Hawai'i Boater's Hurricane and Tsunami Safety Manual

Department of Land and Natural Resources
State of Hawai'i

Sea Grant
University of Hawai'i

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On the cover (left-right): Storm waves, O'ahu's north shore, photo courtesy of Dolan Eversole; Sailboat on the Breakwater at Magic Island, O'ahu, photo courtesy of U.S. Coast Guard; March 2011 tsunami debris, photo courtesy of Hawai'i State Civil Defense.

Table of Contents

Public Advisory contains a list of watches and warnings and provides information on the cyclone position in terms of latitude and longitude coordinates, the distance from a selected land point or island, as well as the current motion. The Public Advisory includes the maximum sustained winds and the estimated, or measured, minimum pressure. The Tropical Cyclone Forecast/Advisory contains similar information as the Public Advisory but also includes the cyclone's position, intensity, and estimated wind fields for 12, 24, 36, 48, and 72 hours from the current time. Boaters should actively monitor advisories so that they can adequately prepare well in advance of a hurricane watch or warning.

Tropical Depression
A storm with distinct rotary circulation at the surface of the ocean with sustained winds of 38 mph (33 knots) or less.

Tropical Disturbance
A moving body of thunderstorms that maintains its identity for 24 hours or more.

Tropical Storm
A storm with distinct rotary circulation at the surface of the ocean with sustained winds of 39 to 73 mph (34 to 63 knots).

Tropical Weather Outlook
During hurricane season, the National Weather Service issues a Tropical Weather Outlook four times daily, with the outlook assessing the genesis potential of tropical disturbances over the next 48 hours.

Tsunami
A series of ocean waves that are set in motion by great disturbances in the earth's crust. These disturbances are normally earthquakes or natural events associated with earthquakes, such as volcanic eruptions and explosions that vertically displace the water column in the ocean.

Tsunami Advisory
A tsunami is expected, but will not be large enough to cause significant land flooding. Evacuation of the coast is not necessary, but the beach and coastal waters may be hazardous because of unusual waves and strong currents. Sirens will not sound, but

beaches will be closed. The advisory will be continued until wave action falls below danger levels, which may take several hours.

Tsunami Warning
A damaging tsunami is expected and people should evacuate from the tsunami zones. When a warning is issued, sirens will sound and the warning will be broadcast by local media. Normally a warning is issued at least three hours before the tsunami arrives; the time the tsunami is to arrive is part of the warning and will be repeated by the media. The warning continues until wave heights have dropped below hazard levels, which may be more than 12 hours. After a damaging tsunami, the warning will be downgraded to an advisory as the threat decays, but the advisory may remain in effect six hours or more before being cancelled. See also, Urgent Local Tsunami Warning.

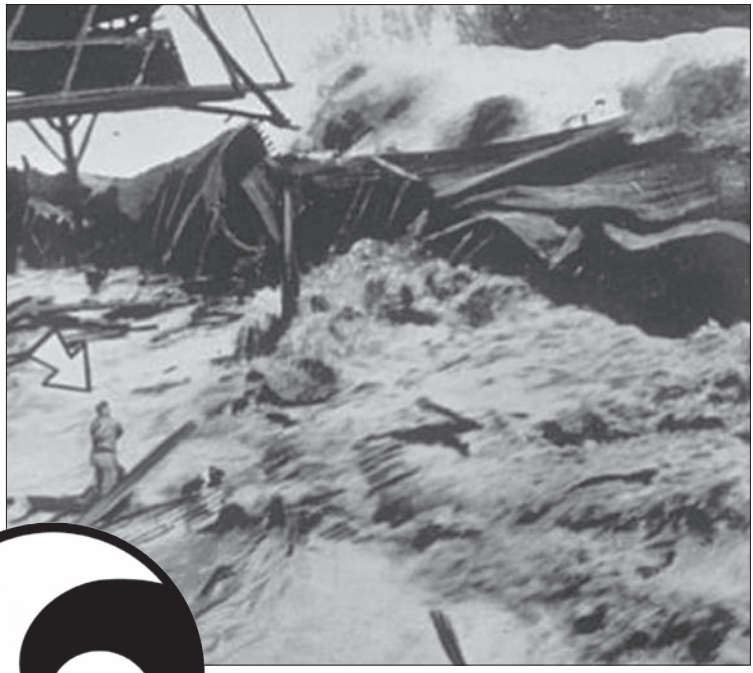
Tsunami Watch
Issued if there is the potential for a damaging tsunami but the existence of a tsunami has not yet been confirmed. A Tsunami Watch will always be upgraded to a Tsunami Warning or a Tsunami Advisory or will be cancelled. If it is upgraded to a warning or advisory, that upgrade will occur with a target of at least three hours before the tsunami arrives. If you learn that a Tsunami Watch has been issued, tune to local television or radio for further information and prepare to evacuate in case the watch is upgraded to a warning.

Urgent Local Tsunami Warning
Issued when there has been a major earthquake in the Hawaiian Islands and a damaging tsunami is likely within minutes to tens of minutes. If you feel ground shaking which is so severe that you have difficulty standing, take the shaking as a natural tsunami warning and move inland immediately; do not wait for the sirens to sound. If you feel shaking, even if it is not very severe, and the sirens sound within a minute or two, immediately leave the coastal area, preferably on foot. Tune to local television or radio once you are out of the evacuation zone. If you are on the water at dock, the compressional shock waves in the water from an earthquake will feel as if the hull has been hit or the boat has run aground. Evacuate the marina immediately. If you are on the water at sea, and an earthquake is felt, head to deeper water (over 300 feet).

Water spout
A tornado occurring over water.

Part 2

Tsunami Information



April 1, 1946 – Hilo, Hawai'i. A magnitude 8.6 earthquake near the Aleutian Islands of Alaska generated a large tsunami causing death and destruction on all the Hawaiian Islands. In this photo, the tsunami wave breaks over Pier No. 1 in Hilo Harbor. The arrow points to a man as one of the 159 identified fatalities in Hawai'i. The photo was shot from a ship that later managed to escape to open sea. Photo courtesy of NOAA/NGDC and the Pacific Tsunami Museum.

General Tsunami Information

A tsunami is a series of ocean waves set in motion by a rapid change in the shape of the ocean bottom over a large area. By far the most common reason for this change is an earthquake, though landslides, volcanic activity, and meteorite impacts can also cause tsunamis.

Tsunamis are sometimes incorrectly called "tidal waves," because the surge and withdrawal may resemble rapidly rising or falling tides. Tsunami waves may come ashore as a "bore," a vertical wall of water, superficially resembling the tidal bores observed in regions with very large tides, such as the Bay of Fundy, the Amazon River and the Turnagain Arm (Cook Inlet, Alaska). Tsunamis have nothing to do with tides, however, and they differ from true tidal waves in three very important respects. First, unlike tidal waves, which can be forecast months in advance, tsunamis occur at random, unpredictable times. Second, a tsunami is a succession of waves rather than a single wave. The false expectation that a tsunami is over after the first wave has resulted in considerable loss of life, even in Hawai'i. Third, tsunami waves proceed as ordinary gravity waves with a typical period of five to 60 minutes, while the period of tides is 12 hours. Consequently, the time of the flooding is drastically different.

There is no tsunami season. A tsunami is an unpredictable event that can happen at any time. Most tsunamis that strike the Hawaiian Islands are generated in the oceanic trenches around the border of the Pacific Ocean. The unstable areas are the Pacific Coast of Japan, the Kuril-Kamchatka Island chain, the Aleutian Island Arc, and the Pacific Coasts of Central America and South America.

It is important to note that a tsunami can be dangerous for several hours and the first wave is often not the largest of the series.

A tsunami has great destructive potential and is capable of quickly inundating (or flooding) areas thousands of feet inland past the normal high tide level. Their fast-moving waters can crush cars, homes, buildings, boats, and anything else in their path. They also have great erosional potential, stripping beaches of sand and undermining trees and other coastal vegetation.

In Hawai‘i, tsunamis have caused death and destruction on all the major islands. The town of Hilo has been hardest hit in historic times with destruction to major parts of the city in both 1946 and again in 1960. Both of these tsunamis were generated by earthquakes along the Pacific Rim: the 1946 tsunami from the Aleutian Trench that impacted mainly the northeast shores of our islands, and the 1960 tsunami from the Peru-Chile Trench that impacted mainly the southeast shores of our state. The 1946 event resulted in 159 deaths, with casualties on every major island.

Tsunami waves generated by the 2011 Tohoku magnitude 9.0 earthquake, caused significant damage to Hawai‘i’s recreational boat harbors with the loss of dozens of vessels and damage to countless more. A tsunami in Hawai‘i can also be generated by a nearby as well as a distant earthquake. This is especially true on Hawai‘i Island where earthquakes occur in association with the volcanic activity at Kīlauea and Mauna Loa. Any violent earthquake–one that causes you to fall to the ground or to hold onto something to keep from falling–should be considered a natural tsunami warning. If in a low-lying area, you should move immediately to higher ground or evacuate vertically to the third floor or higher of a reinforced concrete building that is at least six stories in height.

In 1975, two campers at Halapē campground, a coastal area in Hawai‘i Volcanoes National Park, were killed by a tsunami generated by a magnitude 7.7 earthquake immediately offshore. The earthquake shook the campsite severely and gave the campers only a few minutes to evacuate before the tsunami came on shore, rising to 26 feet above sea level. Farther south, the tsunami damaged the coastal villages of Punalu‘u and Honu‘apo, though, fortunately, no lives were lost. The 1975 event was a repeat of a similar earthquake and tsunami which hit the same coast in 1868.

In general, all coastal areas of the Hawaiian Islands are vulnerable to inundation by a tsunami.

> “As tsunami waves approach islands, they encounter shallower depths which cause the waves to bend or refract. The bending (refraction) means that tsunami waves may wrap completely around an island causing inundation even on the side of the island farthest from the area of tsunami generation. Tsunami wave refraction may result in smaller waves in some areas and larger waves in other areas. Tsunami waves may also be reflected off coastal

areas with steeply sloping shorelines. These reflected waves may combine with incoming, refracted, or other reflected waves to produce large wave run-up in unexpected places. No matter where a tsunami is generated, all sides of our islands are at risk." - The Pacific Tsunami Museum

Tsunami waves can be amplified where a bay, harbor, or lagoon funnels the wave as it moves inland.

Please refer to the Disaster Preparedness Guide in front of the telephone book for maps of the coastal evacuation zones (Maps are also available online at: http://www.csc.noaa.gov/psc/riskmgmt/tsunami.html and http://www.scd.hawaii.gov/). Determine whether you live, work, play, transit, or go to school in an evacuation zone and develop a Tsunami Evacuation Plan for you, your family, and your boat.

Tsunami Warnings

Distant Earthquakes

In the event of a significant earthquake in a distant area of the Pacific Basin, the Pacific Tsunami Warning Center (PTWC) on O'ahu will issue a Tsunami Watch until a tsunami can be confirmed or discounted. PTWC will issue a Tsunami Warning when a tsunami is confirmed and evacuation is necessary. The warning will be announced over the radio and on television through the Emergency Alert System, in conjunction with the sounding of the Outdoor Siren Warning System. The warning will include the predicted time of arrival of the first wave. The Outdoor Siren Warning System will be sounded at 3, 2, 1, and 1/2 hour prior to the estimated arrival time of the first wave.

For land activities only, it may be safe to return to the evacuation zone after a Tsunami Warning is cancelled **and** local officials indicate it is safe to return. This may vary from area to area depending if there is damage. For activities in the water (e.g., wading, swimming, or boating), it is not safe to go in the water or return to a harbor until the Tsunami Advisory is cancelled **and** the harbor has been cleared by local authorities. Boaters should monitor VHF Radio Channel 16.

Local Earthquakes

If a significant earthquake occurs in the vicinity of the Hawaiian Islands, PTWC

will issue an **Urgent Local Tsunami Warning**. The warning will be announced over the radio and on television through the Emergency Alert System, in conjunction with the sounding of the Outdoor Siren Warning System. **If the Urgent Local Tsunami Warning identifies the island you are on as subject to impact, leave any evacuation zone immediately**.

As stated previously, in the event of a local earthquake that causes you to fall to the ground or to hold onto something to keep from falling, **if you are in an evacuation zone,** move immediately to higher ground when the shaking stops. There may be no time for an official warning from PTWC, the Emergency Alert System, or the Outdoor Siren Warning System. **You must act on your own and self evacuate**.

Tsunami Emergency Plan for Boat Owners

The need to evacuate may occur suddenly and at any time. Therefore, all boaters should prepare in advance, maintain a high state of readiness and develop a Tsunami Emergency Plan that covers evacuation scenarios for distant and local earthquakes that generate tsunamis.

Boat and Owner Preparedness

1. Have your local U.S. Coast Guard Auxiliary conduct a free vessel safety check to ensure your boat is in full compliance with all federal and state boating laws for that year. To find a local examiner, visit the U.S. Coast Guard Auxiliary online at http://www.cgaux.org/vsc/. If these safety checks are being offered at a harbor near you, take advantage of the opportunity. It may save a life.

2. Check your emergency gear each and every time you go out on the water. Perform maintenance, make repairs, and replace out-of-date or worn equipment as needed. Check and replace rubber parts and hoses that are brittle or cracked. Make sure you have spare fuel filters aboard.

3. The powder in dry chemical fire extinguishers can pack down into a solid mass over time. This greatly reduces its effectiveness during actual use. Before you launch, unpack and loosen the powder by inverting the extinguisher and giving it a few taps with a rubber mallet at the base.

4. Regular maintenance of your boat and support equipment are vital for any tsunami emergency situation. If your vessel is moored in a state of Hawai‘i recreational boating facility, it is required to leave the confines of the harbor every 90 days to demonstrate its seaworthiness. It should be able to move offshore to the recommended minimum depth of 300 feet.

5. Any towing vehicle or trailer should be in good condition. This can be checked every year during registration, when an annual inspection is required.

6. Vessels should always have enough non-perishable food and drinking water on board so that a trip to the grocery store is not needed when a watch or warning is called.

7. Fuel supplies should be sufficient to keep a boat out of the harbor for 24 hours, if that is part of your Tsunami Emergency Plan.

8. All vessel owners should insure their vessels and make sure their policies cover **salvage costs for grounded and sunken vessels, damage to docks, pollution containment, and wreck removal**.

9. If you do not know about the issuance of emergency notifications, you could lose precious preparation time. You should pay heed to the monthly testing of the State Outdoor Siren Warning System near your workplace, near your home, and other locations that you frequent. Report outages so the system can be properly maintained. Consider adopting a siren at http://sirens.honolulu.gov and you, too, can contribute to keeping this system working properly. For those not on O‘ahu, check your local Civil Defense Agency for such a program.

10. Receive emergency alerts, such as text messages to mobile devices for anyone that signs up for the free service. You can receive warnings issued for tsunamis, earthquakes and severe weather events. O‘ahu uses a system called Nixle, Kaua‘i uses Blackboard Connect CTY, Hawai‘i Island uses

City Watch, and Maui uses Alert Center. See the Resources section of this book for more information on these services.

These practices can keep you and your vessel at a high state of readiness and allow you to successfully implement your Tsunami Emergency Plan.

Evacuation Planning for a Tsunami Emergency

If your vessel is in an evacuation zone you will have three options: move it inland, move it offshore, or leave it in place. The decision to leave a safe place to go to your boat should depend on your equipment, your state of readiness, and adequate warning. Whatever option you choose requires a realistic assessment of the situation. Moreover, have a plan when you are off island or traveling out of state.

If, in your assessment, you, your vessel, and trailer are at a high state of readiness, and you have more than adequate time based on estimated wave arrival time, then you can move the boat inland. However, traffic on the roads, weather conditions and other unforeseen factors can change everything and rob you of precious time. Reassess your situation periodically. If you think that you will have just enough time to move inland or out to sea, you are probably not expecting the unexpected. Be realistic and know when it's time to evacuate, with or without your vessel.

A Tsunami Emergency Plan may include any of the following steps that are applicable to the vessel, the vessel owner, their situation and other considerations:

1. **If your boat is on a trailer in an evacuation zone, move it outside the evacuation zone as soon as a Tsunami Warning is issued.** Don't rush, but try to get off the roadways as soon as you can. Only implement this option if your towing vehicle and trailer are in good condition and there is no risk that there could be a breakdown on the road, worsening traffic.

2. **If your boat is in the water and cannot be trailered, prepare to put to sea as soon as a Tsunami Watch is issued.**

    a. Consider having someone drive you to the harbor. If you drive yourself and leave your vehicle in the harbor parking lot, it may sustain damage

from the tsunami while you are offshore in your boat. Even worse, it may impede vehicle traffic or prevent emergency personnel from conducting their assigned duties.

b. **Move your vessel offshore to waters greater than 300 feet in depth and more than two miles from the channel entrance as soon as a distant Tsunami Warning or Tsunami Advisory is declared**. It is important to note that even if the event is not elevated to a Tsunami Warning, a Tsunami Advisory is still associated with strong currents or waves dangerous to those in or very near the water and that the threat may continue for several hours. The decision to move your vessel out of the harbor under a Tsunami Advisory should be part of your Tsunami Emergency Plan.

c. Maintain the minimum water depth of 300+ feet just prior to and during the expected arrival time of the tsunami. Keep a distance of at least two miles from the channel entrance. You should plan to have enough fuel, food, water, and anything else you consider essential for at least 24 hours. Be sure to turn on your navigation lights at night and in times of limited visibility.

d. **Stay clear of the harbor entrance channel during a tsunami event.** Tsunamis can cause rapid changes in water level and unpredictable and dangerous currents in harbors and entrance channels, in addition to destruction from waves.

e. If your vessel is unable to navigate to a safe depth in advance of the arrival time, do not attempt to move your boat offshore or you may be caught in the tsunami or the dangerous currents associated with it. Do not move your boat offshore if your vessel is not seaworthy (e.g., risk that engine may quit in the entrance channel preventing other vessels from transiting the waterway).

3. If your boat is in an evacuation zone and cannot be moved inland or offshore, determine ahead of time what you want to remove and how you will secure the boat. As soon as a Tsunami Advisory or Tsunami Warning is declared, remove predesignated items, secure the boat, and leave the evacuation zone. Don’t rush, but get off the roadways as soon as you can.

4. All shores of all Hawaiian Islands are subject to seasonal high surf, some of which directly impact boat channels and harbor entrances. **If a Tsunami Warning occurs during a period of seasonal high surf, especially at night, and your Tsunami Emergency Plan calls for moving your boat offshore, you should give serious consideration to leaving it where it is** and just removing whatever you can, securing your boat, and leaving the evacuation zone.

5. Upon initiation of an evacuation, public safety officials will establish roadblocks to control traffic coming into the coastal evacuation zone. When wave arrival is imminent, no one will be allowed back into the evacuation zone for their own safety. Therefore, if you intend to take some kind of emergency action for your boat, you should complete it and be out at sea or out of the evacuation zone at least one hour prior to the expected arrival of the first wave.

6. Anticipate heavy traffic island-wide when a Tsunami Warning is issued. Again, allow ample travel time to reach your boat before the evacuation zones are closed to non-emergency traffic.

7. If, for any reason, you are unable to tend to your boat during a tsunami event, designate someone else to carry out your Tsunami Emergency Plan.

    a. **If your vessel is moored in a state recreational boating facility and you are out of the state, off island, or otherwise unable to immediately respond to an emergency related to your vessel for any length of time, you are required to have a caretaker serve in this capacity.**
    b. Harbor managing agents must have your contact information and/or your caretaker's most current contact information so one of you can be reached at any time. Many times, vessels have been saved from sinking in their slips with a phone call.
    c. Your designated caretaker should be very familiar with your boat and its seaworthiness. If your caretaker is expected to take your vessel to sea, he/she should be very capable of piloting your vessel. If not, your designated caretaker should be prepared to identify the items

on your predesignated list of equipment, remove them and evacuate. **Do not** put your caretaker in harm's way to move your vessel if the condition of your vessel, trailer, etc., is questionable. **Do not** put your caretaker at risk if there isn't adequate time to travel to your harbor to remove items or secure your mooring. Equipment can be replaced. Lives cannot.

In 1964 in Kodiak, Alaska, a warning was received prior to the arrival of the first tsunami waves. People who rushed down to the harbor to secure or take their boats out to sea constituted two thirds of all the fatalities caused by the tsunami at Kodiak City.

Boats at Sea During a Tsunami

1. Tsunami wave activity is imperceptible in the open ocean, so normally that would be the safest place for most boats. Remember, however, that out on the water you are at the mercy of the weather, seasonal ocean conditions, and possible rough seas. You could run out of fuel and anchoring at the minimum safe depth (300 feet of water) could be problematic. This must be taken into consideration before moving your boat offshore.

2. Most large harbors and ports are under the control of a harbor authority and a vessel traffic system. If the harbor authority orders a forced evacuation of vessels to deeper water, you will need to be aware of the marine traffic, especially if it will impact you and your boat.

3. If a tsunami does strike, your cellular phone may not work if power on shore is knocked out. Multiple methods of communication are preferable. With a marine VHF-FM radio, you can call for help if you are adrift. **If you go more than one mile from shore your vessel must be equipped with a VHF radio or an Emergency Position Indicating Radio Beacon (EPIRB) according to state law**. If you only have an EPIRB and you are in distress, it is possible no one will respond to your MAYDAY call during a tsunami. A marine VHF-FM radio is your most practical piece of communication equipment during a tsunami event. It allows you to

monitor Channel 16 for information from the U.S. Coast Guard and harbor management agencies, and hear when it is safe to return to your harbor. You can also hail other vessels and ask for depth readings or signal that you are in distress. Remember that Channel 16 is for distress, safety, and calling (hailing) another vessel. Once you are in contact with another party, agree to switch to a working channel designated for noncommercial vessels. Even if you do have a VHF radio on board, it doesn't hurt to have the EPIRB, a fully charged cellular phone and a working transistor radio in your survival kit.

4. If an official announcement has not been made that it is safe to return to your harbor for some time, operate your vessel in a manner that will conserve fuel. The Tsunami Warnings and Advisories may last for hours and harbor/ocean conditions following the tsunami may not permit a quick return to port.

5. There will be a lot of boating traffic in your area, so do not linger near harbors, ports, and channels. If you actually have adequate line to anchor and it's after sunset, put on your anchor lights to indicate you are stationary. If you are underway, put on your running lights. At night or when visibility is limited, your navigation lights may save lives.

6. Monitor VHF Radio Channel 16 or go to https://homeport.uscg.mil/mycg/portal/ep/portDirectory.do?tabId=1&cotpId=27 to stay aware of U.S. Coast Guard Captain of the Port Safety Zones that may have been established restricting access to ports. Those without Internet or access to a VHF radio can also call the USCG Command Center at 1-800-552-6458.

Boats at Sea After a Tsunami

1. Damaging wave activity and dangerous currents can affect harbors for an undetermined period of time following the impact of the tsunami on the coast. Do not return to port until there is an official announcement that it is safe to return to your specific harbor. Remember cancellation of a Tsunami Warning and instructions that the public on land can return to the evacuation zone is different than an all clear signal for boaters to return to the harbor since there may be lingering currents or waves in

the water hours after the threat of inland wave inundation has passed. An announcement that it is safe for boaters to return will not be given until a Tsunami Advisory is cancelled. Even if a Tsunami Advisory is cancelled, the harbor will still need to be surveyed before it is reopened for traffic. This will allow navigation hazards to be removed or identified prior to your returning to port and allow better protection for you and your vessel.

2. While waiting aboard your boat, be alert for people who may have been swept out to sea by the tsunami as well as large amounts of debris that could become hazards to navigation.

3. Be prepared to yield to or assist emergency personnel involved in rescue or salvage operations.

4. Monitor VHF Radio Channel 16 or go to https://homeport.uscg.mil/mycg/portal/ep/portDirectory.do?tabId=1&cotpId=27 to stay aware of U.S. Coast Guard Captain of the Port Safety Zones that may have been established restricting access to ports. Those without Internet or access to a VHF radio can also call the UHCG Command Center at 1-800-552-6458.

Hilo, Hawai'i. The tsunami that struck Hilo on May 23, 1960 was caused by a magnitude 9.5 earthquake off of Chile the day before. Water and debris carried enough force to crush wooden buildings and twist parking meters by the time it hit Hilo 15 hours later. Photo courtesy of NOAA/NGDC and the Pacific Tsunami Museum.