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ABSTRACT

The purpose of this publication is to promote a better understanding of how basic weather features develop on Chesapeake Bay and enable boaters to enjoy the Bay's unique waterways. Sections include: (1) Chesapeake Bay climate; (2) general weather features; (3) seasonal trends; (4) sources of weather information and forecasts; (5) weather service warnings; and (6) weather and boating safety. (Author/CO)

THE CHESAPEAKE: a boating guide to WEATHER

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SEA GRANT PROGRAM

Virginia Institute of Marine Science
College of William and Mary
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THE CHESAPEAKE: a boating guide to WEATHER

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DESIGN BY DICK COOK

Contents

A MORE IDEAL BOATING area than Chesapeake Bay would be difficult to find along the Atlantic Seaboard. With thousands of miles of sheltered shoreline, good water depth and proximity to major urban centers, the Bay is a boatman's paradise. However, the Bay's many protected harbors and relatively narrow width (a boatman normally can keep at least one shore in sight at all times) tend to produce a feeling of false security about the need to keep a close watch on weather conditions.

The purpose of this publication is to remind boatmen that the Bay has many different weather moods, some of which can change quite rapidly. In addition, it should promote a better understanding of how basic weather features develop on the Bay and enable boatmen to enjoy the Chesapeake's unique waterways with fewer weather surprises.

CHESAPEAKE BAY CLIMATE

The climate of the Bay is established by its location in mid latitudes on the eastern edge of the North American continent. This location results in winter climate being regulated by the polar continental influence, while summer is characterized by continental tropical weather with infrequent invasions of cooler air. The climate is tempered by marine influences which most noticeably result in milder winter temperatures than those found inland at similar latitudes.

Fall, winter and spring are characterized by occasional storm systems producing wind gusts of over 50 knots*, rarely up to 70 knots, about once a year. Such winds usually come from the south, northwest or north, but about once in ten years strike the area from the east, causing unusually high storm surges.

Summers are characterized by weak low pressure systems rarely producing winds as high as 30 knots. The Bay also experiences the majority of its annual average of 30 thunderstorm days during summer, and these, of course, may produce the higher winds noted formerly. Often associated with cold fronts, these storms occur most frequently from May through August.

Hurricanes are experienced in the Bay about once every ten years, generally coming in the latter half of the boating season (August-October).

The Bay's configuration and orientation significantly affect wind and weather patterns important to boatmen (Fig. 1). The relatively straight course of the Bay extends in a north-south direction for nearly 200 miles (332 kilometers). The western shore of the lower Bay is cut deeply by five tributaries varying 2-8 miles (3-13 kilometers) in width at their mouths and exhibiting northwest fetches of as much as 20-40 miles (32-64 kilometers). On the Bay's eastern shore the numerous tributaries are generally less significant in their dimensions. The width of the Bay is greatest in Virginia, where the distance between shores ranges approximately 11-27 miles (18-43 kilometers). The Maryland area of the Bay averages 5-10 miles (8-16 kilometers) in width.

GENERAL WEATHER FEATURES

WINDS

As a very general rule, the prevailing winds over the Chesapeake tend to follow its north-south orientation. Mid-channel winds can be expected to be southerly during warm months and northerly during the cold portion of the year. However, the many smaller bays, inlets, islands and tributaries of the Chesapeake interfere with prevailing wind flow patterns, resulting in local winds which can differ drastically from the general pattern.

Differences in Bay water temperature and air temperature influence wind direction and speed, particularly as compared to patterns over adjacent land surfaces. During cooler months, the passage of light, warm prevailing winds over cold water can result in reduced winds on the Bay as compared to winds inland, unless the warm winds are strong. During warmer months, whenever cold air moves over warm Bay water, winds will be stronger and much more gusty over the Bay than over adjacent land surfaces, due to the unstable situation of cold air overlying rising air warmed by the water.

Another characteristic of winds around the Bay is the sea breeze effect. Occurring during warmer months, sea breeze is caused by differences between air temperatures over the land and water. Basically, air warmed over heat-absorbing land areas is lighter than adjacent air over relatively cooler Bay water. The lighter air rises, causing the cooler air over the Bay to move towards land to fill the void. Sea breeze is noticeable when the two air masses differ by as little as 5°F (about 3°C) and increases as differences become greater.

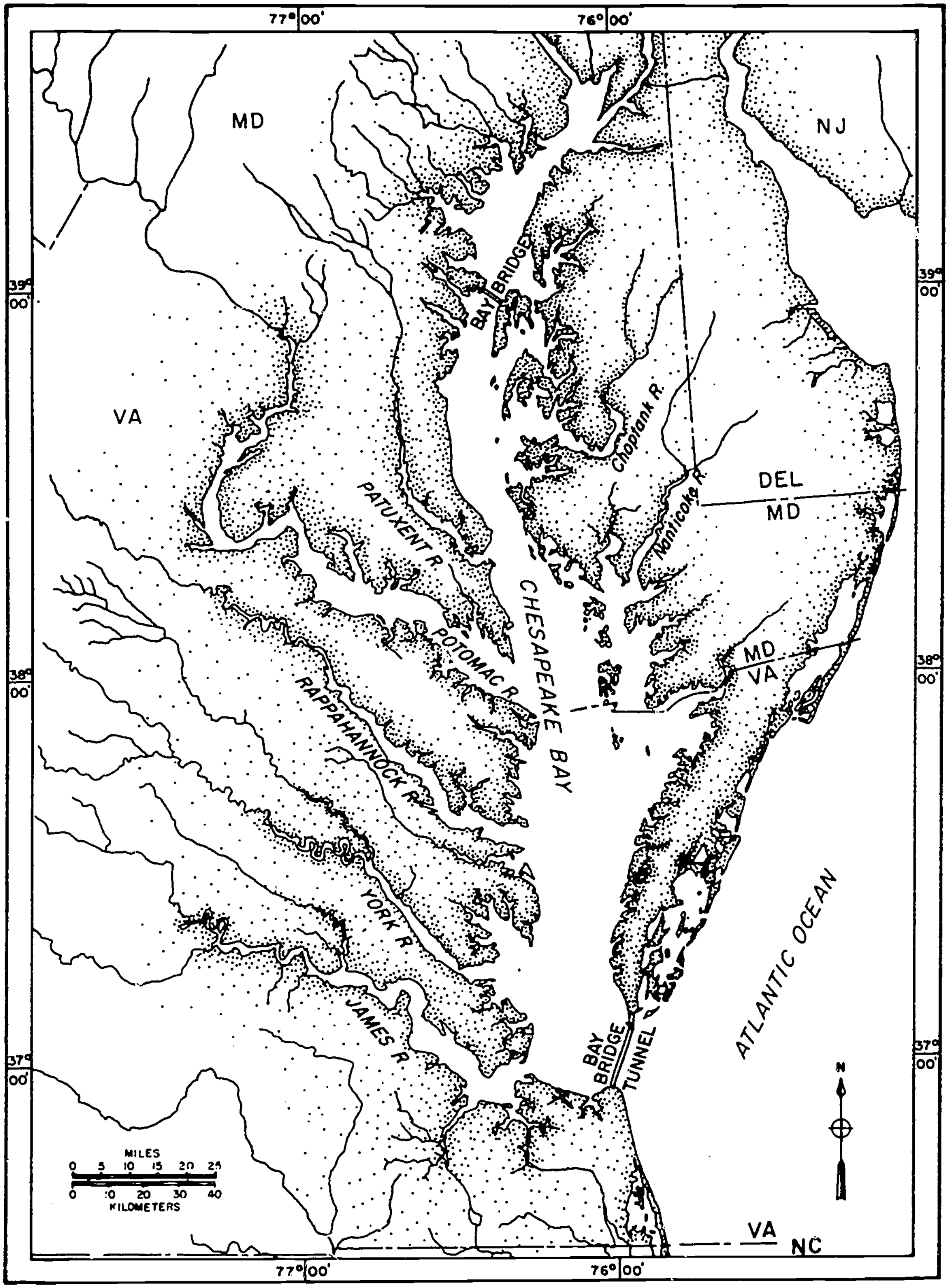
The sea breeze effect is largely responsible for the strong diurnal variation in wind speeds over the Bay during the boating season. When no major weather disturbances are governing the Bay's wind patterns, winds will tend to be very light at night, increasing in strength during the late morning. Maximum winds occur in mid afternoon when air mass temperatures over land and water differ the most, with wind speed falling off rapidly at dusk. Such winds are generally stronger near the shore, especially where shore elevations are higher, and at the mouths of rivers. Normal summer day winds may be nearly calm in the early morning and increase to approximately 15 knots by mid afternoon. As a result of the sea breeze effect, better conditions for high speed boating occur in the morning, while afternoons generally favor sailors.

WAVES

The state of the sea is governed primarily by wind speed and duration, as well as the fetch (distance) over which the wind blows. Winds from the north or south have the greatest fetch

* 1 knot = 1 nautical mile per hour (mph), 1.15 mph or 1.85 kilometers per hour.

Figure 1. Chesapeake Bay and its major tributaries.



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in the Bay, but northwest winds also have a considerable fetch of 20-40 miles (32-64 kilometers) off the mouths of any of the major western shore tributaries. The width of the lower Bay provides considerable fetch for strong westerly or easterly winds associated with major storm systems and cold fronts.

Wind takes time to affect wave height and period (time between successive waves). Sudden wind increases or changes in direction may take an hour or more to produce maximum wave heights. Choppy waves are the immediate result of significant changes in wind speed or direction. A sudden squall does not build huge waves, but rather produces a chaotic sea with steep, short-period waves. However, if the new wind conditions persist long enough, maximum wave heights will be achieved and can cause problems. A rule of thumb for open waters is, that given sufficient time, wave height will increase one additional foot (0.3 meter) for each seven-knot increase in wind speed.

Water depth and interactions of prevailing wave patterns with wakes from other craft can affect the nature of waves. Shallow or shoal water will increase the steepness of waves, thereby producing dangerous choppy situations which can swamp or capsize a boat. This must be considered if one seeks the protection of the lee shore to reduce the fetch of westerly or easterly winds in the Bay. As one moves inside the fish trap (pound net stand) line close to shore, the bottom frequently shoals quite rapidly.

Boat wakes can interact with existing waves to produce a choppy sea, or even unusually high waves if a wake joins with and enhances an existing wave. Large, swell-like wakes from commercial vessels such as freighters and tankers traversing the Bay will also be encountered by recreational boatmen.

CLOUDS

During much of the year, cloud cover over the Bay is essentially the same as that over the adjacent land mass. However, during the spring and summer, when Bay water is cooler than the air overlying the land, the cooler water inhibits development of low level cumulus clouds during late morning and afternoon hours. These clouds may cover most of the sky over land, while the sky over the Bay will be completely clear (Fig. 2). In fall, the opposite effect results when Bay water is warmer than the air over land. This situation usually develops with the passage of a cold front

NASA LANDSAT

Figure 2. Effect of early June water temperatures on cloud cover over the Bay region. Cool air temperature over water (relative to that over land) inhibits cloud formation over the Bay during late morning and afternoon.

and may result in few if any clouds over the land, while the Bay is nearly completely cloud covered.

SEASONAL TRENDS, NOVEMBER THROUGH APRIL

Much of this period is characterized by rough weather, and it should be treated with caution by the casual boatman and experienced mariner, alike. However, it is the time of year that many waterfowl hunters expose themselves to the Bay's elements in rather frail craft, while both ends of the period encompass good boating days. The period is characterized by large weather systems and storm fronts generally heralded by slowly increasing cloud cover and winds. As storm systems move up the Atlantic coast in a northerly or northeasterly direction, the strongest winds normally occur ahead of the storm. Over the Bay, in particular its southern half, the leading winds of such storms come out of the northeast quadrant with speeds of 30-50 knots and higher. Northwest winds, which usually follow these storms, can be quite strong and gusty and may persist for several days.

Strong cold fronts also cross the Bay from west to east during November through March, often produced gusty northwest or northerly winds of 25-45 knots over open water, while winds a few miles inland are considerably lighter. For example, the City of Richmond, Virginia might be experiencing northwest winds of about 10 knots, while along the shore at the Bay mouth wind velocities are at least 50 percent higher. The unstable condition of cold air moving over the relatively warm water, as well as reduced friction surface presented by the water, are responsible for the gustier winds over water. Regarding this phenomenon, remember that a doubling of wind velocity results in a four-fold increase in wind force, a tripling in velocity a nine-fold increase, etc. (Force = Mass x Velocity^2).

Naturally, wave conditions associated with the blustery winds of the period can become quite severe and prove hazardous to small and medium size boats. Problems with bad chop resulting from winds opposing strong tidal currents are also more pronounced during this time and have to be considered. Northerly winds of 25 knots or higher have a long fetch down the Bay and can easily build wave heights to 5-7 feet (1.5-2 meters) in its southern extremities. Westerly winds produce their highest waves in the widest section of the Bay, particularly east of the Potomac and Rappahannock Rivers. At the mouths of these and other large rivers, tide and wind also can interact to further aggravate wave conditions. Easterly winds will produce their highest waves along the seaside beaches and at the Bay mouth where northeasters can result in wave heights of 10 feet (3 meters) or more.

FOG

Fog can become a serious problem, especially from January through April. Most of the Bay's 30-40 dense fog days per year occur during this period. Fog on the Bay most often forms when warm moist air with a dew point higher than the Bay's water temperature moves over the area from the south to southeast. (Dew point is that temperature at which the air's moisture content reaches saturation point or 100 percent relative humidity). As the warm moist air passes over the cooler water, the air can drop in temperature to its dew point and its water vapor can condense into minute water droplets (fog). Formation of dense fog is more common as one moves offshore, and should be anticipated on unusually warm, humid days during winter or spring. Visibility during cold season fogs will often be near zero if winds are less than 10 knots. Higher winds will produce slightly better visibility, but still much less than one mile.

Although it happens frequently, fog should never catch the observant boatman totally by surprise. There are several good clues indicating that fog formation is imminent. According to Donald Whelpley in *Weather, Water and Boating* (Cornell Maritime Press, Inc., Cambridge, MD, 1961) and William Kotsch in *Weather for the Mariner* (2nd Edition, Naval Institute Press, Annapolis, MD, 1977) fog formation is likely if:

* *Fog formed in the same area the previous night and weather conditions are still relatively unchanged*
* *There are sustained, warm, moist winds out of the south blowing over colder land or water surfaces*
* *The daytime sky appears hazy and not very blue, while the horizon is ill-defined; at night, light beams appear misty*
* *The sky is clear at sunset, the wind light and the air humid*
* *The difference between air temperature and the dew point (determined with a sling psychrometer) is 10°F (5-6°C) or less and the expected minimum temperature will be close to the present dew point*

Once fog has set in, Whelpley states there are certain things to look for that signal it will break up:

* *If fog was in the area the previous day and lifted, it will likely lift about the same time again*
* *If the air temperature is rising, the fog will "burn off" as the air temperature rises above the dew point; however, if moderate winds are blowing, the warming trend will be slow, and if rain is falling through the fog, there will be no heating by the sun, further slowing the warming process*
* *Changes in wind direction or increases in wind velocity can move the fog out of the area or lift it off the water surface, improving visibility*

COLD AIR AND WATER TEMPERATURES

Fall, winter and early spring bring with them

TABLE 1. AVERAGE SURFACE WATER TEMPERATURES (°F)* IN CHESAPEAKE BAY

Location	Years of Observations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Little Creek, VA (Norfolk) 36 55'N 76 11'W	6	40	41	47	55	66	74	79	80	75	66	55	45
Solomons, MD (Patuxent River) 38 19'N 76 27'W	32	38	38	43	53	65	74	80	80	76	65	54	43
Baltimore, MD (Patapsco River) 39 16'N 76 35'W	56	37	37	43	53	64	74	80	80	75	65	54	43
				Potential Hypothermia Period							Potential Hypothermia Period		

* °C = 9.556 (°F-32)

Source: United States Coast Pilot 3, Atlantic Coast, Sandy Hook to Cape Henry, 15th Ed., National Ocean Survey, NOAA, Washington, D.C., July 1977.

low air and water temperatures that can be silent killers. Falling overboard or capsizing during the cooler months of the year can prove fatal, although not directly from drowning. Emersion in cold water (water cooler than 70°F or 21°C) quickly lowers the body's core temperature and can be a problem in the Bay from October through May (Table 1). Called hypothermia, the lowering of body core temperature first results in shivering, then loss of manual dexterity and finally muscle rigidity. Continued cooling brings on mental confusion, which renders a person powerless to help himself. Unconsciousness soon follows, and if drowning has not occurred before core temperature reaches 85°F (29.5°C), heart failure completes the scenario.

Wearing a close fitting, garment type foam flotation jacket can dramatically increase survival time over 300 percent in cold water. The next best precaution is wearing a more standard type personal flotation device so that you do not have to tread water or swim to stay afloat. Heat loss occurs primarily from the head, chest and groin areas of the body and movement causes a greater rate of loss. If in cold water with no flotation device, never use the drownproofing method of periodically submerging the head, since this is one of the quickest ways to lose body heat (Table 2).

A flotation device allows one to assume the Heat Escape Lessening Position (H.E.L.P.), if alone in the water, or the HUDDLE position (Fig. 3). In 50°F (10°C) water, survival time using H.E.L.P. or the HUDDLE position is approximately four hours, as compared to only two hours when having to swim or tread water. At midwinter Bay water temperatures (approximately 35°F or 1.7°C), the H.E.L.P. and HUDDLE positions provide about 2.7 hours survival time as compared to 1.2-1.4 hours for swimming or treading water without a flotation device (Fig. 4). Remember that all survival times indicated herein are for the "average" person. Small people cool faster than large people, children faster than adults and thin people faster than fat people.

Cold air temperatures can also cause hypothermia in boatmen inadequately dressed or whose clothes got wet from spray. Multiple layers of light clothing provide better protection than one heavy

TABLE 2. PREDICTED SURVIVAL TIMES FOR AN AVERAGE PERSON IN 50°F (10°C) WATER*

SITUATION	SURVIVAL TIME (HOURS)
NO FLOTATION	
Drownproofing	1.5
Treading Water	2.0
WITH FLOTATION	
Swimming	2.0
Holding still	2.7
H.E.L.P. or HUDDLE	4.0
UVic Thermofloat Jacket	9.5

* Clothing worn was cotton shirt, pants, socks plus running shoes.

Source: University of Victoria research results presented at the "Cold Water Survival and Rescue Symposium" sponsored by the U.S. Coast Guard and American National Red Cross, Santa Rosa Junior College, Santa Rosa, CA, Feb., 1979.

garment. If spray is anticipated, a water repellent or waterproof outer garment should be worn. If boating in cold weather, watch fellow crew members for signs of sluggishness, slurred speech or mental confusion, all signs of creeping hypothermia. Using proper methods for re-warming hypothermia victims is essential, and such methods are described in appropriate pamphlets available from the U.S. Coast Guard.

Also remember that when you add wind exposure to existing low temperature conditions, the actual chilling effect on exposed flesh is much

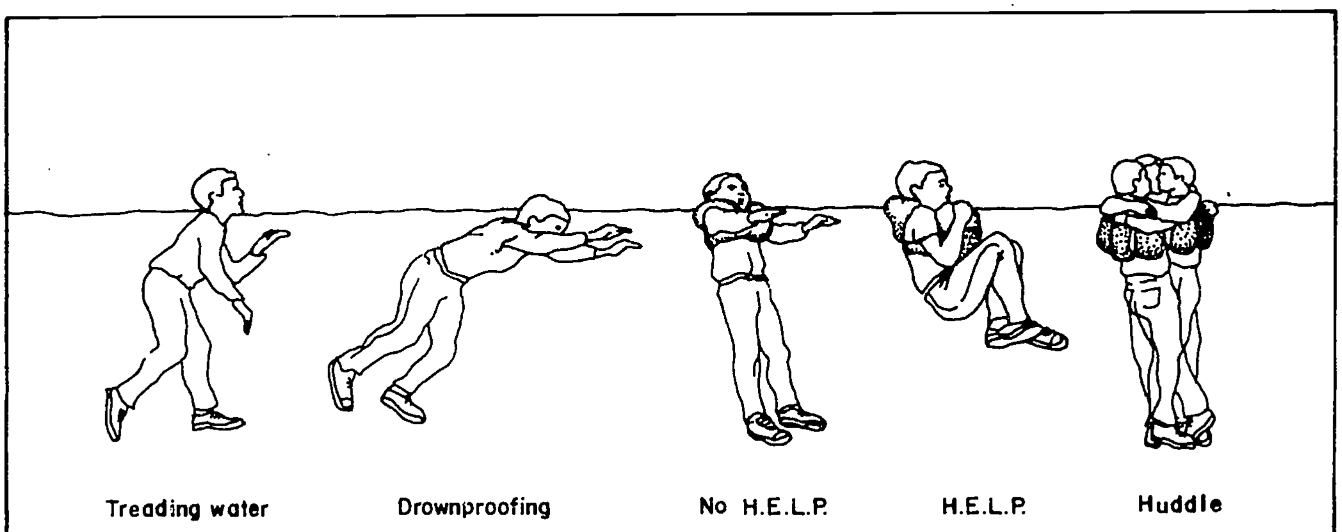


Figure 3. Possible in-the-water survival positions; the H.E.L.P. and HUDDLE positions provide the greatest survival times (adapted from "Cold Water Survival and You." Chesapeake Bay Magazine 8 (7), 1978. J. Groene).

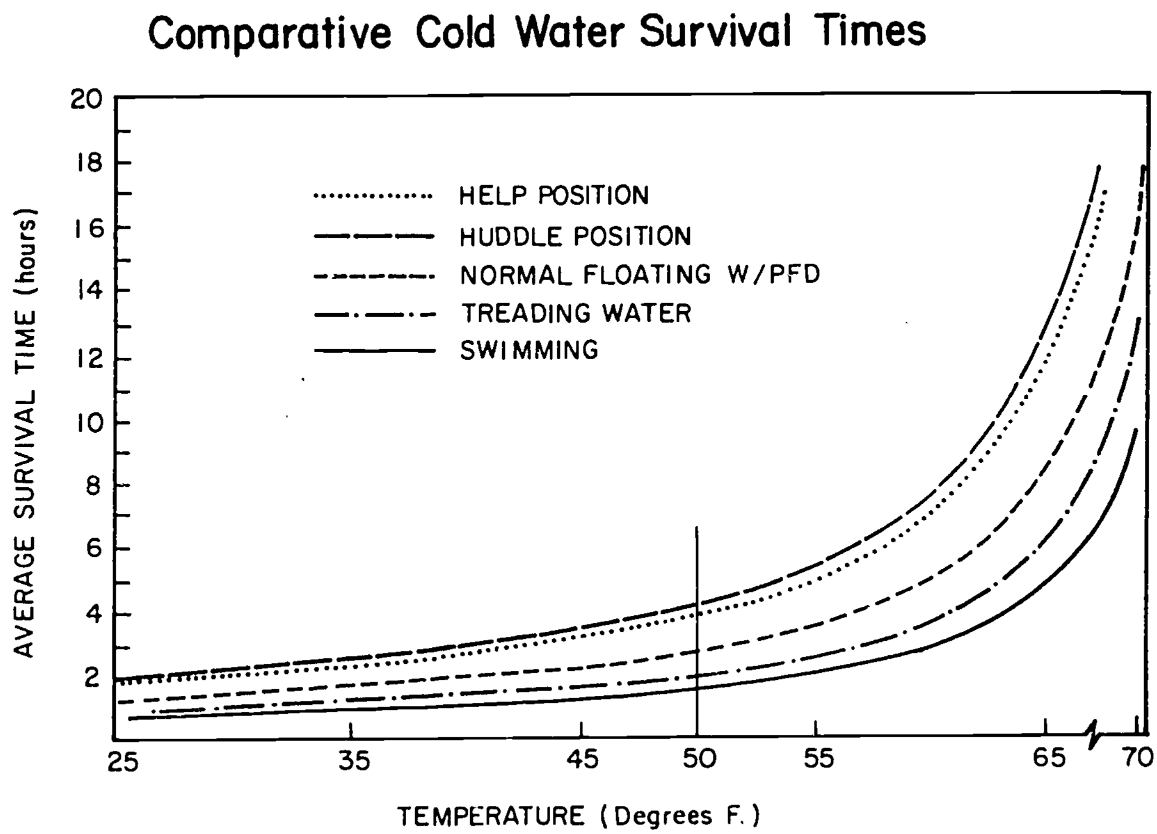


Figure 4. Effect of in-the-water survival positions on survival time (Source: U.S. Coast Guard).

greater than under still conditions. Brisk wind conditions in combination with temperatures slightly below freezing can produce the same chilling effect as temperatures 30-40°F (17-22°C) lower in still conditions. The following wind chill table (Table 3) should be used to better gauge how much cold weather protection is needed.

TABLE 3. WIND CHILL

Equivalent Temperatures (°F)*

Wind Speed (mph)	CALM	35	30	25	20	15	10	5	0	-5	-10
	10	22	16	10	3	-3	-9	-15	-22	-27	-34
	20	12	4	-3	-10	-17	-24	-31	-39	-46	-53
	30	6	-2	-10	-18	-25	-33	-41	-49	-56	-64
	40	3	-5	-13	-21	-29	-37	-45	-53	-60	-69

* °C = 9.556 (°F-32)

Source: "Riding Out Winter Storms," National Weather Service, NOAA, PA 79015.

COLD FRONTS

Thunderstorms are not normally experienced during the cold months. March and April, however, bring an increase in such activity. During these months thunderstorms almost always precede cold fronts, but will often decrease in intensity after moving over colder waters. Such fronts generally move out of the western quadrants towards the east at speeds between 10-30 knots with advancement generally faster in winter than in summer. Because cold fronts normally have a sharply sloping leading edge, they uplift warmer air ahead of themselves rather abruptly, with the result that such frontal storms are usually violent. The only saving grace is that the steeply sloping frontal edge also means that frontal weather is generally limited to a very narrow band or zone. Therefore, the violent frontal storm is usually brief in duration.

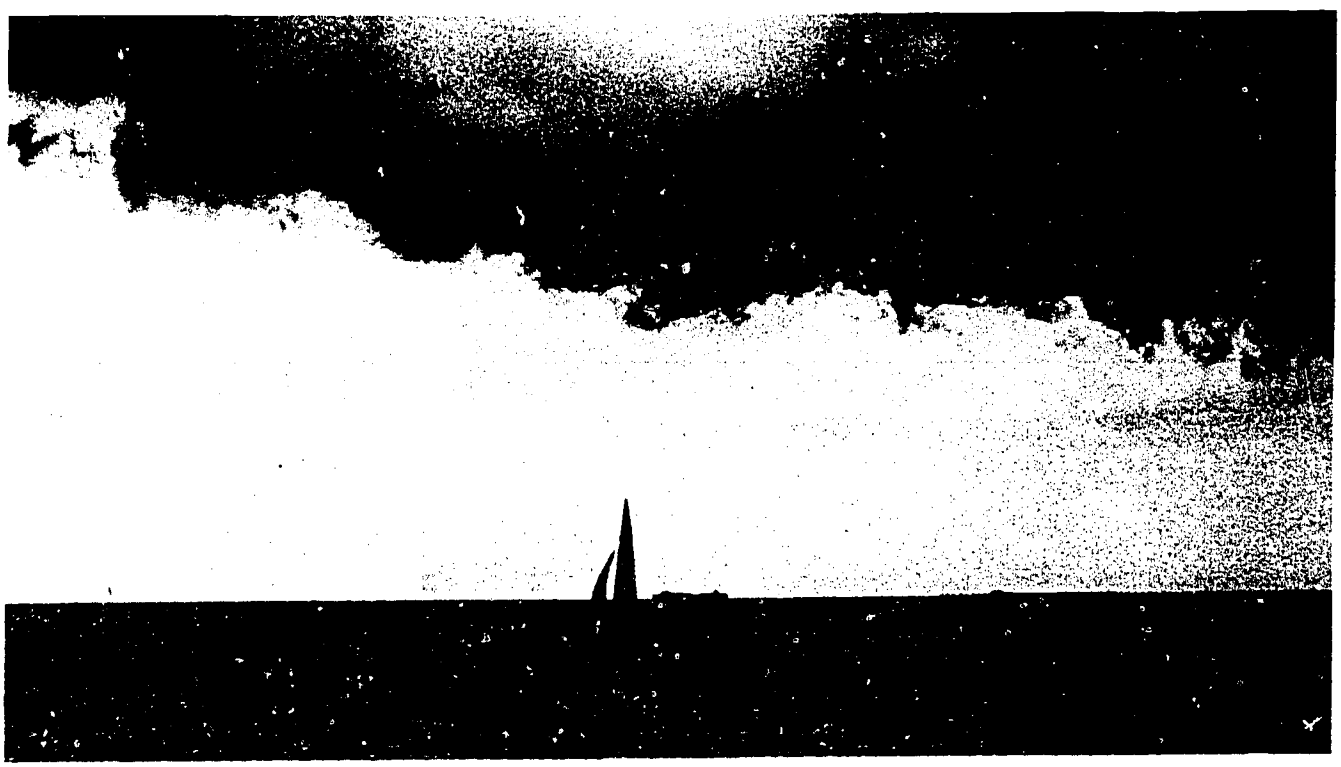
Major squall lines frequently precede cold fronts as much as 100-150 miles (161-241 kilometers). Because squall lines frequently pack sudden, strong winds of 34 knots or more, the National Weather Service may issue a Severe Thunderstorm or Tornado Watch as well as a Special Marine Warning. A "watch" usually precedes storm arrival by an hour or more. *Special Marine Warnings* are issued for winds of 34 knots or higher and waterspout sightings, *Severe Thunderstorm Warnings* for winds of 50 knots or higher and *Tornado Warnings* for tornadic winds when there is good evidence that any of these conditions will occur within one hour.

SEASONAL TRENDS, MAY THROUGH JULY

Typically, weather in this period is fair, with occasional storms. The land and water warm rapidly in May, reaching peak temperatures in July and August. Most of the time the weather is characterized by clear skies and light to moderate winds. However, the most active thunderstorms of the year also occur during this period, producing local squalls with winds up to 50 knots or higher.

THUNDERSTORMS

Thunderstorms pose considerable danger to boats because of their strong, gusty winds and lightning. They are formed by rising air currents and normally occur during maximum heating of the Earth's surface, or from mid afternoon through



Jon Lucy

Figure 5. Rapidly approaching clouds at the leading edge of a thunderstorm indicate trouble for small boats. An alert skipper will head for a protected anchorage well ahead of such storms.

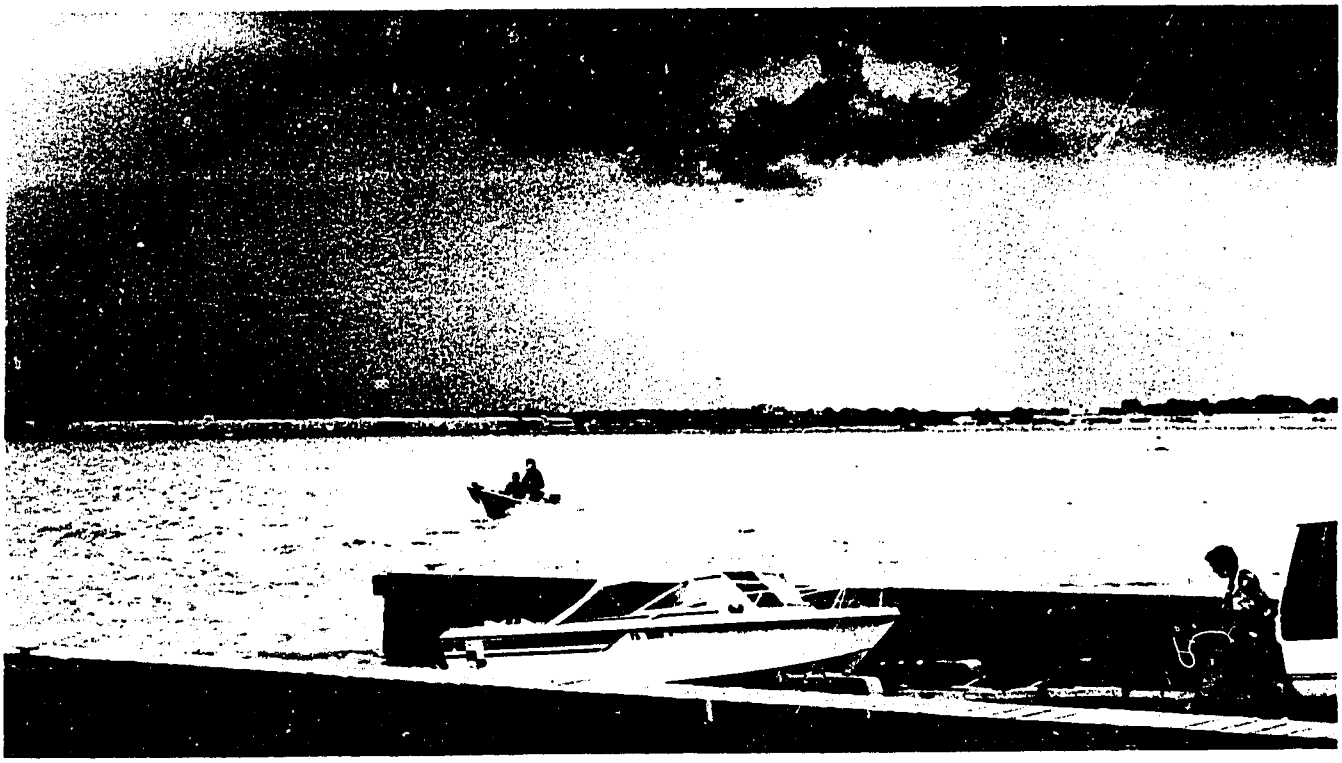


Figure 6. With a thunderstorm bearing down from astern, these boatmen are a bit tardy in seeking the protection of shore.

early evening. However, cold fronts also cause warm surface air to rise up over their leading edge and likewise can produce thunderstorms anytime day or night. Whenever the passage of such a front coincides with the time of maximum daily heating of the Earth's surface, the most violent thunderstorms usually result. Visible indications that unusually strong winds are accompanying an approaching thunderstorm may be the following:

* *A rapidly approaching thunderstorm with what appears to be a heavy fog bank under it*
* *Unusually frequent lightning and thunder in an approaching storm*
* *A rapidly approaching low cloud or line of low clouds, with or without a thunderstorm (Fig. 5)*

During spring and early summer about six days of each month include thunderstorms. These storms develop to the west over land and most often move out of the southwest at speeds averaging 25-35 knots. A particularly careful watch should be kept on the occasional storm approaching out of the northwest. Such thunderstorms have proven to be especially severe, tending to move more rapidly than normal and sometimes packing peak winds of 70-90 knots. This type storm struck Norfolk, Virginia, in June 1977 capsizing a head boat and tearing away the end of a fishing pier.

As summer progresses, weather fronts become weaker, and most of the thunderstorms result from the sun heating the earth's surface. These storms develop over the land mass to the west but move more slowly than the storms of spring and early summer. Their normal rate of approach is about 10-20 knots or less. During July the Bay may experience 8-9 days of thunderstorms, with August averaging 6-7 days.

Boats should head toward safe anchorage whenever a thunderstorm is considered to be approaching (Fig. 6). Storms will generally move in from the southwest, west or northwest, but they may also come out of either the south or north. Usually, thunderstorm activity observed in any of the eastern quadrants is not of concern, since such a storm is already past your location. Always head for shelter sufficiently in advance of an approaching thunderstorm, since it frequently advances at speeds greater than the normal cruising speed of most boats.

LIGHTNING

The winds accompanying thunderstorms are not the only problem such weather systems pose for boats on the Bay. Lightning from these storms occasionally strikes boats and is capable of doing considerable damage to property and people (Fig. 7). More than 100 persons are killed annually by lightning strikes in the United States.

Radio antennas and sailboat masts are the items on boats most frequently hit by lightning. They should be properly grounded according to methods described in the National Fire Protection Association's Lightning Protection Code of 1977. All large metal objects aboard a boat should be connected to a ground system consisting of at least No. 8 copper wire (approximately 1/8 inch or 3 millimeters diameter). The ground connection may consist of any metal surface normally submerged which has an area of at least one square foot (929 square centimeters). Propellers, a metal rudder, centerboard or keel can be used for the ground connection as well as copper plate affixed to the hull.

Remember: The 60° arc cone of protection (Fig. 8) established over a boat by proper grounding procedures does not provide absolute safety from lightning. A direct strike can occasionally

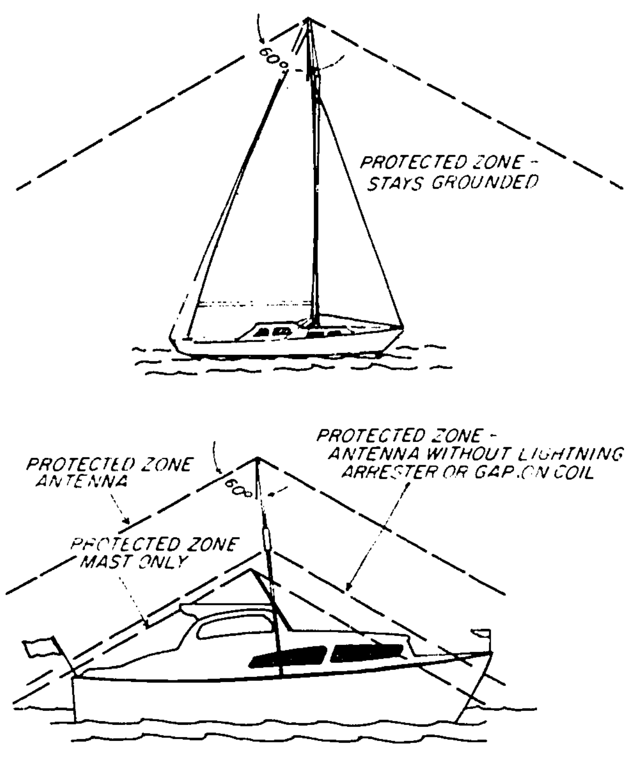


Figure 8. The best lightning protection for small boats is provided by a proper ground system. For best results, ground the highest structure on your vessel.

enter the area of protection, or a person aboard a "protected" boat can be struck by a side flash of lightning capable of jumping 5-6 feet (1.5-1.8 meters) to a ground of less resistance.

A thunderstorm's electrical activity can be used to tell something about the storm's distance and intensity. Because light travels about a million times faster than sound, the distance in miles to a thunderstorm can be estimated by counting the number of seconds between lightning and thunder, and dividing by five (sound travels about 1/5 mile or 0.3 kilometer per second).

A simple AM radio can also warn of impending thunderstorms and lightning problems. In addition to producing static in harmony with lightning discharges from an approaching storm, the radio can tell a boatman when the charged water area associated with a thunderstorm surrounds his boat. According to Thorn Bacon in *Weather for Sportsmen* (The Hearst Corporation, N.Y., N.Y., 1974) an AM radio will produce loud hissing or sizzling noises (a bacon frying sound) when a storm's "electrical shadow" overtakes a boat.

Warnings of an approaching storm should be heeded and precautions taken long before rain occurs. In the Florida Sea Grant Publication *Boating Safety - Thunderstorms* (Marine Advisory Program, University of Florida, Gainesville, FL 32611, 1978), Walter Sitarz, Miami's Port Meteorological Officer for the National Weather Service, emphasizes that in many instances of lightning casualties, no rain was falling at the time of the lightning strike. Frequently, strikes occurred just prior to the onset of a thunderstorm.

Sitarz recommends taking the following lightning precautions aboard a boat caught in a thunderstorm, even if the boat is properly grounded:

* *Remain in the center of the cabin of a closed boat when possible.*
* *Don't go in the water or swim until the storm passes.*
* *Keep away from any metal fittings aboard the boat, particularly those which are connected to the lightning conductive (ground) system.*
* *Disconnect the major electronic equipment not being used.*
* *Don't touch the radio equipment or wiring.*
* *On small power boats, lower the radio antenna and keep a low profile below the freeboard.*
* *Ground small sailboats without sophisticated electronic systems by using a length of battery cable which is clamped to the wire stays of the mast and allowed to hang over the side into the water.*
* *If the boat is near shore, seek refuge under a bridge.*
* *After any lightning storm passes, check the electrical system and compass. Lightning strikes have been known to alter the magnetic characteristics of a boat.*

Several additional precautions are recommended by Terry Ritter, Meteorologist in Charge, National Weather Service, Norfolk, Virginia:

* *If you must ride out a thunderstorm in a boat, try to avoid shallow water; it does not insulate a boat from the earth as well as deep water.*
* *If you feel your body hair stand on end or your skin tingle, lightning may be about to strike you. Drop to your knees and bend forward, placing your hands on your knees. Do not lie flat.*

A person struck by lightning receives a severe shock and may be burned externally as well as internally. However, the body retains no electrical charge and may be handled safely. A person apparently "killed" by lightning can often be revived by prompt, prolonged mouth-to-mouth resuscitation and cardiac massage.

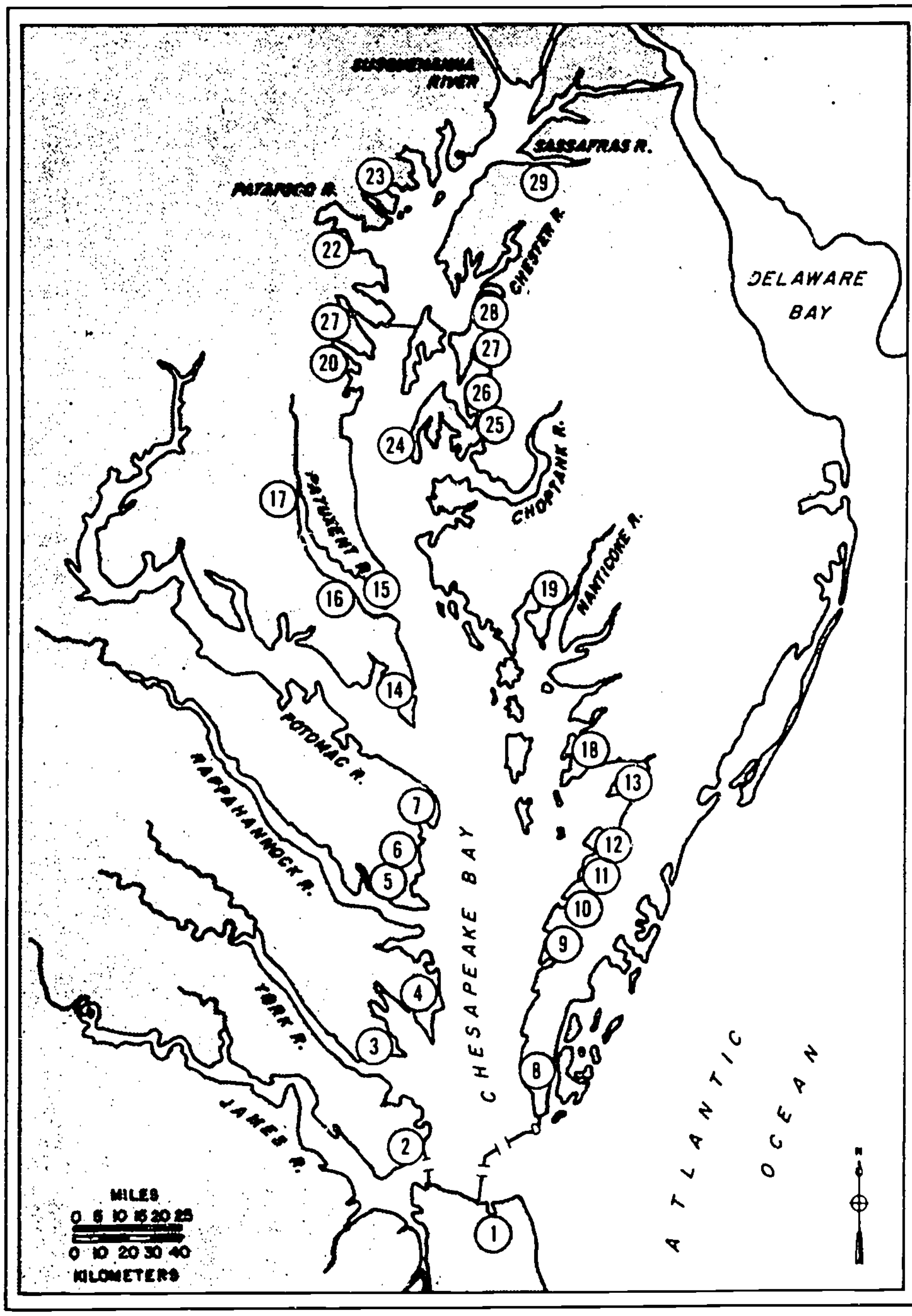
SEASONAL TRENDS, AUGUST THROUGH OCTOBER

This is a fair weather period, although marked by several unusual weather phenomena. Air temperatures begin a slow decline during late summer, the decline becoming more rapid in late September and October. The increasingly cooler temperatures bring a rather abrupt end to the frequent thunderstorms of July and August. Up to 6-9 thunderstorm days per month are typical for portions of the Bay during July and August, while September and October produce only 1-3 such days. Thunderstorms during these latter two months, while rare, are almost always associated with cold fronts that now begin to become more vigorous.

The increasing frequency of cold fronts also marks a slight overall increase in the percentage of days the Bay experiences dense morning fog. Boatmen need to become fog-wary once again, especially from Annapolis north. The upper reaches of the northern Bay appear to experience more fog (1-4 days per month) than other areas. During September and October, the Maryland portion of the Bay generally experiences more foggy days than Virginia waters. Morning fog is the rule, with dense afternoon fog generally experienced less than one day per month on the average throughout the boating season.

In spite of an increasing number of cold fronts, the overall weather pattern for the period is dominated by high pressure systems. Particularly during September and October, long spells of fair, pleasant weather prevail. It is important to keep in mind, however, that water temperatures begin to dip below 70°F (21°C) again in October, making hypothermia a danger once more for anyone finding himself unexpectedly in the water for an extended period of time.

Figure 9. Here are some of the many Chesapeake Bay hurricane holes providing good vessel anchorages during periods of high winds.



HURRICANES

The fair weather of August through October unfortunately brings with it one "demon" that Bay boatmen must expect to encounter on the average of once every ten years--the hurricane. Virginia's hurricane season extends from June 1 through November 30, with a peak between mid August and the first week of October. The activity peak reflects an increase in the number of hurricanes spawned in the southern North Atlantic that tend to track parallel to the East Coast.

Although hurricanes are rare in Chesapeake Bay, near-hurricane force winds (greater than 64 knots) are not uncommon because of severe thunderstorm activity and summertime squalls. This makes it important for boatmen to know the location of well-protected harbors that provide good landlocked water with adequate depth for deep draft vessels. So-called "hurricane holes" are present in most Bay tributaries, according to Julius Wilensky in *"83 Hurricanes Holes of the East Coast" (Sea Magazine,* August 1978, CPS Publications, Inc., N.Y., N.Y., Copyright 1978). Locations of hurricane holes follow (Fig. 9), as recommended by Wilensky and Jon Lucy (indicated by an asterisk).

Chesapeake Bay Hurricane Holes

LOWER BAY (south to north)

Western Shore

1) Linkhorn Bay, off Lynnhaven Bay above Cape Henry* -- Enter Lynnhaven Inlet cautiously because of a shifting bar, but anticipate a well-marked entrance channel with water depths of 6-10 feet (1.8-3 meters); the Inlet and the east channel towards Linkhorn Bay are crossed by fixed bridges with 35 foot (10.7 meter) clearances; after entering the Inlet, swing wide to the left towards the Great Neck Road Bridge and proceed into Broad Bay, then through the 6 foot (1.8 meter) deep Narrows into Linkhorn Bay; protected anchorages can be found in both the south and east branches of the Bay to either side of Bird Neck Point, with shoreside facilities at the ends of each branch.

2) Hampton River, north shore inside Hampton Roads* -- Cross Hampton Roads Bridge Tunnel and enter the channel to the right behind the Tunnel island; as you enter the mouth of Hampton River, be on the lookout for commercial tug and barge traffic; proceed up Sunset Creek on the left where two marinas handle limited numbers of transient boats; do not anchor in the Hampton River channel because of barge traffic and the River's northeast orientation.

3) Lower York River, north shore* --. After passing Sandy Point, look for day markers indicating the winding channel into the Perrin River where dockage can be found at the large marina. Drafts of seven feet (2.1 meters) can be accommodated. Even better protection is offered further up the river in Sarah Creek where good anchorages with water depths of 7-8 feet (2.1-2.4 meters) are available in the northwest branch up to the repair yard and marina, and in the northeast branch as far as the oyster packing house on the north shore.

4) East River, off Mobjack Bay -- Anchor either in Putam Creek or in East River itself, south of Woodas Point.

5) Corrotoman River, lower Rappahannock River, north shore – After clearing the Grey's Point bridge, (vertical clearance of 110 feet or 33.5 meters), anchor in either of the Corrotoman's branches; 7 foot (2.1 meter) drafts can be carried 2½ miles (4 kilometers) up the east branch, while the west branch can handle 8 foot (2.4 meter) drafts for the same distance.

6) Dividing Creek, north of Fleets Bay, about midway between Rappahannock and Potomac Rivers – Anchor up the creek just above Lawrence Cove.

7) Horn Harbor, about 5 miles (8 kilometers) up Great Wicomico River, north shore – This is the best of several well protected creeks going upriver.

Eastern Shore

8) Cape Charles Harbor* -- This harbor of refuge located nine miles (14.5 kilometers)

north of the Cape itself can provide protection with transient docks located in the northeast corner behind the Coast Guard Station; for boats drawing less than five feet (1.5 meters), Kings Creek just north of the harbor also offers protection as well as marina services, but the channel markers must be followed carefully.

9-10) Occohannock and Nandua Creeks* -- Some protection can be found in Occohannock Creek up to the area of Davis Wharf, beyond which water depths drop below 7-8 feet (2.1-2.4 meters). Nandua Creek to the north has a somewhat tricky, winding channel bordered by shoals, but with care, protection can be found by running up to Nandua.

11-12) Pungoteague and Onancock Creeks* -- Good protection is found up Pungoteague Creek in the area of Harborton; further north Onancock Creek provides good storm anchorage in the area of the Onancock town dock.

13) Saxis, upper Pocomoke Sound* -- Protection is available in the commercial fishing harbor for boats requiring depths of 6 feet (1.8 meters) or less.

MIDDLE BAY (south to north)

Western Shore

14) St. Mary's River, lower Potomac, north shore – The new harbor of refuge dredged to 8 feet (2.4 meters) 1 ½ miles (2.4 kilometers) up the Potomac from Point Lookout may prove satisfactory unless high water forces waves over the breakwater; best to continue up to St. Mary's River where good anchorages exist opposite Pagan Point or above Horseshoe Point; Carthegena and St. Inigoes Creeks also offer good protected anchorages.

15) Mill Creek, Patuxent River, north shore at Solomons -- Go up to where the creek widens just east of Old House Cove.

16) Mill Creek, Patuxent River above bridge, western shore -- Another Mill Creek about 4 ½ miles (7.2 kilometers) above river mouth offering good protection; fixed bridge under construction will have 140 foot (42.7 meters) vertical clearance.

17) Patuxent River, above the Potomac River -- Anchor behind one of many bends after the river narrows somewhat, or go up one of the creeks suiting your draft; the entire river is well shown on NOS Chart NO. 12264.

Eastern Shore

18) Crisfield, off Tangier Sound* -- Another commercial harbor where water depths of at least 7 feet (2.1 meters) are available and service facilities are good.

19) Nanticoke River, Tangier Sound, behind Bloodsworth Island -- Anchor up in the river off the channel or in any of the many creeks up the length of the river.

UPPER BAY (south to north)

Western Shore

20) Rhode River, south of Annapolis between West and South Rivers -- Go up past the flashing green light and anchor between High Island and steep south shore or go up Sillman Creek (7-8 foot or 2.1-2.4 meter depths).

21) Little Round Bay, up Severn River, off Round Bay -- Above Annapolis one must open a bascule highway bridge and a swinging railroad bridge, then clear a fixed highway bridge (80 foot or 24.4 meter vertical clearance); anchor in Little Round Bay west of Round Bay, staying either north or west of St. Helena Island; creeks above and below Round Bay are also good anchorages.

22) Stony Creek, off Patapsco River, south shore – Excellent protection is found in upper reaches, e.g. between Sloop Cove and Long Cove or in Nabbs Creek, as well as in other coves and creeks.

23) Frog Mortar Creek off Middle River, north shore -- One of several good creeks off Middle River; go to upper reaches of river past the marinas; the best room and pro-

tection is found in the west fork east of Martin Marietta Airport (5-7 foot or 1.5-2.1 meter depths).

Eastern Shore

24) Dun Cove, off Harris Creek, behind Tilghman Island -- Anchor in either of the tributaries extending north and northeast from the cove; Harris Creek offers good protection where it narrows before dividing into two branches; the Choptank River immediately to the south of Harris Creek also offers good protection in its tributaries and the bends of the river above Cambridge.

25) Tred Avon River, north of entrance to Choptank River -- Good anchorages can be found above Oxford in Plaindealing Creek and Trippe Creek, as well as other creeks farther up the river.

26) Miles River, behind Tilghman Point -- Best protection is found in Leeds or Hunting Creeks on the north shore, or above the bascule bridge in the river itself; Glebe and Goldsborough Creeks are also safe anchorages.

27) Wye River, north of Miles River -- Get behind one of the river's many bends, in one of the creeks to the east or anywhere around Wye Island.

28) Chester River, north of Kent Island -- About 11 miles (17.7 kilometers) upriver on the west bank, Reed Creek provides a good anchorage; the river on up to Chestertown offers good protection in several tributaries or in the river itself behind one of the many bends.

29) Sassafras River, head of the Bay -- Turner Creek, 4 ½ miles (7.2 kilometers) above the mouth on the south shore, offers the best protection, although the entrance is narrow; good protection can also be gained by anchoring off the channel at bends in the river up to Georgetown.

Remember, the anchorages mentioned here may be crowded because of their popularity. If you must look elsewhere for good protection, look for bodies of water in which an extra high tide up to 12 feet (3.7 meters) above mean high water can be handled. Also remember that if you are actually expecting the eye of a hurricane to come ashore in your area, the best protection in the Northern Hemisphere is in the left rear quadrant with respect to where the storm's eye is expected to intersect the coast (determine the left rear quadrant while facing away from the approaching storm along its projected track).

In seeking protected anchorages, also remember that a hurricane usually will produce east or northeast wind speeds of 70-100 knots, followed by lesser winds from the west or northwest. A hurricane's high winds and tides also require that anchor line scope be increased from the usual 7:1 ratio to a 10:1 ratio. If a protected harbor has limited swing room for anchored craft, two anchors should be used 180 opposed to each other. Reduce the likelihood of dragging by anchoring in sand or hard mud rather than grassy bottom or soft mud.

Waterspouts

Waterspouts are occasionally sighted in the Bay and should be avoided because of their potentially destructive nature. Strangely enough, the phenomenon occurs most often during fair weather in late summer and early fall. Fair-weather waterspouts are caused by cooler air overriding a body of warm moist air and are usually associated with cloud build-up over the Bay. At the cool/warm air interface, conflicting wind patterns often describe circular patterns, producing a usually short-lived column of wind and water with wind speeds of 50 knots or less. However, a boat struck by such a waterspout can sustain considerable damage.

Another type of more dangerous waterspout may form in association with the leading edge of a cold front or the squall line associated with a front. Such waterspouts are truly tornados over the water, and winds may exceed 200 knots. They should be avoided at all cost because of their destructive winds and low pressure interior. If a waterspout appears to be approaching your boat, steer a course 90° perpendicular to the spout's path. A moored boat in the path of a tornadic spout should have its hatches and ports open to help equalize the pressure within the boat as the spout passes.

SOURCES OF WEATHER INFORMATION AND FORECASTS

Chesapeake Bay normally is divided into two forecast areas, with Windmill Point at the mouth of the Rappahannock River being the dividing point. While this breakoff point is partly a matter of convenience, it is significant in that the portion of the Bay to the north generally experiences fronts 6-12 hours ahead of the southern Bay area. Slow moving systems also may linger 6-12 hours longer in, or even stall over, the lower Bay.

Under unusually extreme weather conditions, the Bay may be divided into four separate forecast areas to allow more detailed forecasting. Any appropriate combination of the areas may also be utilized for making forecasts. The forecast zones are: (1) north of Baltimore Harbor, (2) Baltimore Harbor to the Patuxent River, (3) Patuxent River to Windmill Point and (4) south of Windmill Point. The tidal portion of the Potomac River (5) may be singled out as a fifth forecast area (Fig. 10).

Forecasts for the ocean side of the eastern shores of Maryland and Virginia are called coastal forecasts and cover an area from Cape Henlopen, Delaware to the Virginia/North Carolina line and 20 miles out to sea. The coastal forecast normally covers this entire area at one time, but it may be broken into a northern and southern component with Chincoteague, Virginia as the breakoff point (Fig. 10).

Prudent boatmen planning an outing on the Bay should begin monitoring marine weather forecasts 12 to 24 hours in advance of their departure time. Weather-wise mariners will also start taking mental or even written notes on basic weather conditions in this same time frame. This helps one to achieve a sense of the developing weather patterns that are likely to be experienced while on the Bay.

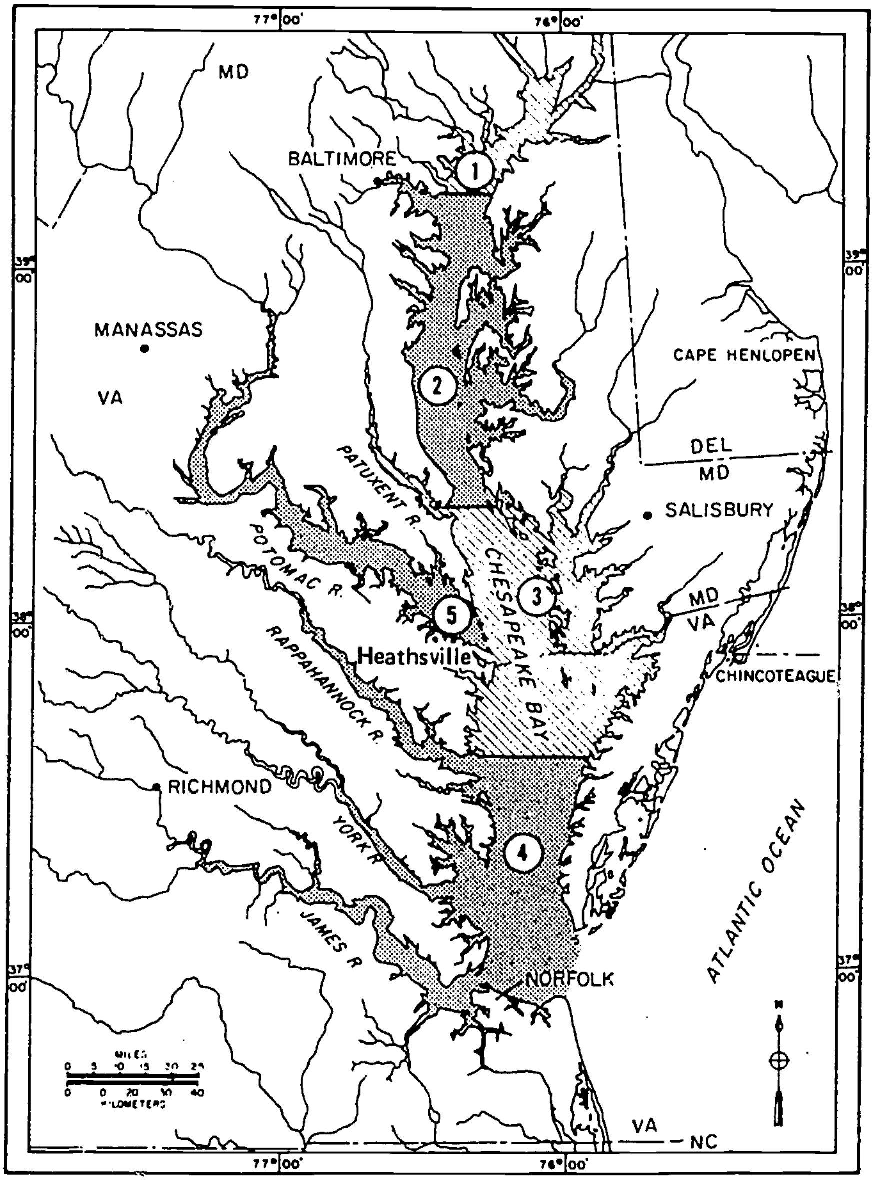


Figure 10. National Weather Service (NWS) forecast areas for Chesapeake Bay and adjacent offshore waters; locations of NWS VHF-FM transmitters are indicated by (•).

The most complete and current weather forecasts and warnings for the Chesapeake Bay and coastal areas are taped and broadcast over VHF-FM radio channels by National Weather Service offices every 4-6 minutes, around the clock. They include the latest marine forecasts, special weather statements, warnings and observations for both land and marine areas. Observations are updated every three hours by Weather Service personnel. Forecasts are updated every six hours, at approximately 5:00 a.m., 11:00 a.m., 5:00 p.m. and 11:00 p.m. Amended forecasts are issued whenever observed conditions differ significantly from the taped forecasts.

National Weather Service VHF-FM transmitters have an approximate line of sight range of 30-70 miles (48-113 kilometers), depending upon the sensitivity of individual receivers. The broadcasts from these stations can be picked up on permanent VHF radios carried in many boats, or on inexpensive portable VHF radios. More expensive portable units contain an alarm tone that is automatically sounded when weather warning broadcasts are made. Appropriate transmitter locations are indicated in Table 4 and Figure 10.

**TABLE 4.
TRANSMITTER LOCATIONS AND FREQUENCIES**

Norfolk, VA	162.55 MHz (Weather 1)
Richmond, VA	162.475 MHz (Weather 3)
Manassas, VA	162.55 MHz (Weather 1)
Heathsville, VA	162.40 MHz (Weather 2)
Salisbury, MD	162.75 MHz (Weather 3)
Baltimore, MD	162.40 MHz (Weather 2)

The U.S. Coast Guard also transmits weather information in combination with "Notice to Mariners" reports on a Single Side Band frequency of 2671.4 KHz. These broadcasts are made at scheduled times only, but have a range of 200-300 miles (322-483 kilometers). Bay forecasts are made at 9:33 a.m. and 10:30 p.m. EST from Group Hampton Roads and Group Eastern Shore. Weather warnings are broadcast upon receipt on the same frequency as well as on VHF-FM frequency 157.1 MHz (Channel 22) from Hampton Roads and Baltimore. All Coast Guard stations broadcast severe emergency weather warnings (Special Marine Warning Bulletins) on VHF-FM frequency 156.8 MHz (Channel 16).

Coast Guard weather forecast information, derived from the National Weather Service, is also broadcast at prescribed times by the Norfolk Marine Operator. Broadcasts are made at 6:00 a.m., 12:00 p.m., 6:00 p.m. and 12:00 a.m. EST on Single Side Band frequency 2538 KHz and approximately 10 minutes later on 2450 KHz. Weather warnings are broadcast when received, with repeat broadcasts customarily 15 minutes later, and then at 1-2 hour intervals.

National Weather Service offices throughout the Bay area also provide a telephone marine weather information service for the onshore mariner (Table 5). Because of the large demand for this taped message service, the lines are frequently busy.

**TABLE 5. MARINE FORECASTS
FROM TELEPHONE RECORDINGS**

FORECAST AREA	TELEPHONE NUMBER	COMMENTS
Hampton Roads and Vicinity	(804) 853-3013 (Norfolk)	Can hold line for forecaster between 6:00 a.m. and 6:00 p.m.
Lower Chesapeake Bay	(804) 222-7411 (Richmond)	Can hold line for forecaster between 9:00 a.m. and 5:30 p.m.
Baltimore to Patuxent and Tidal Potomac	(202) 899-3210 (Wash., D.C.) (301) 761-5380 (Baltimore)	Forecaster available between 9:00 a.m. - 12:00 p.m. and 1:00 p.m. - 4:00 p.m.

Another source of marine weather forecast information is commercial AM and FM radio stations and television stations. Numerous stations around the Bay include marine information in their regular weather forecasts. A few stations at the mouth of the Bay and in the Baltimore area have their own boats on the water during the boating season's weekend and holidays. These boats report current marine weather conditions and forecasts over the air. However, care should be exercised in using only commercial radio and television stations for weather information, since their forecasts and weather warnings are not always up-to-the-minute because of communication delays.

A final source of weather information, gradually being phased out, is the warning display signal. Signals are posted at many marinas, Coast Guard stations and other prominent boating centers, primarily during daylight hours only. The signals consist of a single red pennant for a small craft advisory, two red pennants for a gale warning, a single square flag with a black center for a storm warning, and two such square flags for a hurricane warning.

WEATHER SERVICE WARNINGS - WHAT THEY MEAN

SMALL CRAFT ADVISORY -- Such advisories are issued when wind and sea conditions are expected to cause problems for small craft. Although the term "small craft" has never been defined, it is considered to pertain to boats up to approximately 24 feet (7.3 meters) in length. During the warmer season (April-November), advisories are issued when winds of at least 20 knots are expected, since such winds can produce three foot (0.9 meter) waves. During the colder months (December-March), minimum conditions for issuing advisories are winds of 25 knots, which can generate up to four foot (1.2 meter) waves. Small Craft Advisories are just what they say - advice. In giving this "advice" the National Weather Service must assume that boatmen know the capabilities of their individual craft and can judge whether it is safe to venture out in their particular area.

SPECIAL MARINE WARNING -- Such warnings are issued when sudden strong winds of at least 34 knots are expected. The most frequent use of Special Marine Warnings is for approaching severe thunderstorms, but a waterspout sighting report or a strong cold front packing brief but sufficient winds might require a warning. Forecasters generally have rather limited information concerning the actual strength of winds in severe thunderstorms or the area of the Bay such storms might actually strike. Therefore, when a warning is issued for these severe storms, boatmen should immediately seek protected waters. In seeking a lee shore, remember that the strong, gusty winds associated with thunderstorms will come from the southwest to northwest direction in nearly every instance on the Bay.

GALE WARNINGS - - Such warnings are made when prolonged winds of 34-47 knots are expected. In unprotected waters, 35 knot winds can build up five foot (1.5 meter) waves. Only the largest boats should be on the Bay.

STORM WARNINGS - - Prolonged winds ranging between 48 and 63 knots warrant issuance of Storm Warnings. All boats and oceangoing ships should stay in port or seek out a safe anchorage if a Storm Warning is posted.

HURRICANE WARNINGS -- When this warning is issued, winds exceeding 64 knots are expected and every vessel should be securely moored in port or tucked into one of the many hurricane holes formerly listed. Moorings should be doubled or strengthened to withstand the extra strains that will be placed upon them. If mooring at a dock, allow for increased water heights of as much as 12 feet (3.7 meters) above normal mean high water. Insure that your boat will not ride over top of piles and risk being holed.

Chesapeake Bay has experienced Category I hurricanes, which have sustained winds of 74-95 mph and produce a storm surge 4-5 feet (1.2-1.5 meters) above mean sea level. At least once, in 1933, the Bay experienced a Category II hurricane, which had sustained winds up to 96-110 mph and generated a storm surge of 6-8 feet (1.8-2.4 meters) above mean sea level. Meteorologists believe the Bay could encounter a Category III storm with sustained winds of 111-130 mph and a storm surge of 9-12 feet (2.7-3.7 meters).

WEATHER AND BOATING SAFETY

The National Weather Service provides the marine weather forecasts and warnings to enhance the enjoyment and safety of the boating community. The forecast and warning system is not infallible, however. For example, thunderstorms can produce dangerously strong winds over a small area which escape detection by the Weather Service's observation system. Therefore, boatmen must remain aware of developing weather conditions when underway and be able to reach safety when conditions become threatening. As mentioned before, it also is imperative that boatmen know how ıeir craft will handle under various wind and wave conditions that might be encountered on the Bay, and heed the weather accordingly. The smart skipper will keep an alert weather eye while he enjoys the Bay's unparalleled boating resources.

APPENDIX

BOATING SAFETY CLASSES

For additional information on boat handling, weather and boating safety tips, contact the U.S. Coast Guard's Fifth District Office (431 Crawford Street, Portsmouth, VA 23705) or the local U.S. Power Squadron and ask about enrollment in their boating safety classes. A comprehensive boating home study course and other boating safety information are available from the Safety Officer, Virginia Commission of Game and Inland Fisheries, P. O. Box 11104, Richmond, VA 23230.

MARITIME EMERGENCY AND DISTRESS RADIO PROCEDURES

SPEAK SLOWLY AND CLEARLY

CALL:

1. If you are in DISTRESS (i.e. threatened by grave and imminent danger) transmit the International Distress Call on either 2182 KHz (AM, MAE or SSB), 156.8 MHz (VHF-FM) or Channel 9 for Citizens Band "MAY-DAY (repeated 3 times) this is (your vessel's name and call sign repeated 3 times)."*

2. If you need INFORMATION or ASSISTANCE from the COAST GUARD (other than in a DISTRESS), call "Coast Guard" on either 2182 KHz or 156.8 MHz (the Distress and Calling frequencies). In this situation you will normally be shifted to a common working frequency allowing the DISTRESS frequencies to remain open.

*The Radiotelephone Alarm Signal (if available) should be transmitted prior to the Distress call for approximately one minute. The Radiotelephone Alarm Signal consists of two audio tones, of different pitch, transmitted alternately. Its purpose is to attract the attention of persons on watch and shall only be used to announce that a distress call or message is about to follow.

IF ABOARD A VESSEL IN TROUBLE - GIVE:

1. WHO you are (your vessel's call sign and name).

2. WHERE you are (your vessel's position in latitude/longitude or true bearing and distance in nautical miles from a widely known geographical point; local names known only in the immediate vicinity are confusing). Indicate method of determining your position: give actual LORAN readings, depth of water, radiobeacon bearings, etc. Indicate which information you are certain of and which position information may be doubtful.

3. WHAT is wrong (nature of distress or difficulty).

4. KIND of assistance desired.

5. NUMBER of persons aboard and the condition of any injured.

6. Present seaworthiness of your vessel.

7. Description of your vessel; length, type, cabin, masts, power, color of hull, superstructure and trim.

8. Your listening frequency and schedule.

9. Emergency equipment: color and type of flares, lights, number and description of life jackets, flotation cushions and liferafts.

10. End your message with: "This is (your vessel's name and call sign). Over."

11. Wait for a response. If no answer, repeat your call. If still no answer, try another channel or frequency.

IF OBSERVING ANOTHER VESSEL IN DIFFICULTY - GIVE:

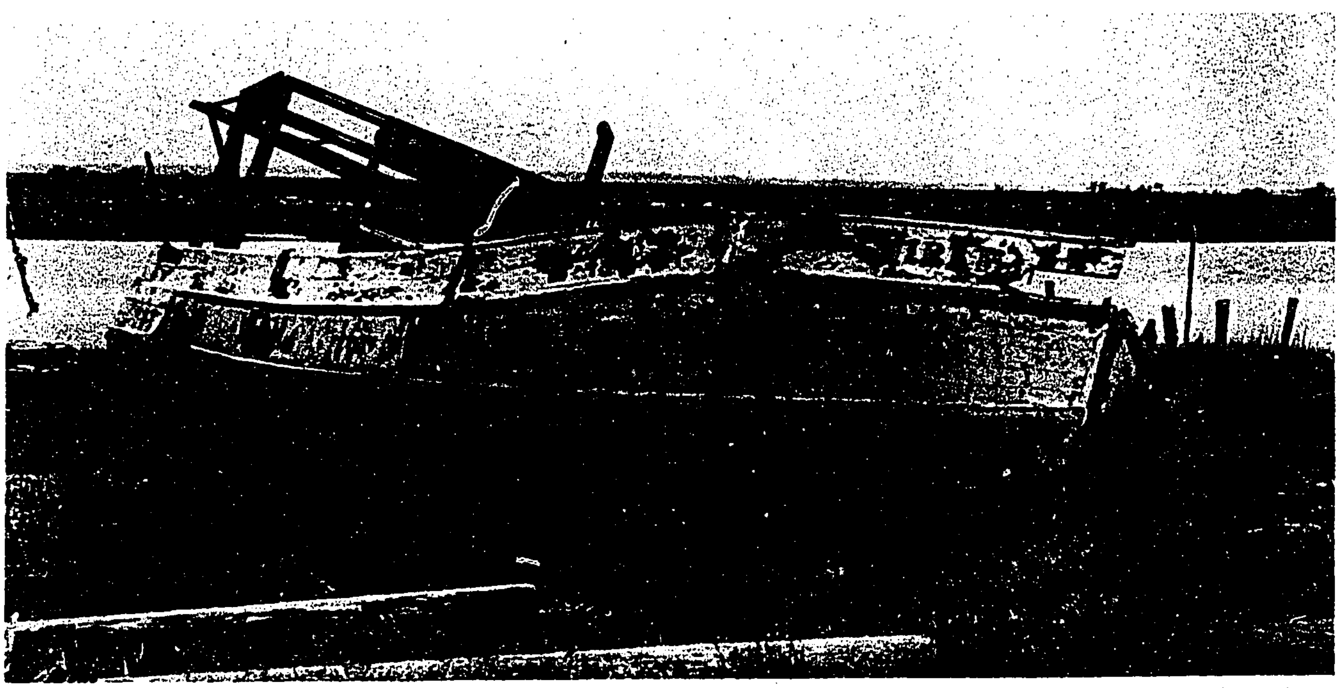
1. Your position, and (if possible) the bearing and distance of the vessel in difficulty.
2. Nature of distress or difficulty.
3. Description of the vessel in distress or difficulty.
4. Your intentions, course and speed, etc.
5. Your radio call sign, name of your vessel, listening frequency and schedule.

The Distress Call has absolute priority over all other transmissions and need not to be addressed to any particular station. Any mariner hearing a Distress Call shall immediately cease all transmissions capable of interferring with the distress message and shall continue to listen on the frequency which the call was heard.

IF YOU HAVE A MEDICAL CASE - SEND:

1. Name of vessel and call sign.
2. Position.
3. Patient's name, age, sex, race and nationality.
4. Nature of problem (symptoms, locations of pain or injury and whether or not the patient is conscious).
5. Whether or not the patient is ambulatory (able to walk).
6. Patient's temperature and pulse. Difficult breathing?
7. Whether or not patient is bleeding, and if so, is bleeding controlled?
8. Duration of pain.
9. Previous similar episode (if yes, treatment and diagnosis).
10. Medicine taken and medicine available.
11. Private physician's name, phone number and hospital address.
12. Description of vessel, intentions and maximum speed possible.
13. Weather: wind direction and speed, wave height and visibility.

Sources: *Mid Atlantic Marine Communications*, Fifth Coast Guard District, U.S. Coast Guard, Summer 1979; *Marine Communications for the Recreational Boater*, SSIC 16772, U.S. Coast Guard, 1979.



Dick Cook