Coast Lines

SUMMER 2002

COMMONWEALTH OF MASSACHUSETTS
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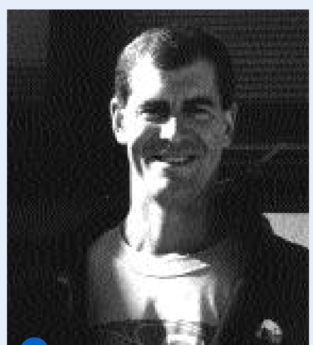


MASSACHUSETTS OFFICE OF COASTAL ZONE MANAGEMENT DIRECTOR TOM SKINNER AT THE ANNUAL CZM COASTSWEEP CLEANUP...

Dear Coastlines Reader:

The question of where and when a hurricane strikes our shores—and its intensity if it does—has confounded meteorologists, insurance adjusters, emergency professionals, and coastal managers for years, but historically, these tropical storms regularly reach Massachusetts. Over the last 100 years, with the exception of the 1920s, the Bay State was hit with at least one major hurricane every decade. Because we haven't seen a serious tropical storm since Hurricane Bob in 1991, however, it can be easy to forget the kind of devastation hurricanes can bring. And although Bob left almost $700 million dollars of damage in its wake, it pales when compared to storms that hit Massachusetts in the mid-20th Century. With all the coastal development in the last 50 years, it is important to remember that Massachusetts is vulnerable to these major weather events.

To help our readers prepare for the inevitable return of a significant storm, the focus of this edition of Coastlines is hurricanes. Along with basic information on Bay State hurricanes and their potential impacts, this edition includes articles on how to build and rebuild to withstand a storm, tips on how to prepare for hurricane season, and information on a wide range of tools available for reducing risks in hurricane-prone areas.

On another front, you may have noticed that our Coastlines format has changed. To provide more detailed information on a wider variety of coastal issues, we have replaced our quarterly newsletter with this semi-annual magazine. Each edition will now include features such as a coastal community profile; a guest column from a noted coastal professional; a "Not Just for Kids" page with interesting activities for children, parents, and teachers alike; and an in-depth spread on a major coastal issue. We chose hurricane preparedness as the feature for our newly revised Coastlines to inform our readers on the latest regulatory and technical information on this issue, and to help people prepare their families and property for the day the next big storm comes. You'll also find many articles on other topics, along with some old features like "Ask Joe" and CZScience.

Please let us know how you like the new Coastlines, as well as any issues you would like us to cover in future editions. For regular updates on issues affecting the coastal zone, sign up for our new monthly e-mail newsletter, CZ-Mail. (See our Web site at www.mass.gov/czm for details.)

Sincerely,

Tom

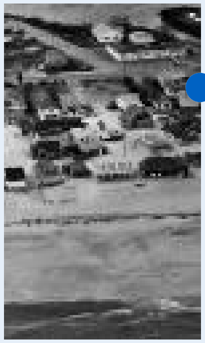
Tom Skinner
CZM Director

Coast Lines

Preparing for hurricane season…6

Public access to beaches…44

SUMMER 2002: focus on hurricanes



Coastal erosion and shoreline change…20

TABLE OF CONTENTS, continued

SUMMER 2002: ebb & flow

Rocky outcroppings at Wingaersheek Beach are perfect for summer exploration.

photo by Arden Miller

MEMA: THE COMMONWEALTH'S FRONT LINE FOR HURRICANE PREPAREDNESS AND RESPONSE

By Governor Jane M. Swift

As the summer draws to a close, we may follow, with great interest and anticipation, the path of a tropical storm or hurricane as it accelerates northward along the Atlantic Coast toward New England. As Governor, I am comforted to know that the Massachusetts Emergency Management Agency (MEMA) has been tracking this storm for well over a week, from its birth off the coast of Africa, as it races across the Southern Atlantic toward the Caribbean. If the storm does indeed head our way, the State Emergency Operation Center, located at MEMA Headquarters in Framingham, will spring to action as members of the Massachusetts Emergency Management Team (MEMT) arrive for the anticipated "long haul."

During a storm event, MEMA's Communications Center, a daily 24-7 operation, is in continual contact with my office, MEMA's four Regional Offices, key local officials, state agencies, and threatened coastal and inland communities. Volunteer amateur radio operators also ensure that their 14,000 member statewide network is set to help out. Together with this information and the constant updates directly from the National Weather Service in Taunton, we plan our response to the emergency at hand.

Dealing with a hurricane does not begin here, however. MEMA is the state agency responsible for coordinating the Commonwealth's storm preparation and response. The members of the MEMT are liaisons of scores of federal, state, local, private, and volunteer agencies and organizations that meet, train, and exercise together on a monthly basis for just such an occasion. The MEMT is the "911" for local communities when an event presents problems that exceed city or town capabilities. The impressive array of agency representatives at hand means that someone in the State Emergency Operations Center has the ability to quickly solve a community's problem, by providing additional equipment, personnel, or technical expertise.

Preparedness is an important spoke on the wheel of emergency management. MEMA's Regional Offices, as well as the agency's Planning and Training Divisions, work very closely with all 351 local municipalities to develop and exercise their own unique Comprehensive Emergency Management Plan to ensure each community has a viable, planned response in place. Plans are also developed on the state level as well. The 25-mile backup of 1996 Labor Day traffic, attempting to exit Cape Cod in anticipation of the near-miss Hurricane Eduard, was the catalyst for the development of the Cape Cod Emergency Traffic Plan. MEMA, along with the National Guard, the State Police, the Coast Guard, the Red Cross, the Army Corps of Engineers, and local officials crafted a plan to more efficiently get traffic over the Cape's two bridges, including a housing strategy to get motorists off the highway if high winds forced the closing of the bridges.

During the early summer months, MEMA, in conjunction with the National Weather Service, conducts local hurricane workshops, where citizens and officials alike can discuss the proper steps for preparation. The MEMT has a two-day hurricane workshop and tabletop exercise in coordination with "Massachusetts Hurricane Preparedness Week," which I will declare this year during the week of July 21-27.

Once a storm has passed and its damage has been done, MEMA's Disaster Recovery Division goes into action, assisting in the evaluation of the destruction caused by the high winds, torrential rains, flash floods, storm surge, and coastal erosion. (See *Kudos to the Storm Team* on page 4 for information on the Executive Office of Environmental Affairs role in these assessments.)

Local communities may be looking for assistance to deal with the costs associated with the cleanup and damage to infrastructure, from seawalls to municipal buildings to roads and bridges. MEMA works with the federal government and the state legislature to secure funds for the cleanup. In the past decade, through MEMA's efforts, local communities have received almost $42 million in hurricane-related assistance, the greatest being over $32 million to 11 counties from Hurricane Bob in 1991. While much of the focus during a hurricane is on the coast, inland communities suffer as well, particularly from flooding. In fact, in 1999, Tropical Storm Floyd produced flooding in Central and Western Massachusetts that required over $2 million of state assistance to make the necessary repairs.

With MEMA leading the Commonwealth's team to deal with the destruction nature can deliver, the citizens of Massachusetts can feel confident that the proper steps have been taken to ensure their safety and security. It is important that you do your part as well by listening to advisories from MEMA and your local officials, particularly evacuation notices, so we can minimize loss to life and property in the face of these terrible storms.

GOVERNOR JANE M. SWIFT AND SECRETARY OF ENVIRONMENTAL AFFAIRS BOB DURAND AT THE OPENING OF THE DEER ISLAND PUBLIC ACCESS TRAIL, MAY, 2002.

KUDOS TO THE STORM TEAM…

By Bob Durand, Secretary of Environmental Affairs

When hurricane season hits, the Storm Team (technically known as the Massachusetts Rapid Response Coastal Storm Damage Assessment Team) is ready to spring into action. State, local, and federal team members volunteer to venture out immediately after a major storm to provide valuable information on the location and extent of damage. These timely reports help to target emergency services, expedite disaster relief, keep coastal residents safe, minimize property damage, and develop plans to reduce future impacts. Although all of the hearty Storm Team volunteers deserve tremendous thanks for going out in horizontal rain, hurricane-force winds, knee-deep snow, and whatever else a storm can throw at them, the efforts of two individuals stand out—Rebecca Haney and Joe Pelczarski.

SECRETARY OF ENVIRONMENTAL AFFAIRS BOB DURAND WITH COMMONWEALTH CITATION FOR OUTSTANDING PERFORMANCE AWARD WINNERS, JOE PELCZARSKI AND REBECCA HANEY.

Rebecca Haney, Coastal Geologist from the Massachusetts Office of Coastal Zone Management (CZM) serves as team leader, making sure that all areas are covered, giving direction and advice to team volunteers, and staying in constant contact with management to determine when the team should be deployed. Rebecca's focused dedication provides the extensive support team members need to perform meaningful assessments under difficult conditions. CZM's Joe Pelczarski, who serves as the Executive Office of Environmental Affairs (EOEA) emergency management liaison, also plays a critical role from the state's emergency operations center at the "Bunker," which is operated by the Massachusetts Emergency Management Agency (MEMA). Joe fields calls from the Storm Team, analyzes the incoming information, and conveys critical details to the appropriate officials so communities get the help they need as soon as possible. Joe's around-the-clock efforts are invaluable, and he has become the "go-to-guy" and institutional memory for the others who staff the Bunker.

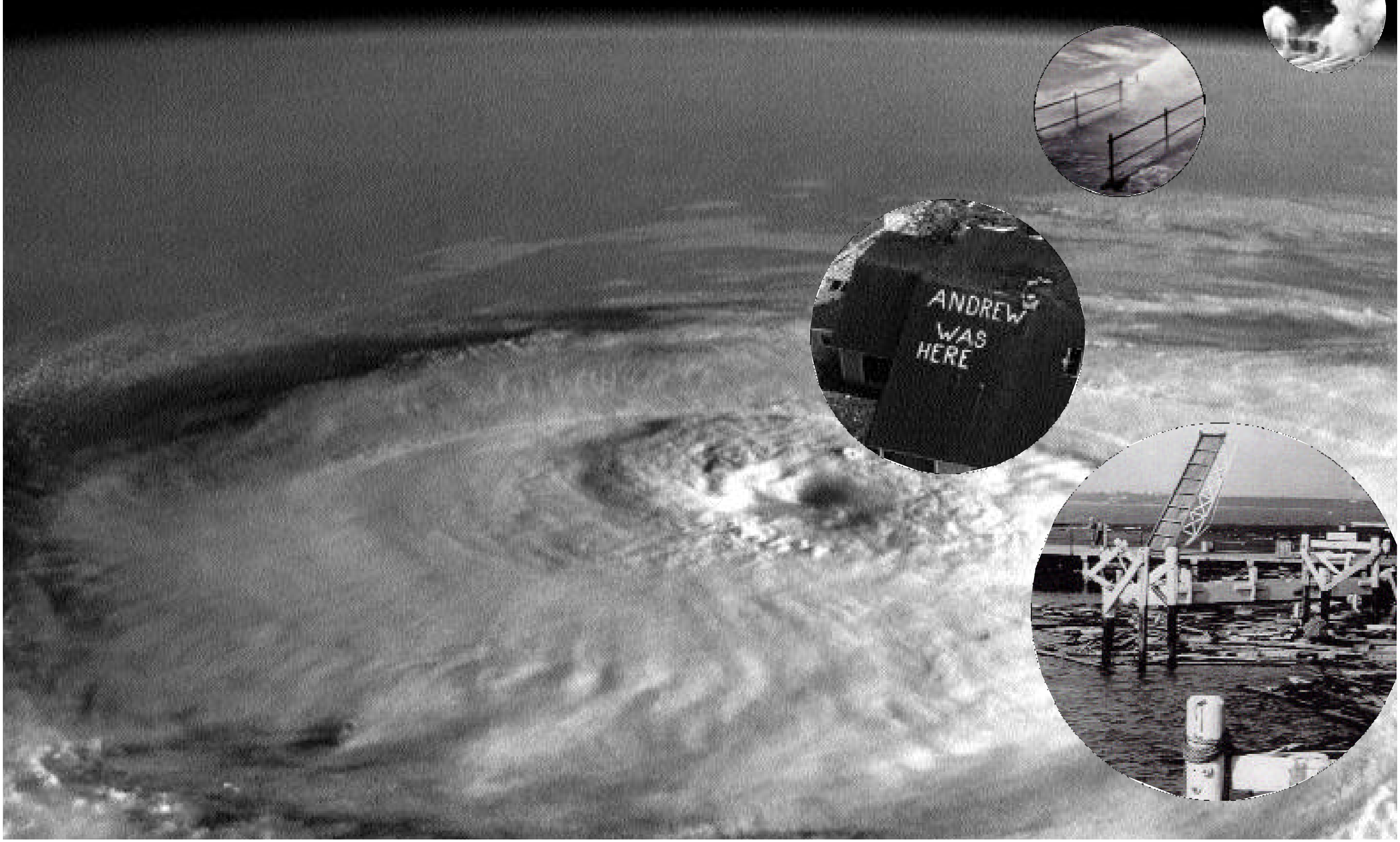
THE STORM TEAM IDENTIFIES DAMAGED AREAS AS SOON AS POSSIBLE TO HELP EXPEDITE DISASTER RELIEF.

Through the efforts of Joe, Rebecca, and other volunteers, the Storm Team helps the Commonwealth and its communities get federal disaster relief funds as quickly as possible. Before the team was established, damage estimates weren't calculated until after the storm had passed, and officials evaluating the damage were unaware of which areas were hardest hit. This delay posed significant hardship to homeowners and communities in need of financial assistance to repair and rebuild after coastal storms. By assessing damage during the storm, the Storm Team significantly shortens the process by identifying areas that are eligible for relief and providing initial damage estimates. This information is used by MEMA personnel to provide federal officials with the details they need to process federal assistance claims. For individuals and communities facing the daunting prospect of cleanup and rebuilding, this streamlined process is incredibly important, reducing the financial costs of lost business days and temporary relocation.

EOEA is proud of the Storm Team and its dedicated leaders who serve the Commonwealth in its times of greatest need. That is why I nominated Joe and Rebecca for a Commonwealth Citation for Outstanding Performance, an honor they received and richly deserve. And if on television you happen to see Rebecca in her raingear or Joe at the Bunker, you may rest assured they are going beyond the call of duty to help protect the citizens of Massachusetts.

feature

HURRICANE SEASON IS HERE!



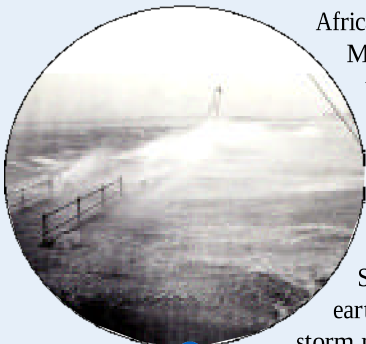
IT'S HERE…GET PREPARED FOR HURRICANE SEASON!

By Anne Donovan, CZM

June 1 marks the beginning of the 2002 hurricane season—and all signs point to an active 6 months of storms. Generally peaking in August and September, the hurricane season officially extends all the way through November. Although Massachusetts has been spared from a truly major hurricane for more than a decade, now is the time to get prepared for the inevitable return of a severe storm.

ANATOMY OF A HURRICANE

The hurricanes that make their way to the Bay State are born in the tropical waters off the coast of Africa, in the Caribbean, or in the Gulf of Mexico. These cyclones are giant heat engines that thrive on the warmth and moisture of these tropical seas, where storms typically flourish. If a developing storm encounters a wind pattern that sets off the characteristic counter-clockwise rotation of a Northern Hemisphere cyclone (in the Southern Hemisphere, the rotation of the earth creates a clockwise motion), a tropical storm may be born, and once born, given a name and an identity (see *It's All in a Name* on page 10). Spiraling around its extreme low-pressure center, which will ultimately become the "eye," the storm siphons heat and moisture from the sea. Sucked through the eye and above the storm, the air cools and condenses, expanding and falling as rain. As long as the heat and the moisture source continues, the storm can grow in intensity, spiraling wildly around the eye and growing up to 500-miles wide.



HURRICANE OF 1938: HEAVY SURF IN WOODS HOLE.

The energy created through a hurricane is tremendous; if it could possibly be harnessed, one hour of hurricane energy would supply the electrical needs of the entire United States for a year. The quantity of water involved is also staggering. A typical hurricane drops 2 billion tons of water a day.

Northeasters—named for the direction their winds come from—are also cyclones, but start in the north Atlantic when cold air from the land clashes with warm ocean temperatures from the Gulf Stream. Unlike hurricanes, whose season runs from late spring through fall, Northeasters are typically seen in Massachusetts from October to April. But, these major weather events can look very much alike, despite the differences in their origins.

THE TRIPLE THREAT: SURGE, WINDS, AND FLOODS

In Massachusetts, we are in the unenviable position of being vulnerable to all the possible threats from a hurricane: relentless storm surge at the coast, high winds battering coastal and inland areas, and torrential floods in streams and rivers from the tip of Cape Cod to the Berkshires. While recent tropical storms have caused all three of these conditions in the Bay State, it has been almost 50 years since a Category 3 hurricane has hit here, and more than 10 years since we've seen a Category 2. (See *1 through 5: The Hurricane Categories* on page 11.)

STORM SURGE - Pushed toward the shore by powerful winds, storm surge is a dome of water, often up to 50 miles wide. Topped with violent storm waves, this pile of water climbs over the normal tide. With luck, the surge will hit at low tide, consequently muting its impact. But, on top of a high tide, storm surge can be devastating, raising water levels by more than 25 feet at its worst and essentially bulldozing everything in its path. Luckily, hurricanes are generally fast-moving storms in New England, with the worst of the winds passing in a manner of hours. Unlike Northeasters that can linger over several tidal cycles, the narrow window for hurricane storm surges often misses high tide altogether. This numbers game doesn't change the fact that if storm surge and high tide coincide, the outcome can be disastrous. For coastal areas, this wall of water holds the most potential danger. With the most severe impacts felt near where the eye of the storm hits land, storm surge can crush vessels and structures, erode miles of beach, and undermine inappropriately designed or low-lying buildings.

WINDS - Gusting at least 74 miles per hour (mph), hurricane winds can be devastating. These winds pick up debris of all kinds, transforming it into missiles hurtling through the air. Winds also tear at rooftops and shingles, blow in windows, and when strong enough, can even topple over mobile homes and other small structures, as well as larger buildings in the wrong place at the wrong time. Hurricanes can also spawn tornadoes, with their extreme but targeted wind damage.

All hurricane photos, unless otherwise noted, courtesy of NOAA

FLOODS - The rains from hurricanes can continue well after the wind and storm surge have passed. In New England, these storms can dump up to 6 to 12 inches of rain, flooding streams and rivers throughout the state. These rising flood waters damage roads, homes, and buildings of all kinds, disrupting transportation, contaminating water supplies, and creating a waterlogged mess requiring months to years of cleanup. It is this lingering threat that proves most deadly, with more people losing their life from hurricane floods in the last 30 years than from storm surge and wind combined.

THE COMMONWEALTH COASTLINE AT RISK

Mid-Atlantic, southeastern, and Gulf States usually bear the brunt of hurricane forces, but by virtue of our geography, Massachusetts is also vulnerable. Jutting eastward into the Atlantic, Cape Cod, the Islands, and everything to their west lie exposed to storms tracking up the east coast. The cooler waters off our shores do offer some protection, sapping the energy from the storm as it approaches. Although this hurricane-muffling system keeps us relatively sheltered from a Category 4 or 5 hurricane, it is no guarantee. In fact, four major hurricanes (Category 3) hit Massachusetts in the last century alone.

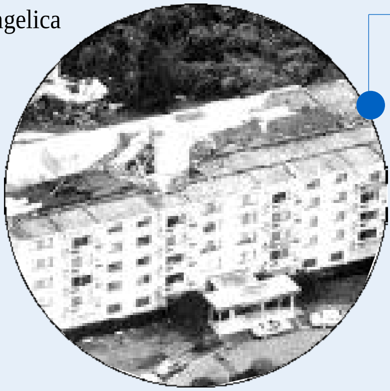
The counter-clockwise motion of the hurricane means that the winds are worst to the right of the storm path, while the rains are worst to the left. Storm surge is greatest right around the eye. For storms with eyes that make landfall along the South Coast, therefore, Buzzards Bay gets the worst of the storm surge, acting like a giant funnel, channeling this dome of water toward these susceptible coastal communities. Cape Cod, along with the storm surge, gets battered with southwesterly winds and waves. When the eye hits east of the Cape, however, the predominant winds are from the northeast, causing the storm to act more like a Northeaster, packing its biggest punch from Cape Cod Bay northward.

These natural risks from hurricanes have existed for centuries, significantly altering the Commonwealth's landscape by periodically sculpting the shoreline, leveling inland forests, and flooding rivers, streams, and surrounding lowlands. The unprecedented development in Massachusetts over the last 50 years, especially along the coast, means that the periodic and natural effects of hurricanes can mean tremendous losses.

THE WORST MASSACHUSETTS HURRICANES OF THE 20TH CENTURY

The worst hurricanes to hit Massachusetts in the last 100 years, in reverse order, are: Hurricane Bob in 1991; "the twins" from 1954, Hurricanes Carol and Edna; and last but not least, the Great New England Hurricane of 1938.

HURRICANE BOB - Developing in the central Bahamas on August 16, 1991, Hurricane Bob intensified and accelerated north-northeastward, paralleling the East Coast, and barreling into Block Island, Rhode Island, and later Massachusetts on August 19. Although this Category 2 hurricane was not among the worst in terms of wind speed or storm surge, the property damage totals alone secured a top-three spot for Hurricane Bob. The Category 3 storms from earlier in the century packed more of a punch, but the extensive coastal development in the second half of the 20th Century left many more homes and other structures in the path of Bob's fury. Overall, New England experienced $680 million in damage, $39 million in Massachusetts alone. Most of southeast Massachusetts faced hurricane-force winds, with coastal communities in these areas seeing sustained winds of 75 to 100 mph. Brewster and North Truro experienced gusts of 125 mph, with North Truro enduring sustained winds of 100 mph. Trees and utility polls were routinely damaged, and 60 percent of the residents of southeastern Massachusetts lost power. The storm surge in Buzzards Bay was 10 to 15 feet, ripping boats from their moorings, destroying homes, and eroding large sections of coastline. Onset, Bourne, Mashpee, and Wareham saw the worst surge, 12 to 15 feet. Mattapoisett was also hit hard, with 29 of 37 homes destroyed on Cove Street and 32 of 35 homes destroyed on Angelica Point. Southern-facing shorelines experienced significant erosion, with some spots along Martha's Vineyard and Nantucket losing up to 50 feet of shoreline.


HURRICANE BOB: THE ADMIRALTY APARTMENTS IN FALMOUTH, AFTER BOB BLEW OFF A SECTION OF THE ROOF.

HURRICANE PREPAREDNESS KIT

We've all seen it on the news. Some of us may even have experienced it first hand. Long lines at grocery stores and empty shelves at home supply warehouses as the hurricane bears down on some unfortunate coastal community. Like most things in life, the time to prepare for a hurricane is well before you hear warnings on your local radio station. In fact, the time to prepare for the 2002 hurricane season is now.

To help, the Massachusetts Office of Coastal Zone Management (CZM) has compiled a detailed Web page, listing links to all the best sources of information on hurricane preparedness. The site provides information on:

- Building and rebuilding to withstand the storm.
- Supplies to assemble at the beginning of hurricane season.
- How to develop an emergency plan for your family.
- Tips for what to bring to a storm shelter.
- Information on what to do with your pets in a weather emergency.
- Boat protection strategies.
- How to best protect yourself and your family before, during, and after the storm.
- Hurricane tracking.
- Storm prediction and hurricane warnings.
- Flood insurance.

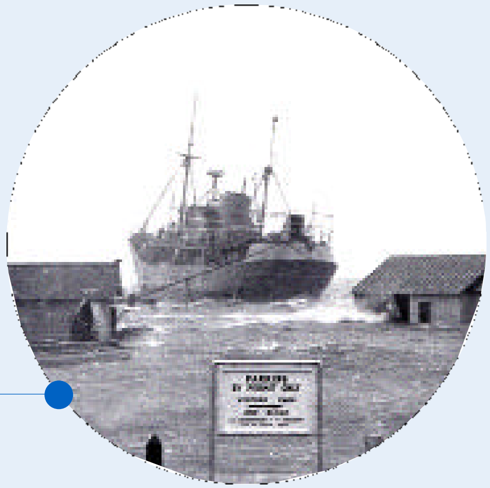
To access the CZM Hurricane Preparedness Kit, check out our Web site at: www.mass.gov/czm/hurricanes.htm. If you don't have Web access, call the CZM Information Line at (617) 626-1212 and we'll send you a printed copy. ACT NOW AND DON'T GET CAUGHT OUT IN THE RAIN AND HURRICANE-FORCE WINDS!

HURRICANE FRAN DOES SOME SERIOUS DAMAGE IN NORTH CAROLINA.

1954 - In this year, not one but two Category 3 hurricanes hit New England, Carol and Edna. This double-whammy began at the end of August when Carol formed in the Bahamas. After several days of slow northward progress, Carol accelerated rapidly the evening of August 30, passing just to the east of Cape Hatteras, North Carolina, and continuing toward eastern Long Island and southeastern Connecticut for an August 31 landfall. Most of eastern Massachusetts saw sustained winds of 80 to 100 mph, toppling trees and miles of power lines. Strong winds caused devastation from eastern Connecticut to Cape Cod, ruining 40 percent of apple, corn, peach, and tomato crops. Making landfall just after high tide, Carol's storm surge caused massive flooding, with the Somerset and New Bedford areas receiving the worst of it in Massachusetts. New Bedford's storm surge was over 14 feet. Rainfall of 2 to 5 inches spread across the region, and peaked in north central Massachusetts at 6 inches. Throughout New England, 4,000 homes, 3,500 cars, and 3,000 boats succumbed to Carol, and most of eastern Massachusetts lost phone service and power. And if that wasn't enough . . .

Following a track slightly to the east of Carol, Hurricane Edna barreled up the East Coast, passing over Martha's Vineyard and Nantucket on September 11. All of eastern Massachusetts faced winds of 75-95 mph, with peak gusts on Martha's Vineyard of 120 mph. Portions of eastern Massachusetts and nearly all of Cape Cod and the Islands lost power. The 6-foot storm surge coupled with a rising tide caused severe flooding on Martha's Vineyard, Nantucket, and Cape Cod, and many boats were lost in this region as well. Because Carol had so heavily eroded beaches just days before, these areas were more vulnerable to this second storm. (See *The Art and Science of Identifying Flood Zones* on page 26 for more on how cumulative impacts and a lack of recovery time can compound the destructiveness of a storm.) Also, with the storm passing to the east, a heavy rainfall of 3 to 6 inches covered most of Massachusetts, with northeastern parts of the state receiving 7 inches. Still saturated from the rains of Carol, the area experienced extensive urban and stream flooding, with street washouts common, especially in northeast Massachusetts where rivers rose several feet above flood stage. Overall, 21 people died throughout New England as a result of this storm.

Storms are unpredictable, and "100-year" events can happen in rapid succession. (See *100 Year Floods Don't Come on Schedule* on page 15.) Less than a year after Carol and Edna, Connie and Diane brought more destruction to the region. Both storms started as hurricanes, but came ashore in North Carolina, weakened, and moved northward bringing colossal amounts of rain. Together, they dumped almost 25 inches of rain in parts of Massachusetts, causing unprecedented flooding, with 40 percent of downtown Worcester submerged. More than 100 homes were lost in New England, another 1,500 damaged, and 90 people were killed.



HURRICANE OF 1954: ALBATROSS III BREAKING LOOSE FROM A PIER IN WOODS HOLE.

1938 - Undoubtedly, the Massachusetts hurricane of the century was the Great New England Hurricane of 1938. Developing off the Cape Verde Islands on September 4, this storm took an unusual track over the Gulf Stream, maintaining its strength over these warm waters until it crashed into Long Island on September 21. The winds were devastating, with the Blue Hill Observatory recording the strongest winds ever for the region, 121 mph sustained winds and gusts of 186 mph. Roofs, trees, and crops were extensively damaged and power outages were widespread, lasting for weeks in some areas. The storm surge was substantial, causing 18 to 25 foot tides from New London east to Cape Cod. Downtown Providence was covered with 20 feet of storm tide and sections of Falmouth and New Bedford were buried under 8 feet of water. Western Massachusetts saw 3 to 6 inches of rain. In Springfield, the Connecticut River rose 6 to 10 feet above flood stage. Overall, 8,900 buildings were destroyed in New England, and another 15,000 were damaged. Coastal communities were decimated; 2,600 boats were destroyed and another 3,300 damaged, and fishing fleets suffered terribly, with 2,605 vessels destroyed and 3,369 damaged. A total of 564 people were killed and another 1,700 injured in southern New England.

WHAT'S IN THE BAY STATE'S FUTURE?

When a storm the size of the '38 Hurricane hits again, emergency management professionals expect considerable flooding, erosion, and property loss. Sixty-four years ago, Massachusetts was predominantly farmland, and what development existed along the coast was mostly small, summer cottages. Now, sprawling cities and suburbs have replaced open farmland; coastal communities face continual construction along the shore with year-round residences, many of substantial value; and what isn't developed has largely been transformed from farm to forest. Storm surge in developed areas will swallow houses, businesses, and roads along with beaches and dunes. Torrential rains will find more impervious surfaces, increasing runoff and exacerbating flooding impacts. Wind will topple trees, small structures, and much that is not adequately anchored. The storm surge and floods will wreak havoc on septic systems, oil tanks, and the many other low-lying products of development vulnerable to the onslaught of water.

Hurricane Bob clearly demonstrates our increased vulnerability to coastal storms. At only a Category 2 hurricane, Bob caused millions of dollars of damage. Even the Blizzard of '01, a Northeaster with 45 mph sustained winds and a storm surge of only 2.5 feet (which would be equivalent to a relatively lackluster tropical storm), caused significant damage along our developed coastlines, crumbling seawalls and flooding low-lying roads. Stronger winds and a higher storm surge would pose a far more significant threat to coastal communities.

2002 HURRICANE FORECAST

Dr. William Gray of Colorado State University, world-renowned hurricane forecaster, indicates that 2002 is shaping up as an active year. On average, we see almost 10 tropical storms each year in the Atlantic. This year, Gray's April predictions call for 12 named tropical storms, 7 of these hurricanes, and 3 of these major hurricanes (at least a Category 3). This forecast says there's a 75 percent probability of one of these major hurricanes hitting somewhere along the U.S. coast. (Gray's forecast will be updated May 31. See the Colorado State University Web site at http://tropical.atmos.colostate.edu/forecasts/ for details.)

IN THE AFTERMATH OF HURRICANE FLOYD, PETS ARE RESCUED IN NORTH CAROLINA.

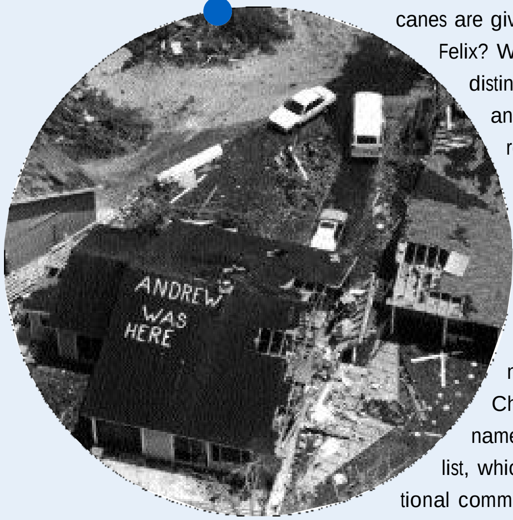
photo courtesy of FEMA

6 STEPS TO PREPARE FOR HURRICANE SEASON

Before the storm, the Massachusetts Emergency Management Web site (http://www.state.ma.us/mema/prepare/hurricane.htm) suggests you take the following actions to get prepared:

- Plan and practice evacuation routes. Your community may have a designated route; contact the local emergency management agency for details.
- Assemble a disaster supply kit in a waterproof container that includes nonperishable foods, drinking water in non-breakable containers, cooking utensils (including a can opener), identification and valuable papers in a water-proof container, personal hygiene items, first aid kit, medications, battery-operated radio, flashlight, extra batteries, sleeping bag, pillow, sheets, change of clothing, rainwear, and toolkit.
- Make arrangements for pets. It is the policy of shelters not to allow pets. You may want to contact animal boarding facilities or hotels for emergency information.
- Protect your windows. Permanent shelters are the best protection, but plywood panels will also work.
- Purchase flood insurance. (See Flood Insurance …Are You Covered? on page 15.)
- Develop an emergency communication plan. If family members get separated during a disaster it is helpful to have a friend or relative, outside the impacted area, who can be contacted and told everyone is ok.

HURRICANE ANDREW LEFT HIS MARK.



IT'S ALL IN THE NAME

Did you ever wonder why tropical storms and hurricanes are given names like Chantal and Felix? Weather watchers found that distinctive names are more easily and effectively communicated, reducing the confusion of using coordinates to label a storm. In 1953, the U.S. Weather Service began using women's names, abandoning an earlier plan to use names from the phonetic alphabet (Able, Baker, Charlie). Since 1979, men's names have been added to the list, which is now kept by an international committee of the World Meteorological Organization. Six lists are used in rotation, so the names for 2002 will be used again in 2008, with one major exception. When a storm is particularly deadly or costly, the name is retired and a new name beginning with the same letter replaces it. On the 2002 list, Cristobal replaced Cesar, Fay replaced Fran, and Hanna replaced Hortense.

HERE ARE THE NAMES YOU CAN EXPECT TO SEE DURING THE 2002 HURRICANE SEASON:

Arthur
Bertha
Christobal
Dolly
Edouard
Fay
Gustav
Hanna
Isidore
Josephine
Kyle
Lili
Marco
Nana
Omar
Paloma
Rene
Sally
Teddy
Vicky
Wilfred

UNPREDICTABILITY AND PREPAREDNESS

Any tropical storm that reaches the Bahamas has the possibility to hit Massachusetts. The tracks of these fickle storms are extremely difficult to predict, however. In fact, the forecasted track of a hurricane 72 hours before expected landfall can be off by as much as 248 miles in any direction. At the 36 hour mark, this estimated error is only down to 127 miles, meaning that a storm expected to be a direct hit for Martha's Vineyard could ultimately make landfall as far west as the Connecticut River or as far east as George's Bank. Even 12 hours before landfall, the resolution is only within 47 miles.

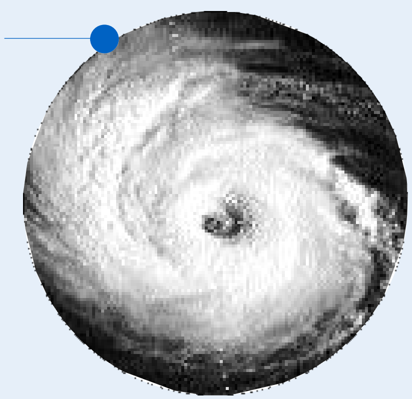
This unpredictability exacerbates the biggest problem when a hurricane approaches: time to prepare. When few people lived along the coast, evacuation took little time. Now, even with the improvements in forecasting and the advanced warning coastal and riverside residents will receive, evacuations must be called for before the exact location of hurricane landfall is known with certainty. The Bourne and Sagamore bridges, for instance, close with winds of more than 75 mph, a condition that is likely to occur hours before the eye descends on the Cape. This means that summer visitors and permanent residents need at least 24 hours of lead time, when the forecast could be off by 88 miles. Boat owners face a similar guessing game. To have enough time to battle the crowds to get your boat out of the water, over-congested ramps, and along packed roads—and then still have time to evacuate yourself and your family—you probably need at least 36 hours of advanced warning.

While prediction methods are continually improving, the vagaries of these complex weather patterns remain. Consequently, the best thing you can do if a major hurricane approaches is to listen to state, federal, and local emergency preparedness officials. They have the responsibility to make the tough calls about evacuations—and they need to make these calls with enough time to get everyone out safely.

Finally, when it comes to major storms, you can take steps to protect your family and your property. Over the years, we have learned a lot about how to build, rebuild, and otherwise prepare for the worst these storms can bring.

CZM has assembled additional information on what you need to know to be ready for a hurricane. See the *Hurricane Preparedness Kit* on page 8 for details and a Web address and telephone number to access this information. In addition, see *Coastal Construction Manual: A Great Tool for Protecting Homes from Storm Damage* on page 24 for more on construction strategies. By taking proper precautions, we can all be ready for whatever hurricane season 2002 brings.

ERIN AS SEEN FROM ABOVE.



FLOYD WAS HERE (AND LEFT A LOT OF WATER BEHIND IN FRANKLIN, VIRGINIA).

IGNACIO IN THE SKIES: A PLANE'S EYE VIEW OF HURRICANE IGNACIO, 900 MILES SOUTHEAST OF HAWAII.

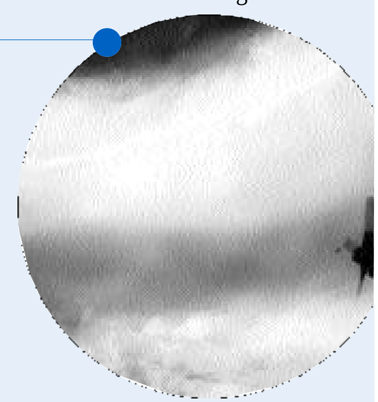


photo courtesy of Hurricane Hur

1 THROUGH 5: THE HURRICANE CATEGORIES

Wind speed dictates the potential damage that a hurricane can cause. The National Hurricane Center uses the Saffir/Simpson scale to classify hurricanes into five categories, based on wind speed.

CATEGORY 1 - 74-95 mph sustained winds with 4-5 foot storm surge. Minimal damage, including: flooding of low-lying coastal roads; minor pier damage; small, exposed vessels torn from moorings.

CATEGORY 2 - 96-110 mph sustained winds with 6-8 foot storm surge. Moderate damage, including: some wind damage to roofing material, doors, and windows; flooding of low-lying coastal escape routes 2-4 hours before eye passes; considerable damage to piers and mobile homes; marinas flooded; small vessels with unprotected anchorages torn from moorings.

CATEGORY 3 - 111-130 mph sustained winds with 9-12 foot storm surge. Extensive damage, including: destruction of smaller structures by coastal flooding and destruction of larger structures by battering waves and floating debris; mobile homes destroyed; low-lying roads flooded 3-5 hours before eye hits; terrain less than 5 feet above sea level flooded for up to 8 miles inland.

CATEGORY 4 - 131-155 mph winds with 13-18 foot storm surge. Extreme damage, including: some complete roof failure of small residences; flooding of flat terrain up to 10 feet above sea level, as far as 6 miles inland; major damage from flooding and wave battering to lower floors of structures near shore; major beach erosion; low-lying roads flooded 3-5 hours before eye hits.

CATEGORY 5 - Greater than 155 mph winds and storm surge over 18 feet. Catastrophic damage, including: complete roof failure of many residences and industrial buildings; some complete building failure with small utility buildings blown over or away; damage to lower floors of structures less than 15 feet above sea level, within 500 yards of shore; massive evacuation of residential areas within 5-10 miles of shoreline may be required.

AN EXAMPLE OF ANDREW'S DAMAGE... THE PROPERTY OWNER PUTS INFORMATION ON THE REMAINS OF THE PROPERTY TO MAKE IT EASIER FOR AGENTS TO ASSESS THEIR COLLECTION ALLOWABLES.

HELL HATH NO FURY LIKE THE HURRICANE OF '38... MAIN STREET IN WOODS HOLE.

A CENTENNIAL REVIEW OF MAJOR LAND-FALLING TROPICAL CYCLONES IN SOUTHERN NEW ENGLAND

By David R. Vallee, National Oceanic and Atmospheric Administration / National Weather Service Forecast Office, Taunton, Massachusetts

Hurricanes and tropical storms are no strangers to Massachusetts. Forty-one such tropical cyclones have affected the region since 1900, 12 of which made landfall with significant impact. These 12 systems displayed similar characteristics with respect to the storm track for acceleration, high winds, storm surge, and heavy precipitation. This article reviews southern New England tropical cyclones since 1900, focusing on the similarities of these 12 land-falling systems as they impacted Massachusetts.

DATA SOURCES

Track information for each tropical cyclone was obtained from the National Climatic Data Center (NCDC) Historical Climatology Series 6-2 (NCDC 1993). Storm surge information was gathered through a collection of southern New England Hurricane Evacuation Studies produced by the U.S. Army Corps of Engineers. Rainfall analyses were obtained from prior publications (Vallee 1993, Vallee and Czephya 1996).

OVERVIEW OF THE 12 MAJOR LAND-FALLING TROPICAL CYCLONES

Table 1 shows the major tropical cyclones that have struck southern New England since 1900.

With the exception of the 1920s, Southern New England has experienced at least one major land-falling system in each decade of the 1900s (Figure 1). The 18-year period from 1938 to 1955 was quite active with five major systems, including four Category 3 hurricanes. The 15-year period from 1985 to 1999 was also active with four major systems, including two Category 2 hurricanes. Perhaps the most interesting statistic with regard to frequency is that since 1954, there have been no land-falling Category 3 hurricanes. August and September (Figure 2) were the most active months for tropical cyclone activity in Massachusetts, with 10 occurrences. The remaining two occurred in July.

TABLE 1 - TWELVE SIGNIFICANT TROPICAL CYCLONES IMPACTING SOUTHERN NEW ENGLAND, 1900-1999

Storm intensity at landfall is given by the Saffir / Simpson scale (see page 11) or listed as a tropical storm (TS). Forward motion is at time of landfall (miles per hour).

NAME	DATE	INTENSITY	FORWARD MOTION
Unnamed	7/21/1916	CAT 1	18
Unnamed	9/21/1938	CAT 3	51
Unnamed	9/14-15/1944	CAT 3	30
Carol	8/31/1954	CAT 3	40
Edna	9/11/1954	CAT 3	46
Diane	8/18-20/1955	TS	15
Donna	9/12/1960	CAT 2	25
Belle	8/9-10/1976	CAT 1	20
Gloria	9/27/1985	CAT 2	45
Bob	8/19/1991	CAT 2	30
Bertha	7/12-13/1996	TS	30
Floyd	9/18/1999	TS	35

COMMON CHARACTERISTICS OF THE 12 LAND-FALLING TROPICAL CYCLONES

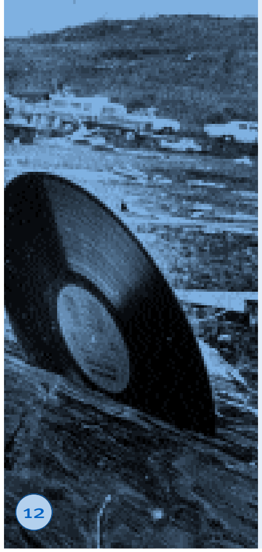
Each of these 12 systems, with varying degrees of impact, brought high winds, coastal flooding, and heavy precipitation to the region. Each system experienced some degree of forward acceleration. The core of strongest winds and the largest storm surges were always focused east of the storm track. The heaviest precipitation was always focused along and west of the storm track.

Forward Motion

Each system displayed significant northward acceleration. The average forward speed at time of landfall was 33 miles per hour (mph), while 51 mph was observed with the Great New England Hurricane of 1938. The rapid acceleration enhanced high winds, storm surge, and heavy precipitation.

Wind

The rapid acceleration of these systems produced a rather short duration of both tropical storm and hurricane force winds, when compared to slower moving tropical cyclones elsewhere in the western Atlantic. The average duration of tropical storm force winds ranged from 12 to 15 hours. Hurricane force winds were generally produced for three to six hours centered around the time of landfall. Systems accelerating up the coast were often imbedded in deep layer southerly flow. In the Northern



Hemisphere, the components of surface wind and the mean flow act in the same direction, producing enhancement (Elseberry et al. 1987). Also, as this acceleration occurs, the eye diameter expands, causing an eastward displacement of the radius of maximum wind (RMW). This pattern was observed in Hurricane Bob, with a RMW of approximately 25 miles (National Weather Service 1992), and in the Great New England Hurricane of 1938 with a RMW of over 40 miles.

As a crude rule of thumb, an area due to experience this core of sustained winds can add the forward motion to the sustained wind speed. This sum gives an estimate of the maximum gust potential. In 1938, for example, the Great New England Hurricane of 1938 was moving rapidly north near 60 mph, producing sustained winds of 125 mph. Adding the forward motion to this sustained wind speed gives an estimated maximum gust potential of 185 mph. The Blue Hill Observatory, in Milton, Massachusetts, recorded a wind gust of 186 mph.

Storm Surge

The rapid acceleration impacts the magnitude of the storm surge. Wind stress and pressure gradient are the key components in surge production, with wind stress accounting for approximately twice the surge produced solely by pressure gradient (Anthes 1982). The angle at which the systems made landfall in Massachusetts was generally 60 to 90 degrees, or close to perpendicular to the coastline, aiding in surge production on north-south oriented bays and inlets.

While the stronger tropical storms produced surges of 1 to 3 feet, the Category 2 and Category 3 storms generated storm surges in excess of 12 feet. For the two most powerful storms, the Great New England Hurricane of 1938 and Hurricane Carol in 1954, the RMW was focused on eastern Connecticut and Narragansett Bay. Surge modeling indicates that for a storm similar to Hurricane Carol but focused on the South Coast of Massachusetts surges in excess 25 feet will occur on portions of Buzzards Bay (U.S. Army Corps of Engineers 1997).

Most of east coastal Massachusetts is quite vulnerable to storm surges, but due to the rapid movement of hurricanes, the tidal piling most often associated with major coastal flood episodes in the wintertime on the east coast doesn't have time to materialize. Slosh modeling suggests that a surge of 4 to 7 feet is possible in and around Boston Harbor. If this struck on a high astronomical tide, the resulting tidal elevations could surpass those produced by the October 1991 storm and the Blizzard of 1978. But it would take a unique sequence of events for such a surge to materialize—unlike along the exposed south coast where there is far greater potential and frequency of occurrence.

The uniqueness of Cape Cod Bay provides a different problem. Hurricane Edna of 1954 provided nearly the optimum set of circumstances to produce a surge of 10 feet across Wellfleet and Truro. For this to occur, the storm had to travel directly over the top of Cape Cod. The northeast wind flow ahead of this type of storm track would pile the water into Cape Cod Bay. Then approximately 1 to 1½ hours after the storm has passed, a wind shift to the southwest will literally slosh the water around the base of the bay into Wellfleet and Truro. Researchers believe that this did occur with Edna, but her arrival at low tide spared the region significant flooding.

Rainfall

Nearly half of all tropical cyclones that have impacted southern New England since 1900 produced significant river and small stream flooding. Heavy rainfall typically developed well in advance of the storm center, in response to the dramatic increase in moisture advection and a rapidly destabilizing atmosphere produced by a deepening upper level trough or cut-off low. In addition, as shown by Vallee and Czephya (1996), strong east or southeast inflow produced an enhancement of rainfall in upslope regions of the major river basins in the region. The duration and strength of this inflow was critical to the magnitude of the enhancement. Tropical cyclones tended to maximize both components, thus explaining why, in spite of such a rapid forward motion, tropical cyclones impacting southern New England also produced widespread torrential rainfall.

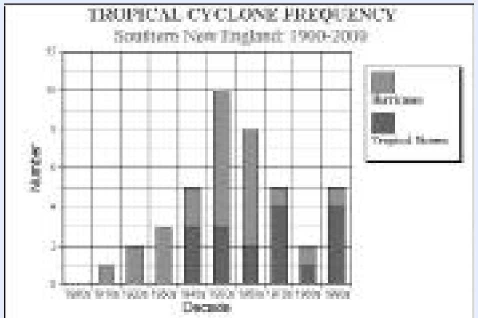


FIGURE 1: TROPICAL CYCLONE FREQUENCY IN SOUTHERN NEW ENGLAND

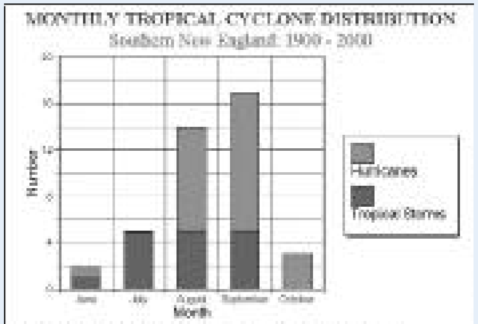


FIGURE 2: MONTHLY TROPICAL CYCLONE DISTRIBUTION FOR SOUTHERN NEW ENGLAND

Typically, the first bands of heavy rainfall arrived 12 to 15 hours in advance of the storm center. The average rainfall of 6 to 10 inches was west of the track of the storm, with the heaviest amounts in topographically enhanced locations. East of the storm, two inches or less was common. Hurricane Bob, a tight Bahama-born system, produced a dramatic rainfall distribution across Rhode Island with a maximum of more than 7 inches in the northwest and less than 0.5 inches in nearby southeast Massachusetts.

One of the most dramatic displays of heavy rainfall was associated with Tropical Storm Diane, August 1955. One week prior to Diane, a very weakened Tropical Storm Connie sent 4 to 8 inches of rain across western Massachusetts. Then, just 5 days later, Diane would produce 10 to 20 inches of rain in a 2-day span across much of the Bay State. In Westfield, Massachusetts, Diane produced a record one-day rainfall total of 18.15 inches; to put this in the proper perspective, that was nearly half their annual rainfall!

CONCLUSION

Major land-falling tropical cyclones in southern New England during the last 100 years have all displayed similar characteristics. This consistency in behavior should allow forecasters and emergency managers to better anticipate and prepare for the evolution of the storm's impact across the region.

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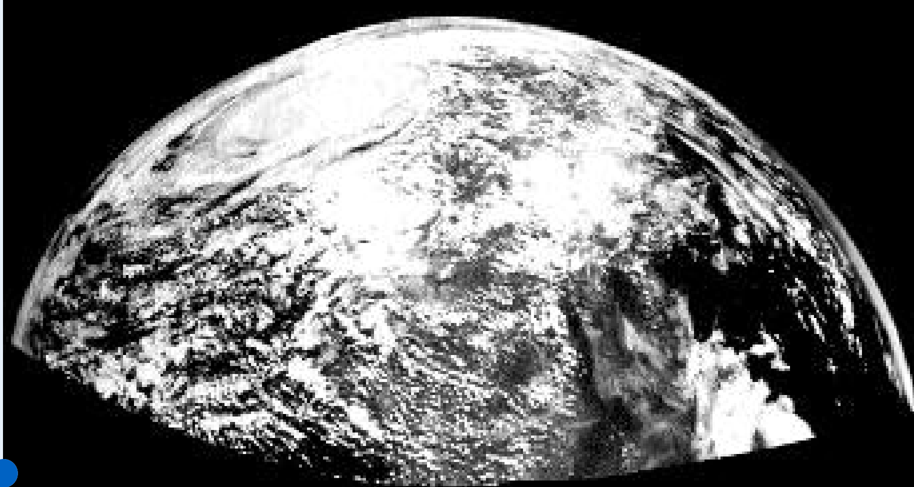
CHECK OUT CZM'S HURRICANE KIT AT

WWW.MASS.GOV/CZM/HURRICANES.HTM

FOR MORE ON HURRICANES AND HOW

TO PREPARE FOR HURRICANE SEASON.



SATELLITE VIEW OF TROPICAL CYCLONE NEAR DEL RIO, TEXAS, OCTOBER 5, 1954.

photo courtesy of NOAA

FLOOD INSURANCE . . . ARE YOU COVERED?

By Anne Donovan, CZM

The winds are whipping and the furious seas are lashing against the crumbling seawall. As the waters rise in one immense tidal surge, the seawall, the road behind it, and the entire first story of your house are awash. Knee-deep in this briny mess is not the time to start thinking about flood insurance.

Every year, floods damage more U.S. homes than any other type of natural disaster. And it's not just the houses along the shore or a riverbank at risk. In fact, 20 to 25 percent of flood insurance claims are outside areas considered "high-risk" for floods.

Bottom line, your homeowner's policy does not cover flood damage. If you are expecting federal disaster relief to save the day in case of a major flood, you will be in for a long wait and will most likely get a loan that has to be repaid with interest, if disaster relief becomes available at all. So, the National Flood Insurance Program (NFIP) is your best bet for protecting what is probably your biggest investment.

The NFIP, created by Congress in 1968 and managed by the Federal Emergency Management Agency (FEMA), makes federally backed insurance available in communities that develop and enforce floodplain management mechanisms. The NFIP flood-proofing standards also offer a great benefit to homeowners, with houses meeting these standards suffering 77 percent less flood damage than other homes. (In addition, FEMA's *Coastal Construction Manual* provides state-of-the-art recommendations for flood-proofing and storm protection. See *Coastal Construction Manual: A Great Tool for Protecting Homes from Storm Damage* on page 24 for details.)

Almost all communities in the Commonwealth participate in the NFIP. The only coastal communities that don't are Chilmark and Rowley, so citizens in those towns cannot obtain flood insurance. In addition, those communities are not eligible for federal financial assistance (including many forms of disaster assistance) for property acquisition or construction within a Special Flood Hazard Area (an area prone to flooding and designated on FEMA Flood Insurance Rate Maps with the letter "A" or "V").

> "Joining the NFIP is not difficult for a community, and we can help."
>
> - Richard Zingarelli, DEM

"Joining the NFIP is not difficult for a community, and we can help," said Richard Zingarelli of the Flood Hazard Management Program (FHMP) at the Department of Environmental Management (DEM). "Nearly all of the community requirements are already covered by existing state regulations, such as the Wetlands Protection Act and the State Building Code. The few remaining requirements are typically handled by establishing a floodplain overlay district within the community's zoning bylaw, a copy of which can be obtained from FHMP." For more information, contact Rich at (617) 626-1406 or by e-mail, Richard.Zingarelli @state.ma.us.

Maps are available to help you determine your flood risk, and there's plenty of information on NFIP. To find out more, check out the FEMA Web site at http://www.fema.gov/nfip/index, call your insurance agent, or call FEMA at 1-888-FLOOD29, TDD# 1-800-427-5593.

100-YEAR FLOODS DON'T COME ON SCHEDULE

What, exactly, is a "100- year flood?" A flood that happens every 100 years? Nope. This confusing and often mis-used term is really a statistical assessment, indicating that a flood of that magnitude (or greater) has a 1-percent chance of occurring in any given year, with a typical recurrence every 100 years. To help clarify, the Federal Emergency Management Agency has stopped using the term, opting instead for "1-percent annual chance flood." Just because such a major flood happens in one year does not reduce the likelihood of that event the next year. Each year, no matter what has happened before, the chance of seeing that kind of flood is 1 percent.

The statistics can get even more confusing. For any particular 100-year period, there is a 63.5 percent chance of having a "1-percent annual chance flood." Confused? Over long periods of time these events are likely to happen every 100 years, but over any particular 100-year period, the chances are less simply because these things are not scheduled and are not absolutely predictable. From a more practical perspective, over the typical life of a mortgage (30 years), there is a 26 percent chance of seeing a "100-year flood." If that statistic makes you nervous, see Flood Insurance . . . Are You Covered? at left for more information.

EVERY YEAR, FLOODS DAMAGE MORE U.S. HOMES THAN ANY OTHER TYPE OF NATURAL DISASTER.

BEACH NOURISHMENT FOR STORM PROTECTION

By Rebecca Haney and Anne Donovan, CZM

How do you "nourish" a beach? Why feed it sand, of course. And a well-nourished beach provides better protection from scouring storm waves and punishing storm surge. The most common type of beach nourishment project in Massachusetts reuses clean material from nearby dredging projects, which is technically called "beach fill." The primary purpose for these projects is to keep the sand in the system and find a convenient place to unload the dredged material. Although these projects can provide some storm protection, they are not designed for this purpose, and the sand can be washed away in relatively short order, causing potential environmental problems. To help extend the life of these valuable beach fill projects, and to ensure that there are no unintended environmental consequences, planning and proper design are required.

The second kind of project, technically referred to as "beach nourishment," is designed by an engineer to add a specific amount of sand to a system to provide storm protection. Such nonstructural alternatives are the recommended form of storm protection, because seawalls, jetties, and other structures provide only temporary protection with high costs, and do not address the underlying problem. Seawalls, for example, while providing some protection to homes and roads behind them, accelerate erosion, ultimately lowering the elevation of the fronting beach and undermining the seawall itself. Property owners downcurrent also face the brunt of these unnatural structures, when sand is trapped behind jetties and other structures, accelerating erosion downcurrent and exposing these properties to greater damage.

To help promote beach fill/beach nourishment and design projects that will last, as well as to reduce potential environmental impacts of these projects, the Massachusetts Office of Coastal Zone Management (CZM), the Department of Environmental Protection (DEP), and the Division of Marine Fisheries (DMF) are developing beach nourishment best management practices (BMPs).

The most important factor when designing a beach nourishment project is to make sure the new sand is "compatible" with the old sand by comparing the grain sizes. Finer materials more easily erode, reducing the longevity of the storm protection and potentially smothering nearby eelgrass beds and other natural resources. Coarser material may negatively impact the recreational value and aesthetics of the beach, but will not readily erode. Consequently, material with slightly coarser or equal grain size is best, but coarser material can also be acceptable.

The slope of the beach is also important. If the new sand creates a steeper pitch to the beach, rapid erosion and redistribution of the sand is likely. Again, matching original conditions is best.

> "A well-nourished beach provides better protection from scouring storm waves and punishing storm surge."

The beach nourishment BMPs, which include extensive additional details on using public dredging projects for beach nourishment, endangered species protection, and other topics, are currently under development.

2000 Erosion Report: A WAKE-UP CALL

By Anne Donovan, CZM

photo by Rebecca Haney

Over the next 60 years, erosion is expected to claim one out of four houses within 500 feet of the U.S. shoreline. What other figures should you know about? Well...

- Roughly 1,500 structures and the land on which they are built will be lost to erosion each year, costing coastal property owners $530 million per year. In beach areas, the risk posed by erosion is equivalent to the risk from flooding.

- At current enrollment levels, the National Flood Insurance Program, which makes federally-backed flood insurance available in communities that agree to adopt and enforce floodplain management ordinances, will pay $80 million per year for erosion-related damage.

These are some of the staggering conclusions from *Evaluation of Erosion Hazards*, a report completed by The H. John Heinz III Center in April 2000 for the Federal Emergency Management Agency. The report is a wake-up call to coastal property owners at risk, state and local governments involved in land-use planning, and federal decision-makers dealing with National Flood Insurance policy and the need for reform. The conclusions of the Heinz report?

- Congress should instruct the Federal Emergency Management Agency to develop erosion hazard maps that display the location and extent of coastal areas subject to erosion. The maps should be made widely available in both print and electronic formats.

- Congress should require the Federal Emergency Management Agency to include the cost of expected erosion losses when setting flood insurance rates along the coast.

For the complete report, check out the Heinz Center Web site at www.heinzcenter.org/programs/SOCW/erosion.htm.

THE MASSACHUSETTS BEACHES CONFERENCE

If you are interested in protecting our sandy shores, plan to attend Northeast Beaches: A Balancing Act on October 24-26. The Massachusetts Office of Coastal Zone Management (CZM) is teaming up with the Woods Hole Oceanographic Institution's Sea Grant Office, Northeast Shore and Beach Preservation Association, the Waquoit Bay National Estuarine Research Reserve, the U.S. Geological Survey, the University of Massachusetts' Urban Harbors Institute, the Woods Hole Oceanographic Institution's Coastal Ocean Institute, and Massachusetts Audubon to sponsor a three-day, multi-disciplinary conference at the Woods Hole Oceanographic Institution. The event will bring together individuals interested in protecting and enhancing beaches to discuss a variety of issues including coastal processes, beach nourishment, dredging, coastal habitat, coastal access, water quality, and beach management. The focus of the discussion will be on the state-of-the art science and techniques for protecting beaches, with the recognition that without such protection, these resources will be lost forever. The conference will provide a forum for discussion and coordination of beach protection and management strategies; raise public awareness of the status of the Northeast's beaches; and provide a networking opportunity for individuals and local groups working on beach issues.

An agenda and registration information will be posted on the CZM Web site (www.mass.gov/czm) this summer.

balancing our beaches

October 24-26

WHAT YOU NEED TO KNOW BEFORE REBUILDING

Property damage or destruction during a major storm can be a devastating experience. People are available, however, to provide you with information on how to safely, soundly, and legally rebuild.

So if rebuilding is in your future after a hurricane or other major storm, be sure to contact appropriate local, state, and federal officials before beginning work. This includes your local Building Inspector; your Conservation Commission if you're in or near a resource area such as a beach, dune, bank, salt marsh or other wetland, etc.; your Board of Health for septic system work; and the state Department of Environmental Protection (DEP) Waterways Program at (617) 292-5695 if you are subject to Chapter 91 regulations. (Chapter 91 governs piers, seawalls, and other structures on the waterfront, as well as development on filled tidelands.) In addition, contact the U.S. Army Corps of Engineers for any work to be conducted in wetlands or below the high tide line.

DEP enforces many of the laws regarding building along the coast and has developed a helpful publication on this topic, called *Protecting Coastal Property from Major Storm Damage: What to Do and Who to Contact Before Building or Rebuilding Near the Coast*. Along with details on who to call before rebuilding, this publication includes many of the requirements for coastal construction, as well as summaries of the key laws that apply. See www.mass.gov/czm/protectcoastalproperty.pdf for a copy. If you don't have Web access, call the CZM information line at (617) 626-1212 and we'll send it to you.

HOMES CAN BE EXTENSIVELY DAMAGED BY STORM WAVES AS WITNESSED ON COVE STREET IN MATTAPOISETT AFTER HURRICANE BOB PASSED BY.

photo courtesy of Jim O'Connell

SCIENTIST TO STUDY STORM-DAMAGED PROPERTIES

Ocean-front property that has been battered by hurricanes and other storms is often vulnerable to repeat damage. To address this problem, the Massachusetts Office of Coastal Zone Management (CZM) is hiring a scientist to look at properties that have been repeatedly damaged by storms with the goal of reducing such damage in the future. This one-year project will be conducted in cooperation with the U.S. Geological Survey (USGS) in Woods Hole. Repetitively damaged properties along the Massachusetts coast will be catalogued and the patterns of damage will be evaluated, looking at flood zones, erosion rates, landform types, degree of shoreline armaments (groins, jetties, seawalls, revetments), and exposure of the property (open coast vs. areas protected by barrier beaches, etc.). Distinctions will be made between minor, moderate, and major structural damage.

The scientist will document correlations between damage and the potential contributing factors and make recommendations to CZM and the Department of Environmental Protection on the need for policy and regulatory changes. In particular, strategies to balance development with preservation and restoration of resources areas, dissipate storm wave energy, and reduce flooding will be considered.

A team of experts will oversee the project, including Rebecca Haney, CZM's Coastal Geologist and Hazards Coordinator, Rob Thieler from the USGS, Jim O'Connell from the Woods Hole Oceanographic Institution Sea Grant Program and Cape Cod Cooperative Extension, and Richard Zingarelli from the Department of Environmental Management Flood Hazard Mitigation Program.

AFTER THE STORM: DAMAGED PROPERTY IN SCITUATE FOLLOWING A 1991 NORTHEASTER.

photo courtesy of Jim O'Connell

SHORELINES: NEW DATA ON SHORELINE CHANGE

By Rebecca Haney and Anne Donovan, CZM

Coastal shorelines change constantly in response to wind, waves, tides, sea level fluctuation, seasonal and climatic variation, human alteration, and other factors that influence the movement of sand and material within a shoreline system. Major storms, such as hurricanes, can have dramatic and immediate impacts. The loss (erosion) and gain (accretion) of coastal land is a visible result of the way shorelines are reshaped in the face of these dynamic conditions.

To help make informed and responsible decisions, coastal managers, shorefront landowners, and potential property buyers need information on both current and historical shoreline trends, including reliable measurements of erosion and accretion rates in non-stable areas. The goal of the Massachusetts Office of Coastal Zone Management (CZM) Shoreline Change Project is to develop and distribute scientific data that will help inform local land use decisions.

A word of caution to shorefront landowners, potential buyers, and others interested in this information as it relates to a particular property—the Shoreline Change Project presents both long- and short-term shoreline change rates at 40-meter intervals along the entire Massachusetts coast. In a broad sense, this information may provide useful insight into the erosional forces at work along the Massachusetts coast. But care must be used when applying this information to specific property or local sections of coastline. Due to the multitude of natural and human-induced factors that can influence shoreline position over time, correct interpretation of the data requires an in-depth knowledge of coastal processes. Those without extensive backgrounds in coastal geology, while encouraged to explore the historical migration of Massachusetts shorelines, are strongly advised to consult with a professional when attempting to use the Shoreline Change Project data for planning purposes. In no case should the long-term shoreline change rate be used exclusively before the short-term rates and contributing factors are understood and assessed.

HOW AND WHY SHORELINES CHANGE

As the waves gently lap the shore of a beautiful stretch of sandy beach, do you ever wonder where that sand came from? The answer is: erosion. The source of the sand that created and continues to feed the beaches, dunes, and barrier beaches in Massachusetts comes primarily from the erosion of coastal landforms. For example, the material eroded from the Atlantic-facing coastal bluffs of the Cape Cod National Seashore supplies sand to downdrift (i.e., down current) beaches of the Cape.

Erosion, transport, and the accretion that results are continuous and interrelated processes. Every day, wind, waves, and currents move sand, pebbles, and other small materials along the shore or out to sea. Shorelines also change seasonally, tending to accrete slowly during the summer months when sediments are deposited by relatively low energy waves and erode dramatically during the winter when sediments are moved offshore by high energy waves and storm surge. Hurricanes, Northeasters, and other major storms, of course, can cause severe erosion whenever they strike.

SHORELINE CHANGE AND COASTAL PROPERTY

Given its aesthetic and recreational appeal, the Massachusetts coastal zone has been and continues to be subject to intense development. Much of this development is susceptible to on-going risks from winds, waves, storm surge, flooding, relative sea level rise, and the associated erosion of coastal landforms. Consequently, shoreline change is an important issue in Massachusetts.

While erosion and flooding are necessary and natural, they do have the potential to damage coastal property and related infrastructure, particularly when development is sited in unstable or low-lying areas. These dynamic and powerful processes can expose septic systems and sewer pipes, contaminating shellfish beds and other resources; release oil, gasoline, and other toxins to the marine environment; and sweep construction materials and other debris out to sea. Public safety is also jeopardized when buildings collapse or water supplies are contaminated.

Shoreline change can result in significant economic and emotional loss in a system of fixed property lines and ownership. Attempting to halt the natural process of erosion with seawalls and other hard structures, however, simply shifts the problem, subjecting downdrift property owners to similar losses. Also, without the sediment transport associated with erosion, some of the Commonwealth's greatest assets and attractions—beaches, dunes, barrier beaches, salt marshes, and estuaries—are threatened and will slowly disappear as the sand sources that feed and sustain them are eliminated.

The challenge, therefore, is to site coastal development in a manner that allows natural physical coastal processes, such as erosion, to continue. To meet this challenge, coastal managers, property owners, and developers must work with erosion—not against it—by understanding the magnitude and causes of erosion, and applying appropriate management techniques that will allow its beneficial functions to continue.

THE CZM SHORELINE CHANGE PROJECT

In the previous phase of the Shoreline Change Project, CZM completed a statistical analysis from the mid-1800s to 1978 for Massachusetts' ocean-facing coastline and produced 76 maps showing several historic shorelines to demonstrate long-term shoreline change. CZM distributed these maps to coastal Conservation Commissions in 1997, helping local decision makers identify coastlines that are prone to storm damage and significant erosion and to assess erosion potential. CZM recently completed an update of the Shoreline Change Project, using 1994 National Oceanic and Atmospheric Administration (NOAA) aerial photographs of the Massachusetts shoreline. CZM established an agreement with the U.S. Geological Survey (USGS), the Woods Hole Oceanographic Institution (WHOI) Sea Grant Program, and Cape Cod Cooperative Extension (CCCE) to produce a 1994 shoreline, add it to the previous project, and update the statistics and calculate erosion rates. The work was conducted by Rob Thieler and Courtney Schupp at the USGS and Jim O'Connell at the WHOI Sea Grant Program and CCCE. The new maps and statistical analysis of shoreline change now cover the time period from the mid-1800s to 1994.

The 1:10,000 scale shoreline change maps show the relative positions of four or five historic shorelines and depict the long-term change rate at 40-meter (approximately 131-feet) intervals along the shore. In all, 30,300 transects were constructed and used in the statistical analysis. Data tables that accompany the 76 shoreline change maps also show the short-term shoreline change (i.e., the change between successive historic shorelines), the total landward or seaward change in distance, and the long-term shoreline change rate for each transect.

It is very important to note that due to necessary adjustments in the baseline for this project, the location of current transect numbers are not consistent with those reported on the 1997 shoreline maps or data tables. Therefore, shoreline rates of change noted at the end of numbered transects on these shoreline change maps and data tables should not be compared directly with previous numbered transects.

HOW TO CORRECTLY INTERPRET THE DATA

To correctly interpret the shoreline change data, all shoreline data (i.e., both long- and short-term data) must be analyzed and evaluated in light of current shoreline conditions, recent changes in shoreline uses, and the effects of human-induced alterations to natural shoreline movements. In areas that show shoreline change reversals (i.e., where the shoreline fluctuates between erosion and accretion) or areas that have been extensively altered by human activities, professional judgment and knowledge of natural and human impacts are typically required for proper interpretation.

For example, a transect along Springhill Beach in Sandwich that is downdrift from a jetty shows a long-term annual erosion rate of -2.82 feet per year. From 1860-1952, the average rate of erosion at this transect was -3.74 feet per year. From 1952-1994, however, the annual erosion rate was only -0.20 feet per year. These rates show that, following construction of the jetty in 1914, there was an accelerated short-term rate of erosion. Once the shoreline adjusted to the presence of the jetty, however, the erosion rate decreased and leveled off. If the jetty was properly engineered and is properly maintained, the short-term erosion rate of -0.20 feet per year is more likely to be representative of how this shoreline is functioning currently and should be used for planning purposes, rather than the long-term rate, which dampens the effect of the jetty installation.

In contrast, an area along the southeastern shore of Nantucket exhibits a long-term annual shoreline change rate of +0.07 feet per year with a net movement of the beach of only 34.6 feet from 1846-1994. This beach is far from stable, however, as illustrated by an analysis of the short-term rates of change. Between 1846 and 1887 the beach accreted 215 feet; from 1887-1955 it eroded 12 feet; from 1955-1978 it eroded 113 feet; and from 1978-1994 this same beach eroded 56 feet. Despite the apparent long-term statistical stability of the beach, any buildings constructed on the accreting beach would have been threatened when the erosional trend returned, a situation that is presently occurring at Low Beach on Nantucket.

In addition, in many cases human attempts to stop erosion result in a change to the natural equilibrium of the shoreline. Where segments of the shoreline have been armored with sea walls and other structures to stop erosion, the shoreline change data must be looked at very closely to determine what affect these structures are having on short- and long-term erosion rates. For example, much of the sand sources for Humarock Beach in Scituate have been eliminated due to seawall and revetment construction in the 1940s and 1950s. Consequently, the recent trend of erosion that

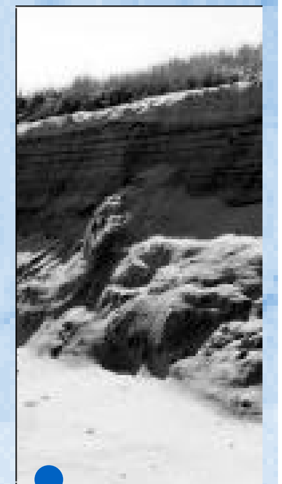


photo by Rebecca Haney

SHORELINE CHANGE IS A NATURAL, NECESSARY PROCESS.

began in the 1950s is not only continuing—it is accelerating.

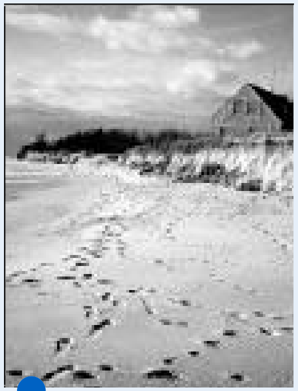
Finally, the shoreline positions presented in the maps and data tables were compiled using several historical map and near-vertical air photographic data sources and state-of-the-art analytical techniques. The shoreline change maps produced for this report meet National Map Accuracy Standards for 1:10,000 scale mapping. Recognizing various sources of error, this results in a positional accuracy for individual shorelines of +/- 8.5 meters (28 feet). The rates of shoreline change (the focus of this project) are derived statistically from these shorelines and have a resolution of +/- 0.12 meters/year (0.4 feet/year).

This review will give you a good sense of how a particular shoreline has behaved over time, and may provide an indication of future shoreline behavior. However, professional expertise is necessary when attempting to use these maps and data for planning purposes.

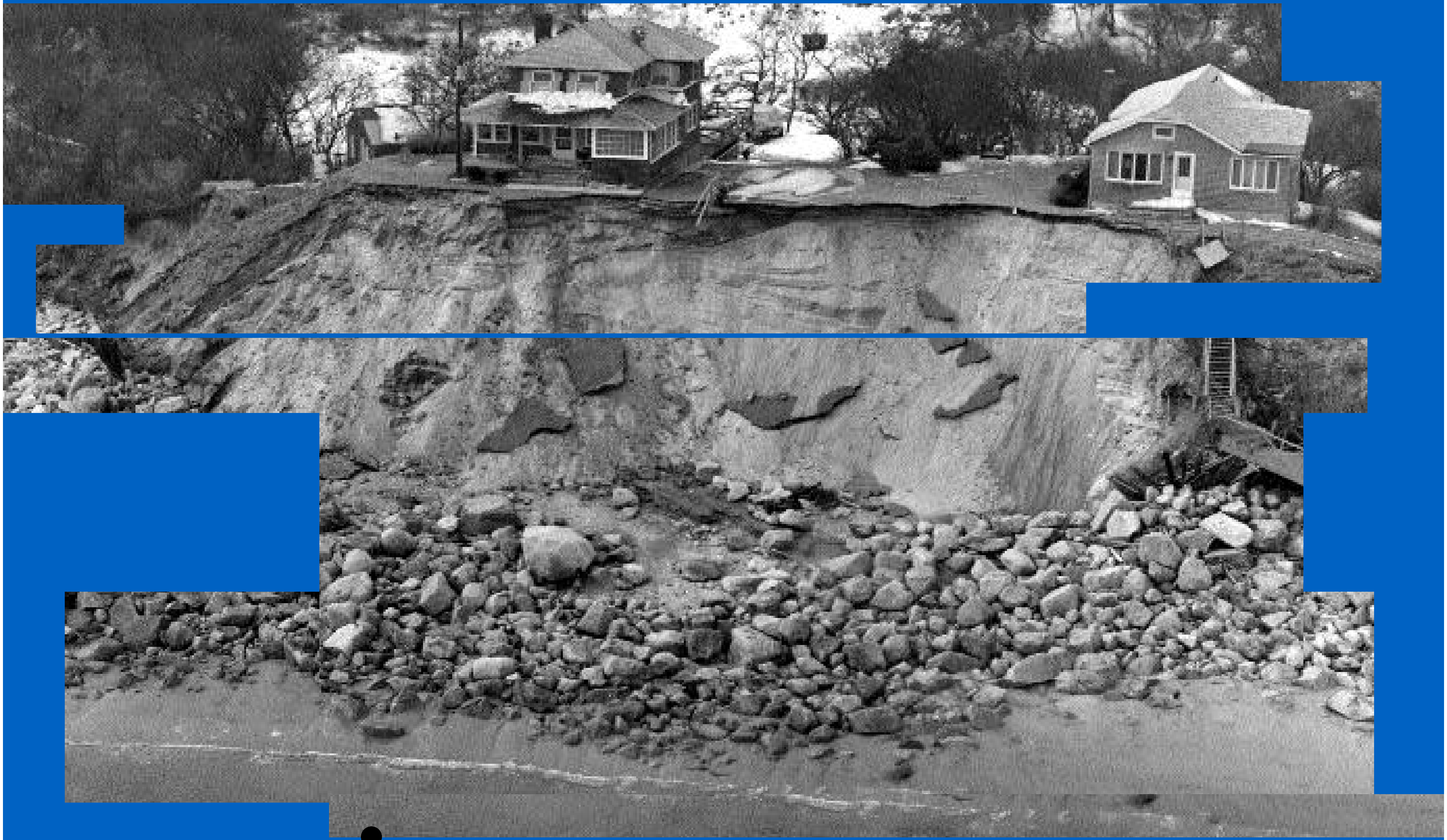
FOR MORE INFORMATION . . .

CZM will provide a set of maps and data tables to each coastal community, covering the shoreline within its boundaries. These maps should be available in the town or city hall, probably with the Conservation Commission or Planning Departments, and at the CZM Regional Offices. CZM will also have the shoreline change maps, accompanying data, and all supporting technical documents on its Web site at: www.mass.gov/czm. If you do not have Web access and would like the map (36” x 44”), for your area, please call (617) 626-1191.

BLUFFS, LIKE THIS ONE ON CAPE COD BAY IN EASTHAM, CAN EXPERIENCE HIGH SHORT-TERM EROSION RATES WHEN STORMS UNDERMINE THE TOE OF THE BLUFF.



RAPIDLY ERODING COASTLINE IN NANTUCKET.



SHORELINE CHANGE MAY HAVE
SERIOUS CONSEQUENCES.

COASTAL CONSTRUCTION MANUAL: A GREAT TOOL FOR PROTECTING HOMES FROM STORM DAMAGE

By Wendy Quigley, CZM

When you think of the houses along the Massachusetts coastline, do you envision quaint cottages where families take their summer vacations? Or, do you think of grand shore-side homes, many of them newly built, where people enjoy the beautiful views of the ocean all year long? Whatever image comes to mind, do you think these dwellings might be in harm's way come the next hurricane or other coastal storm? Coastal property owners, as well as local building inspectors and coastal developers, should understand the potential impacts of coastal storms, and use all the tools at their disposal to protect all properties, from the smallest cottage to the most spacious mansion, from the wrath of these potentially devastating weather events.

Now, thanks to a tremendous effort by the Federal Emergency Management Agency (FEMA), a valuable new and improved tool is available to help coastal developers, planners, regulators, and the property-owners they serve identify potential hazards to property and reduce risks through proper planning and construction of residential structures in coastal areas. This tool is the recently revised third edition of the *Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas*, also known as the CCM.

Given the significant financial losses from major coastal storms, such as an estimated $1.75 billion in damage (1996 dollars) from Hurricane Bob in 1991, which greatly impacted Buzzard Bay shorelines, the CCM is invaluable. It provides advice for coastal construction "best practices" to reduce the vulnerability of houses in coastal areas. The wealth of information found in the CCM offers professionals, such as engineers, architects, and local building inspectors, state-of-the-art guidance to ensure that when construction does occur in hazard-prone coastal areas, details are incorporated into planning and design to minimize potential damage and loss.

Although the expansion of the third edition into a large, three-volume publication may appear intimidating at first–it's almost 3 inches thick!–the new format is user-friendly with figures and tables summarizing complex details and calculations. For those people more comfortable with digital formats, the CD-Rom contains interactive hyperlinks, automatic formula calculations, and an index.

The first volume of the CCM provides a historical perspective, introducing issues in the coastal environment. Statistics and photographs from past storms, including those that impacted New England such as the Hurricane of 1938 and the Halloween Northeaster of 1991, are highlighted to demonstrate the importance of proactive planning in the coastal high-hazard zones. The damages that have occurred to at-grade buildings (i.e., those at ground level) underscore the importance of CCM recommendations and requirements for elevating dwellings on piles in flood-prone coastal settings. Excerpts about storm events for regions of the U.S. are followed by an overview of the fundamentals of hazards and risk assessment for coastal properties. Volume I draws upon lessons learned to discuss how to identify and evaluate site alternatives, investigate regulatory requirements, identify hazards, and determine the financial and insurance implications for building in the coastal zone.

Volume II of the CCM leads the reader through the detailed determination of site-specific loads or pressures affecting a coastal dwelling, such as high winds, coastal floodwaters, and even earthquakes (not as vital a design consideration here in New England as it is in California). After determining the loads that would affect a specific site, the reader is guided through design and construction considerations. In addition to the proactive hazard-planning aspects of the design and construction phases, the CCM also addresses maintenance of buildings in the sometimes harsh conditions along the coast.

The appendices provided in Volume III offer helpful topic-specific details about a variety of issues ranging from material durability in the coastal environment to design guidelines for swimming pools and elevators in flood-prone areas.

HOW CAN YOU USE THE CCM TO MITIGATE COASTAL HAZARDS?

- If you are a coastal property-owner having a new home built or existing one renovated, ask your developer if they are applying the planning, design, and construction standards and recommendations from the most recent CCM.
- If you are a coastal developer (engineer, architect, builder, etc.), review the latest version of the CCM and apply the "best practices" approach to coastal residential construction when required whenever possible.

- If you are a coastal development regulator (building inspector, conservation commissioner, etc.), use the CCM as a guide and reference as you review residential coastal construction projects to ensure that "best practices" have been applied.

Printed copies and easy-to-navigate CDs of the third edition of the CCM are available by contacting the FEMA Publications Distribution Facility at 1-800-480-2520 and request FEMA Publication 55.

PROPER CONSTRUCTION IS IN THE DETAILS, SUCH AS USING AN OPEN PILE FOUNDATION AND ELEVATING THE FIRST FLOOR ABOVE BASE FLOOD ELEVATION (I.E., ABOVE THE 100-YEAR FLOOD LEVEL).

photo courtesy of FEMA

THE ART AND SCIENCE OF IDENTIFYING FLOOD ZONES

By Wendy Quigley, CZM

Are you planning to develop oceanfront property? Are you responsible for coastal floodplain management? If so, whether you are a coastal developer, geologist, building inspector, or conservation commissioner, you will want to familiarize yourself with how to accurately define the extent of flood zones. In some cases, it is not as simple as reading the latest Flood Insurance Rate Map (FIRM) from the Federal Emergency Management Agency (FEMA). Although this article targets people with experience in these issues, coastal property-owners or potential buyers should be aware that flood zone maps do not always tell the whole story.

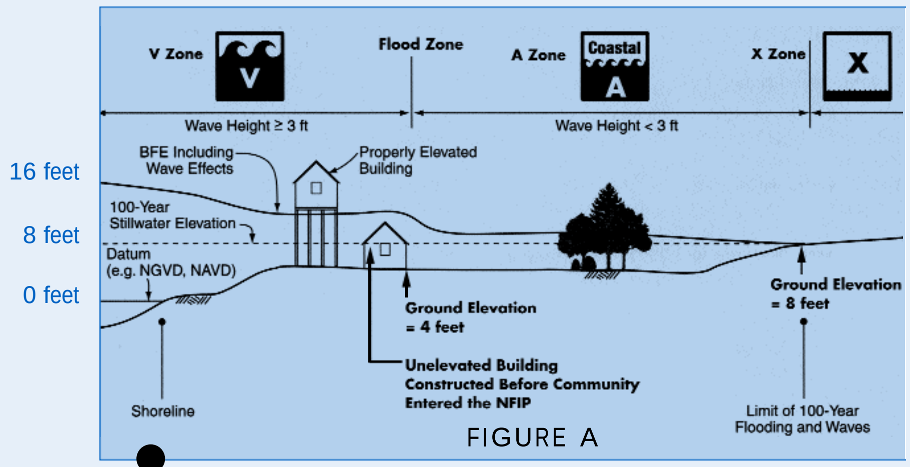


FIGURE A

BFE = BASE FLOOD ELEVATION

NFIP = NATIONAL FLOOD INSURANCE PROGRAM

ADAPTED FROM FEMA
CCM, VOLUME 1,
JUNE 2000, p. 3-9

FLOOD ZONES DEFINED

The two primary types of flood zones (or special flood hazard areas) included in the Massachusetts Wetlands Protection Act regulations as Land Subject to Coastal Storm Flowage are velocity zones and A-zones. Velocity flood zones, also known as V-zones or coastal high hazard areas, have been identified by FEMA as areas "where wave action and/or high velocity water can cause structural damage in the 100-year flood," a flood with a 1-percent chance of occurring or being exceeded in a given year (See *100 Year Floods Don't Come on Schedule*, on page 15). Because of this potential for damage, stringent regulatory requirements seek to ensure that work and construction in V-zones will minimize environmental and structural impacts, as well as economic loss. A-zones are areas inundated in a 100-year storm event that experience conditions of less severity than conditions experienced in V-zones, for example, wave heights less than 3 feet. Since FEMA flood zones may experience dangerous storm-generated wave action and surges, an accurate determination of the spatial extent of these zones is vital to understanding the level of risk for a particular property or activity.

USING FIRMS TO IDENTIFY FLOOD ZONES

The first step in determining if a property is in a flood zone is to examine the most up-to-date FIRM. FIRMs, as well as Flood Insurance Study reports, are available from FEMA for a nominal fee by calling the Map Service Center at 1-800-358-9616 or by ordering on-line at http://msc.fema.gov/MSC. Also, they can usually be viewed at local government offices, such as the building inspector, planning board, and conservation commission.

The base flood elevation (BFE) for a flood zone is the level that flood waters are calculated to reach during a 100-year event. This value is usually printed on a FIRM for each coastal flood zone. FIRM elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD), except for Nantucket, which is referenced to the Half Tide Level Datum of 1934. If your project plan does not use NGVD, convert to a consistent datum. Please note that for V-zones, the BFE is not necessarily a ground elevation. As seen in Figure A, although the BFE for the seaward portion of this V-zone is 16 feet, the velocity conditions do not reach as far landward as the 16-foot ground elevation. Instead, as waves break and wave heights diminish in the landward direction, the BFE is reduced.

In general, to delineate specific A-zones, identify the BFE on the FIRM and locate it on the corresponding topographic contour on the project plan (remembering to convert datums if necessary). To delineate V-zones, scale the zone boundary from a known, fixed point, such as a benchmark or road intersection (if scaling from a road on the FIRM, use the center of the road since the lines do not accurately represent road edges), or, at the same scale, overlay the FIRM onto the project plans and trace the zone boundary. When scaling, do not use a shoreline location as a reference point since its position may change over time.

Due to limitations associated with the scale of flood zone mapping, actual V-zone conditions may not match the FIRM boundary for a specific site. Therefore, site topography, landform type, and nearby transect data from the local FEMA Flood Insurance Study may need to be considered in delineating V-zones for planning purposes. When a detailed study of site conditions is necessary, those without extensive background in flood zone mapping are advised to consult with a professional.

COASTAL SAND DUNES–A SPECIAL CIRCUMSTANCE

For sites partially or completely within a coastal sand dune, the FIRM may not give the complete answer as to the extent of the flood zone. FEMA recognizes that their original mapping oversimplified the flood zone/sand dune issue by not taking into account erosion and associated wave runup (the rush of the breaking wave). During a coastal storm, sand dunes often erode, providing sediment to the coastal beach and nearshore areas. Depending on the original dune volume, the coastal sand dune may be overtopped or eroded completely resulting in velocity conditions and wave action that extend farther landward than depicted on the FIRM. In 1988, FEMA revised the National Flood Insurance Program (NFIP) regulations, specifically Title 44, Code of Federal Regulations, Section 65.11, Evaluation of sand dunes in mapping coastal flood hazard areas to address this issue. However, due to budgetary constraints, even FIRMs dated post-1988 generally do not reflect these regulatory changes. In most cases, the only recent update involved the addition of Coastal Barrier Resource Units in 1992. Any revisions made since the original maps were created are listed under the legend provided with each FIRM.

These updated NFIP regulations define a V-zone or coastal high hazard area as an "area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms or seismic sources." Due to the dynamic nature and erosion potential of primary frontal dunes, such as changes in shoreline configuration from the impact of consecutive storms, "the final rule definition of coastal high hazard area includes all primary frontal dunes. Therefore, the boundary line of the V-zone, at a minimum becomes the landward 'toe' of the dune." (*Federal Register*; May 6, 1988)

In some cases, the V-zone may extend farther landward than the inland limit of the primary dune. Section 65.11 (b) of the NFIP regulations indicates that "primary frontal dunes will not be considered as effective barriers to base flood storm surges and associated wave action where the cross-sectional area of the primary frontal dune, as measured perpendicular to the shoreline and above the 100-year stillwater flood elevation and seaward of the dune crest, is equal to, or less than, 540 square feet." Figure B demonstrates how the 540 square foot area is measured.

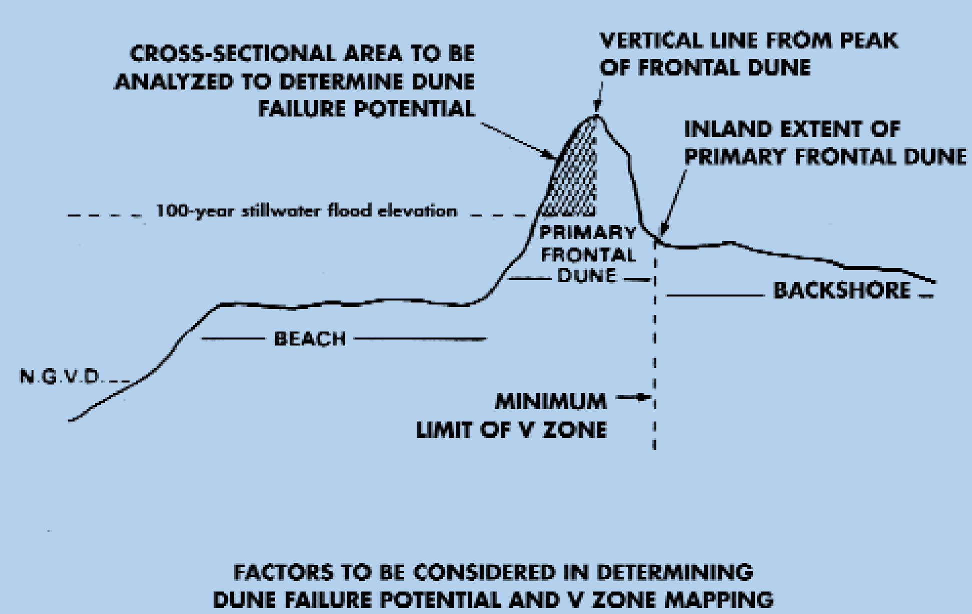


FIGURE B

FEMA provides further clarification of this "540-rule" in its 1995 *Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping*. Although a dune with a cross-sectional area greater than 540 square feet may provide some level of protection during the 100-year event, by definition the V-zone still includes the entire primary frontal dune. Further analysis is necessary to establish the landward edge of the V-zone if the dune will be overtopped and/or if the cross-sectional area of the primary dune is less than 540 square feet. When the cross-sectional area of the primary dune is less than 540 square feet, the additional analysis involves assuming the dune is removed by erosion during the storm event, and assessing the results of wave runup models to determine how far inland velocity conditions would extend. The FEMA Guidelines provide methodology for evaluating site-specific conditions and delineating V-zones in sand dunes.

Why 540 square feet? FEMA's assessment of dune erosion is based on a statistical analysis of erosion data from actual storm events of different severities. FEMA graphed the cross-sectional area that was eroded from the primary dunes during various coastal storms, then determined the median value of erosion for the data set. For 100-year storms, the median area of erosion was 540 square feet. Using the median means that in 50 percent of the cases, less than 540 square feet is eroded, while more than 540 square feet is eroded in the other 50 percent of the cases. In addition, this analysis does not account for cumulative impacts from multiple storms and long-term erosion. The recent revision of FEMA's *Coastal Construction Manual* (CCM) addresses these limitations by recommending that a more conservative primary frontal dune measure of 1,100 square feet be used for planning purposes.

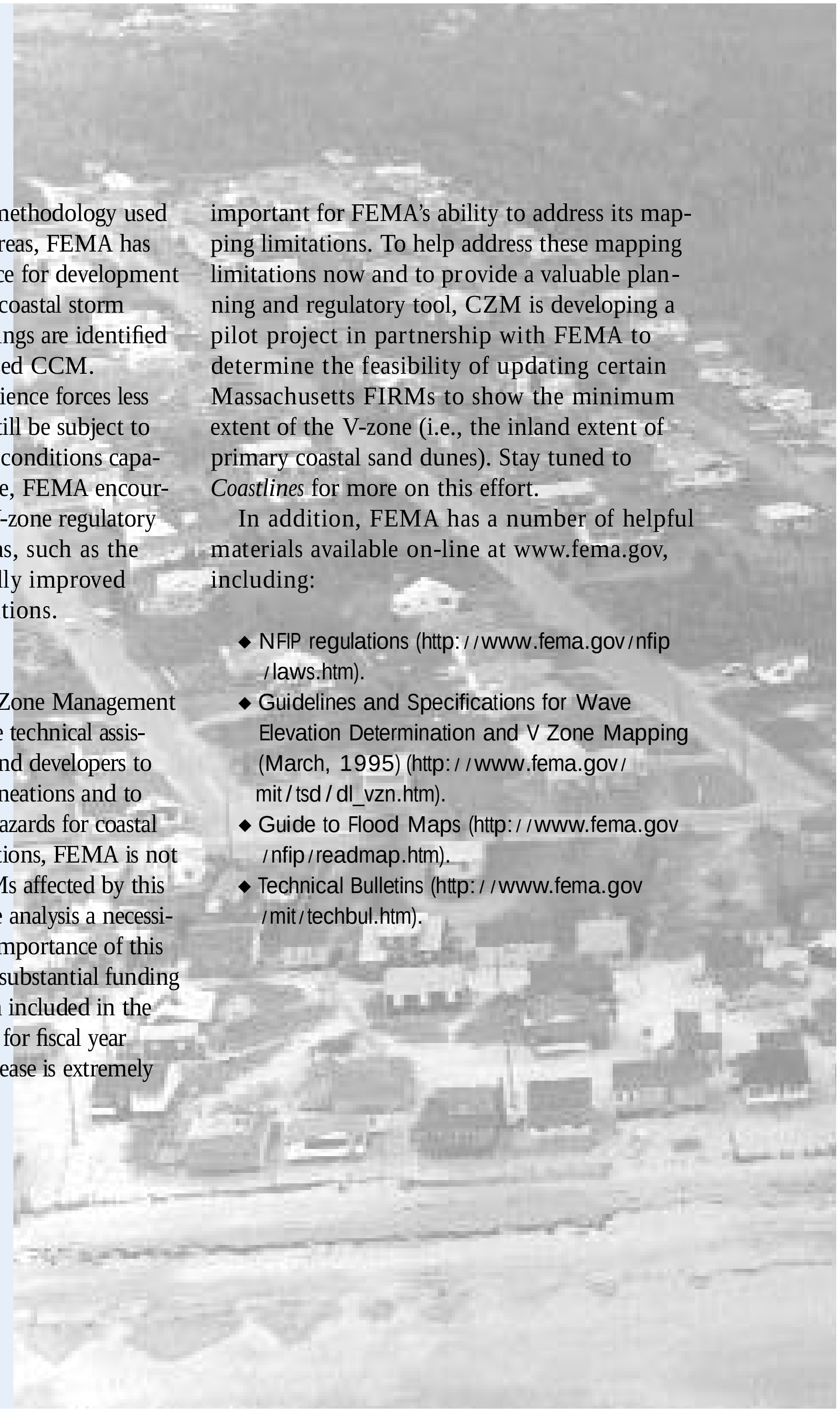
In addition to updating the methodology used to identify coastal high hazard areas, FEMA has also provided additional guidance for development in A-zones that may experience coastal storm flooding. A-zones in coastal settings are identified as "Coastal A-zones" in the revised CCM. Although Coastal A-zones experience forces less severe than V-zones, they may still be subject to velocity and wave-related storm conditions capable of causing damage. Therefore, FEMA encourages the application of certain V-zone regulatory requirements within these areas, such as the elevation of new or substantially improved dwellings on open pile foundations.

NEED MORE HELP?

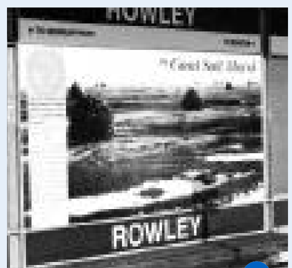
Massachusetts Office of Coastal Zone Management (CZM) coastal geologists provide technical assistance to local coastal regulators and developers to facilitate accurate flood zone delineations and to better assess potential risks and hazards for coastal properties. Due to budget limitations, FEMA is not currently able to update all FIRMs affected by this issue, making detailed site-by-site analysis a necessity. It appears, however, that the importance of this issue has been recognized by the substantial funding increase to the mapping program included in the recently proposed federal budget for fiscal year 2003. Passage of this budget increase is extremely important for FEMA's ability to address its mapping limitations. To help address these mapping limitations now and to provide a valuable planning and regulatory tool, CZM is developing a pilot project in partnership with FEMA to determine the feasibility of updating certain Massachusetts FIRMs to show the minimum extent of the V-zone (i.e., the inland extent of primary coastal sand dunes). Stay tuned to *Coastlines* for more on this effort.

In addition, FEMA has a number of helpful materials available on-line at www.fema.gov, including:

- NFIP regulations (http://www.fema.gov/nfip/laws.htm).
- Guidelines and Specifications for Wave Elevation Determination and V Zone Mapping (March, 1995) (http://www.fema.gov/mit/tsd/dl_vzn.htm).
- Guide to Flood Maps (http://www.fema.gov/nfip/readmap.htm).
- Technical Bulletins (http://www.fema.gov/mit/techbul.htm).



ACCURATELY DEFINING THE EXTENT OF FLOOD ZONES OFTEN IS NOT AS SIMPLE AS READING A FEMA FLOOD ZONE MAP.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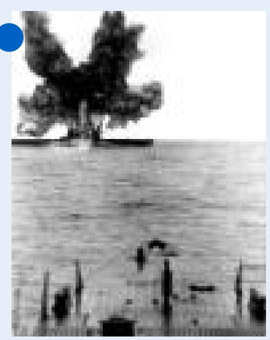
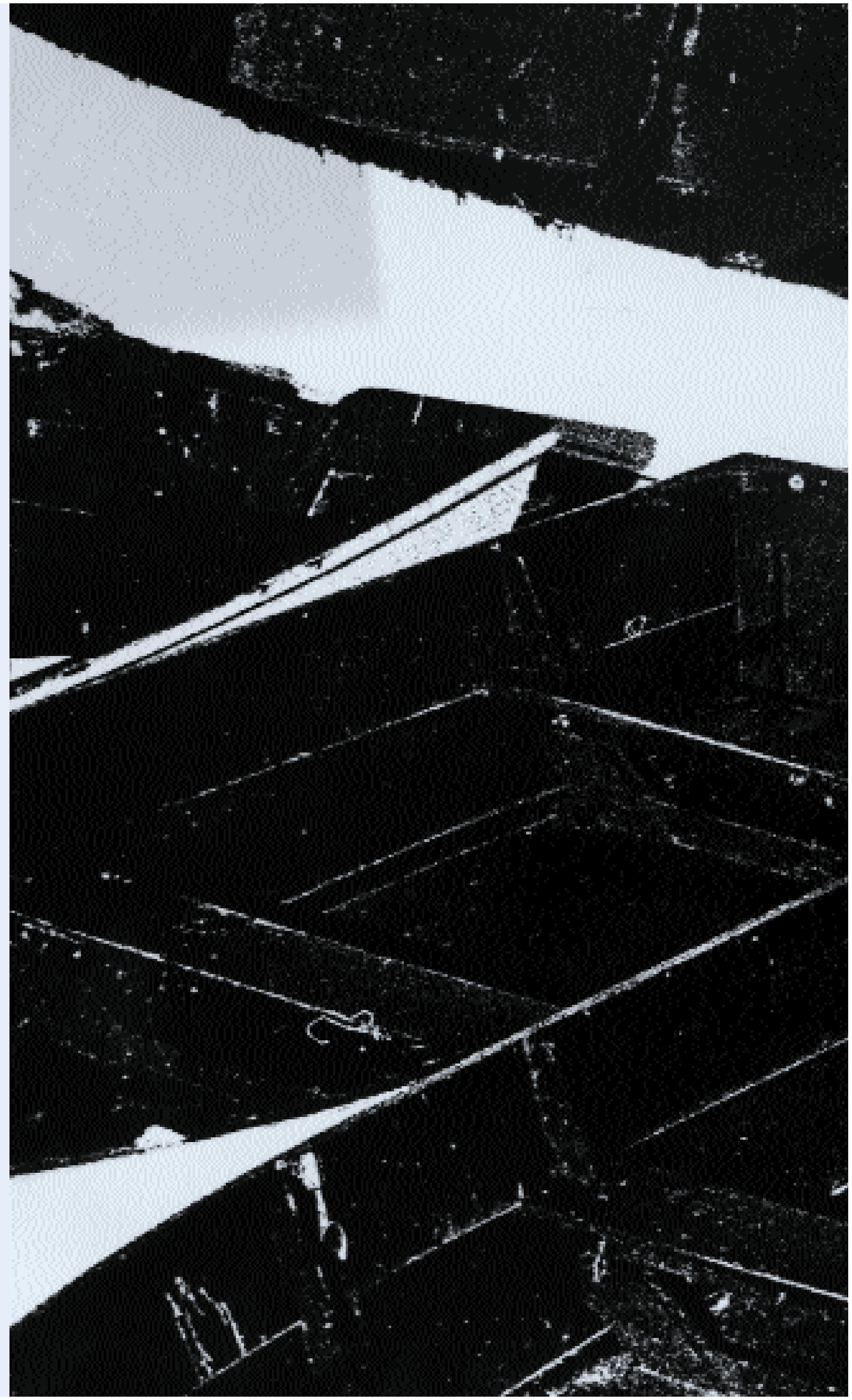
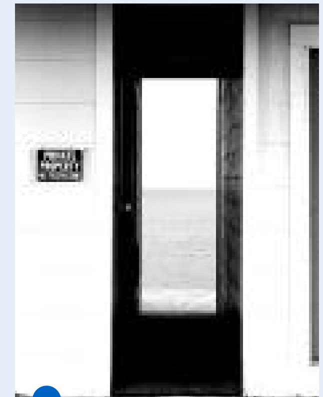
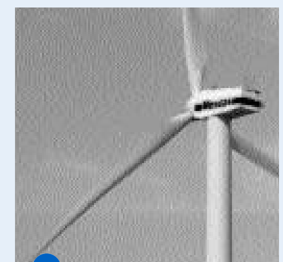


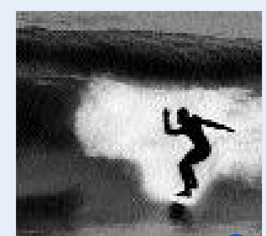


EBB & FLOW

EVENTS & ISSUES GOING ON AROUND THE COAST







THEY'RE HERE, THEY'RE THERE, THEY'RE EVERYWHERE—THEY'RE THE WAVE OF THE FUTURE!

One has been sighted on a station wagon in Norwell. Several are firmly attached to a building in downtown Boston. They've been reported in American Samoa, and officials from New Hampshire, Maryland, and Delaware have inquired about them. Are they some unknown marine life form? Or a rare bird? Hardly. They're this summer's hottest item: blue, white, and purple "coastal zone management - it's the wave of the future" window decals and they're available for the asking...

WANNA GET IN ON THE ACTION? Order your free "wave of the future" decals today by calling the Massachusetts Office of Coastal Zone Management's Information Line at 617-626-1212 or e-mail us at czm@state.ma.us.

SHARI CURREY, CZM'S 2000-2002 NOAA COASTAL SERVICES FELLOW AT THE CHARLES RIVER ESPLANADE ON EARTH DAY, 2002.

photo courtesy of American Samoa Coastal Management Program

CATCHING THE WAVE, AMERICAN SAMOA.STYLE.

DEFENDING MASSACHUSETTS AGAINST BIOLOGICAL INVADERS

By Jay Baker, CZM

In the early 1980s, curators of tropical aquariums throughout Europe began to cultivate an alga imported from the Caribbean for use in tanks displaying tropical fish. This bright green, feathery alga called caulerpa (*Caulerpa taxifolia*) provided a brilliant backdrop for tropical displays, resisted wilting in the artificially lighted tanks, and grew vigorously in a wide range of temperatures. Caulerpa provided the perfect habitat for aquarium animals in the artificial aquarium environments. In 1984, a small patch—only about one square meter—of caulerpa was noted on a submerged flat under the windows of the Oceanographic Museum of Monaco on the Mediterranean Sea, likely discharged with wastewater from an aquarium display. Scientists soon noted the remarkable tendency of this alga to aggressively crowd out native plant and animal species. Its ability to spread by extending long stems, or rhizomes, which are toxic to most plants and fish, makes it a fierce competitor for space. The alga forms large, dense mats, uninhabitable by almost all other species. The rhizomes also cause caulerpa to be easily entangled in and transported with boat anchors and fishing gear, and by 1990 caulerpa had spread as far as 120 miles from its original point of introduction. In 1997, caulerpa covered a total area of 17-square miles, and by the spring of 2001, caulerpa, now commonly referred to as the "Killer Algae," had invaded the coastlines of six Mediterranean countries.

GOOD PETS CAN BE GREAT PESTS

The adaptable and aggressive characteristics of *Caulerpa taxifolia* and other invasive species are causing great concern not only in the Mediterranean, but also among scientists and natural resource managers across the globe, including those working here in Massachusetts. Many organisms that thrive in artificial or stressful environments, both plants and animals, are in high demand for use in home aquariums, water gardens, aquaculture operations, research facilities, or as bait for fresh or saltwater fishing. As a result, many of these species are transported for sale around the world. In fact, though it is now illegal to possess caulerpa in the United States, a brief search of the Internet will reveal a number of companies willing to deliver the "Killer Algae" right to your doorstep. In the summer of 2000, populations of caulerpa were discovered in two Southern California estuaries, both likely getting their start as a result of releases by aquarium hobbyists.

The very characteristics that make species like caulerpa so desirable for use in artificial environments also make them a great threat to the natural diversity of aquatic systems. Species transported beyond their native range and introduced to natural systems often have no competitors, allowing them to grow rampant and displace many or all native species. As a result, these invasive species are considered to be second only to human development in causing declines in the total number of species in the United States and worldwide. The explosive growth of invasive species also causes major conflicts with human uses of aquatic resources. These species often completely clog waterways and water intakes, making them unusable for recreational, municipal, or industrial purposes.

INVADERS IN MASSACHUSETTS

While Massachusetts has not yet had to deal with the presence of an invader like caulerpa, a number of other invasive species are well established, and many more are encroaching on the Massachusetts border. In the summer of 2000, a team of researchers from across the country, led by the Massachusetts Office of Coastal Zone Management, the Massachusetts Bays Program, and MIT Sea Grant, conducted a survey of invasive species along the coast of Massachusetts and Rhode Island (see *Coastlines* Winter 2000-2001). This Rapid Assessment Survey documented the presence of 24 introduced species and 49 cryptogenic species, or species whose origin could not be determined. While many of these species, such as the European green crab

A RESEARCHER REMOVES ATTACHED ORGANISMS FROM A FLOATING DOCK DURING THE RAPID ASSESSMENT SURVEY.

(*Carcinus maenus*), and the common periwinkle snail (*Littorina littorea*) were likely "hitchhikers" on international shipping vessels, several of these invaders are thought to have been introduced by recreational boaters or as escapees from aquariums, aquaculture operations, or research facilities. On the freshwater side, officials from Massachusetts Department of Environmental Management estimate that 50 - 70 percent of the public lakes and ponds in Massachusetts are infested with invasive plant species. Infestations by the likes of water chestnut (*Trapa natans*) and Eurasian watermilfoil (*Myriophyllum spicatum*) have rendered many Massachusetts lakes and ponds unusable for fishing, boating and swimming. Massachusetts state agencies spent more than $500,000 on the control of these species in 2001.

A COMMON SALT MARSH INVADER, PHRAGMITES AUSTRALIS OR COMMON REED.

TASK FORCE TAKES ACTION

Recognizing the need to stall the introduction of new invasive species, and minimize the spread of established invaders, a coalition of Massachusetts state agencies, federal officials, and area scientists began developing the *Massachusetts Aquatic Invasive Species Management Plan* in the fall of 2001. The Plan addresses invasive species concerns in both marine and freshwater environments, and includes actions such as monitoring estuaries throughout the Gulf of Maine for invasive species, creating a database of invasive species occurrences throughout the region, and training volunteers across the state to monitor for introduced plants and animals. (For more information on this planning effort, please visit www.mass.gov/czm/invasivemanagementplan.htm.)

WHAT YOU CAN DO TO STOP THE INVASION

Of highest priority in the Plan is the education of the general public, researchers, and industry representatives regarding their role in invasive species prevention. People who live near and utilize waterways for a variety of purposes—just about everyone—can play a part in limiting the spread of aquatic invaders. In many cases, introductions can be avoided by exercising minimal care in the use and handling of living aquatic organisms. The following are a few simple guidelines that can be followed to limit the spread of these species.

DON'T LET THE LITTLE PACKAGE FOOL YOU: THE EUROPEAN GREEN CRAB IS A HARDY INVASIVE!

Proper Disposal of Home Aquarium Contents

Plants and animals used in both salt and freshwater aquariums should never be disposed of in a lake, stream, pond, estuary, or even in a municipal storm drain. Like caulerpa, plants and animals sold for use in these aquariums are often very hardy and aggressive, and many freshwater invasions across the country have been attributed to the release of aquarium plants. Plants and algae can also harbor unseen snails or other small invertebrates, which might become established in local waters. All unwanted aquarium plants, algae, and fish should be placed in a plastic bag and disposed of in the trash. Many researchers even recommend that aquarium plants be placed in a freezer for 24 hours prior to disposal, ensuring that they are unable to reproduce if they do come into contact with a local waterway. A few pet stores will accept unwanted aquarium plants and animals for disposal.

Choosing Plants and Animals for Your Water Garden

Outdoor water gardens are growing in popularity across Massachusetts as a centerpiece of residential landscapes. As with home aquariums, plants and fish used in water gardens are often selected because they grow well in stressful environments and require minimal care. Some of the most problematic aquatic invasive species in Massachusetts, such as purple loosestrife (*Lythrum salicaria*), can still be purchased in area nurseries. Because water gardens are usually outdoors and directly exposed to natural environments, the escape of imported plants is not uncommon. Seeds or other reproductive components of plants can be transported by wind or wild animals such as birds and small mammals.

Before purchasing plants or seeds for use in water gardens (or any garden for that matter) find out if the plant is native to New England or a potentially invasive import. CZM is currently working on an Ecological Landscape Initiative, which will develop guidance for landscapers and homeowners on selecting native plants for use around the home, including wetland species that might be selected for water gardens (look for an update in an upcoming issue of *Coastlines*). In the meantime, lists of native plants can be obtained from the Massachusetts Division of Fisheries and Wildlife's Natural Heritage Program. If you are unsure of the origin of a plant, avoid buying it. Express your interest in purchasing native plants for use around your home to your local nursery.

Proper Disposal of Unused Fishing Bait

While the sources of fish used as live bait in Massachusetts are carefully regulated, the import of invertebrate species such as worms and crustaceans are not. Worms imported from Southeast Asia, for example, may comprise a portion of the marine live bait industry in New England. Surprisingly, many species used for bait are hardy enough to be sold live in coin operated vending machines! Of additional concern is the material in which the intended bait species are shipped. Often made up of seaweed or plant matter, the packaging itself may become a problematic invader, or harbor additional species not intended for use as bait.

While it may seem the humane thing to do, unused bait or bait packing materials should never be released into the water. Unused bait should be placed in a plastic bag or container and disposed of in the trash.

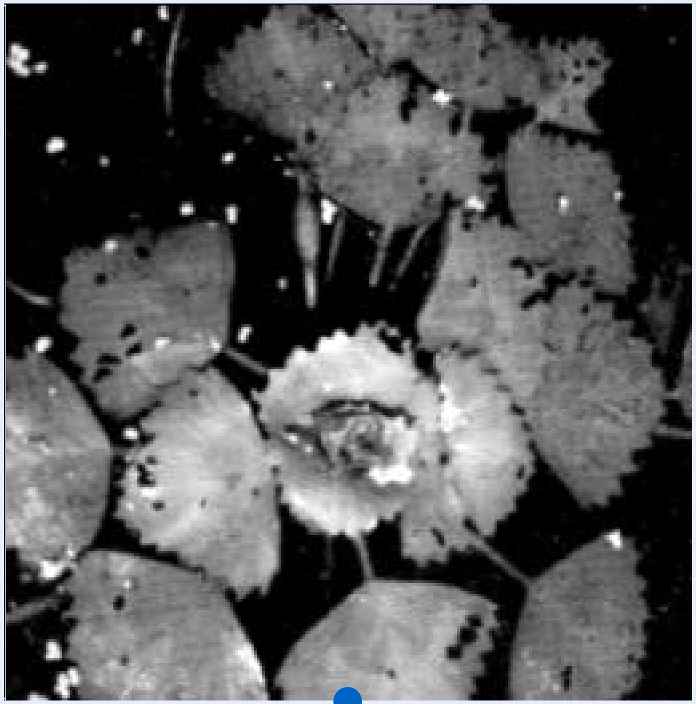
Thorough Cleaning of Boat Hulls, Engine Props, and Boat Trailers

Recreational boats and their trailers are likely the most common means of transport for invasive species between water bodies within New England and Massachusetts. Aquatic plants are easily entangled in engine props, anchors, boat trailers, and fishing gear. In many cases, the transport of just a fragment of a plant to an uninfested water body can allow for the generation of a thriving and damaging population. Likewise, boat hulls provide suitable habitat for a variety of invasive fouling organisms such as the notorious European zebra mussel (*Driessena polymorpha*), which has been sited in lakes only a few miles from the Massachusetts border.

Boat hulls, props, boat trailers, fishing gear, and other submerged components should be thoroughly cleaned before leaving a boat access. All animals and plant material should be disposed of in a trash receptacle as far from the water as possible. Likewise, water from bait buckets, motors, and other equipment should always be drained far from a water body. Animals, plant material, or water should never be released upon arriving at a new lake, pond, estuary, or any other water body.

Proper Disposal of Shellfish or Shellfish Waste

As with home aquarium contents, live shellfish or shellfish remnants should be kept clear of natural aquatic systems. Even shellfish harvested in Massachusetts can harbor invasive shellfish pathogens such as dermo (*Perkinsus marinus*) and QPX (quahog parasite unknown), which can linger in shells and other waste materials and cause significant mortality in economically important shellfish stocks. The Massachusetts Division of Marine Fisheries is also concerned about the intentional or unintentional introduction of European, Asian, and Pacific-Coast shellfish species such as the Asian clam (*Corbicula fluminea*) and the Pacific oyster (*Crassostrea gigas*). It is illegal to place any live shellfish in Massachusetts waters without a permit from the Division of Marine Fisheries, and shellfish waste should be disposed of in the trash.



THE WATER CHESTNUT (TRAPA NATANS) WAS INTENTIONALLY INTRODUCED TO THE U.S. AS A FOOD SOURCE. TODAY, DUE TO DRAMATIC PROLIFERATIONS, IT CLOGS LAKES, PONDS, AND RIVERS.

THE THREAT IS HERE AND NOW

Just this past fall, Massachusetts researchers made a discovery that underscores the need for a greater awareness of the invasive species issue in the state. Scientists from the University of Connecticut and the Massachusetts Department of Environmental Management found a potentially devastating invader called hydrilla (*Hydrilla verticillata*) in Long Pond on Cape Cod. Dubbed, the “Perfect Weed,” hydrilla is one of the most aggressive invasive plants now present in the United States. Hydrilla is native to Asia where it coexists with other submerged plants and provides habitat for many aquatic organisms. In the United States, however, it quickly crowds out all other species, growing in thick mats that make recreational use of the infested pond impossible, and often impeding water movement to the point that it can cause flooding in infested areas. A common aquarium and water garden plant, hydrilla was first released in Florida, and now infests 43 percent of the public lakes and ponds in that state. With the recent addition of Massachusetts, hydrilla has now spread to 18 states across the country.

While no one is absolutely certain how hydrilla made it to Long Pond, the discoverers of the Perfect Weed suspect that it escaped from a water garden on the grounds of an area home. Though a less likely scenario, the hydrilla may also have been introduced by a boater who had recently visited an infested lake or pond in another state. Since its discovery, all boat ramps accessing the pond have been closed to prevent the spread of this species to other water bodies in the area, and Barnstable Town Officials are considering a herbicide application program estimated to cost as much as $60,000 in the first year, and almost certainly requiring follow-up applications in the following years.

HYDRILLA OVERTAKES A FLORIDA LAKE.

Clearly, the introduction of hydrilla and the resulting impairment of Long Pond was not an intentional act. Regardless, eradication of this invader will likely require the investment of significant resources, and make the pond all but unusable over the next several years. Department of Environmental Management officials are also concerned that hydrilla may have already been spread to other ponds in the area.

A greater awareness of the invasive species issue would likely result in a significant decrease in the number of aquatic invasive species introductions in Massachusetts and across the globe. By exercising a few cautions, such as those listed above, Massachusetts could be spared the negative impacts of many encroaching invaders. For more information on the invasive species issue, and how to stop aquatic invasions, please visit the following web sites:

- www.anstaskforce.gov
- http://nas.er.usgs.gov
- www.cce.cornell.edu/programs/nansc/nan_ld.cfm

THOUGH SMALL IN SIZE, CONTROL OF THE EUROPEAN ZEBRA MUSSEL SHOWN HERE COSTS THE U.S. HUNDREDS OF MILLIONS OF DOLLARS ANNUALLY.

WEB CAM CRAZE HITS COMMONWEALTH COAST

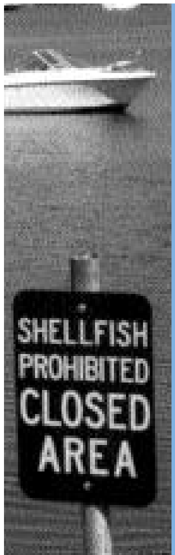
By Brian Mardirosian, CZM

WOULDN'T IT BE NICE IF, from your office cubicle, YOU HAD A WINDOW TO THE wider WORLD, a way to look out onto a beautiful beach or striking shoreline? Well, with the World Wide Web and the advent of the Web cam era, you do. With an estimated half million sold in the year 2000 alone, these ubiquitous video cameras hooked up to PCs are everywhere, broadcasting their instantaneous images all over the world. With this many electronic eyes out there, it's no surprise that some Web cams are focused on the Commonwealth's coast. Here's a sampling:

WEB CAM IMAGE FROM THE BEACHCOMBER RESTAURANT IN WELLFLEET. TO SEE A CURRENT VIEW, GO TO www.thebeachcomber.com/beach/.

- One of the most famous of Web cams can be found at the New England Aquarium. The giant ocean tank video camera is in the 200,000-gallon center tank, which mimics the underwater ecology of a coral reef. At any given moment, you may see sharks, turtles, or rays gliding past—and those are just three of the over 50 varieties of fish and reptiles that you might spot!
- The long lines of traffic down to Cape Cod during a summer weekend are notorious. Each year, the Sagamore and Bourne bridges handle an estimated 35 million vehicles crossing to and from the Cape. To brace yourself for the trip, take a real-time look at the traffic via the bridge cams that are provided by Cape Cod Online.
- The folks at the Beachcomber, a restaurant and bar in the town of Wellfleet on Cape Cod, have a Web cam facing east from their 3rd floor. This is the only Web cam on Cape Cod that faces the Atlantic Ocean and is a must-watch when there's a storm!
- A rather unique Web cam can be found at the Fish Pier in Chatham. The panoramic camera provided by TeleCam Systems allows a "sweeping panorama from Aunt Lydia's Cove on Pleasant Bay, across Tern Island, along Nauset Beach to the 'Break' at the entrance to Chatham Harbor." It's a great way to get a taste of a Cape Cod fishing harbor without actually being there.

Plenty of other Web cams are listed on the CZM site at ww.mass.gov/czm/webcams.htm. Take a moment to visit the coast from your computer. If we are missing a Web cam or if you have any comments, questions, or suggestions for the CZM Web site, please e-mail brian.mardirosian@state.ma.us.



WHAT LIES BENEATH...

By Paul Somerville, CZM

SOMETIMES THERE ARE SIGNS TO LET YOU KNOW OF POTENTIAL CONTAMINANTS IN THE WATER.

If there's one thing most people agree on, it's that the coastal areas of the Commonwealth have more than their share of very special, incredibly beautiful vistas. Think about the Great Marsh on the North Shore, Duxbury Bay on the South Shore, boat-filled Mattapoisett Harbor, and the marshes of the Westport River on the way to Horseneck Beach, both on the Buzzard's Bay shoreline. Then there's the Cape and Islands, affectionately called "God's Country" by Truman Henson, Cape and Islands Regional Coordinator for the Massachusetts Office of Coastal Zone Management (CZM). Places like Hatch's Harbor in Provincetown, Nauset Marsh from Fort Hill in Eastham, Barnstable's Sandy Neck, Nantucket's Madaket Harbor and the Vineyard's Menemsha Harbor or Gay Head. They are all beautiful for one reason or another.

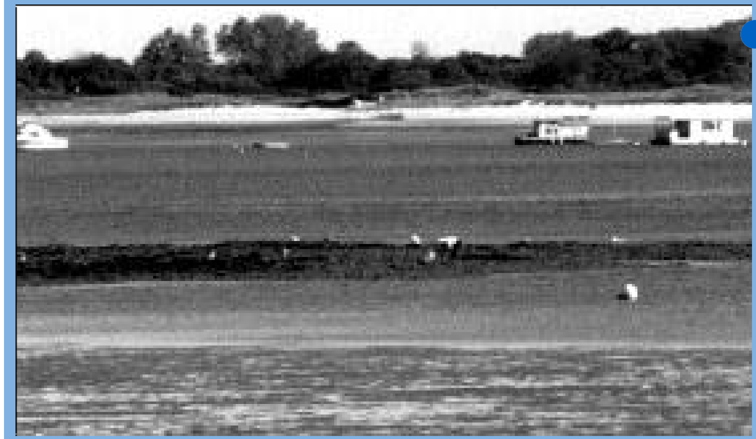
But for some folks, many of these picture-post-card-perfect views contain numerous flaws—and some of us are paid to find them. I'm talking about local, state, and federal employees whose job it is to look for potential sources of pollution that alter natural ecosystems, causing coastal ponds and embayments to age at unnaturally accelerated rates, or that cause beaches to be closed to swimming and productive shellfish areas to be closed to shellfish harvesting. Let's not forget the many employees and volunteers from non-profit groups, as well as independent, unpaid volunteers that work out of their concerns for the environment. These folks all learn to look past the striking beauty and see the whole area from an environmental perspective, knowing that sometimes the very thing that makes a place so pretty might also be a potential problem. And sometimes nature hides the problem or disguises it, only to reveal it later on.

The photos included here were taken at various places along the coast of Massachusetts. I am going to show you what lies beneath the pretty picture as filtered through my alert-to-potential-environmental-issues eyes. This is an exercise in contamination-source assessment and investigation and is not meant to indicate that any person, thing, or property in these pictures has been, is, or may be an actual source of fecal coliform bacteria contamination.

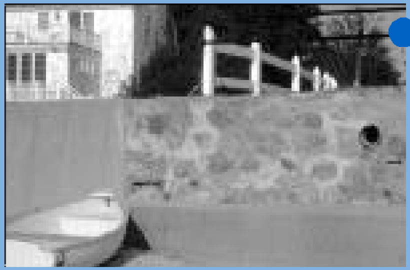
Oh, and when you look at such scenes in the future, you may develop a heightened awareness of what could be lurking in the background, but don't ever look so hard for the faults that you lose your appreciation for the beauty that's there. Trust me. Even the most hardcore pollution seeker can be stopped dead in their tracks by a colorful sunset.

A CLOSER LOOK...behind the pretty pictures

Comments by Paul Somerville, CZM

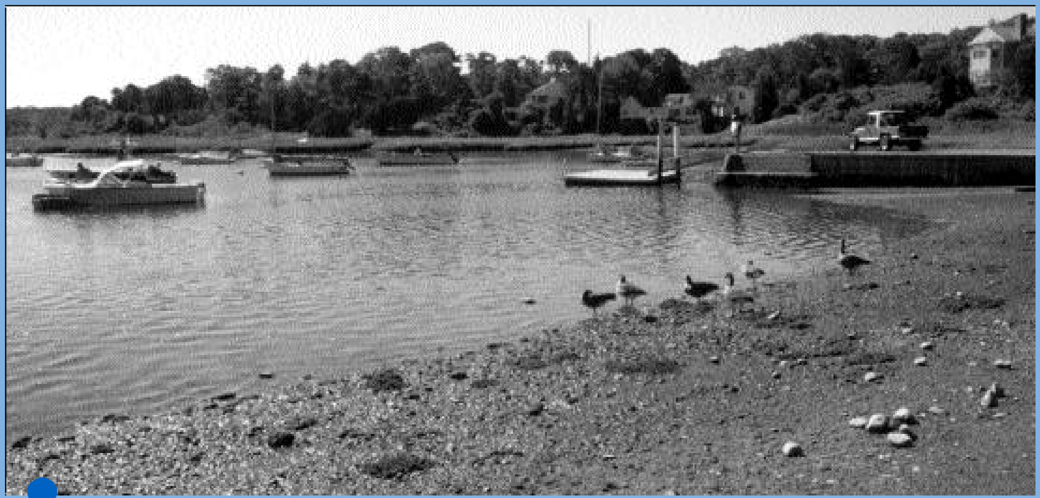


"The main thing I notice here is the houseboats. Are they weekend cottages? How are their holding tanks emptied? Does the owner take them to a pumpout facility? Also, I see the barrier beach and wonder if there are houses near the beach, just out of sight, and, if so, how old are their septic systems? Are they cesspools or Title 5 systems?"



"A storm drain coming out of a seawall; what particularly catches my eye is the amount of erosion at the base of the seawall, indicating that there's A LOT of water shooting out of that pipe. This leads me to wonder how much impervious surface there is. I also happen to know that a lot of the soils are heavy clay, which doesn't lend itself to natural filtration."

"What you DON'T see in this photo that would be revealed in water quality investigations is the sewage treatment plant just around the corner. Also, upriver, just out of site, is the center of a small town with lots of storm drains and impervious surfaces. A lot of the area is built on rock, which means that pollutants don't have the benefit of sand or soil filtration before they hit the water."



"We have houses fairly close to the bank, which means that faulty septic systems could be a real problem. And the geese! A definite bacteria source. Birds like to eat and then make room for more. And with boats I have to wonder, do they have enclosed heads? Also, all of the green algae in the intertidal area indicates loads of nitrogen-rich groundwater."

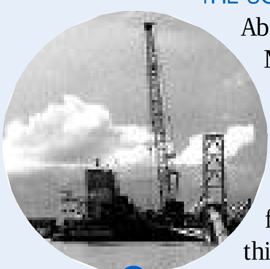
ENERGY: A MAJOR COASTAL ZONE MANAGEMENT ISSUE

By Jane Mead, CZM

When you flip on the light or turn up the thermostat, do you wonder where the energy comes from? With most of our energy sources in Massachusetts coming from out of state, it's an easy question to avoid. Each year, Bay State residents and businesses consume more than one and a half quadrillion Btus of energy. Because so much of the state's raw energy is brought in by ship, many storage and generating facilities have been located on the Commonwealth's coast, which is just one reason energy is a major coastal management issue.

About 50 PERCENT OF THE ENERGY CONSUMED IN MASSACHUSETTS IS DEVELOPED FROM PETROLEUM PRODUCTS, pumped FROM WELLS IN VENEZUELA AND THE MIDDLE EAST and delivered to regional tank farms by ship and barge...

THE SOURCES: CURRENT AND PROJECTED



BARGE LAYING A NATURAL GAS PIPELINE

About 50 percent of the energy consumed in Massachusetts is developed from petroleum products, pumped from wells in Venezuela and the Middle East and delivered to regional tank farms by ship and barge. At the moment, New England is more heavily dependent on fuel oil for heat than other parts of the country, though this is changing as new sources of natural gas become available.

Natural gas, currently the source of 30 percent of our energy, is mostly piped from the Gulf of Mexico, western Canada, and the Scotian Shelf off the Canadian Maritime Provinces. About 15 percent of the natural gas used in Massachusetts is imported as Liquefied Natural Gas (LNG), primarily from Trinidad. The huge reserves that have been found off the Canadian Maritimes, and the demands of new electrical generating facilities for clean fuel, however, are expected to increase natural gas use in the region. By 2005, it is anticipated that natural gas will be used to generate 45 percent of the region's electricity.

About 15 percent of the state's power is generated from coal and nuclear energy, with two large coal-fired power plants and one nuclear plant in Massachusetts. It is not expected that any new coal or nuclear generating facilities will be built in the foreseeable future.

Right now, renewable energy is a fairly small part of the Massachusetts fuel mix. Hydropower is the major source of homegrown electricity, but is gradually being phased out because of the damage that dams cause to spawning fish. Small projects to capture wind and solar power have also been installed in the state, and wind power projects are expected to be proposed in increasing numbers.

ELECTRICITY GENERATION AND DEREGULATION

Massachusetts is part of ISO New England (ISO-NE), an Independent System Operator for an integrated six state power region. ISO-NE manages bulk power and transmission systems within these states.

New England power plants can generate about 25,000 megawatts (MW) of electricity per day. The region can also import up to 4,200 MW from New York, Quebec, and New Brunswick. The transmission system, or power grid, consists of about 7,000 miles of high-capacity electric lines.

In 1998, Massachusetts passed an electrical energy deregulation statute, which has had a significant impact on the power generation market in Massachusetts and the New England region. Existing electric utility companies were strongly encouraged to divest themselves of all generating facilities. Generators were expected to compete for sales to local distribution companies on price. Under deregulation, existing retail utility companies transmit power to retail users and they maintain the transmission systems. Prices that the electric suppliers can charge are unregulated, but retail prices to businesses and homeowners are regulated, though the price of electricity can be raised or lowered in response to market conditions. Other features of the statute require that renewable energy be included in the mix of power sources used by the retail power suppliers.

This structure has led to enormous interest in developing additional generating capacity, as well as renewable sources of energy in Massachusetts. In the past year, about 1,000 MW of new capacity were brought on line, another 6,500 MW have been permitted, and 3,500 MW are under construction and will be on line within the next 2-3 years. To fuel these plants, a high-pressure gas pipeline to bring natural gas from Sable Island, Nova Scotia, is under review. A proposal to develop a 420 MW wind farm in Nantucket Sound is also currently under consideration.

REVIEW: POWER PLANTS AFFECTING THE COASTAL ZONE

The Massachusetts Office of Coastal Zone Management (CZM) has had significant involvement in the review of all new and expanded energy facilities in the coastal zone. Under our federal consistency authority, any project that affects the land or water resources or uses of the Massachusetts coastal zone must be consistent with state coastal policies. Power plants have the potential to affect many coastal resources and CZM review helps to minimize those impacts.

In 1998, four existing coastal generating plants that are within CZM's jurisdiction were purchased from local utilities by large generating companies. Sithe acquired Boston Edison facilities in South Boston on the Reserved Channel, in Everett on the Mystic River, and in Weymouth on the Fore River. No changes were proposed to the South Boston plant, but Sithe wanted to double the capacity of the Mystic and Fore River plants and convert them from oil to gas fired turbines. At the Mystic plant, CZM worked with the owners to identify marine docking facilities, allowing the construction materials to be barged to the site rather than trucked through the streets of Everett. At the Fore River, CZM and other agencies objected to the owner's plan to use large amounts of river water to cool the plant and instead successfully advocated for the use of an air-cooling system.

Another existing power plant at Kendall Square on the Charles River in Cambridge was purchased by Southern Energy (now Murant). Again, plant cooling was a major issue. The applicant proposed an innovative cooling design using a diffuser to spread heated water throughout the Charles River Basin, however many resource agencies are concerned that the heated water will have adverse effects on fish. These agencies, with CZM, are working with the applicant to modify the design to avoid fishery impacts.

REVIEW: NATURAL GAS PIPELINES

The new power plants proposed in Massachusetts are primarily natural gas fired, as this fuel burns more efficiently than oil and has fewer adverse impacts on air quality. To provide fuel to these power plants, new high-pressure gas pipelines are being proposed to bring gas from the fields off the Canadian Maritimes to the New England region. Algonquin Gas Transmission Company has proposed the HubLine, a 29.4-mile long, 30-inch high-pressure gas transmission line to be located in western Massachusetts Bay. The proposed pipeline would interconnect with Maritimes and Northeast's system at Beverly and would be buried under the sea floor through Beverly Harbor, Salem Sound, Massachusetts Bay, Boston Harbor, and the mouth of the Weymouth Fore River, delivering gas to the Sithe Fore River plant mentioned above. CZM has been particularly concerned about the potential impact of this project on deep-sea shipping, as the proposed route crosses several shipping channels and anchorages. Algonquin has re-designed the project to bury the pipeline by at least 10 feet in areas where ships might anchor or where shipping channels may be dredged below current depths. Another consideration has been the impact of the extensive anchoring system used to steady the barges that lay the pipeline in the water–these anchors affect significantly more of the ocean bottom than the pipeline itself. Algonquin has agreed to use a system of buoys on the anchor lines, which will minimize damage to the ocean bottom.

REVIEW: WIND POWER

Because of improving technology and the requirement that Massachusetts retail electric companies use renewable sources of energy, there is considerable interest in wind power. Cape Wind Associates has proposed a 170-machine wind farm that would generate up to 420 MW of power on Horseshoe Shoals in Nantucket Sound. This project would be the first in the world of this size in the open ocean. The proponents plan to provide power to the New England power grid, offering a source of renewable energy to the region. This project, while outside of state waters, will be reviewed by CZM, as it will affect the Massachusetts coastal zone.

Several other projects are expected to be proposed in the near future including an offshore gas pipeline from Sable Island passing along the continental shelf off Massachusetts to the New York/New Jersey area, and a wind and wave energy project on Nantucket shoals.

FUTURE CONSIDERATIONS

A major constraint on the New England energy market is the condition of the surrounding infrastructure. ISO-NE has identified a shortage of transmission capacity, and has begun a project to improve high voltage transmission lines, both to bring power in from sources outside the region and to improve transmission within the region.

Though new natural gas pipelines will become available, distillate fuels, such as gasoline, jet fuel, and home heating oil, will continue to be transported by ships and barges. A very significant percentage of the storage capacity for these fuels is bridge-bound, meaning that the storage tanks are upstream of often aging bridges. Two bridge repair projects in the Boston area alone have upset regional fuel delivery schedules over the past the past three years, and the projects are not finished yet. It is important that the state develop an overall plan for repair and replacement of bridges that takes maritime needs into account.

CZM will continue to work with the energy suppliers and generators to ensure that alterations and additions to our badly needed energy system are built in a manner that is consistent with Massachusetts coastal policies.

HYDROPOWER DAM

PETROLEUM TANKER

NATURAL GAS-FIRED ELECTRICAL GENERATION FACILITY IN EVERETT

DID YOU KNOW?

Current sources of energy for electric power generation in New England are as follows:

NUCLEAR	24%	COAL	13%
OIL	20%	HYDROELECTRIC	6%
NATURAL GAS	16%	SOLAR / WIND	5%

(The remaining 16% is made up of energy purchased from other states.)

HULL MUNICIPAL LIGHT COMPANY'S WIND TURBINE ON POINT ALLERTON.

photo by Charlotte Z. Krouner

REFLECTIONS: IN HULL, THE ENERGY FUTURE IS HERE

By Jane Mead, CZM

On a sunny February afternoon, the occupants of the dozen or so cars parked next to Hull Gut were not as interested in ocean views as they were in this new-fangled machine on the grounds of the high school. Standing 240 feet tall at the tip of its 90-foot blades, the Hull Municipal Light Company's new 660 kW wind turbine is an object of great interest and, from what I could overhear, of admiration. The three-bladed Vestas turbine sitting on top of its 150-foot mono-pile structure was described by on-lookers as "majestic"and "a piece of sculpture."

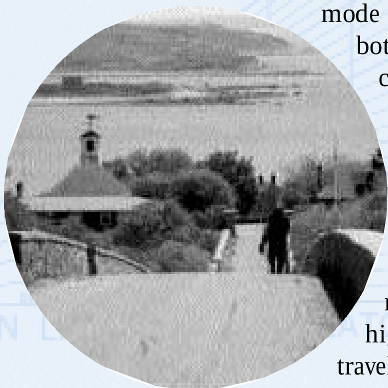
Average area wind speeds of 13 mph provide enough energy to power all of Hull's street and traffic lights at an annual savings of $50,000, and there is electricity left over to contribute to the power grid. The wind turbine replaces a 40 kW turbine that operated on the site for 10 years, before it was damaged in a storm in 1995 and taken out of service. The new machine incorporates design features that make it stronger. Birds can't roost on the mono-pile structure and the slowly rotating blades are easy for birds to see and avoid. There is a slight downwind sound from the turning blades. I'm not sure if the residents on the other side of the school can hear it, though the faint rhythmic whooshing might be very soothing. And, of course, there is no air, water, or soil pollution to clean up.

> Average area wind speeds of 13 mph provide enough energy to power all of Hull's street and traffic lights at an ANNUAL SAVINGS OF $50,000...

ALL ABOARD FOR POOCUOHHUNKKUNNAH!

By Arden Miller, CZM

At the turn of the century, most of coastal America was served exclusively by hundreds of small excursion vessels, steam ships, and ferry boats. Today, while planes, trains, and cars have, in many cases, replaced the *need* for water transportation, ferries remain a viable mode of transportation for both vacationers and commuters. Unlike their 19th century forefathers, today's boats often have amenities like snack bars, flushing toilets, and flexible schedules, and many fleets include high-speed boats that cut travel time in half. In Massachusetts, popular destinations such as Nantucket and Martha's Vineyard are only accessible via water or air—if anyone ever directs you to a mainland bridge, they're spinning a tall tale. Add Cuttyhunk Island to the list of such destinations; with ferry service departing regularly from New Bedford, it's easier than ever to explore this small maritime village.



Originally called Poocuohhunkkunnah by the native Wampanoag tribe, Cuttyhunk Island is often referred to by the name of its town center, Gosnold. Discovered by Bartholomew Gosnold in 1602—who, incidentally, also named Cape Cod (so christened due to the bounty of cod fish in the surrounding waters)—geographically, Cuttyhunk is 14 miles off the coast of New Bedford and has the distinction of being the southwestern most of the 13 Elizabeth Islands. Just over two miles long and less than a mile wide, the entire 500-plus acre island has a winter population of less than 100 and only slightly more during the summer. Transportation on the island consists mainly of golf carts (although there is no actual course to play on) and there are few street or trail signs to guide you. But, not to worry: wherever you go, you can retain your sense of direction as you can see the sea. And there are other things to see as well; the island is an Audubon Bird and Wildlife Sanctuary (tours for bird enthusiasts are available on Sundays from July through October). Don't like avifauna? There's the Cuttyhunk Historical Museum, the Gosnold Monument, and the Cuttyhunk Historical Society has exhibits chronicling the island's history.

For fresh sea food enthusiasts, the Cuttyhunk Fishing Club serves breakfast 7-11 a.m. daily mid-May through Labor Day. And between May 15 and October 15, a call ahead to Cuttyhunk Lobster will net you live lobsters cooked to order, served on the fish dock. Gosnold, Cuttyhunk, or Poocuohhunkkunnah—call it what you will. Just don't call too late for dinner...

TO PLAN A TRIP...

FERRY SCHEDULES:
www.cuttyhunk.com/schedule.htm
(508) 992-1432

FOR INFORMATION ON MASSACHUSETTS AUDUBON SOCIETY BIRD WALKS:
(508) 362-1426

CUTTYHUNK FISHING CLUB:
(508) 992-5585

CUTTYHUNK LOBSTER:
(508) 999-1263

GENERAL INFORMATION:
www.cuttyhunk.com/history.htm

www.impulz.net/buzzardsbay/harbors/cutty.htm

CUTTYHUNK ISLAND, MASSACHUSETTS

PUBLIC ACCESS RIGHTS ALONG THE COMMONWEALTH COAST

By Anne Donovan, CZM

As summer begins, a frequent question is, "What are my legal rights along the more than 1,500 miles of Commonwealth coastline?" For the privately owned shoreline, the answer is somewhat complicated, but we'll do our best to explain.

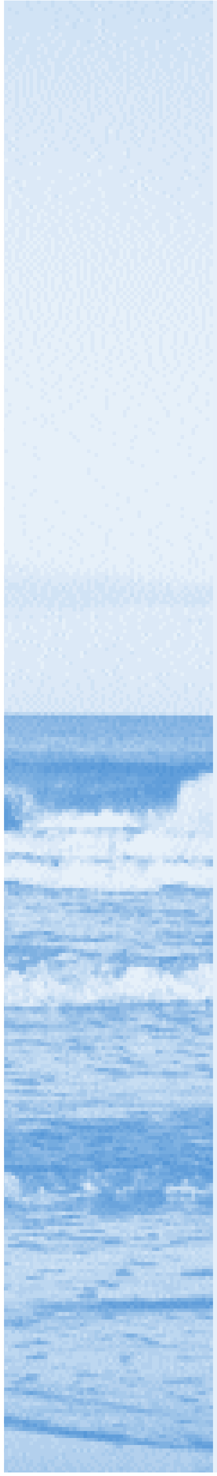
Let's start with the most straightforward things first. For natural shorelines (i.e., those never modified by filling), the area beyond the typical reach of the high tide (technically known as "mean high tide") is generally private property. The owner can exclude the public completely from this area, unless an easement or other legal right-of-way allows public access across the property. Equally straightforward is the submerged land beyond mean low water, which is almost always owned by the Commonwealth and generally open to all.

The tricky part is the so-called "tideflats," or the area between mean high tide and mean low tide. This intertidal area is governed by the Public Trust Doctrine, which was born in ancient Rome, later made its way to English common law, and was adopted by the Colonies and then by all coastal states upon formation of the Union. Basically, the Public Trust Doctrine holds that certain property rights in tidelands (i.e., all lands presently or formerly subject to tidal action) are held by the state for the common good of its people. In most of the U.S., this doctrine has been used to keep the tideflats in public ownership. In these states, once you get to the shore, you can walk freely over this periodically wet strip of coastline.

In Massachusetts (except for a large section of Provincetown), our Colonial forefathers in the 1640s granted ownership of the tideflats to shorefront property owners to stimulate coastal economic development through the building of wharves and docks. Public rights to use this portion of the tidelands, however, were specifically reserved for three purposes: fishing, fowling, and navigation. So, once you make your way to the Massachusetts shore through some kind of public accessway, you are free to move about below the high water mark to catch fish and harvest shellfish, hunt birds, and maneuver a vessel, as long as you obey local and state regulations, of course. In addition, the Massachusetts Attorney General's Office broadly defines "fowling" to include birdwatching, although this definition has not been tested in the courts.

To add to the complexity, property owners were granted ownership of the tideflats for only 100 rods (in modern terms, 1,650 feet) from high water. So on intertidal areas wider than 1,650 feet, the public can use the seaward-most reaches for any lawful purpose. Also, on tidelands that have been filled for development and are now dry land, a host of public property rights are protected by Chapter 91 of the Massachusetts General Laws (but that is another story altogether).

Still confused? The AG's Office has a great pamphlet, *Public Rights/Private Property: Answers to Frequently Asked Questions on Beach Access*, available at http://www.ago.state.ma.us/pubs/beachacc.pdf (PDF version) and http://www.ago.state.ma.us/pubs/beachacc.htm (HTML version). The CZM Web site also has a piece called *Public Rights Along the Shoreline* at http://www.mass.gov/czm/shorelinepublicaccess.htm. If you don't have Web access, call the CZM Information Line at (617) 626-1212 and we can send you copies.



POINTS OF ACCESS...

For more information on Massachusetts BEACHES WITH PUBLIC ACCESS, check out these web sites:

www.state.ma.us/film/feefree/beaches.htm

www.boston.com/sports/swimming

www.msba.net
(click on "Access Points" on the navigation bar)

www.tbha.org

SURFING AT GLOUCESTER'S GOOD HARBOR BEACH

Good Harbor Beach on Cape Ann is an east-facing sandy barrier beach about one-half mile long. This public beach is a popular local and regional recreational destination in summer and winter. While the ocean temperature remains chilly during the summer (mid-60 degrees), the width and gentle slope of the beach and the relatively shallow nearshore area make this a nearly perfect beach for all activities. The southern end of the beach ends at a rocky headland, where east and southeast swells wrap around the point and produce good surfing waves. Under just the right conditions, waves breaking to the left inside Bass Rocks can be ridden 50 yards up the creek. In the summer, when lifeguards patrol the beach, surfing is permitted only before 9:00 am and after 5:00 pm. Water quality is generally good, except after heavy rains when an outgoing tide drains the marsh. The summer parking fee (Memorial Day to two weeks after Labor Day) for non-residents is $15.00 on weekdays and $20.00 on weekends and holidays.

photo by Brandy

SURF'S UP IN NEW ENGLAND

By Deerin Babb-Brott, CZM

Mention "surfing" to most people and they think of California sunshine, crystal blue water, and gentle breezes. That picture is about as far from reality as you can get when you're talking about surfing in New England.

Here, a great surfing day often means that a low-pressure system tracking just offshore is bringing heavy snow and 8-12 foot waves whipped up out of 40-degree water by 35 mph winds. Heavy weather means good surfing, and the 50 or so surf spots along the Massachusetts coast (with names like Long's, Stinky's, and Shopping Carts) don't "go off" until a storm somewhere off the coast builds up the waves.

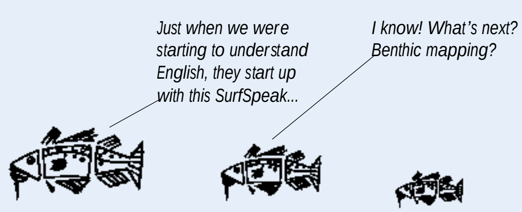
Chest-head+ Points are bigger than the beaches. Light SSE wind started puffing around noon giving some of the spots a ripple on the face, clouds rolled in at the same time. Air temp 50 water 38, high tide 5 PM.

February 20,
http://www.noreaster.surfshop.com/

East coast surfers are preoccupied with weather and storms, and for a perfectly logical reason: weather typically moves west to east. Unlike the West Coast, where every meteorological hiccup across the vastness of the Pacific is east-bound and eventually causes a wave to bump up against a west-facing beach, East Coast surfers are largely dependent on waves traveling in the opposite direction of the weather–a frustrating state of affairs. And since the only systems that can do this reliably are coastal lows (including full blown Northeasters) and tropical storms, surfers closely follow every weather pattern that even hints of generating good waves.

Out to sea, our low is fizzling out, but it's already made its waves and the buoys from here all the way to the Hotel buoy off Jersey are all smelling long period stuff, some of it with respectable size. Looks like the real deal is tomorrow.

February 20,
http://www.surfinfo.com/
html/reports.html



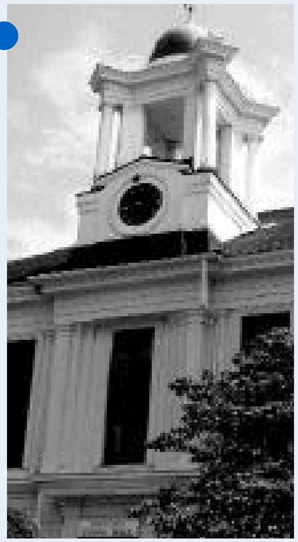
WHERE DO THEY GET THESE NAMES?

Although most surfing locations are christened with nothing more original than the name of the beach, a few receive unusual (if not very poetic) monikers. For example, "Stinkys" got its name from the decaying algae at this location, which is especially aromatic in the hot summer sun, while "Shopping carts" was labeled for the abandoned shopping cart, half buried in mud, visible at low tide.

ROWLEY IS ONE OF THE TOWNS IN ESSEX COUNTY KNOW FOR HAVING MANY ANTIQUE STORES.

ROWLEY: HISTORIC HIDEAWAY ON THE NORTH SHORE

By Arden Miller, CZM

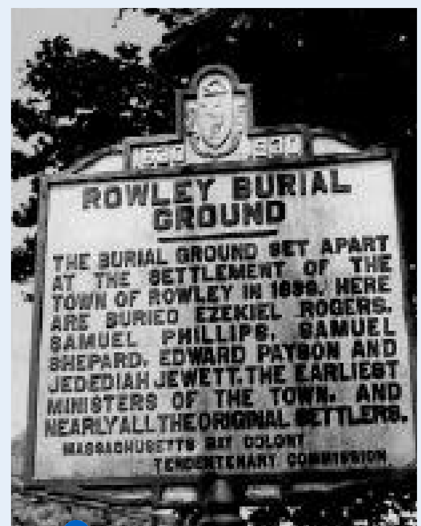


TOWN HALL, ROWLEY.

Led by Reverend Ezikiel Rogers from St. Peter's Church of Rowley, Yorkshire, England in the fall of 1638, 20 adventurous British families boarded the sailing vessel *John of London* for what were then known as "the colonies." (A side note of interest—perhaps only of interest to those interested in the history of print and typography—this ship was also transporting the first printing press to be used in the United States.) A few weeks later, the printing press, and the families, safely landed on the shores of what is now Salem, Massachusetts. The printing press was moved to Cambridge and published many early works—including those of Benjamin Franklin—that would be coveted by today's bibliophiles and fans of *Antiques Road Show*. The families settled closer to their landing spot, in an area 32 miles from Boston, between the Atlantic Ocean and the Merrimack River. People took to calling this township "Mr. Ezikiel Roger's Plantation," until its official incorporation on September 4, 1639 when, in the language of the day, it was declared that "Mr. Ezikiel Roger's Plantation Shalbee Called Rowley, Massachusetts."

As one of the five communities within the Parker River/Essex Bay Area of Critical Environmental Concern (ACEC), Rowley is known locally as part of the "Great Marsh," so named as the ACEC boasts 12,800 salt marsh acres—the largest contiguous area of marsh north of Long Island, New York. Originally, the hay from the Rowley portions of the salt marsh was used by settlers for thatching roofs and cattle feed. While the market for hay-thatched roofs isn't what it once was, the hay continues to serve Rowley well by providing flood control and serving as a natural filter for contaminants from upland discharge and urban runoff, and the marshes, beautiful throughout the year, can be accessed for boating.

In 2002, Rowley is home to more than 5,000 people. As part of Essex County—an area given the lofty moniker "The Most Historic County of America"[1]— Rowley is the northeastern-most town in Massachusetts. Its 19 square miles are home to a number of historic sights including Jewel Mill. Originally called Pearson Mill, it has the distinction of being the oldest continuously operating water mill in the United States and, due to its original purpose of combing and spinning wool, Rowley is known as the birthplace of the American wool industry. Also, the Old Stone Arch Bridge, erected in 1643, still stands. Other vestiges of Rowley's venerable past include "Old Nancy," a cannon used during the American Revolution, a Civil War Monument, an original cobbler's shop from 1830, and the Rowley Burial Ground where Reverend Rogers, and the original members of his "plantation" are laid to rest.



THE ROWLEY BURIAL GROUND IS THE FINAL RESTING PLACE FOR MANY HISTORIC FIGURES.

[1] *Standard History of Essex County, Massachusetts*, Jewett & Co., 1878

THREE GENERATIONS OF ROWLEY CLAMMERS.

photo (left) courtesy of James Gundstrom - all others: Arden Miller

PERLEY'S MARINA—ONE OF MANY SCENIC SCENES IN ROWLEY.

Bordered by Boxford and Georgetown on the west, Newbury on the north, Ipswich on the south, and the Plum Island River on the east, Rowley is less than 10 miles from the New Hampshire border. For the antique lovers, Sundays in the summertime mean the outdoor antique flea market at Todd's Farm Antiques is open for business and bargains (the devotees claim it's best to get there around 6 a.m. for the *very* best bargains!).

An anonymous writer of the times when people used phrases like "green hillocks" wrote of Rowley:

"It is one of the pleasantest towns in Essex County... In the summer season, it is hardly possible to go over the green hillocks...or by the sparkling brooks fringed with luxuriant grass and flowers...without wishing that one had been born in Rowley... To be born in such a place...and to sleep at last in the same dust with the good old fathers of olden times, were enough to fill the cup of mortal happiness full."

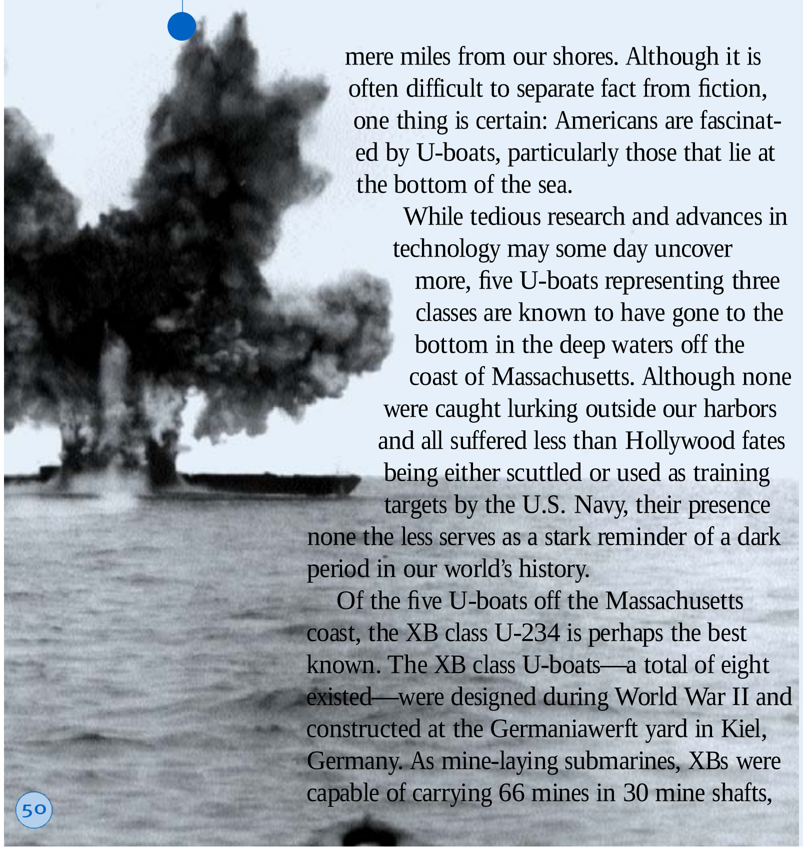
Indeed...

U-BOATS: NAVAL FOLKLORE 700 FEET UNDER THE SEA

By Dave Trubey, Massachusetts Board of Underwater Archeological Resources

Whether fostered by fanciful images of adventure, fear, nationalism, or curiosity, the German U-boat, that elusive hunter from a far-off land, has become an established part of American naval folklore. Particularly along the New England coast, in many a seaport town, an old salt can be found with a tale to tell of the night he or someone he knows came face to face with a U-boat, mere miles from our shores. Although it is often difficult to separate fact from fiction, one thing is certain: Americans are fascinated by U-boats, particularly those that lie at the bottom of the sea.

> They saw them on the horizon: the two hard shapes topping the sea level stood out like squat battlements: they could only be U-boats—the hated and longed-for targets that were now part of the rubbish of defeat. – Nicholas Monsarrat, *The Cruel Sea* 1951



EX-GERMAN SUBMARINE U-234 IS TORPEDOED BY US SS GREENFISH ON NOVEMBER 20, 1947, 40 MILES NORTHEAST OF CAPE COD.

While tedious research and advances in technology may some day uncover more, five U-boats representing three classes are known to have gone to the bottom in the deep waters off the coast of Massachusetts. Although none were caught lurking outside our harbors and all suffered less than Hollywood fates being either scuttled or used as training targets by the U.S. Navy, their presence none the less serves as a stark reminder of a dark period in our world's history.

Of the five U-boats off the Massachusetts coast, the XB class U-234 is perhaps the best known. The XB class U-boats—a total of eight existed—were designed during World War II and constructed at the Germaniawerft yard in Kiel, Germany. As mine-laying submarines, XBs were capable of carrying 66 mines in 30 mine shafts, which were at times also used for storing freight. Additionally, XB U-boats were equipped with up to 15 torpedoes, but unlike a number of other U-boat classes, these subs had only two torpedo tubes, both located on the stern. The XBs measured 295 feet in length, 30 feet in breadth, and 15 feet in draft, making them the largest German U-boats ever built. The XBs could travel at a top speed of 17 knots on the surface, seven knots submerged, and had a maximum oil capacity of 368 tons. Designed for a crew of 48-60 submariners, the XBs were able to reach depths of more than 700 feet. As with most vessels, size comes with some significant drawbacks. What the XB class U-boats gained in size, they lost in diving speed; a compromise that ultimately resulted in the loss of six of the eight XB class U-boats constructed.

U-234, construction of which commenced on October 1, 1941 at Germaniawerft, sustained damage from bombing raids before even coming off the stocks. Originally intended for mine laying operations, it was rebuilt as a transport submarine to ferry war materials from Germany to Japan in order to fill the void left by the July 1944 loss of its predecessor, U-233. From March 1944 to February 1945, U-234 was a part of the Fifth Flotilla based at Kiel and for the last two months of its career served the Thirty-Third Flotilla at Flensburg, Germany. U-234 took part in only one active patrol from Kiel to Kristiansand, Norway, with the intention of sailing to Japan under the command of Kptlt. Johann-Heinrich Fehler. Despite the vessel's size and firepower, it was unsuccessful in the destruction of Allied shipping.

Upon reception of cease-fire instructions from headquarters on May 4, 1945, U-234 was en route to Japan carrying technical drawings, two crated Me-262 fighter jets, 550 kilograms of uranium, and several senior-ranking German officers. Due to the cease-fire, Commander Fehler aborted his mission and set a course for the United States to surrender the vessel, but not before two Japanese officers, passengers on U-234, took their own lives. Historian Samuel Eliot Morison contends that much to the skipper's repulsion, the officers "dosed themselves with liminal instead of performing the traditional seppuku, and died slowly and ignobly," while other sources attribute the deaths to an overdose of sleeping pills.

Following the broadcasting of its position, U-234 was boarded by a U.S. Navy crew to prevent the anticipated destruction of the craft by the Germans and brought under escort to the Portsmouth Naval Shipyard in Portsmouth, New Hampshire. Two years following its surrender, U-234 was motored northeast of Cape Cod where it was sunk on November 20, 1947 as a torpedo test target by the submarine *U.S.S. Greenfish*.

Today, the remains of U-234 lie in more than 600 feet of water some 40 miles off shore. While the condition of this site and that of the other four U-boats is unknown, rapid advances in deep water technology suggest that a new generation will catch a glimpse of these elusive vessels from a far off land.

More information on U-234 and other U-boats is available online at www.uboat.net.

ASK JOE... By Arden Miller, CZM

JOE: THE ANSWER MAN.

WHAT WOULD BE THE FIRST THREE THINGS YOU WOULD PERSONALLY DO TO PREPARE FOR A HURRICANE?

Well, the first concern would be that I'd have to prepare well ahead of everyone else since I'd have to take care of my stuff before going to the Bunker. [Editor's note: Joe is the Executive Office of Environmental Affairs' emergency management liaison and, as such, serves as part of the agency's Emergency Operations Center—aka "The Bunker"—staff. For more on Joe and the liaison roll, see "Kudos to the Storm Team" page 4.] That said...I would secure all my lawn furniture—everything from the beach chairs and toys to the barbeque would have to be tied down—and make sure my family was safe and prepared. I'd make sure all of the things that are supposed to be in the safety kit are there: water, batteries, flashlight, radio, perishables... Lastly, I would take care of my boats. One of them I'd actually sink as it would be safer on the bottom. I've done all of this before, but luckily nothing ever hit.

TRY TO CHANNEL NOSTRADAMUS—JOESTRADAMUS—WHEN AND WHERE DO YOU PREDICT THE NEXT HURRICANE WILL HIT?

For starters, I took this "How Psychic Are You?" test on the internet recently, and out of a possible 100, I got 16, meaning I have NO psychic ability whatsoever! So I cannot even begin to try to predict such a thing.

ARE THERE GEOGRAPHIC FEATURES SPECIFIC TO MASSACHUSETTS THAT WOULD BE IRREPARABLY DAMAGED BY A HURRICANE?

Definitely. In fact, it doesn't even take a full-on hurricane to forever alter geography. In the past, excessive rainfall has caused rivers to flood in such a way that their mouths were permanently altered. In other cases, beaches can be forever changed. One such example is Chatham Breach. During a storm in January of '93, the barrier beach that protected Chatham Harbor was literally split in two. Without the protection of the beach, the buildings downtown were susceptible to all sorts of erosion and flooding, causing a lot of property damage and destruction.

PUTNAM, CONNECTICUT 1955: WORST STORM JOE'S EVER WITNESSED.

photo courtesy of the Pelczarski photo album

WHAT'S THE MOST DRAMATIC STORM YOU'VE EVER PERSONALLY WITNESSED?

In 1955, when I was four going on five, the east coast was hit with two tropical storms. I lived in Putnam, Connecticut on the Quinnebauge River and the river completely went. There was a magnesium plant in town that exploded when all the water hit. It was unbelievable—water everywhere. Hundreds, if not thousands, of houses were destroyed. My grandmother stayed with a mentally challenged girl whose own mother had suffered a heart attack from the shock of the flood and both my grandmother and the girl had to be rescued by the Coast Guard. For weeks, everyone in the town had to get their water from the town's filtering plant. During the rest of the '50s and early '60s, the part of town that was level with the river was nothing but dirt and everything left standing was full of dirt. Eventually, it all had to be bulldozed down. Now it's a shopping mall...

> IT WAS UNBELIEVABLE—WATER EVERYWHERE. HUNDREDS, IF NOT THOUSANDS, OF HOUSES WERE DESTROYED...

AND HAVE YOU EXPERIENCED ANY SIMILAR DRAMAS HERE?

Hurricane Bob was the first disaster I witnessed from the Bunker. My overall impression was that things were very intense and there was a lot of humidity. I specifically remember that all of the apples fell off the trees and a number of vessels were destroyed. The excessive rains had everyone worried about mosquitoes; at that time the threat of Eastern Equine Encephalitis was very real to people. The state was able to get FEMA (Federal Emergency Management Agency) to reimburse us for spraying (to kill mosquitoes and their larvae). There were only a couple such cases reported within Massachusetts, so we were spared larger dramas.

LAST QUESTION: IF YOU WERE ON THE HURRICANE NAMING COMMITTEE, WHAT WOULD YOU NAME THE NEXT HURRICANE?

Kara, after my four year old niece. She's a little terror!

THE ANSWER IS BLOWING IN THE WIND…

By Arden Miller, CZM

Meteorologists—you know, the people you see on the news who tell you if it's going to rain and get very excited when a "big pressure system" is moving toward us—are paid to predict the weather. They base their predictions on what they understand to be going on in the skies and oceans of not just the United States, but the whole world. A storm in India, extra cold air in Chicago, Illinois, and high velocity winds in Africa can all have a potential affect on what happens in Massachusetts.

If this sounds like an interesting way to spend your time, or you like the idea of seeing patterns in how things around the world are interconnected, this exercise in charting hurricanes and tropical storms can be a useful way to see science at work.

To track the storms of 2002, all you'll need is a pen or pencil, the graph at right, and access to weather service bulletins (these are available on t.v. and radio news reports, or by checking on-line Internet sites such as www.noaa.gov/wx.html on a regular basis). So if you have these things and want to see how you measure up to the people who get paid to do this, here's what you do:

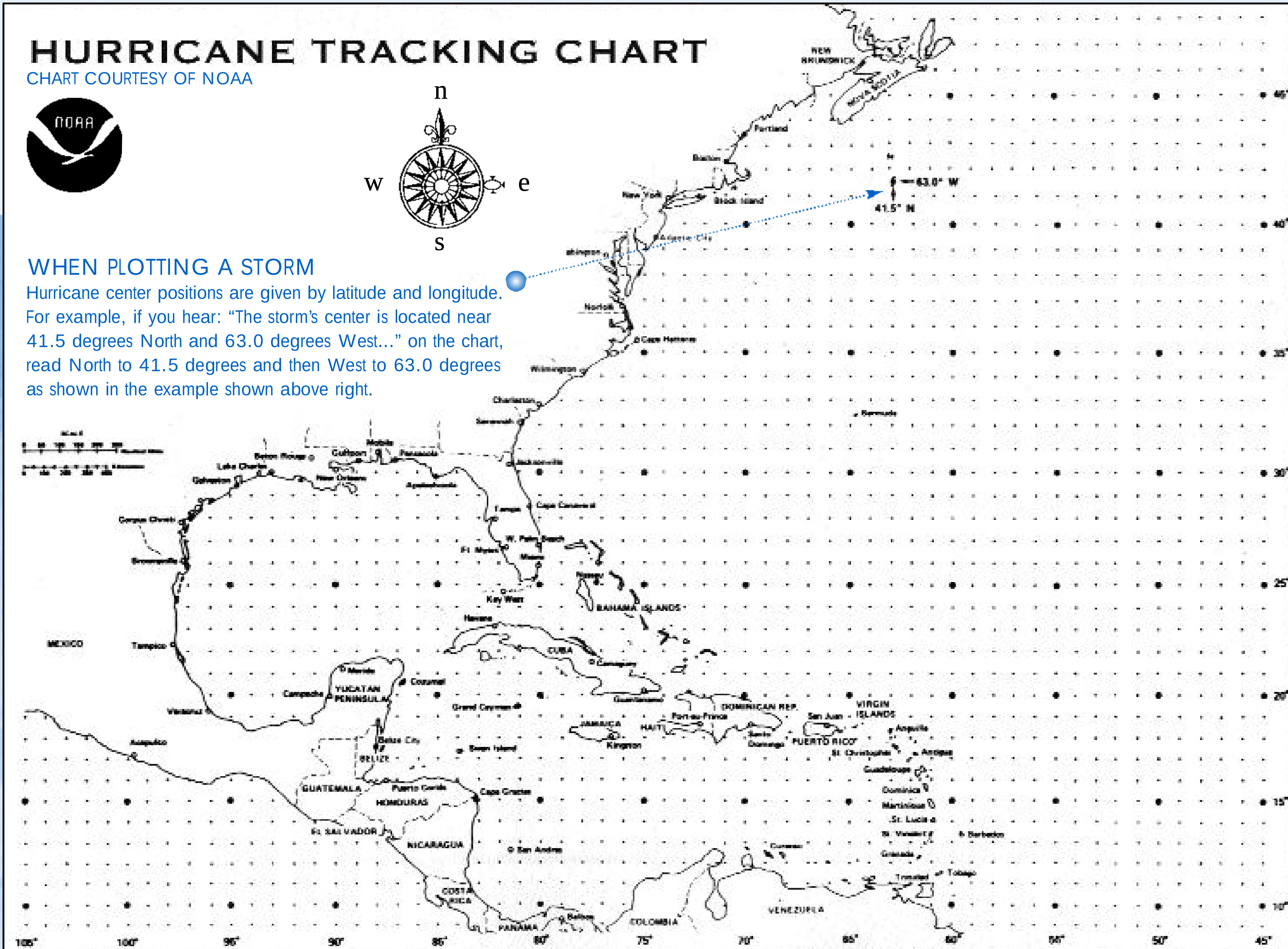
1) Whenever you hear about a hurricane, or a tropical storm that has the potential to become a hurricane, plot its position on the map. Just make sure to note the name, as sometimes more than one hurricane or tropical storm can be on the radar screen at a time.

2) Follow weather updates, via the radio, Internet, or t.v. daily.

3) As you hear about any movements, note them on the map. Also, if your news source of choice is getting excited about wind speeds or gusts, make a note of that, perhaps using an arrow and an exclamation point next to your plotted dot.

Now, here's the fun part: based on what you've heard, and what you can see on your chart, try to guess the path of the storm/hurricane. Bonus points if you can predict the time it will touch over a particular area. As you are doing this, think about what you know of weather factors: is it over the jet stream? Are there low or high-pressure systems from other areas that could interfere with its path?

And here's a potentially fun twist (no pun intended): get together with friends or classmates and each pick one, and only one, source to get your hurricane or storm information from and agree to how often you'll update your map (i.e. everyday at noon and 6 p.m.). When it's all over, compare your sources to see which news source was the most accurate. Based on what you find out, you may develop a greater understanding and appreciation of weather. Or at least an idea of why the weather people are not always 100 percent accurate. You may even discover that you have a hidden talent that could someday lead to career as a meteorologist!



HURRICANE TRACKING CHART
CHART COURTESY OF NOAA
NOAA
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WHEN PLOTTING A STORM
Hurricane center positions are given by latitude and longitude. For example, if you hear: “The storm’s center is located near 41.5 degrees North and 63.0 degrees West...” on the chart, read North to 41.5 degrees and then West to 63.0 degrees as shown in the example shown above right.
63.0° W
41.5° N
NEW BRUNSWICK
NOVA SCOTIA
Portland
Boston
New York
Block Island
Atlantic City
Norfolk
Cape Hatteras
Wilmington
Charleston
Savannah
Bermuda
Jacksonville
Cape Canaveral
Tampa
W. Palm Beach
Ft. Myers
Miami
Key West
Nassau
BAHAMA ISLANDS
Havana
CUBA
Camaguey
Guantanamo
Mobile
Pensacola
Gulfport
New Orleans
Baton Rouge
Lake Charles
Galveston
Apalachicola
Corpus Christi
Brownsville
MEXICO
Tampico
Veracruz
Campeche
Merida
YUCATAN PENINSULA
Cozumel
Acapulco
Grand Cayman
JAMAICA
Kingston
HAITI
Port-au-Prince
DOMINICAN REP.
Santo Domingo
San Juan
PUERTO RICO
VIRGIN ISLANDS
Anguilla
St. Christopher
Antigua
Guadeloupe
Dominica
Martinique
St. Lucia
St. Vincent
Barbados
Grenada
Trinidad
Tobago
Curacao
VENEZUELA
COLOMBIA
PANAMA
Balboa
COSTA RICA
NICARAGUA
San Andres
Cape Gracias
HONDURAS
Puerto Cortés
Swan Island
Belize City
BELIZE
GUATEMALA
EL SALVADOR
45°
40°
35°
30°
25°
20°
15°
10°
105°
100°
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90°
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