the rest of the harbor. For most boats, you'll want to arrange the bow toward open water or, lacking that, toward the least protected direction. This reduces windage. The exception is boats with swim platforms, especially swim platforms that are integral to the hull. These boats have been sunk when their platforms were bashed against a bulkhead. If your boat's swim platform can't be kept safely away from a bulkhead, secure the boat with its stern toward open water.

Next, look for trees, pilings, and dock cleats—anything sturdy—that could be used for securing dock lines. Not all pilings are sturdy. Old wood pilings that are badly deteriorated (rot, worms) should obviously not be relied on in a storm. The same is true of older concrete pilings, which seem to be more susceptible to snapping in two (and sometimes landing on boats) than their more pliant wood counterparts. Many of the boats that were wrecked in Hurricane Charley had been secured to concrete pilings that couldn't stand up to the lateral stress and twisting. And at least one marina in Pensacola had almost all its concrete pilings fail. All things being equal, wood is a better choice.

With most docking arrangements, lines will have to be fairly taut if the boat is going to be kept away from pilings. The key to your docking arrangement is to use long lines, the longer the better, to accommodate the surge. (A good rule of thumb: Storm dock lines should be at least as long as the boat itself.) You will probably want to use other boat owners' pilings (and vice versa), which calls for a great deal of planning and cooperation with slip neighbors and marina management.

Lines should also be a larger diameter to resist chafe and excessive stretching. On most boats, you should use 1/2" line for boats up to 25'; 5/8" line for boats 25' to 34'; and 3/4" to 1" lines for larger boats. Chafe protectors (see "Critical Points") must be on any portion of the line that could be chafed by chocks, pulpits, pilings, etc. To secure lines to hard-to-reach outer pilings, put the eye on the piling so that lines can be adjusted from the boat. For other lines, put the eye on the boat to allow for final adjustment from the dock.

At a Floating Dock. Because they rise with the surge, floating docks allow boats to be secured more readily than boats at fixed docks. There's no need to run lines to distant pilings because the boats and docks rise in tandem. Floating docks only offer protection from the surge, however, if—a HUGE if—the pilings are tall enough to accommodate the surge. In almost every major hurricane, there have been instances where the surge has lifted floating docks up and over pilings. When that happens, the docks and boats, still tied together, are usually washed ashore in battered clumps.

If you plan to leave your boat at a floating dock, it's critical that you measure the height of the pilings—will they remain above the predicted storm surge? Pilings that are only six or seven feet above the

normal high tide probably won't be safe. When floating docks have been rebuilt after hurricanes, the new pilings have almost always been much taller, about 18' tall, and are far less likely to be overcome by surge than the six- to eight-foot pilings that they replaced. Taller pilings are much more "storm proof."

Hurricane Holes: Canals, Rivers, and Waterways

Whenever canals, rivers, or waterways are available, they serve as shelters—hurricane holes—and offer an attractive alternative to crowded harbors and marinas. Your mooring arrangement will depend on the nature of the hurricane hole.

In a narrow residential canal, a boat should be secured in the center with several sturdy lines ashore (the "spider web") to both sides of the canal. This technique was common to most of the boats in canals that survived recent hurricanes. Conversely, boats that were left at docks without the benefit of lines to both sides of the canal didn't fare any better than boats at marina docks.

The boat should be facing the canal's entrance and be as far back from open water as possible. Besides sheltering the boat, being away from the entrance should help with another consideration, which is the need to maintain a navigable waterway.

Securing boats in residential canals is possible only if you make arrangements with the homeowners whose trees and pilings you will be using to secure your boat. This can be difficult if your boat isn't normally moored in the canal. If your boat is already in the canal, getting other homeowners involved in planning for a hurricane increases the chances that your boat (and theirs) will survive. This is important. All it takes to wreak havoc in a narrow canal is one or two neglected boats coming loose.

In wider canals and waterways, boats should be secured using a combination of anchors and lines tied to trees ashore. More lines and anchors are always better. Try to find a spot that is well away from open water and that has tall banks, sturdy trees, and few homes. Moor your boat away from the main channel. Other considerations: A hurricane hole that ordinarily takes an hour to reach may take two hours to reach when winds and seas are building; bridges may not open as frequently once a hurricane warning has been posted; or the bridges may be locked down to evacuate cars. Plan

on moving your boat early.

At a Mooring, at Anchor, or Both

Mooring in a sheltered location can also be a good alternative to exposed harbors and/or crowded marinas. A boat on a mooring can swing to face the wind, which reduces windage, and it can't be slammed into a dock unless the mooring or anchor drags.

The first question, then, is: Will your mooring hold? As a result of numerous moorings being dragged during recent hurricanes and northeasters, a search has been underway for a more secure mooring anchor. A study by the BoatU.S. Foundation, *Cruising World* magazine, and Massachusetts Institute of Technology (MIT) found that a 500-lb. mushroom buried in mud could be pulled out with 1,200 lbs. of pull (supplied by a 900-hp tug); an 8,000-lb. deadweight (concrete) anchor could be pulled out with 4,000 lbs. of pull. A helix mooring, however, could not be pulled out by the tug and the strain gauge recorded 12,000 lbs. of pull—its maximum—before a shackle was burst apart by the strain. Scope in each case was slightly less than 3:1. (In another helix test, a strain gauge had registered 20,800 lbs. before the hawser snapped.)

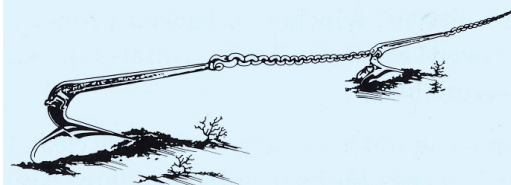
The holding power of a mushroom or deadweight mooring anchor can be increased by extending the pennant's scope, which has as much to do with holding power of a mooring as the anchor itself. (Additional scope, while always advantageous, appears to be less critical with helix anchors.) Studies have found that when the angle of pull increases to 25°, a mooring's holding power begins to weaken precipitously. So in shallow harbors, where a scope of 3:1 can be had with, say, 20'-30' of chain, the advantage of scope is all but eliminated in a storm by a combination of a large tidal surge and the high, pumping motion of waves. Note that in a crowded harbor, scope must be increased uniformly on all boats.

Finally, when was the last time your mooring's chain was inspected? Chain that is marginal in the spring will not be sufficiently strong at summer's end to stand up to a hurricane. A harbormaster should know how long your chain has been in use and whether its condition could be iffy.

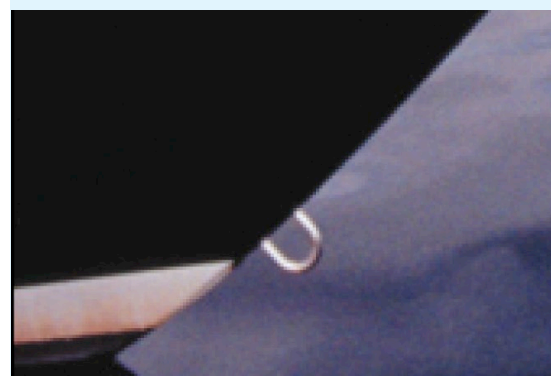
If you have any doubts about your mooring, the chances of it failing can be reduced significantly by using one or two additional storm anchors to enhance its holding power and to decrease the room your boat will need to swing.



This sailboat was tied off in a canal in Gulf Breeze, Florida using three large anchors and 13 lines to shore. Despite considerable damage to other nearby boats and homes, the sailboat survived Hurricane Ivan without so much as a scratch.

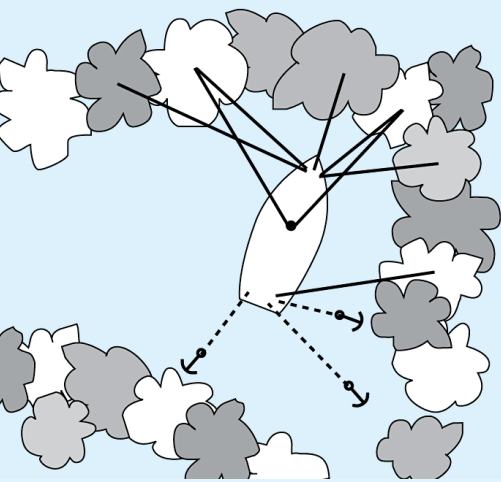


Anchors used in tandem give you the advantage of 100% holding power of both anchors simultaneously. Use only chain to join the anchors before setting. Tandem rigs should be prepared well in advance of the hurricane season.



A sturdy eye installed down near the waterline at the bow eliminates the problem of chafe on chocks, anchor rollers, and bobstays. An eye also reduces the angle of pull on the anchor, which has the same effect as increasing scope. Note that the eye will be under a tremendous load and must be properly backed.

For more damage-avoidance articles to help prepare your boat for a hurricane, go to BoatUS.com/hurricanes. The site includes up-to-date information on active hurricanes, including tracking models and NOAA forecasts. Also, download the BoatUS app, which can also send you hurricane updates and even allow you to file a claim.



One boat that survived Hurricane Andrew was secured in a mangrove channel with eight 5/8" lines to shore and three large anchors: a 60-lb. Danforth; a 37-lb. Fortress; and a 45-lb. Bruce. Each of the lines had 10' of slack to allow for the tidal surge.



Most boats do well on trailers in a hurricane. The exception is deep-draft sailboats, which are vulnerable when the wind is on the beam. Whenever a sailboat with a deep keel is stored on a trailer, jack stands should be used to provide additional support.



A boat on davits is extremely vulnerable to storm surge. If possible, store the boat ashore.

At Anchor

As with moorings, conventional storm anchors rely on scope—at least 10:1 if possible—to increase holding power. Heavy, oversize chain is also recommended; 50/50 is probably the optimum chain-to-line ratio. In theory, a riding weight, or sentinel, placed at the chain/line juncture will lower the angle of pull on the anchor and reduce jerking and strain on the boat. During a hurricane, however, its value will be diminished by the extreme pressure of wind and waves and a sentinel (and the weight of the chain) should never be relied on to compensate for lack of scope. To absorb shock, an all-chain rode must have a snubber (usually nylon line) that is 30% of the rode's length. Without the nylon line, the surging waves and intense gusts are much more likely to yank the anchor out of the bottom.

BoatU.S. CAT team members have consistently found boats that used single working anchors were much more likely to have been washed ashore. Conversely, more and larger anchors (suited for the type of bottom) increased a boat's chances of staying put. One CAT team member says he is impressed with the number of boats that ride out storms successfully using two large anchors with lines set 90° apart. With this technique, one rode should be slightly longer than the other so they won't become tangled should they drag. Even more staying power can be had using the tandem anchoring technique—backing each anchor with a second anchor. Using tandem anchors allows the first anchor to dig a furrow so that the second can dig in even deeper (see diagram, page 5). A study done by the U.S. Navy found that the use of tandem anchors yields a 30% improvement over the sum of their individual holding powers.

One more important note: Chafe gear is essential on any line, but it is especially important on mooring and anchor lines. Recent storms have given dramatic evidence that a boat that is anchored or moored is especially vulnerable to chafing through its pennants (see "Critical Points"). Unlike a boat at a dock, which is usually more sheltered and secured with multiple lines, a boat on a mooring is more exposed to wind and wave and will typically be secured with only two lines. Lines on the latter will be under tremendous loads and will chafe through quickly if they aren't protected.

Trailerable Boats

A trailer is, or should be, a ticket to take your boat inland to a more sheltered location away from the tidal surge. But your boat won't get far on a neglected trailer that has two flat tires and rusted wheel bearings. Inspect your trailer regularly to make sure it will be operable when it's needed.

If you take your boat home, you may want to leave it, and not your car, in the garage. A boat is lighter and more vulnerable to high winds than a car. If this isn't practical, put the boat and trailer where they will get the best protection from wind, falling branches, etc.

Let some air out of the trailer tires and block the wheels. You can increase the weight of lighter outboard boats by leaving the drain plug in and using a garden hose to add water. (Rain will add a lot more water later.) This has the added advantage of giving you emergency water (non-drinking) if the main water supply gets knocked out by the hurricane. Place wood blocks between the trailer's frame and springs to support the added weight. On a boat with a stern drive, remove the drain plug so that the engine won't be damaged by flooding.

Secure the trailer to trees or with anchors or augers. Strip all loose gear, bimini tops, canvas covers, electronics, etc. and then lash the boat to the trailer.

Boats on Davits and Lifts

When asked, "Where wouldn't you want your boat to be in a hurricane?" just about all of the BoatU.S. CAT Team members consistently say they wouldn't want their boat to be on a hoist or lift. Damage to boats on lifts has been high and has included boats being blown off cradles; bunk boards breaking (and spilling the boats); boats grinding against lift motors and pilings; boats being overcome by the storm surge; and boats filling with rainwater and collapsing lifts. Have any boats on lifts survived? In areas that have been hard hit, the answer is not many. The few that did survive were typically subjected to only a slight surge, and the lift had been secured so that the boat and its cradle couldn't be tossed around by the wind. Whenever possible, boats on lifts or davits should be stored ashore.


If the boat must be left on its lift, remove the drain plug so the weight of accumulated rainwater will not collapse the lift. (If the tidal surge reaches the boat, it will be flooded, but to leave the plug in place is likely to result in more serious struc-



High-rise storage racks can be toppled by a storm's high winds. Especially if your boat is in an older building, which is likely to have been built to less stringent standards, consider putting it on a trailer and moving it further inland.

tural damage.) Tie the boat securely to its lifting machinery to prevent the boat from swinging or drifting away. Some boats survived on their lifts when their owners used heavy straps to attach them to well-secured cleats on the dock. Plug the engine's exhaust outlet and strip the boat. Make sure cockpit drains are free of debris.

Boats on High-Rise Storage Racks

In Hurricane Wilma alone, three large steel storage racks with thousands of boats were collapsed. Typically, older storage racks are more vulnerable than ones that were constructed in the past few years. On newer buildings, the supports will be free of rust and the "loosening" effect of previous storms. Newer ones are also more likely to have been built to a higher standard with more and heavier structural supports to withstand higher winds. (A marina owner should know how much wind a steel building was designed to withstand.) If not, or if there is any doubt about the structure's ability to stand up to an approaching storm, boats on storage racks should be placed on trailers and taken elsewhere. 


AXIOM: Never Stay Aboard in a Hurricane!

One of the most dangerous mistakes a skipper can make is to stay aboard his or her boat during a hurricane. Several accounts given in claim files indicate that there is little, if anything, a skipper can do to save a boat when winds are blowing over 100 mph, tides are surging, and visibility is only a few feet.

What can happen? Consider the case of a 68-year-old skipper in Charleston, who together with his grown nephew, took their trawler up the Wando River to ride out Hurricane Hugo in what they thought would be a "sheltered" hurricane hole. He reported that the boat seemed to be doing fairly well initially, but later that night the wind picked up to over 100 mph and 15' seas sent the boat crashing completely over.

The two men were trapped briefly in a pocket of air underwater when another wave rolled the boat back upright. They then scrambled onto the deck and were eventually rescued, but not before almost drowning and being overcome by exposure.

Another skipper who stayed aboard his motorsailer at a marina during Gloria had to jump overboard and swim through breaking waves, drifting boats, and debris after another boat broke free and rammed its mast (the boat was on its beam ends) through his boat's pilothouse window. Again, he was lucky to reach shore alive. Two Miami men who stayed aboard a Sportfisherman (not insured by BoatU.S.) during Andrew were not so lucky. They both drowned while trying to escape their battered and sinking boat.

When a hurricane is approaching, you should certainly do everything you can to protect your boat: Secure extra lines, set out anchors, add chafe protection, strip the boat above and below decks, etc. Do whatever it takes, and then head inland. Your boat can be replaced; you can't. 



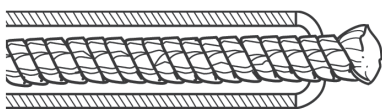
Critical Points

Chafe Gear!

Nylon stretches and absorbs shock, which is good, but this stretching under tremendous loads also works the line against chocks and other contact points. Chafe protectors are essential on all lines: at a dock, at a mooring, or at anchor. At a dock, lines are liable to abrade against chocks, pilings and the dock itself. If your chocks are large enough, fit a second, larger-diameter hose around another hose that fits snugly to the line. Drill holes in both hoses, and use cord to tie them securely to the line. In a pinch, you can use a single hose.

On moorings or at anchor, the line stretched over the edge of the rail can create sufficient heat to melt the line internally. Using hose to protect the line can encourage heat related failure by not allowing water to cool the nylon fibers. One solution is to mount the cleats directly at the rail so that the line won't be worked against a chock. Another is to use polyester (Dacron) line, which has much less stretch, but is far more chafe resistant than nylon. By using a polyester line from the cleat through the chock and then joining it with a nylon line (use two eyes) to the piling or mooring, you can get the best of both types of line—the chafe resistance of polyester and the stretch of nylon. An alternative is to use polyester sleeves, which are available at chandleries and will protect the nylon lines from chafe while also allowing water to reach the heated fibers.

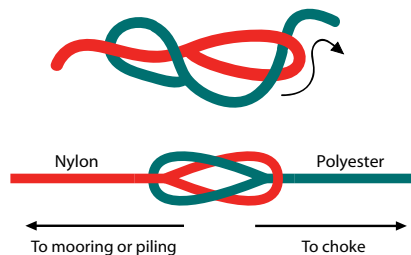
If you need chafe protection quickly, use duct tape (a lot) to secure several layers of heavy canvas to the lines. It isn't pretty, but works surprisingly well.



Super system to prevent chafe at docks: use neoprene garden hose at all potential chafe points. Drill holes and use cord to secure it to the line.

Cleats at Docks to Prevent Chocks

Many boats have cleats and chocks that are woefully inadequate. This problem becomes critical when more and larger-diameter storm lines are used during a storm. If necessary, add more and larger cleats and chocks now; they'll make securing the boat



Using a polyester line from the cleat through the chock, secured to an existing nylon line to the piling or mooring, gives you better protection from chafe, while also absorbing shock. Use eye splices in both lines with at least five tucks.

easier all year.

Assess the ability of cleats to carry heavy loads. This means making sure all are backed properly with stainless steel or aluminum plates. Marine plywood is OK if it's healthy—free of rot and delamination. On sailboats, winches (if backed properly) and even keel-stepped masts can also be used to secure lines at a dock. (NOTE: Anchor lines should NOT be secured to the mast, as it creates that much more stretch on the line at the chock, which further increases the chances of chafe failure.)

Don't put too many eggs in one basket by leading numerous lines to a single cleat, even if it is backed properly. Two lines per cleat is the maximum. Also, a cleat is not reliable when lines are led perpendicular to the base and the cleat can be wrenched out by the tremendous loads (see diagram).

Reduce Windage!

Strip all loose gear that creates windage: canvas covers, bimini tops, outriggers, antennas, anchors, running rigging, booms, life rings, dinghies, portable davits, etc. Anything on deck that can't be taken off should be lashed securely.

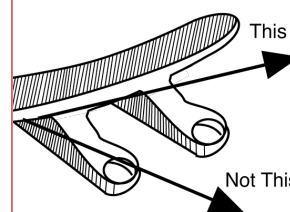
Unstepping masts on sailboats is strongly advised. If this is impractical, sails—particularly roller furling headsails—must be removed. Roller furling headsails create a lot of windage, especially when they come unfurled, which is almost guaranteed to happen no matter how carefully they're secured. All halyards should be run to the masthead and secured with a single line led to the rail. This reduces windage and minimizes flogging damage to the mast. The line can be used to retrieve the halyards.

Fenders and Fender Boards

Fenders and fender boards won't compensate for a poor docking arrangement

in a hurricane. However, when the boat has been well secured, they may offer some additional protection. When asked about fender boards, CAT Team members said they were effective at preventing "dock rash" but only if heavy boards were used with several large fenders. Using only two fenders at either end of a long board wasn't effective; the fenders were either bounced out or the boards broke in the middle.

One example of a system that worked: A member in Punta Gorda said he used several 12" x 32" fenders and a 2" x 10" x 16' fender board at his dock to keep his 50' Sea Ray from banging against a piling during Hurricane Charley. The member credits the fender board for helping to minimize damage to his boat.



Lines led perpendicular from a cleat can wrench the cleat out of the deck. Two-hole cleats are more vulnerable than four-hole cleats.

Preventing Theft

Electronics and other valuable gear should be taken home for safekeeping. Not only are electronics vulnerable when vandals comb through boatyards after the storm, they can also be wrecked by all of the water. Personal belongings and other loose gear (potential missiles) should be taken home and the cabinets and cabin doors secured. All ship's documents should be taken off the boat.

Preventing Water Damage

Remove cowl ventilators and seal the openings. Use duct tape to cover instrument gauges. Duct tape should also be used around hatches, ports, lockers, etc. to prevent water damage below. (Some types of duct tape leave less gummy residue than others.) Close all but the cockpit drain seacocks and shove a plug into the engine's exhaust ports. If the boat does take on water, it will sit lower, and water could back up into the engine. (Remember to remove the plug before starting the engine when the storm has passed.)

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BOAT OWNER'S HURRICANE WORKSHEET

Use this worksheet, after reading the material in this guide, to adapt it to your own circumstances. Then be sure to distribute copies to your alternates as well as your marina owner/manager.

Boat's Name: _____

Length: _____ Model: _____

Your Name: _____

Address: _____

City: _____ State: _____ Zip: _____

Phone Day: _____ Night: _____

Alternates/Caretakers (if you are not available):

Name: _____

Address: _____

City: _____ State: _____ Zip: _____

Phone Day: _____ Night: _____

Has Boat Keys? _____ Access to Hurricane Equipment? _____

Name: _____

Address: _____

City: _____ State: _____ Zip: _____

Phone Day: _____ Night: _____

Has Boat Keys? _____ Access to Hurricane Equipment? _____

Boat's Current Location: Slip #: _____

Marina Name/Address: _____

List All Equipment Needed Aboard to Prepare Boat:

<i>Equipment</i>	<i>Current Location</i>
1. Extra Lines	_____
2. Chafe Protectors	_____
3. Fenders	_____
4. Anchors	_____
5. Swivels	_____
6. Shackles	_____
7. Duct Tape	_____
8. Plugs (Exhaust Ports)	_____
9. : _____	_____
10. : _____	_____

List Equipment To Be Stripped from Boat:

<i>Equipment</i>	<i>Storage Location</i>
1. Electronics	_____
2. Dinghy	_____
3. Outboard/Fuel	_____
4. Sails	_____
5. Bimini	_____
6. Galley Fuel	_____
7. Ship's Papers	_____
8. Personal Effects	_____
9. _____	_____
10. _____	_____

Planned Location During Hurricane: _____

If at a Dock: Slip #: _____

Marina Name/Address: _____

Additional Lines #: _____ Length: _____ Size: _____

Chafe Gear: _____ Fenders: _____

If at a Hurricane Hole:

Travel Time by Water from Present Location: _____

Are There Any Bridges? _____

If Yes, Will They Open Prior to Hurricane? _____

Has Owner of Surrounding Land Been Contacted? _____

How Will the Skipper Get Ashore? _____

Type of Bottom: _____ Depth: _____

Additional Anchor Needed: #: _____ Size(s): _____

Type(s): _____

Additional Lines: #: _____ Length: _____ Size: _____

Additional Chain: #: _____ Length: _____ Size: _____

Chafe Gear: _____ Swivel: _____ Shackle(s): _____

If at a Mooring/Anchorage:

Has Mooring Been Inspected Within the Last Six Months? _____

How Will the Skipper Get Ashore? _____

Type of Bottom: _____ Depth: _____

Mooring Line Should Be Extended _____ to Increase Scope

Additional Anchors Needed: #: _____ Size: _____

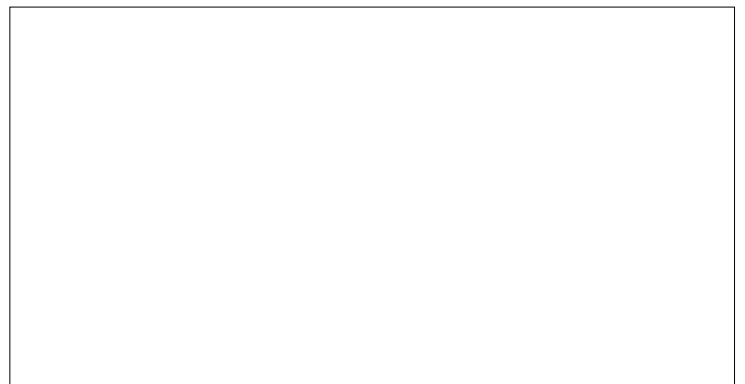
Type(s): _____

Additional Lines: #: _____ Length: _____ Size: _____

Additional Chain: #: _____ Length: _____ Size: _____

Chafe Gear: _____ Swivel: _____ Shackle(s): _____

Diagram of Proposed Hurricane Docking/Mooring Arrangement:



If Stored Ashore:

Windage Reduced by Stripping Sails, Furling Gear, Bimini, Antennas? _____

Blocking Adequate for Storm Conditions? _____

What Arrangements Have Been Made for Hauling? _____

Storage Location: _____

Contact Name (Marina/Property Owner): _____

Phone #: _____

Learning from Experience

A Guide for Preparing Marinas for Hurricanes

Philip Hale says he sometimes stands in his boatyard and imagines it under four or five feet of water. Philip looks at all of the yard's valuable equipment and he looks at the boats. What could be done to secure all of those boats?

It's a scene that isn't difficult for Hale to imagine. His marina, Martha's Vineyard Shipyard, has been pounded on at least two occasions, by Hurricane Bob in 1991 and then by the big "No-Name" storm that swept up the coast in early 1992. Other marina owners in areas like Louisiana, Mississippi and Florida, who were hit hard by Katrina and Wilma, are plagued by the same sorts of questions. Hurricanes do that to people. What if it happens again?

Experience ... the Teacher that Gives You the Test First and the Lesson Afterward

One mistake that any responsible marina owner would never make twice is to wait until a hurricane warning is posted to think about hurricane preparations. An extraordinary amount of work has to be done in a short time, perhaps only a few hours, and important decisions have to be made months in advance. Where will boats be stored? If boats are going to be stored ashore, which boats will be pulled first? What arrangements have been made with the owners?

Any hurricane plan ultimately involves people, and one of the first things Hale did after Hurricane Bob was to put together a list of emergency employees, including many former employees and some local boat owners who are familiar with the boats and boatyard. This emergency staff is organized into teams, each having a specific assignment and leader, who can be called upon to join the regular staff whenever a large storm is approaching.

Most marinas don't have the personnel available to attend to all of the boats, and they depend on boat owners to strip their boats and add extra lines and chafe protection. James Frye, who runs a group of Westrec marinas in Florida, says that in addition to evaluating their own procedures, one of the biggest parts of their new hurricane plan is getting the name of a local alternate for each boat owner who will take care of hurricane preparations if



the owner is out of town. There isn't enough time before a storm, Frye says, for marina personnel to take care of all of the boats and still have time left for their homes and families.

Time is critical. At Martha's Vineyard Ship-yard, preparations start at the beginning of the boating season by requiring that all boats in the harbor use extra pennants and chafe gear. At other yards, like Burr Brothers in Marion, Massachusetts, a second, extra-heavy pennant is added to boats in the beginning of August, when the hurricane season gets started in earnest. Although boats would still have to be stripped, sails stowed, ports taped, etc., adding extra lines and chafe gear gives marinas and boat owners a valuable head start before a storm.

In the likely event that at least some owners won't be available to prepare their boats, many marinas will haul and/or prepare boats for a fee, but this should be arranged at the start of the season, not in the waning hours before a storm is due ashore. One marina in a particularly exposed Florida location has arranged to have several paid captains available to move boats to a more secure marina further inland. In this case, the agreement was written into the hurricane contract, but extra services usually require a separate agreement.

Hauling Boats

A study by MIT found that boats stored ashore were far less likely to have been wrecked than boats stored in the water, and for many marinas, hauling boats is the foundation of their hurricane plan. Toby Burr at Burr Brothers has a list of boat owners who have agreed to have their boats

hailed by the marina whenever a hurricane threatens. The decision to haul boats is left to the marina, and Burr says it puts an extra burden on them to decide at what point a storm might pose a threat. The responsibility is more than offset, however, by the additional time it gives them to evacuate boats.

While almost all of the boats hauled by Burr Brothers for Hurricane Gloria escaped with relatively little damage, boats that were stored ashore during Hurricane Bob were not so fortunate. Unlike Gloria, which came ashore at low tide, Bob came ashore at high tide and many of the boats stored in the yard got knocked off their cradles by the surge. To prevent a recurrence of the damage done by the rising water, Burr Brothers has arranged to receive NOAA charts that predict when and where the surge is likely to be highest. If the surge predicted poses a threat to boats stored ashore, Burr Brothers has a contingency plan to unstep masts so that boats can be moved further inland to higher ground.

Ashley Marina in South Carolina doesn't have the facilities to haul boats, and even if it did, Ed Rhodes at Ashley says the grounds are too close to sea level to offer even minimal protection from tidal surge. Rhodes recommends boat owners take boats to nearby Ross Marina, which has a travel lift and a storage area that is a much safer 15' above sea level. David Browder at Ross acknowledges that many of his regular customers have already made arrangements to have their boats hauled and stored at his yard whenever a storm threatens.


Moving Boats

When it became likely that Katrina would come ashore in Alabama, Sonny

Middleton, the owner of Dog River Marina in Mobile, Alabama, began giving employees assignment from a list that he had prepared months before. Dog River is a good size facility, with 40 employees and 100 slips. Like many marinas in the sunny south, a large percentage of the boats at Dog River are owned by people who live out of state. At most marinas, these boats are typically ignored before a hurricane; canvas isn't removed, extra lines and chafe protection aren't added. The result, not surprisingly, is that they are far more likely to break free and damage other boats. At some marinas, the solution has been to make arrangements with absentee owners to haul their boats and block them ashore. Boats are safer stored on shore if they will be safely beyond the surge. That's not the case at Dog River, however, which sits in a low-lying

area that's only a foot or two above normal high tide.

Before the start of the hurricane season, Sonny makes arrangements to have professional captains available to take the marina's larger boats further inland to hurricane holes up the Tenn-Tom Waterway. One of the marina's workboats is used to ferry the captains back and forth to the marina. This exodus of boats upriver results in many empty slips at Dog River, which allows the remaining boats, typically the smaller boats, to be moved into wider slips. This keeps them further away from pilings and the use of longer lines means that the boats can rise more readily with the surge. The system has been used successfully at Dog River several other times in past hurricanes. Most recently, the technique was used prior to Hurricane Katrina in 2005 when almost 60

boats were moved upriver and secured using multiple anchors and lines to shore. Some of the boats were moved by the professional captains and others by their owners. Katrina's winds at Dog River topped out at 80 mph, a far cry from the 145 mph winds that devastated much of Mississippi and Louisiana. Katrina's surge, however, was a different story. Even after the hurricane was well inland, water continued to pile into the River, finally topping out at 15'. The worst damage was to the boats in Dog River's covered shed. Some of the larger sportfishermen that remained in the shed were lifted up to the rafters by the surge. In all, four of the boats at the marina were completely destroyed. Sonny said in his 50 years these were the first boats he'd lost in a hurricane. All of the boats that were moved, however, were undamaged. 

After The Storm

Some Guidelines to Help Get You Back on the Water Sooner

After a storm has passed and authorities are allowing travel, get to your boat quickly. It is a boat owner's responsibility to protect the boat from further damage, and its equipment from theft, regardless of its condition. If there is severe damage at the marina, you will be needed to help arrange moving the boat. An important task is calling your insurance company. They need to know the exact location and condition of the boat, and will assist you in what steps to take. The BoatU.S. Emergency Dispatch phones are manned 24 hours a day, and will be heavily staffed after a storm to assist BoatU.S. insureds.

Don't take chances. A marina can be a hostile environment after a storm. Leave children and sightseers at home. Be cautious of exposed electrical lines, leaking fuel, sewage backups, missing dock boards, and other dangers. And don't mind if you are challenged to show proof of ownership or asked to keep out of damaged areas. Marina management and authorities should restrict access to damaged and undamaged boats.

Some things to take to the boat include duct tape to secure broken rigging or railings and seal cracks or holes; pencil and paper to inventory damage; and lots of cleaning gear and anti-corrosion spray. Removing salt, mud, and moisture should begin as soon as it can be done safely. Take trash bags to

remove leaking cans and debris that could clog bilges and pumps. Don't forget bug spray, boots, and gloves.

If the boat appears undamaged or has only minor scrapes, inspect for chafed lines and broken ports or hatches where rain can enter. Monitor water level in the bilge in the event there is underwater damage. Make sure the galley and main engine fuel systems are undamaged and the bilge pump is working. Report damage to the insurance company.


If the boat is sunk, beached, or otherwise in need of salvage, contact your insurance representative on how to proceed. While you have the right to salvage your boat, contracting with salvors can be tricky business and is best left to insurance professionals. Inexperienced, poorly equipped, or overpriced crews can cause delays and additional damage that may keep you ashore longer than necessary. If the marina wants to act as a contractor, it should have your permission and the agreement of your insurance company before moving or salvaging your boat.

Boat owners insured with BoatU.S. should call the 24-hour Emergency Dispatch Center, 1-800-937-1937, before contracting for salvage or removal work. If communications are impaired, look for BoatU.S. Catastrophe Team field people who will be in the area immediately after a major hurricane.

Whoever raises a sunken boat should begin cleaning the boat and "pickling" and preserving the engine and machinery



immediately. Flush everything with fresh water, remove cushions and clothing to dry, and dry out the interior. Your yacht policy should cover the reasonable cost of any steps you take to reduce further damage.

Your policy should also reimburse any costs incurred for security you may hire if the boat is exposed. After past storms, boats thrown onto beaches or parking lots fell victim to looters. In one sad case, a classic yawl cast onto a New England beach by a storm was dismembered by souvenir hunters with chain saws. After Wilma, boats stranded in marshes were stripped clean before salvors could reach them. After Andrew, someone painted a claim on a large yacht, mistakenly thinking that an "abandoned" boat was up for grabs. Police will be occupied with higher priorities and it is up to you to protect your damaged boat and its equipment. 

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