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The Coastal Environment and Pollution Impacts

Numerous plants and animals thrive in the water surrounding Massachusetts marinas. Clean water is key to sustaining this diverse and abundant marine life. This chapter provides an overview of the coastal environment around marinas, of marina activities and the contaminants they can produce, and of the potential effects of those contaminants on the marine environment.

2.1 The Massachusetts Coast

The Massachusetts coastline is unique and varied, to a large degree a product of glacial activity that took place more than 10,000 years ago as well as shoreline processes over time. In northern Massachusetts and Buzzards Bay, glaciers scoured the bedrock to form rocky shores as seen at Cape Ann and Sconticut Neck. Interspersed among the rocky stretches are sand and gravel deposits in the form of drumlins such as the Boston Harbor Islands. Drumlins provide the anchor and sediment source for barrier beaches, like those seen on Plum Island and on outer Cape Cod. Large rivers like the Merrimack and the Taunton end as coastal estuaries where fresh and saltwater mix and nutrients contributed from the land feed the smallest marine organisms. On the north coast, a large 10-foot tidal range results in a broad intertidal zone creating other diverse marine habitats.

Southeastern Massachusetts, Cape Cod, and the Islands represent part of the southern margin of glacial activity. When the glaciers stopped their progression southward and receded, they left behind deposits of sand and gravel that formed the Cape and the Islands. The coastline is characterized by vast stretches of sandy beach and bluffs. This shoreline has been sculpted by the Atlantic Ocean, which has eroded some shores and built up others. Broad barrier beaches and associated dune systems have formed along the outer coast, while extensive salt marsh systems have developed in protected bays behind these outer barriers.

Cape Cod also forms a major regional boundary between ecological zones, and separates groups of marine organisms from north to south. For example, different species of crustacean dominate north and south of Cape Cod. To the north, in what is referred to as the Boreal Region extending from Cape Cod to Newfoundland, American lobster and rock crab dominate. To the south, in the Mid-Atlantic Region, which extends from Cape Cod south to Cape Hatteras North Carolina, blue crab dominates. The migratory range of marine animals is also defined by these ecological zones. For example, sea turtles, like loggerhead and green turtles, do not migrate further north than Cape Cod.

Water temperature, more than any other factor, influences species distribution. Currents regulate the water temperature and thus determine these ecological zones. The Mid-Atlantic Region is influenced by the Gulf Stream, which transports warm waters from the lower latitudes northward to Cape Cod where it is deflected and directed across the Atlantic to northern Europe. The Boreal region north of Cape Cod is influenced by the colder Labrador Current, which creates inshore currents south of New Foundland across Nova Scotia and into the Gulf of Maine. As a result, the Massachusetts coastline has a rich assortment of marine habitats and species.

Currents, Waves, and Tides

Coastal energy in the form of currents, waves, and tides is fundamental to defining coastal environments. Coastal energy sustains physical and chemical conditions of each coastal habitat type, particularly by regulating salinity, temperature, and dissolved oxygen.

The Gulf Stream and the Labrador currents regulate regional water temperature. Smaller, nearshore currents, further affect water movement along the coast and contribute to localized changes in water temperature, salinity, and species migration. In addition, wave action influences the development of coastal habitats, both chemically and physically. Chemically, waves mix the water column providing oxygen and nutrients to organisms that live on the seabed. Mixing in the water column also provides for moderated water temperature by transferring heat from surfaces waters warmed by solar energy into the lower levels of the water column. Waves also help define the physical nature of the coast by constantly altering the landscape.

Marine species have adapted to particular parts of the coast subject to different degrees of wave energy. Tides, on the other hand, have a buffering effect on coastal water quality by flushing the coast twice daily and maintaining the strong ties between local waters and the ocean. This process also helps to moderate the effects of pollution on coastal harbors by regularly exchanging coastal and ocean waters. Tides also define distinct nearshore habitats between those that have adapted to regular exposure to the sun and the wind and those that are protected by marine waters.

Marinas are often located in bays and coves that protect boats from the ocean's wave energy. Currents can be swift in these areas at mid-ebb or flood tide when the tides are transferring water on and offshore. These conditions require that marina structures be designed and constructed to withstand energy produced by currents.

Coastal Water Chemistry

Important components of water chemistry in Massachusetts coastal waters include salinity, temperature, dissolved oxygen, and nutrients. Ocean waters off the Massachusetts coast have a salinity level of approximately 33 parts per thousand (ppt). However, salinity varies greatly in nearshore waters where streams and rivers dilute the concentration of salt. Coastal water temperature is also variable. Surface waters exposed to solar energy are warmed, while isolated bottom waters remain cooler. Dissolved oxygen is also regulated by atmospheric conditions. Oxygen is rich at the water surface where oxygen is regularly infused into the water, but is limited in bottom waters that are not directly connected to sources of oxygen. Energy caused by waves, currents, tides, wind, and other atmospheric conditions is an essential mechanism for mixing oxygen into the bottom waters and sustaining the benthic life forms found at depth. Nutrients, particularly nitrogen and phosphorus, stimulate growth of the smallest marine organisms. Freshwater rivers and stream are important sources of nutrients that contribute to an abundance of marine life.

The water in sheltered bays and estuaries where marinas are often located is less saline, more nutrient enriched, and warmer. These conditions provide a good growing environment for plankton, which feed the fish nurseries of nearshore waters. However, excess pollution from boat sewage systems, septic systems, and stormwater runoff can upset the natural coastal water chemistry and lead to excessive algae growth and depleted oxygen needed by marine life.

The land between low and high tide, also known as the intertidal zone, is biologically-productive, providing habitat for many animals including fish, shellfish, and shorebirds.

Coastal Habitats

Natural communities found along the coast include barrier beach/coastal dune, rocky intertidal shore, salt marsh, eelgrass, mud flats, shellfish beds, the nearshore seabed, and coastal ocean waters. These habitats have developed, as a result of local physical and chemical conditions, and the marine organisms occupying each habitat have adapted to these environmental conditions. Barrier beaches, for example, are formed by wind and wave energy, and the marine organisms associated with barrier beaches have adapted to and thrive on this high energy environment. Salt marsh, on the other hand, is found in low energy environments where currents are weaker, and sediments carried in the water are deposited. Colonization by salt marsh vegetation helps stabilize these areas. Conversely, when salt marsh becomes exposed to waves, it often sloughs and erodes. Other natural habitats are found in different nearshore areas depending on the relationship of the daily tides. For example, eelgrass grows in waters that are shallow at low tide where the plant is exposed to the sun's energy needed for photosynthesis. Mud flats are habitats that are covered by water at high tide but are exposed to the atmospheric conditions at low tide.

Because coastal habitats of sheltered embayments are often found near marinas, conflicts between marina activities and these habitats can occur. While these fragile habitats have adapted to their unique environments, each is sensitive to changes in water chemistry, wave action, and boating activity, and thus, need to be safeguarded from unintentional harm.

2.2 Marina Activities and Potential Impacts to the Marine Environment

Developed areas, including marinas, yacht clubs, and boatyards, collect pollutants of all types. While this Guide focuses on the strategies available to reducing pollution from marinas to coastal waters, a basic knowledge of pollutants and their impacts on the environment is helpful to understanding why pollution reduction is important.

Impacts from pollutants on marine life range from direct poisoning through ingestion of pollutants to indirect habitat degradation through pollution that produces poor water quality and creates coastal waters uninhabitable by marine organisms. Pollution often harms organisms by retarding or preventing reproductive development. Indirect effects can also impact populations by reducing available habitat for successful breeding. For example, where eelgrass beds are degraded by water pollution, scallops no longer have the habitat necessary for reproduction and early life stage development.

The types of pollutants that are produced by individual facilities depend on the activities that occur there. Potential pollutants from marinas are described below by the activities that generate them.

Hull Maintenance

Hull paints can contain metals, such as tin and copper, pesticides, and volatile organic compounds (VOCs), all of which are toxic to marine life. In addition, paints and solvents release VOCs into the air, which are harmful to humans when inhaled.

Hull scraping and sanding generates paint chips that can be washed off-site during rainfall events. Hull painting can expose fresh paint to marine organisms. Shellfish are particularly vulnerable to these pollutants because paint chips sink through the water column and settle in the sediments where clams, oysters, and mussels live and feed. The pollutants may be ingested and build up in the animal tissue without being fatal to the specific individuals. However, when other animals consume the shellfish, they can be affected. Over time, the pollutant works its way up the food chain impacting both animals and humans. Long-term exposure to certain compounds can produce abnormal cell development and cancers.

Because they are located on the water, all marinas have the postential to impact the marine environment.

VOCs

Volatile Organic Compounds (VOCs) are carbon-based chemical compounds commonly used in paints, solvents, and thinners that rapidly evaporate or volatize. In paints, the VOCs evaporate leaving behind the dry pigment in the paint. The characteristics that make VOCs effective for applying paints also make them a potential air/water pollution hazard. When released into the atmosphere, some VOCs can contribute to the development of ozone. (Ozone is a primary ingredient in smog. It leads to health problem such as aggravated asthma, reduced lung capacity, and increased susceptibility to disease.) VOCs are also soluble in water, which can result in pollution. Furthermore, VOCs are flammable and can be toxic to humans and aquatic life. VOC-containing products can be replaced with less hazardous, aqueous or water-based substances at little or no extra cost.

Consider This

Read the product label. If the cleaner is harmful to humans when ingested, or when in contact with eyes or skin, then it will harm marine life as well.

Boat Cleaning

Soaps contain different cleaning agents, such as chlorine, ammonia, and phosphates, at concentrations that can be harmful when ingested. Excess use of soaps and solvents can harm marine life. The greatest impact occurs in surface waters, where soaps are most concentrated and where plankton – tiny creatures at the bottom of the food chain – is most abundant. Soaps can also break down oil products floating on the water surface and become exposed to marine life that inhabits the water column. Impacts decrease from the point of the spill as the concentration of soap is diluted.

Cleaning agent chemicals can also produce cumulative impacts. In particular, excess nutrients, such as phosphates and nitrates, become available at lower concentrations and accelerate the growth of plants. This can upset the natural balance in coastal waters and lead to excessive plant growth and a decrease in dissolved oxygen. Use of biodegradable products can significantly reduce problems associated with boat cleaning. However, even biodegradable soaps can cause an adverse impact, and should be used in moderation.

Gas and Oil from Engine Maintenance, Bilge Water, and Fueling

Oil and anti-freeze are polycyclic aromatic hydrocarbons, a family of chemicals that can cause abnormal cell development and cancer. Oil also contains other chemicals components, such as zinc and sulfur, at toxic levels. Solvents are comprised of carbon compounds that are also toxic.

Most petroleum products, particularly fuel and oil, will float if spilled on water. Bilge water collects oil, grease, and other pollutants from the engine, leaky fuel lines, and the washing down of the boat deck. When gasoline gets into the bilge, a hazardous condition can develop that can lead to gas combustion and an explosion. Because bilge water is always being collected, it and the pollutants it contains, are regularly discharged to coastal waters where the fuel or oil component can harm birds and small animals, which also float or dive into the water. Floating oil also reduces the normal oxygen exchange into the water. If a detergent is used to disperse the petroleum, it leaves the surface and mixes in the water column where it can harm the plankton communities that are the basic food for fish and small marine animals.

Spills of gasoline and oil during boat fueling are a common source of marine pollution. While large spills are uncommon, small drip spills occur regularly, and can cause minor impacts on the local marine environment.

Boat Sewage

Raw sewage contains water-borne disease and pathogens that can make people sick. Boat holding tanks and marina rest rooms are potential sources of raw sewage. While some marine toilets treat the waste prior to discharge, impacts from nutrient loading and chemical additives still occur. Direct contact with pet waste can also bring people in close contact with unhealthy bacteria. When it rains, pet waste runs into the marina waters causing contamination. Waterbirds, such as geese, ducks, and gulls are also major sources of waste contamination in the water as well as on docks and boats, so feeding them should be discouraged. Bacteria from all these sources collect in shellfish, and then can be passed on to humans who eat them.

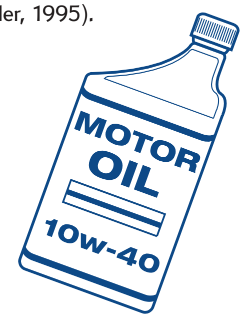
Sewage and animal wastes contain nutrients, which, in large volumes, can disrupt the natural chemical balance in water by reducing oxygen levels. Increased nutrients can trigger a chain reaction that starts with the excessive growth of marine plants and algae, and can lead to an overabundance of bacteria that breakdown dying plants and at the same time further deplete dissolved oxygen in bottom waters. When oxygen is depleted by the bacteria in bottom waters, a dead zone develops. This problem is exacerbated in protected coves and shallow waters, particularly during the very hot days of summer often after heavy rains that add massive amounts of runoff from all sources. Increased water temperature accelerates bacteria metabolism, activity, and growth.

Solid Waste

Just as with all human activities, marinas and boats produce waste. Trash and other solid waste can be harmful to humans and wildlife. Some plastics, such as nylon fishing line and plastic six-pack holders, can be ingested or entangle seabirds and fish. Food garbage left uncovered can attract flies and gulls and can contribute to the nutrient overload in the water.

Consider This

It requires only a small amount of gasoline or oil to cover a large area of water. For example, a single pint of oil released onto the water can cover one acre of water surface area (Buller, 1995).



In addition, large pieces of floating trash, such as boards, can be hazardous to boats and can cause damage in collisions. Floating plastic bags can also be sucked into cooling water intakes, resulting in overheating of engines, or can get wrapped around propellers. Often, the most obvious problems with solid waste are aesthetic. Floating paper cups and cigarette butts in the water are unsightly and detract from the beauty of the ocean and from people's enjoyment of their boating experience.

Fish Waste

If thrown into the water, dead fish and fish parts are unpleasant to look at and attract gulls, which create their own mess to clean up.

The dumping of large quantities of fish wastes in the marina waters, for example, during a fishing derby can harm marine life. Bacteria naturally colonize the waste and break it down. Thus, large quantities of decomposing fish parts can deplete the oxygen in confined water, especially during the hot days of summer when conditions are best for bacteria production. This phenomenon can create low oxygen zones that prevent marine life from surviving.

2.3 Protecting the Massachusetts Marine Environment

The Massachusetts coastline includes natural features and aquatic life that are important to our heritage and our future. Pollution from many sources threatens to impair these valuable resources. Marinas have a vested interest in protecting the coastal waters because clean water sustains recreational boating and the marina industry.

The following chapters will help marina owners identify potential pollution problems at their facilities, plan for improvements, and implement best management practices to prevent pollution and protect Massachusetts' coastal environment.