Auxiliary Prevention Outreach Specialist Study Guide

(Previously Marine Environmental Education Specialist)
(AUX – MEES)

Introduction

This Study Guide is designed to accompany the Prevention Outreach Specialist PQS (formerly the Marine Environmental Education Specialist PQS). It is not intended to be a simplified guide, as members are expected to be highly knowledgeable about **all** of the subject matter covered in this Study Guide in order to successfully complete an oral board exam.

The Study Guide is divided into two parts:

> The **PQS Task List** and discussion will help the member understand what specific information is needed to master the Task.
>
> The **General Background** section will acquaint the member with basic marine environmental ideas and concepts and includes information in addition to what is required in the Task list. It should not be ignored **since oral board questions may also come from this material.** It provides a basic grounding in the sciences behind the PQS and is supplied so that members with no prior knowledge of the subject area may begin to understand the breadth and depth of marine environmental education.

A Verifying Officer who holds the AUX Prevention Outreach Specialist qualification (AUX MEES) will discuss each Task in the PQS Task list with the member and sign off on a Task only when the member demonstrates an acceptable command of that knowledge. The entire PQS Booklet should be completed prior to requesting an oral board through the member's DSO-MS.

AUX – Prevention Outreach Specialist PQS Tasks:

1.0 Knowledge of Pollution Issues

1.1 Pollution Sources

a. Define the difference between point and non-point pollution.

Point sources of pollution are confined discharges, generally within a pipe or other conduit used to move fluids or solid waste from the point of origin to the point of disposal. All point sources introduce pollution into the environment at a specific site or "point." Point sources of pollution are generally the easiest to identify, monitor, and regulate. By law, point sources of pollution are required to be registered and regulated by federal, state, and local laws.

Non-point source pollution comes from a wide variety of diffuse sources and is unconstrained or unchanneled in movement. According to the U.S. Environmental Protection Agency (EPA), non-point source pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our underground reservoirs of drinking water. Non-point sources are more difficult to measure, quantify, and regulate because they tend to be diffuse and widespread. In fact, non-point sources of water pollution are virtually unregulated in the United States, even though they contribute about 60-70% of the pollution in our waters.

b. Give examples of point and non-point pollution.

Classic examples of point source pollution include industrial and sewage or municipal outfall pipes. Non-point source pollution includes runoff from parking lots, roadways, or agricultural land. Atmospheric deposition (for example: smokestack emissions, volcanic or forest fire ash) and hydro-modification (for example: any chemical modification of the water due to human activity) are also sources of non-point pollution.

Source: Good Mate Recreational Boating and Marina Manual

c. Give examples of point and non-point pollution in your AOR.

Examples of point pollution include:

- Industrial facilities
- Municipal sewage treatment plants

Unfortunately, the majority of water pollution in the United States is non-point pollution. Sources of non-point pollution include:

- Urban landscapes and environments
- forestry and agricultural runoff
- atmospheric deposition from industry and vehicles (air pollution, acid rain)
- recreational boating and fishing

Another way of thinking about non-point pollution is the following journey.

A plastic bag's journey from the grocery store…

1) Bag leaves grocery store in Memphis
2) Blows off picnic table in Overton Park
3) Falls into storm drain
4) Flows into the Mississippi River
5) Travels downstream, to the Gulf
6) Sea turtle mistakes bag for a jellyfish, swallows it and dies

d. Give examples of containing or reducing point pollution.

Examples include:

- Upgrade and properly maintain wastewater treatment facilities
- Reduce disposal of nutrients and organic material into waterways
- Utilize waste holding ponds
- Recycle and reuse water during industrial cooling operations
- Frequently inspect all storage facilities and equipment for signs of wear, breakage, rust, or corrosion
- Combine sewer overflow, which is the discharge of raw sewage, and storm water runoff when water treatment facilities are overwhelmed by storm events

Source: Guide to Understanding Water Pollution

e. Give examples of containing or reducing non-point pollution.

The EPA has identified a number of potential boating and marina non-point pollution sources, including improper solid waste and sewage disposal, oil and fuel discharges, improper vessel maintenance, and stormwater runoff. Stormwater runoff can pick up fertilizers and animal waste from agricultural fields, grass clippings, litter, and household chemicals from urban and suburban streets and oil and other automotive substances from roadways and parking lots. In addition, marinas may impede shoreline stabilization, and inattentive boating operations can damage wildlife and fish habitats. Boating and marina activities use a wide variety of chemicals and materials that pose a threat to the environment if used or disposed of improperly.

Source: Good Mate Recreational Boating and Marina Manual

Examples include:

- Follow exact directions for fertilizer applications
- Use biodegradable products
- Recycle oil and other car maintenance materials
- Keep automobiles in good working condition to minimize emissions
- Conduct all boat sanding and painting away from water in designated areas and collect waste
- Encourage marinas to install pump-out stations
- Install and use Marine Sanitation Devices (MSDs)
- Report spills immediately

Source: Guide to Understanding Water Pollution

f. Give examples of containing or reducing man-made pollution.

- Select nontoxic cleaning products that do not harm humans or aquatic life
- Fuel boats carefully, recycle used oil, and discard worn motor parts into proper receptacles to prevent needless petroleum spills. Keep boat and auto motors well-tuned to prevent fuel and lubricant leaks and improve fuel efficiency

- Dispose of trash, including cigarette filters and monofilament line, properly in onshore bins. If bins are overflowing, alert marina staff
- Build detention ponds that temporarily detain a percentage of stormwater runoff for up to 24 hours after a storm, allowing solids and pollutants to settle out. These ponds usually stay dry between storm events
- Construct manmade wetlands that are engineered systems designed to imitate the function of natural wetlands to treat and contain stormwater runoff and to decrease pollutants to coastal waters. They attempt to replicate all of the functions of natural wetlands including enhanced wildlife habitat and scenic areas

Source: Good Mate Recreational Boating and Marina Manual

1.2 Marine/Aquatic

a. Describe effects of excessive soil on standing water

Freshwater is divided into two types: standing water (lakes, marshes, and swamps) and flowing water (rivers and streams). Sediment (soil) is made up of minerals and organic matter that is transported by runoff as a result of coastal and upstream erosion. When the runoff flow is light, sediments quickly drop to the bottom, starting with the densest and coarsest material first. During times of heavy water flow sediment remains suspended in the water for longer periods. The finest sediments can remain in suspension for a long time.

Excessive amounts of sediment in runoff create several problems. Suspended sediments can reduce water clarity, interfere with animal respiration and digestion, and block sunlight through the water column, which affects plants that require light for photosynthesis. Sediment deposition can smother plant and animal life throughout the water column, but especially on the bottom. Sediments often contain heavy metals, pesticides, and other pollutants as well. Waterways, channels, and marina basins can be filled in by excess sediment, leaving us with increased dredging and dredge spoil disposal costs.

Source: Good Mate Recreational Boating and Marina Manual

b. Give a brief description of an estuary and its importance to the food chain.

An estuary is a partially enclosed body of water formed where freshwater from rivers and streams flows into the ocean, mixing with the salty seawater. Estuaries and the lands surrounding them are places of transition from land to sea and from fresh to salt water. Although influenced by the tides, estuaries are protected from the full force of ocean waves, winds, and storms by the reefs, barrier islands, or fingers of land, mud, or sand that define an estuary's seaward boundary.

Estuaries come in all shapes and sizes and go by many different names, often known as bays, lagoons, harbors, inlets, or sounds. (Note: Not all water bodies by those names are necessarily estuaries. The defining feature of an estuary is the mixing of fresh and salt water, not the name.) Some familiar examples of estuaries include San Francisco Bay, Puget Sound, Chesapeake Bay, Boston Harbor, and Tampa Bay.

The tidal, sheltered waters of estuaries support unique communities of plants and animals, specially adapted for life at the margin of the sea. Estuarine environments are among the most productive on earth, creating more organic matter each year than comparably sized areas of forest, grassland, or agricultural land (1). Many different habitat types are found in and around estuaries, including shallow open waters, freshwater and salt marshes, sandy beaches, mud and sand flats, rocky shores, oyster reefs, mangrove forests, river deltas, tidal pools, sea grass and kelp beds, and wooded swamps.

The productivity and variety of estuarine habitats foster a wonderful abundance and diversity of wildlife. Shore birds, fish, crabs and lobsters, marine mammals, clams and other shellfish, marine worms, sea birds, and reptiles are just some of the animals that make their homes in and around estuaries. These animals are linked to one another and to an assortment of specialized plants and microscopic organisms through complex food webs and other interactions.

Estuaries are places where rivers meet the sea. They are fascinating and beautiful ecosystems distinct from all other places on earth. Estuaries are critical for the survival of many species. Tens of thousands of birds, mammals, fish, and other wildlife depend on estuarine habitats as places to live, feed, and reproduce. Estuaries provide ideal spots for migratory birds to rest and refuel during their journeys. Also, many species of fish and shellfish rely on the sheltered waters of estuaries as protected places to spawn, giving them the nickname "nurseries of the sea." Hundreds of marine organisms, including most commercially valuable fish species, depend on estuaries at some point during their development (1).

Besides serving as important habitat for wildlife, the wetlands that fringe many estuaries also perform other valuable services. Water draining from the uplands carries sediments, nutrients, and other pollutants. As the water flows through fresh and salt marshes, much of the sediments and pollutants are filtered out. This filtration process creates cleaner and clearer water, which benefits both people and marine life (1). Wetland plants and soils also act as a natural buffer between the land and ocean, absorbing floodwaters and dissipating storm surges. This protects upland organisms as well as valuable real estate from storm and flood damage (1). Salt marsh grasses and other estuarine plants also help prevent erosion and stabilize the shoreline.

Among the cultural benefits of estuaries are recreation, scientific knowledge, education, and aesthetic values. Boating, fishing, swimming, surfing, and bird watching are just a few of the numerous recreational activities people enjoy in estuaries. Estuaries are often the cultural centers of coastal communities, serving as the focal points for local commerce, recreation, celebrations, customs, and traditions (2). As transition zones between land and water, estuaries are invaluable laboratories for scientists and students, providing countless lessons in biology, geology, chemistry, physics, history, and social issues (1). Estuaries also provide a great deal of aesthetic enjoyment for the people who live, work, or recreate in and around them.

Finally, the tangible and direct economic benefits of estuaries should not be overlooked. Tourism, fisheries, and other commercial activities thrive on the wealth of natural resources estuaries supply. The protected coastal waters of estuaries also support important public infrastructure, serving as harbors and ports vital for shipping, transportation, and industry. Some attempts have been made to measure certain aspects of the economic activity that depends on America's estuaries and other coastal waters:

- Estuaries provide habitat for more than 75% of America's commercial fish catch, and for 80-90% of the recreational fish catch (5). Estuarine-dependent fisheries are among the most valuable within regions and across the nation, worth more than $1.9 billion in 1990, excluding Alaska (4)

- Nationwide, commercial and recreational fishing, boating, tourism, and other coastal industries provide more than 28 million jobs (2). Commercial shipping alone employed more than 50,000 people as of January 1997 (5). In just one estuarine system- Massachusetts and Cape Cod Bays - commercial and recreational fishing generate more than $240 million per year. In that same estuary, tourism and beach-going generate more than $1.5 billion per year, and shipping and marinas generate more than $1.86 billion per year

- There are 25,500 recreational facilities along the U.S. coasts, including estuaries, (5) - almost 44,000 square miles of outdoor public recreation areas. The average American spends 10 recreational days on the coast each year. More than 180 million Americans visit ocean and bay beaches each year. Coastal recreation and tourism generate in excess of $12 billion annually

In short, estuaries provide us with a whole suite of resources, benefits, and services. Some of these can be measured in dollars and cents; others cannot. Estuaries are an irreplaceable natural resource that must be managed carefully for the mutual benefit of all who enjoy and depend on them.

The economy of many coastal areas is based primarily on the natural beauty and bounty of estuaries. When those natural resources are imperiled, so too are the livelihoods of the many people who live and work there. Around half the U.S. population now lives in coastal areas, including the shores of estuaries. Coastal counties are growing three times faster than counties elsewhere in the nation.

Unfortunately, this increasing concentration of people is upsetting the natural balance of estuarine ecosystems and threatening their integrity. Channels have been dredged, marshes and tidal flats filled, waters polluted, and shorelines reconstructed to accommodate human housing, transportation, and agriculture needs (1). Stresses caused by overuse of resources and unchecked land use practices have resulted in unsafe drinking water, beach and shellfish bed closings, harmful algal blooms, unproductive fisheries, fish kills, loss of habitat and wildlife, and a host of other human health and natural resource problems.

As our population grows, the demands imposed on our natural resources increase. So too does the importance of protecting these resources for all of their natural, economic, and aesthetic values. It is the mission of the National Estuary Program (NEP) to restore and protect America's nationally significant estuaries. Through its approach of inclusive, community-based planning and action on the watershed level, the NEP is an important initiative in conserving our estuarine resources and an effective model for the protection and management of other coastal areas.

Sources:

1. National Estuarine Research Reserves Introduction to Estuaries

2. Restore America's Estuaries- What is an estuary?

3. Natural Resource Valuation: A Report by the Nation's Estuary Programs, August 1997.

4. Estuaries of the United States: Vital Statistics of a Natural Resource Base, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, October 1990

5. Coastal Challenges: A Guide to Coastal and Marine Issues, a publication of the National Safety Council's Environmental Health Center, prepared in conjunction with Coastal America, February 1998.

c. What are the results of excess vegetation in the aquatic environment?

Nutrients, such as phosphorus and nitrogen, enter the runoff "stream" through sewage, detergents, agricultural and lawn fertilizers, animal waste, and yard waste. Small amounts of nutrients are necessary for the healthy development of a natural ecosystem, but excessive nutrients can disrupt the natural balance of an ecosystem.

Algae are single-celled organisms that are important beginnings of most food chains or food webs in the aquatic environment. Algae use light for photosynthesis to produce their food. This process in turn produces oxygen that supports animal life in the water.
Excessive nutrients act as a "fertilizer" and stimulate algal growth, creating what is called an algal bloom. Once the overabundant algae begin to decay naturally, dissolved oxygen in the water can be depleted. This process increases the biochemical oxygen demand of an ecosystem and leads to foul odors and resultant harm to aquatic life, such as fish kills.

Source: Good Mate Recreational Boating and Marina Manual

d. Flowing water and standing water environments.

Freshwater is divided into two types: standing water (lakes, marshes, and swamps) and flowing water (rivers and streams). The effect of an oil spill on freshwater habitats varies according to the rate of water flow and the habitat's specific characteristics (1).

Rivers are flowing bodies of fresh water fed by smaller tributaries flowing from upland sources. Seventy percent of the Earth's surface is drained from a system of rivers that carries 34,000 cubic miles of water to the sea each year. All of this water is carried downhill through river channels that are surrounded on either side by an area known as the floodplain. A river transports not only water from the uplands, but also sediments and pollutants, and deposits them downriver and onto the adjoining flood plains (2).

Lake ecosystems (standing water environments) vary enormously depending on their size, depth, and geographical location. Lakes have traditionally been considered closed, balanced ecosystems with water and nutrients constantly being recycled. Small lakes can experience enormous daily and seasonal environmental variations while large lakes present a more stable environment for wildlife. As with most aquatic food webs, the primary food source supporting life in lakes is supplied by photosynthetic plankton, algae, and aquatic plants.

In addition, aquatic plants such as aquatic grass provide food and habitat for many commercially important species. Due to a lake's enclosed nature, it is highly vulnerable to the pollution-generating activities of humans (2).

Standing water, such as marshes or swamps, are likely to incur more severe impacts than flowing water when there is spilled oil because the oil tends to "pool" in the water and can remain in calm water conditions for long periods of time. In those circumstances, the affected habitat may take years to restore. The variety of life in and around lakes has different sensitivities to oil spills (1).

- The bottoms of standing water bodies, which are often muddy, serve as homes to many worms, insects, and shellfish. Lake bottoms also serve as a breeding ground and food source for these organisms and higher animals. Oil in sediments may be very harmful because sediment traps the oil and affects the organisms that live in or feed off the sediments.
- In the open water, oil can be toxic to the frogs, reptiles, fish, waterfowl, and other animals that make the water their home. "Oiling" of plants and grasses that are rooted or float in the water also can occur, harming both the plants and the animals that depend on them for food and shelter. Fisheries located in freshwater are also subject to the toxic effects of oil.
- On the surface of the water, water bugs that skim the water surface and floating plants such as water lilies are threatened by oil slicks that spread across the surface.
- In the shoreline habitats of lakes and other bodies of standing water, cattails and other weeds and grasses provide many important functions for life in and around the water. They serve as food sources, nesting grounds for many types of animals, and shelter for small animals. Oil spills can coat these areas, affecting the plants and the organisms that depend on them.
- Marsh environments are among the most sensitive freshwater habitat to oil spills due to the minimal water flow. Oil spills have a widespread impact on a host of interconnected species. For example, lush marsh vegetation is used as nurseries for shellfish and fish, as a food source for many organisms, and a home for fish, birds, and mammals.

Oil spills impact flowing water less severely than standing water because the currents provide a natural cleaning mechanism. Although the effects of oil spills on river habitats may be less severe or last for a shorter amount of time than standing waters, the sensitivity of river and stream habitats is similar to that of standing water, with a few special features (1):

- Oil spilled into most rivers often collects along the banks, where the oil clings to plants and grasses. The animals that ingest these contaminated plants may also be affected

- Rocks found in and around flowing water serve as homes for mosses, which are an important basic element in a freshwater habitat's food chain. Spilled oil can cover these rocks, killing the mosses and disrupting the local ecology

Sources: AUX –MEES Study Guide and Good Mate Recreational Boating and Marina Manual

e. Define Ghost Fishing.

Ghost fishing is the capability of lost or discarded fishing gear, such as nets, traps and fishing line, to continue to ensnare fish, shellfish or other marine life.

f. Give examples of 2 or more Invasive Species (aquatic and non-aquatic) in your AOR.

An "invasive species" is defined as a species that is 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the primary means of invasive species introductions.

Examples of invasive species include:

Atlantic Coast	European Green Crab	Water Hyacinth
	Alewife	Rusty Crayfish

Great Lakes area	Zebra Mussel	Sea Lamprey
	Eurasian Watermilfoil	Round Goby

Mississippi River drainage	Asian Carp – bighead and silver	Zebra Mussel
	Purple Loosestrife	

Gulf Coast states	Hydrilla	Cholera
	Giant Salvinia	Zebra Mussels

Plains and Mountain West	Zebra Mussels	New Zealand Mud Snails
	Eurasian Watermilfoil	Water Hyacinth

Pacific Coast	Amur River Clam	Smooth Cord Grass
	European Green Crab	Chinese Mitten Crab

g. Give brief descriptions of results of invasive species both good and bad.

Good Results

Many invasive species (often called introduced, exotic, or alien) do not cause harm to our economy, our environment, or our health. In fact, the vast majority of "introduced" species do not survive and only about 15% of those that do become "invasive" or harmful.

Many invasive species have been used in horticulture and agriculture with limited success in controlling other invasive species.

Bad Results

Unless we can reduce or stop the spread of invasive species, they will continue to require significant dollars to treat, control and remedy damage that is caused to public resources.

For those who love the outdoors, recreate in the outdoors or are in a business that depends on the health of natural resources, invasive species become very important. Whether you are a hiker, biker, camper, bird watcher, gardener, fisherman, boater, hunter, logger, forester, rancher or farmer, invasive species can have a negative impact on your enjoyment and use of the natural environment.

For example, species like giant salvinia and zebra mussels can take over lakes and make boating, fishing and general water recreation less than enjoyable. Zebra mussels can clog water pipes and other machinery, which has cost millions to replace or repair east of the Mississippi River.

Source: **http://www.texasinvasives.org/i101/**

h. What is the importance of a wetland?

A wetland is a low-lying ecosystem where the water table is always at or near the surface. It is divided into estuarine and freshwater systems, which may be further subdivided by soil type and plant life into bogs, swamps, and marshes. Because wetlands have poor drainage, the area is characterized by sluggish or standing water that can create an open-water habitat for wildlife. Wetlands help to regulate the water cycle, filter the water supply, prevent soil erosion, and absorb floodwaters. More significantly, however, wetlands serve as spawning and feeding grounds for nearly one-third of the endangered animal and plant species in the United States and their ecological value in most other countries is comparable.

Many wetlands were destroyed by urban growth and farming before their value was recognized. More than half of U.S. wetlands in the lower 48 states have been lost since colonial times. Federal wetlands policy today is based on the wetlands provisions (1987) of the Clean Water Act. The working concept is that of “no net loss,” a concept that has been interpreted in various ways by each federal administration. Although the U.S. Fish and Wildlife Service has estimated that more than one million acres (about 400,000 hectares) of wetlands were lost in the decade from 1985 to 1995, this assessment was down from nearly 3 million acres (1.2 million hectares) lost in the previous decade, before the wetlands preservation policy was in force. As part of the “no net loss” policy, developers who fill wetlands may create new ones, but a 2001 National Academy of Sciences report found that new wetlands were not always created and when they were they were often of lesser value, both to the environment and to people, than the wetlands they replaced. The report recommended that replacement wetlands be designed to recreate the function of the mature natural wetlands.

i. Give a brief description of a Watershed and its function.

A **watershed** is an area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel. The word watershed is sometimes used interchangeably with drainage basin or catchment. Ridges and hills that separate two watersheds are called the **drainage divide**. The watershed consists of surface water--lakes, streams, reservoirs, and wetlands--and all the underlying groundwater. Larger watersheds contain many smaller watersheds. It all depends on the outflow point; all of the land that drains water to the outflow point is the watershed for that outflow location. Watersheds are important because the streamflow and the water quality of a river are affected by things, human-induced or not, happening in the land area "above" the river-outflow point.

Traditionally, water quality improvements have focused on specific sources of pollution, such as sewage discharges, or specific water resources, such as a river segment or wetland. While this approach may be successful in addressing specific problems, it fails to address the more subtle and chronic problems that contribute to a watershed's decline. For example, pollution from a sewage treatment plant might be reduced significantly after a new technology is installed, and yet the local river may still suffer if other factors in the watershed, such as habitat destruction or polluted runoff, go unaddressed. Because watersheds are defined by natural hydrology, they are a good basis for managing water resources. Watershed management can offer a stronger foundation for uncovering the many stressors that affect a watershed. The result is management better equipped to determine what actions are needed to protect or restore the resource.

Watersheds come in all shapes and sizes. They cross county, state, and national boundaries. In the continental US, there are 2,110 watersheds; including Hawaii, Alaska, and Puerto Rico, there are 2,267 watersheds.

1.3 Water Quality Parameters: (define each parameter and describe its importance to marine/aquatic environmental quality in your AOR)

a. Salinity

Salinity is a measure of dissolved salts in seawater. It is calculated as the amount of salt (in grams) dissolved in 1,000 grams (1 kilogram) of seawater. In much of Earth's oceans, there is a marked difference in salinity between the surface area and the deep ocean. Although salinity generally increases with depth, there is a distinct layer where salinity increases sharply, called the **Halocline**. The electrical conductivity of seawater is strongly dependent on its salinity. Thus, oceanographers use a "CTD" instrument to measure Conductivity, Temperature and Depth. From conductivity, they can calculate seawater salinity. With no external forces applied, the ocean would stratify into a simple layered structure based on its density (mass divided by volume).
Factors that influence seawater's density are: Pressure (which is related to water depth), Temperature, and Salt Content (or salinity).

Salinity affects seawater density and thus influences ocean water layering. Other factors held constant, increasing the salinity of seawater causes its density to increase. High salinity seawater generally sinks below lower salinity water. This leads to layering of water -- or stratification -- by salinity. Salinity varies throughout the oceans, depending on whether freshwater (salinity = 0) has been added by precipitation or removed by evaporation.

Many regions are affected by processes that both increase and decrease salinity. For example, near the margins of continents, dry winds blow off landmasses and increase salinity via high evaporation. In these same areas, salinity is decreased by the influx of freshwater from nearby rivers. In general, the higher ocean salinities occur in the centers of ocean basins, where trade winds evaporate water and rain is rare. Lower salinities occur at high latitudes where the ocean receives fresh water from rain and melting ice.

b. pH

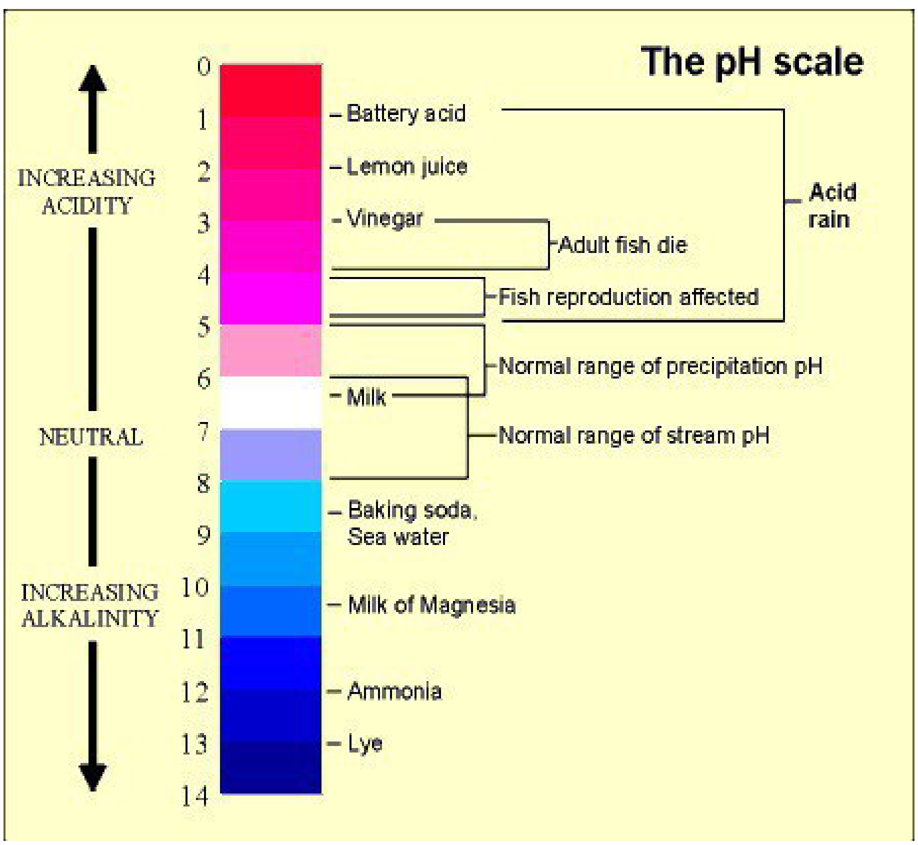
In chemistry, pH is a measure of the acidity or basicity of a solution. Pure water is said to be neutral, with a pH close to 7.0 at 25 °C (77 °F). Solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are basic or alkaline.

Water molecules separate into charged compounds (i.e., ions) called H+ (hydrogen ion) and OH- (hydroxyl ion). A solution containing an excess of hydrogen ions is said to be acidic and tastes sour. A solution containing an excess of hydroxyl ions is said to be basic and tastes bitter; note that an excess of hydroxyl ions has a corresponding dearth of hydrogen ions.

The acidity increases from neutral toward 0. Because the scale is logarithmic, a difference of one pH unit represents a tenfold change. For example, the acidity of a sample with a pH of 5 is ten times greater than that of a sample with a pH of 6. A difference of 2 units, from 6 to 4, would mean that the acidity is one hundred times greater, and so on.

Normal rain has a pH of 5.6 – slightly acidic because of the carbon dioxide picked up in the earth's atmosphere by the rain. Air pollution creates a phenomenon called "acid rain", where rain will absorb pollutants such as Sulphur Dioxide to form Sulphuric Acid.

Various aspects of biological systems work best at well-defined pHs. In order to keep pHs within well-defined ranges, biological systems employ solutes, which together are able to mop up excessive hydrogen ions or hydroxide ions. The reason for the need to keep pHs within well-defined ranges has to do with enzymes typically functioning optimally only within narrow pH ranges, and if enzymes stop working well, the whole system falls apart (e.g., organisms die).
Consequently, most marine organisms are sensitive to changes in pH.



c. Suspended solids

Total Suspended Solids (TSS) are comprised of organic and mineral particles that are transported in the water column. TSS is closely linked to land erosion and to erosion of river channels. TSS can be extremely variable, ranging from less than 5 mg per milliliter to extremes of 30,000 mg per milliliter in some rivers. TSS is not only an important measure of erosion in river basins, but is also closely linked to the transport through river systems of nutrients (especially phosphorus), metals, and a wide range of industrial and agricultural chemicals.

In most rivers, TSS is primarily composed of small mineral particles. TSS is often referred to as '**turbidity**' and is frequently poorly measured. Higher TSS (>1000 mg per milliliter) may greatly affect water use by limiting light penetration and can limit reservoir life through sedimentation of suspended matter. TSS levels and fluctuations influence aquatic life, from phytoplankton to fish.

TSS, especially when the individual particles are small (< 63 microns), carry many substances that are harmful or toxic. As a result, suspended particles are often the primary carrier of these pollutants to lakes and to coastal zones of oceans where they settle. In rivers, lakes and coastal zones these fine particles are a food source for filter feeders which are part of the food chain, leading to increased concentrations of chemical pollutants in fish and, ultimately, in man. In deep lakes, however, deposition of fine particles effectively removes pollutants from the overlying water by burying them in the bottom sediments of the lake. In river basins where erosion is a serious problem, suspended solids can blanket the riverbed, thereby destroying fish habitat.

d. Temperature

The sunlit and wind-driven upper layer of Earth's oceans rests on relatively colder and denser waters. At times, there is a distinct temperature difference between the wind-stirred Surface Zone and the quieter Deep Zone below. Temperature generally decreases with depth. With no external forces applied, the ocean would stratify into a simple layered structure based on its density (mass divided by volume). Factors that influence seawater's density are: Pressure (which is related to water depth), Temperature, and Salt Content (or salinity).

When heated, seawater volume expands and density decreases. Sun-warmed surface waters generally float on top of colder, denser waters below. This leads to layering of water -- or stratification -- by temperature. However, stratification can be "undone" by other forces including wind and tides. Without ocean currents, sea surface temperatures would depend only on latitude with the bands of warmest waters located along the equator. Because ocean currents transport heated water around the globe, the distribution of sea-surface temperatures is more complicated.

e. Turbidity

Turbidity is the existence or degree of suspended solids in water. (See “suspended solids,” above).

Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality.

Source: https://en.wikipedia.org/wiki/Turbidity

f. Coliform bacteria

Coliform bacteria are a natural part of the microbiology of the intestinal tract of warm-blooded mammals, including man. Coliform bacteria can also be found in soil, other animals, insects, etc.

Increases in levels of Coliform bacteria are associated with the dumping of human waste into our waterways.

The total Coliform group is relatively easy to culture in the lab, and therefore, has been selected as the primary indicator of bacteria for the presence of disease-causing organisms. The total Coliform bacteria test is a primary indicator of "potability," suitability for consumption, of drinking water. It measures the concentration of total Coliform bacteria associated with the possible presence of disease-causing organisms. If large numbers of Coliforms are found in water, there is a high probability that other pathogenic bacteria or organisms, such as Giardia and Cryptosporidium, may be present. The Pennsylvania Department of Environmental Protection (PA DEP) requires public drinking water supplies to demonstrate the total absence of Coliform per 100 mls (about 4 oz) of drinking water.

Approved tests for total Coliform bacteria include the membrane filter, multiple tube fermentation, MPN (Most Probable Number) and MMO-MUG ("Colilert") methods. The membrane filter method uses a fine-porosity filter, which can retain bacteria. The filter is placed in a petri (culture) dish on a pad with growth enrichment media (mEndo) and is incubated for 24 hours at 35 degrees C. Individual bacterial cells that collect on the filter grow into dome-shaped colonies. The Coliform bacteria have a gold-green sheen and are counted directly from the dish. Since some other bacteria may develop a similar color, a confirmation test using more specific media is required. The confirmation procedure requires an additional 24 to 48 hrs. to complete the test for suspected positive total Coliform bacteria.

The MPN method uses a test tube full of media with a smaller inverted test tube inside which captures carbon dioxide gas released from the growth of Coliform bacteria. A series of dilutions and replicates are set up, and those producing gas in 24 hours at 35 degrees C are counted. A statistical analysis is used to determine the most probable number of bacteria cells present.

1.4 Pollution and Pollution Mitigations Terms (Define each of the following terms and describe their importance to your AOR)

a. Adsorbent/Absorbent

An **adsorbent** is a material which attaches or holds on to another material, such as petroleum products, and is often used in pads for containing and disposing of bilge oil and related environmental hazards. An **absorbent** is a material, which soaks up other materials. Some of the most useful materials will **ad**sorb petroleum products while releasing water, making them more efficient in cleaning up environmental hazards.

b. Black-water and Grey-water

Sewage, also called black water, consists of wastewater generated from toilets and medical. facilities. Sewage on ships is typically diluted with smaller volumes of water than sewage on land (three quarts per flush compared with three to five gallons), and ship sewage is therefore more concentrated.

Human sewage can carry enteric bacteria, pathogens, diseases, viruses, the eggs of intestinal parasites, and harmful nutrients. Ingesting contaminated fish or direct exposure to water contaminated with sewage pose health risks for humans. Bivalve mollusks (oysters and clams) and other filter-feeding marine organisms often inhabit waters with the greatest concentrations of nutrients from organic wastes, and they absorb high levels of these pollutants. Discharges of untreated or inadequately treated sewage from ships can cause bacterial and viral contamination of commercial and recreational shellfish beds, producing serious risks to public health.

Gray water consists of non-sewage wastewater, including drainage from dishwashers, showers, laundry, baths, galleys, and washbasins. It can contain pollutants such as fecal Coliform, food waste, oil and grease, detergents, shampoos, cleaners, pesticides, heavy metals, and, on some vessels, medical and dental wastes.

Source: Cruise Ship Pollution, a report by the Ocean Conservancy

c. Biodegradable

A "biodegradable" product has the ability to break down, safely and relatively quickly, by biological means, into the raw materials of nature and disappear into the environment. These products can be solids biodegrading into the soil (which we also refer to as compostable), or liquids biodegrading into water. Biodegradable plastic is intended to break up when exposed to microorganisms (a natural ingredient such as cornstarch or vegetable oil is added to achieve this result).

Sustainable disposal of any product requires that its wastes return to the earth and are able to biodegrade. Nature biodegrades everything it makes back into basic building blocks, so that new living things can be made from the old. Every resource made by nature returns to nature: plants and animals biodegrade, even raw crude oil will degrade when exposed to water, air, and the necessary salts. Nature has perfected this system-we just need to learn how to participate in it.

By the time many resources are turned into products, however, they have been altered by industry in such a way that they are unrecognizable to the microorganisms and enzymes that return natural materials to their basic building blocks. Crude oil, for example, will biodegrade in its natural state, but once it is turned into plastic, it becomes an unsustainable pollution problem. Instead of returning to the cycle of life, these products simply pollute and litter our land, air, and water.

Of all the environmental buzzwords, "biodegradable" has perhaps been the most misused and is perhaps the most difficult to understand. Because in the past there have been no guidelines or regulations, many products have been called biodegradable without any real justification.

Unfortunately, the word “biodegradable” has frequently been applied to products that generally aren't (such as detergents or plastics) and almost never used for products that really are (such as soap or paper).

A leaf is a perfect example of a biodegradable product: it is made in the spring, used by the plant for photosynthesis in the summer, drops to the ground in autumn, and is assimilated into the soil to nourish the plant for the next season. The basic concept seems straightforward enough; however, there are several factors to consider in determining the biodegradability of a product or material.

The first is the question of the inherent biodegradability of the material. Any material that comes from nature will return to nature, as long as it is still in a relatively natural form. Therefore, any plant-based, animal-based, or natural mineral-based product has the capability to biodegrade, but products made from man-made petrochemical compounds generally do not. When a manmade compound is formulated in a laboratory, combinations of elements are made that do not exist in nature, and there are no corresponding microorganisms to break them down.

The next issue is how long it takes for the material to actually break down. In nature, different materials biodegrade at different rates. A leaf takes approximately a year to become part of the forest floor. An iron shovel, on the other hand, can take years to rust away to nothing, and a large tree can take decades to completely break down. Common sense tells us that any material will ultimately biodegrade, even if it takes centuries.

So, what is the proper rate for a material to be biodegradable? It really depends on the material itself. The leaf example suggests that the proper rate is that which is appropriate to the ecosystem. A liquid going into a waterway should biodegrade fairly quickly, whereas there's no harm done if it takes a while for a newspaper to break down. Plastics, on the other hand, will not biodegrade in anyone's lifetime, and certainly will never break back down into the petroleum from which it was made.

And then there is the question of what exactly does the product or material break down into, and are there any toxic substances formed along the way or as the end result. In his book The Closing Circle, ecologist Barry Commoner gives the example of the benzene unit in synthetic detergents being converted as it biodegrades into phenol (carbolic acid), a substance toxic to fish. To be truly biodegradable, a substance or material should break down into carbon dioxide (a nutrient for plants), water, and naturally occurring minerals that do not cause harm to the ecosystem (salt or baking soda, for example, are already in their natural mineral state and do not need to biodegrade).

The characteristics of the environment that the substance or material is in can also affect its ability to biodegrade. Detergents, for example, might break down in a natural freshwater "aerobic" (having oxygen) environment, but not in an "anaerobic" (lacking oxygen) environment such as sewage treatment plant digesters, or natural ecosystems such as swamps, flooded soils, or surface water sediments.

Many products that are inherently biodegradable in soil, such as tree trimmings, food wastes, and paper, will not biodegrade when we place them in landfills because the artificial landfill environment lacks the light, water, and bacterial activity required for the decay process to begin. The Garbage Project, an anthropological study of our waste conducted by Dr. William Rathje and a group of graduate students at the University of Arizona, has unearthed hot dogs, corncobs, and grapes that were twenty-five years old and still recognizable, as well as newspapers dating back to 1952 that were still easily readable. When the conditions needed for biodegradable materials to biodegrade naturally are not provided, major garbage problems are the result.

Once it is determined that a substance or material will actually biodegrade under particular conditions, then there is the problem of actually using the product in those conditions and in an amount that can be sustained by the ecosystem that is receiving it. The sustainable rate of biodegradation is that amount which a given ecosystem can absorb as a nutrient, and if necessary, render harmless.

Soap, for example, is a natural, organic product that is inherently biodegradable. The soapy greywater from a single household may biodegrade easily in a backyard. However, if that same soap went down a sewage line that fed into a waterway along with the soap used by a million or more residents that live along that waterway, there may be waves of soapsuds on the beaches, simply because more soap would be going into the waterway than its existing microorganisms can biodegrade.

Oil spills are devastating not because oil doesn't biodegrade, but rather because the amount of oil is too much for the number of microorganisms available to degrade it. It has been estimated that it will take 50 years for the oil spilled in 1989 by the Exxon Valdez to degrade. Lakes and streams have become polluted because the amount of sewage dumped into them has been overwhelming. As much as we need to consider the biodegradability of the product, we also need to consider the capacity of the system into which the biodegradable substance or material is being placed.

Those who have attempted to define biodegradable for product labels run into the same dilemma encountered when defining recyclable: should a product be called biodegradable if it has the inherent ability to biodegrade, or should it only be called biodegradable if it also is commonly disposed of in a way in which it really will biodegrade? For example, should a paper grocery bag be labeled biodegradable? It will biodegrade if placed in nature; however it won't biodegrade in a landfill because the conditions are not right.

Here's how long it takes for some of our commonly used products to biodegrade, when they are scattered about as litter:	
Cotton rags	1-5 months
Paper	2-5 months
Rope	3-14 months
Orange peels	6 months
Wool socks	1 to 5 years
Cigarette butts	1 to 12 years
Plastic coated paper milk cartons	5 years
Plastic bags	10 to 20 years
Leather shoes	25 to 40 years
Nylon fabric	30 to 40 years
Tin cans and styrofoam cups	50 to 100 years
Aluminum cans	200 years
Plastic beverage holders	400 years
Monofilament Fishing Line	600 years
Glass	Undetermined; at least 4500 years

d. Best Management Practices (BMP)

In the context of pollution and pollution mitigation, Best Management Practices are practices that ensure environmentally responsible behavior and are determined to be the most practical means of preventing or reducing the amount of non-point source pollution to levels compatible with water quality goals.

Source: Guide to Understanding Water Pollution and the Good Mate Manual

e. Emulsion

Emulsions are mixtures of liquids that do not dissolve in each other. Emulsification is the process of dispersing one liquid in a second immiscible (non-mixable) liquid. There are two types of emulsions: oil-in-water, such as milk, and water-in-oil, such as butter.

Oil-in-water spills produce an iridescent "sheen" as the oil spreads on the surface of the water due to wind and wave action as well as currents, both at sea and in bodies of fresh water.

Water-in-oil emulsions are extremely stable and may persist for years after a spill; they usually contain 50% to 80% water and have a reddish brown color with a grease-like consistency. They are commonly referred to as "chocolate mousse" due to their pudding-like appearance. The largest groups of emulsifying agents are soaps, detergents and other surface-active compounds (surfactants). Their use in clean-up operations is strictly regulated because dispersion of the oil into the water column can pose significant risks both to the habitat and marine life.

Source: Guide to Understanding Water Pollution and Oil, Water and Chocolate Mousse

f. No Discharge Zone

No discharge zones are areas designated by the Environmental Protection Agency, where no sewage, treated or untreated, may be discharged into the water. This includes effluent treated using a Type 1 or 2 marine sanitation device (MSD). In San Francisco Bay, the only No Discharge Zone is Richardson Bay; in District 11 North, the other No Discharge Zone is Lake Tahoe. For the most current listing of No Discharge Zones check the EPA's Office of Water web page:
http://water.epa.gov/polwaste/vwd/vsdnozone.cfm

g. Photodegradable

Photodegradation is the process in which sunlight (ultraviolet light) breaks down a material, especially plastics. The term "photodegradable" means that a product is biodegradable when exposed to sunlight. For example, manufacturers have begun to make plastic six-pack holders out of a photodegradable plastic, which will break down into smaller pieces of plastic when exposed to direct sunlight. The term may also be used on plastic trash bags and agricultural mulch film.

To be labeled as such, the material must have the proven capability to decompose into non-toxic carbonaceous soil, water or carbon dioxide in the most common environment in which it is disposed within one year through physical processes such as exposure to heat and light. Plastics made from petrochemicals are not a product of nature and cannot be broken down by natural processes; therefore, no matter how small the pieces of plastic may become, they are not – and cannot be – biodegradable.

h. Sheen

Sheen is a gleaming luster of brightness, part of an oil slick. "Sheen" refers to the shiny, rainbow-tinted iridescent film of oil on the surface of the water which occurs when petroleum products such as gas or oil are spilled into either fresh or salt water.

1.5 Describe the three (3) types of marine sanitation devices (MSDs), including the requirements for various-sized vessels, proper use, and operation in coastal/inland areas, no-discharge zones and beyond 3 nautical miles (nm).

The Clean Water Act (CWA) is the centerpiece of Federal legislation addressing pollution in U.S. waters. Under Section 312 of the CWA, discharges of sewage from vessels are controlled in part by regulating the equipment that treats or holds the sewage: marine sanitation devices (MSDs).

For purposes of the CWA, a marine sanitation device is "any equipment for installation on board a vessel which is designed to receive, retain, treat, or discharge sewage, and any process to treat such sewage."

Section 312 of the CWA requires the use of operable, U.S. Coast Guard-certified MSDs onboard vessels that are 1) equipped with installed toilets and 2) operating on U.S. navigable waters (which include the three-mile territorial seas).

The U.S. Environmental Protection Agency (EPA) and the U.S. Coast Guard jointly regulate MSDs under CWA Section 312.

EPA has issued regulations setting performance standards for MSDs (the standards address fecal Coliform and total suspended solids - TSS), and the Coast Guard has issued regulations governing the design, construction, certification, installation, and operation of MSDs consistent with EPA's standards.

Source: http://water.epa.gov/polwaste/vwd/vsdmsd.cfm

The purpose of a marine sanitation device is to keep untreated sewage out of the water. The following chart describes the various MSDs.

Types of Marine Sanitation Devices

Sewage treatment device	Vessel length	Standard required for the device
Type I Flow through device (maceration and disinfection)	Only allowed on vessels equal to or less than 65 feet in length.	The effluent produced must not have a fecal Coliform bacteria count greater than 1000 per 100 milliliters and have no visible floating solids.
Type 1 MSDs rely on maceration and disinfection for treatment.		

Type II Flow through device (maceration and disinfection)	Greater than 65 feet in length	The effluent must not have a fecal Coliform bacteria count greater than 200 per 100 milliliters and suspended solids not greater than 150 milligrams per liter.
Type II MSDs are similar to Type I MSDs, but usually require more space and power to operate, and are usually installed on larger vessels only. Type II MSD effluent is cleaner than Type I, but contains greater levels of chemicals.		

Type III- Holding tank	Any length	This MSD is designed to prevent the overboard discharge of treated or untreated sewage.
Type III MSDs include recirculating and incinerating MSDs and holding tanks. Holding tanks are the most common kind of Type III MSD. Sewage flushed from the marine head is deposited into a tank containing deodorizers and chemicals. The contents are stored until they can be disposed of at a shore-side pumpout facility. Type III MSDs can be equipped with a discharge option, usually called a Y-valve, which allows a boater to direct the sewage from the head either into a holding tank or, while offshore outside the 3 nm limit, directly overboard.		

It is illegal to discharge treated or untreated sewage in any area designated by the EPA as a No Discharge Zone. For the most current listing of No Discharge Zones, check the EPA's Office of Water web page: http://water.epa.gov/polwaste/vwd/vsdnozone.cfm

1.6 Explain the basic garbage dumping restrictions and placard requirements (33 CFR 151).

It is illegal to dump:	
Distance from shore:	**Material:**
Inside 3 nautical miles and in U.S. Lakes, Rivers, Bays and Sounds, and anywhere on the Great Lakes no matter how far from shore	Plastic, dunnage, lining, and packing materials that float and any garbage except dishwater/ greywater/ fresh fish parts.
3 to 12 nautical miles	Plastic, dunnage, lining, and packing materials that float and any garbage not ground to less than one square inch.
12 to 25 nautical miles	Plastic, dunnage, lining, and packing materials that float.
Outside 25 nautical miles	Plastic

The placard requirements are:

The master or person in charge of each manned ship (other than a fixed or floating platform) that is 26 feet or more in length shall ensure that one or more placards of at least nine inches wide by four inches high, made of a durable material, and lettered with letters at least1/8 inch high, be displayed in prominent locations and in sufficient numbers so that they can be read by the crew and passengers.

Each placard must notify the reader of the following:

(1) The discharge of plastic or garbage mixed with plastic into any waters is prohibited

(2) The discharge of all garbage is prohibited in the navigable waters of the United States and, in all other waters, within three nautical miles of the nearest land

(3) Other garbage ground to less than one inch may be discharged beyond three nautical miles of the nearest land

(4) Other unground garbage may be discharged beyond 12 nautical miles from the nearest land

(5) The discharge of dunnage, lining, and packing materials that float is prohibited within 25 nautical miles of the nearest land

1.7 Explain the purpose of the National Response Center (NRC), describe how to report a spill or incident and what information to provide, give the spill reporting number, and describe the reporting requirement.

The primary function of the NRC is to serve as the **SOLE** national point of contact for reporting all oil, chemical, radiological, biological, and etiological discharges into the environment anywhere in the United States and its territories.

It is also the operations and communications center for the National Response Team (NRT) – a planning, policy and coordinating organization. It is the operational link between the local Federal On-Scene Coordinator (FOSC) and the National/Regional Response Teams. The NRC does not actually respond to incidents, but takes pollution discharge reports and immediately passes the information, by phone and fax, to the FOSC and other affected Federal and State agencies.

The party responsible for any oil or chemical discharge that meets federal reporting requirements **MUST** report the incident to the NRC immediately. Calling the NRC meets all federal and initial reporting requirements; failure to do so is a violation of Federal law. **NOTE:** Additional state or local notifications may be required by law. If you are not the responsible party you can, and should, call the NRC to report hazardous material incidents – your call may be the first. Any agency taking an initial discharge report must either pass the information to the NRC or have the responsible/reporting party call the NRC. In life-threatening situations, **ALWAYS** call local EMS or 911 first.

What information does the NRC need?

Who you are:

Your name, address and phone number.

The name, address and phone number of the responsible party, if known.

Anonymous calls are accepted.

What happened:

What material was released?

How much was released?

Where it happened:

City, County, State.

Location, nearest street corner, landmark, navigation coordinates.

When it happened:

When did it happen?

When did you discover it?

Why it happened:

How did it happen?

What caused the discharge?

What if you do not have all the above-listed information? The NRC still wants and needs your call. You might be providing the NRC with the first indication that a major incident has occurred.

NEVER approach someone you fear may be about to commit an illegal act or crime. Make some notes, such as the person's appearance, clothing, car license plate, and the type of boat, vehicle or aircraft involved. Take a picture if you can, but keep your distance if the situation seems hostile.

Never use race or religion as an indicator of suspicious activity. Always rely on the idea that what you are observing is like a puzzle; if your instincts suggest suspicious activity, and you have observed actions that support your instincts and feelings, then you can report your observations using reliable methods.

Use C.Y.M.B.A.L.S.

C.Y.M.B.A.L.S. is an acronym that may also help you remember descriptive information about people, boats and vehicles.

People	Boats	Vehicles
Color (hair, eyes, clothing, skin)	**Color** (Paint, markings, etc.)	**Color** (Paint, markings, etc.)
Year of birth, approximate age	**Year** (of manufacture)	**Year** (of manufacture)
Make (Race, Ethnicity)	**Make** (make and model of boat)	**Make** (make and model of vehicle)
Body (Body type, height, weight, build, etc)	**Body** (Length, Runabout, Cruiser, Etc.)	**Body** (Sedan, Truck, SUV, Van, 4-door, 2-door, Etc.)
Attire (Clothing description, dress, etc.)	**Accessories**: (Name, antennas, flags, pennants, inboard or outboard, etc.)	**All Others** (Dents, Bumper Stickers, Rims, Tinted Glass, etc.)
Looks (Hair, Scars, Tattoos, Facial hair, etc.)	**License/Registration Number**	**License Plate Number**
Sex (Male, Female)	**State of registration**	**State of registration**

The National Response Center phone number is **1-800-424-8802**

Source:Environmental Impacts of Recreational Boats

1.7 Describe restrictions and recommendations when approaching and observing marine mammals in the wild.

It is important that boaters (and others on land) follow proper wildlife interaction procedures and know the restrictions placed on interaction with wildlife, particularly marine mammals and sea turtles.

As a rule, boaters should always slow their boats when approaching a water animal. Many states and natural park areas have pre-set safe distance requirements between a boat and wildlife. When observing a water animal, maintaining a safe distance of 100 yards is generally the rule (500 yards for the highly endangered northern right whale). However, boaters should always check local regulations.

The Marine Mammal Protection Act (16 U.S.C. §§1361 et seq.) makes it illegal to feed, harass, molest, or injure a marine mammal such as a whale, dolphin, manatee or sea otter. Anyone witnessing such action is asked to report the incident to the US Coast Guard or local marine police or local police authorities as soon as possible.

Source: Environmental Impacts of Recreational Boats and the Good Mate Manual

1.8 Explain the basic steps a recreational boater should take to prevent the spread of aquatic nuisance species (ANS) from one body of water to another.

The only real way to stop an invasive species from causing harm is to prevent it from entering the environment in the first place. This is because once established, invasive species are almost impossible to eradicate. Managing their impacts and controlling their spread then become the best options.

In general:

- Don't release exotic pets or plants into the environment
- Buy and plant only native trees and plants
- Learn to identify invasive species in your area and report sightings to the proper authorities
- Prevent and help clean up pollution on land and in the water
- Obey all related laws and educate others about the negative impacts of invasive species

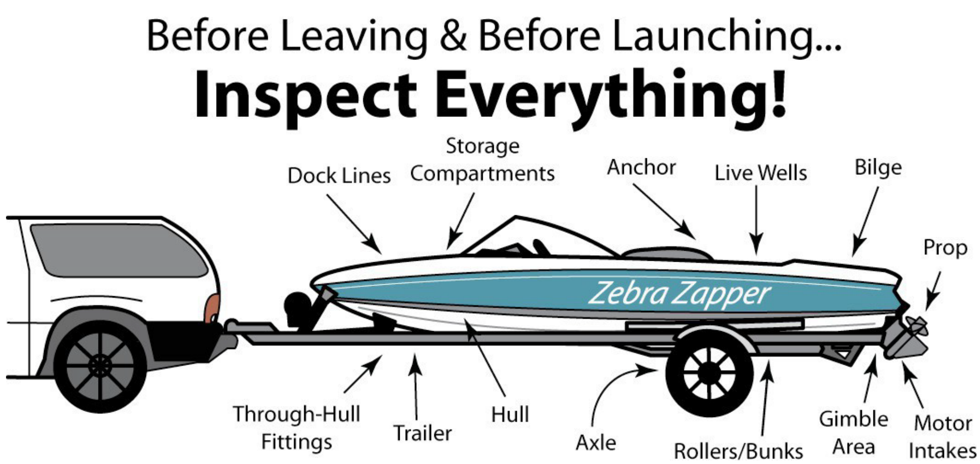
ANS often spread between waterways by "hitching" a ride on boats and boat trailers. Because of this, it is important for boaters to take extra care and properly clean their boats after each use. Some states have laws requiring specific cleaning procedures before boaters may use certain lakes and rivers. Here are some tips for boaters to follow:

- Spray your boat and trailer with high-pressure water and then rinse with hot water after each use. DO NOT use salt and/or chlorine water mixtures as the runoff can pollute the waterway and the mixtures can damage boat equipment
- Drain and flush the motor, live well, bilge and transom wells with hot water
- Remove all visible vegetation from your boat, propeller, anchor, trailer and any other equipment or objects that were in the water
- Dry your boat and equipment for at least five days before entering another body of

water. Some ANS, like Zebra and Quagga mussels, can live for days or even weeks out of water depending on the relative humidity and time of year

- DO NOT dump unused bait or its packing material into the water. While bait may be bought locally, it is often shipped from farther away

Some places where Aquatic Nuisance Species can hide and hitchhike to new waters:



In addition to the instructions above, people who use personal watercraft with jet-drive systems (such as Jet Skis) should also:

- Avoid running your engine through aquatic plants when on the water
- Push or winch the watercraft onto the trailer when leaving the water
- Once on the trailer, run the engine for five to ten seconds to blow out excess water that may contain ANS
- Carefully inspect the engine and steering nozzle for fragments of aquatic plants or other ANS. Be sure the motor is turned off first! DO NOT dump unused bait or its packing material into the water. While bait may be bought locally, it is often shipped from farther away

2.0 Knowledge of Laws and Regulations and the Coast Guard's Role in Pollution Prevention

2.1 Demonstrate a basic knowledge and application of environmental protection laws and regulations administered by the US Coast Guard (USCG) and by the US Environmental Protection Agency (US EPA)

a. CERCLA (Comprehensive Environmental Response, Compensation and Liability Act)

Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as **Superfund**, on December 11, 1980. This law created a tax on the chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. Over five years, $1.6 billion was collected and the tax went to a trust fund for cleaning up abandoned or uncontrolled hazardous waste sites.

CERCLA:

- established prohibitions and requirements concerning closed and abandoned hazardous waste sites
- provided for liability of persons responsible for releases of hazardous waste at these sites; and
- established a trust fund to provide for cleanup when no responsible party could be identified

The law authorizes two kinds of response actions:

- Short-term removals, where actions may be taken to address releases or threatened releases requiring prompt response.
- Long-term remedial response actions that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life-threatening. These actions can be conducted only at sites listed on EPA's National Priorities List (NPL).

CERCLA also enabled the revision of the National Contingency Plan (NCP). The NCP provided the guidelines and procedures needed to respond to releases and threatened releases of hazardous substances, pollutants, or contaminants. The NCP also established the NPL.

CERCLA **requires** that all releases of hazardous substances exceeding reportable quantities be reported by the responsible party to the National Response Center.

b. CWA (Clean Water Act)

In 1972, Congress passed the Federal Water Pollution Control Act, commonly referred to as the Clean Water Act (CWA). Its mission was to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." The CWA prohibits the discharge of pollutants, oil, oily waste, and hazardous substances into U.S. waters. The CWA also prohibits the use of detergents, soaps, surfactants, or emulsifying agents to disperse oil spills without the express permission of the U.S. Coast Guard. Violators are subject to maximum civil penalties of up to $137,500, as well as criminal penalties. The CWA set up a permit system to limit industrial and municipal discharges and to protect wetlands. In addition, states were required to adopt water quality standards with federal government oversight.

Section 312 of the CWA (33 USC 1322) required the U.S. Environmental Protection Agency (EPA) to set standards for MSDs, and charged the Coast Guard with enforcing those standards. It also enabled states to request the designation of certain bodies of water as "No Discharge Zones;" these requests are published in the Federal Register (FR) by the EPA.

c. ESA (Endangered Species Act)

The Endangered Species Act (16 U.S.C. §1531 et seq. 1973) provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The lead federal agencies for implementing ESA are the U.S. Fish and Wildlife Service (FWS) and the U.S. National Oceanic and Atmospheric Administration (NOAA) Fisheries Service. The FWS maintains a worldwide list of endangered species, which includes birds, insects, fish, reptiles, mammals, crustaceans, flowers, grasses, and trees.

The law requires federal agencies, in consultation with the U.S. Fish and Wildlife Service and/or the NOAA Fisheries Service, to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat of such species. The law also prohibits any action that causes a "taking" of any listed species of endangered fish or wildlife. Likewise, import, export, interstate, and foreign commerce of listed species are all generally prohibited.

The Endangered Species Act prohibits the catching, collecting, transporting, harming, or killing of any animal or plant species designated as endangered or threatened. For a complete list of endangered and threatened species, visit the U.S. Fish and Wildlife Service's website at http://endangered.fws.gov/ wildlife.html.

d. FWPCA (Federal Water Pollution Control Act) – 33 U.S.C. 1251 to 1387

The Federal Water Pollution Control Act (1997), now referred to as the “Clean Water Act”, is a comprehensive statute aimed at restoring and maintaining the chemical, physical and biological integrity of the nation's waters. Enacted originally in 1948, the Act was amended numerous times until it was reorganized and expanded in 1972 as the first Clean Water Act. It continues to be amended almost every year.

Even prior to the enactment of the 1972 version of the Act, the Act authorized the Public Health Service to prepare comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries and improving the sanitary condition of surface and underground waters. Due regard was to be given to improvements necessary to conserve waters for public water supplies, propagation of fish and aquatic life, recreational purposes, and agricultural and industrial uses. A number of other provisions found in the current Act were adopted prior to 1972.

Primary authority for the implementation and enforcement of the Clean Water Act now rests with the U.S. Environmental Protection Agency (EPA). In addition to the measures authorized before 1972, the Act authorizes water quality programs, requires federal effluent limitations and state water quality standards, requires permits for the discharge of pollutants into navigable waters, provides enforcement mechanisms, and authorizes funding for wastewater treatment works construction grants and state revolving loan programs, as well as funding to states and tribes for their water quality programs. Provisions have also been added to address water quality problems in specific regions and specific waterways.

Important for wildlife protection purposes are the provisions requiring permits to dispose of dredged and fill materials into navigable waters. Permits are issued by the Army Corps of Engineers under guidelines developed by EPA. What is known as Section 404 permitting applies to many wetlands, which has proven controversial.

e. MARPOL (International Convention Governing the Prevention of Pollution From Ships)

In 1973, the International Convention for the Prevention of Pollution from Ships at Sea (also known as MARPOL for MARine POLlution) was drafted and signed by a number of seafaring nations. In 1978, it was updated to include five annexes on ocean dumping. In 1997, an annex on air pollution by ships was added. By ratifying MARPOL 73/78, a country automatically adopts annexes I and II; the remaining annexes are optional. The United States has ratified optional annexes III and V.

- Annex I   Oil
- Annex II   Hazardous liquid carried in bulk
- Annex III   Hazardous substances carried in packaged form
- Annex IV   Sewage
- Annex V   Garbage
- Annex VI   Air Pollution

Annex IV contains requirements to control pollution of the sea by sewage. According to the International Maritime Organization (IMO), 73 nations have accepted Annex IV as of February 1999. This represents 42.59 percent of the world's merchant fleet in gross tonnage. Annex IV will be "entered into force," or become binding upon governments that have ratified it, 12 months after being ratified by at least 50 percent of the world fleet. The United States has not ratified Annex IV because existing federal and state regulations to prevent sewage discharge are more stringent than the guidelines put forth in the current version of Annex IV. MMPA (Marine Mammal Protection Act)

Through the Marine Mammal Protection Act of 1972 (amended many times since), Congress declared that marine mammals are resources of great international significance (aesthetic, recreational and economic), and should be protected and encouraged to develop to the greatest extent feasible commensurate with sound policies of resource management. The MMPA (16 U.S.C. §§1361 et seq.) prohibits the harassment of endangered or threatened marine mammals, such as whales, polar bears, dolphins, seals, sea lions, sea otters, and manatees. It also establishes a moratorium on taking and importing marine mammals, their parts and products; it provides protection for polar bears, sea otters, walruses, dugongs, manatees, whales, porpoises, seals and sea lions.

f. MPPRCA (Marine Plastic Pollution Research and Control Act of 1987)

This law specifically prohibits the overboard disposal of plastics anywhere in the world by U.S. vessels, implementing Annex V of the MPPRCA (MARPOL 73/78). In addition, it prohibits the disposal of plastics by any foreign or domestic vessel within U.S. waters. The law also regulates the disposal of non-plastic items depending on a vessel's distance from shore.

The MPPRCA requires all vessels 26 feet or longer to have a MARPOL placard displayed on board. A MARPOL placard illustrates distances from shore and the materials that may be thrown overboard. Vessels 40 feet or longer that are engaged in commerce or have a galley, and berthing area must also have a waste management plan and logbook on board. Waste management plans are designed to inform the crews about standard refuse practices applicable to the vessel.

The U.S. Coast Guard is the enforcement agency for MARPOL within the Exclusive Economic Zone (EEZ) of the United States, which extends 200 miles from shore. The Coast Guard cannot catch every violation and relies on sharp-eyed citizens to report MARPOL violations. If you observe any boat not complying with water pollution regulations, document the event and report it to the USCG Prevention Office or your local Marine Patrol.

g. NANPCA (Non---indigenous Aquatic Nuisance Prevention and Control Act of 1990)

The NANPCA is aimed at preventing the unintentional introduction of non-indigenous species into the waters of the U.S. and controlling the spread of species already introduced. Congress enacted NANPCA in response to the infestation of zebra mussels in the Great Lakes region. Under the Act, an 'aquatic nuisance species' means a non-indigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters. The Act gives the Assistant Secretary of the Army (Civil Works) the authority to issue regulations that prevent the introduction and spread of aquatic nuisance species through the ballast waters of vessels into the Great Lakes and the Hudson River north of the George Washington Bridge. These regulations require any vessel equipped with ballast water tanks that plans to enter a port in the Great Lakes to carry out an exchange of ballast water on the waters beyond the EEZ prior to entry into any port, or, if the Secretary finds it effective in controlling non-indigenous species, to use environmentally sound alternative ballast water management methods. These regulations are not to supersede any requirements of the Clean Water Act.

The Act created the Aquatic Nuisance Species Task Force to identify pathways by which aquatic organisms are introduced and evaluate whether measures to prevent introductions of aquatic nuisance species are effective. It also authorized state management programs designed to prevent the spread of non-indigenous species.

Regulations now require that vessels entering ports on the Great Lakes exchange ballast water and meet other requirements, while voluntary guidelines recommended similar conduct on other waters of the U.S. As amended by the National Invasive Species Act of 1996, the Act required that these guidelines become law if voluntary compliance is inadequate. The Act authorized a number of studies and monitoring programs to assess the spread of aquatic nuisance species and develop methods for controlling them.

NOTE: Other environmental protection laws and regulations administered by the USCG and the EPA are discussed within the General Background section of this Study Guide.

2.2 Explain the basic elements of the Coast Guard's role in marine environmental protection:

a. Prevention

Prevention focuses largely on gaining compliance with regulatory standards and the design and maintenance of waterway systems to prevent incidents.

Prevention functions include:

- Inspections and examinations of vessels and waterfront facilities to ensure compliance with federal safety, security, and environmental regulations
- Investigations of marine casualties to determine the cause of accidents, pursuing Maritime Personnel Actions/Civil Penalties, and to serve as a feedback loop into compliance inspections and regulatory development
- Patrol the U.S. Exclusive Economic Zone boundary areas to reduce the threat of foreign poaching of U.S. fish stocks
- Development and maintenance of the waterway navigation infrastructure (i.e. Aids to Navigation [ATON])
- Education and outreach, through programs like Sea Partners, are another effective form of prevention

b. Preparedness

Preparedness functions and goals include:

- The development of environmental regulations and standards for domestic vessels and marine facilities
- Support for the Sea Partners Campaign
- To educate and train Coast Guard personnel to make certain every individual understands that stewardship of the ocean environment is a fundamental part of their duty. The Coast Guard operates the National Response Team, Strike Teams strategically positioned in each area, and Command Duty Offices at each Sector as part of their preparedness.
- To inform the public of both the importance of the mission and the ways in which they can help lessen the impact of human activities on marine protected species

c. Response

Response functions focus on command and control activities associated with an emergency incident response and/or heightened threat situation that requires swift enforcement actions.

Response functions include:

- Stop unauthorized ocean dumping and regulate the discharge of oil, hazardous substances, and other shipboard wastes into U.S. and international waterways

- Respond to oil and hazardous substance accidents, supervise clean-up operations and reduce their impact on the marine environment

2.3 Describe the purpose of the USCG Ocean Steward, Ocean Guardian and Ocean Protector Strategic Plan and explain how the plan's four strategies are being implemented in your AOR.

2.4

Ocean Steward

The strategic goal of the Ocean Steward program is the elimination of *environmental damage* and natural resource degradation associated with all maritime activities. The purpose of Ocean Steward is to help the Coast Guard achieve its strategic goal of Protection of Natural Resources and its performance goal of enforcing federal regulations that result in all living marine resources achieving healthy, sustainable populations.

Ocean Guardian

Ocean Guardian is a *fisheries enforcement* strategic plan.

It is the Coast Guard's long-range strategy to provide effective and professional at-sea enforcement to advance national goals for the conservation and management of living marine resources and their environment.

Four key concepts serve as the framework of the Ocean Guardian plan:

- **<u>Sound Regulations</u>**

  Fisheries management plans and associated regulations must be simple, enforceable and provide for safe fishing operations

- **<u>Effective Presence</u>**

  Effective presence is the allocation of fisheries enforcement resources at levels that ensure adequate compliance with management measures implemented to recover and maintain healthy fish stocks

- **<u>Application of New Technology</u>**

  The application of new technologies is necessary to meet the growing demands for fisheries enforcement

- **<u>Productive partnerships</u>**

  Productive partnerships with fisheries managers, the commercial and recreational fishing industry, and foreign, federal and state enforcement agencies are necessary to effectively enforce regulations and ensure compliance in a legitimate, highly regulated industry

Together, Ocean Steward and Ocean Guardian provide a roadmap for the Coast Guard's efforts in ensuring our nation's waterways and their ecosystems remain productive by protecting all our nation's living marine resources from degradation.

Four strategies for implementing the Ocean Steward and Ocean Guardian Strategic Plans include:

1) Raise the Profile of the Marine Protected Species (MPS) Mission.

We will raise the profile of the MPS mission to the status of missions such as maritime drug interdiction, marine pollution prevention and fisheries enforcement

2) Obtain Necessary Resources and Authorities.

We will prioritize existing resources, use existing authorities, and seek additional resources and authorities as necessary to implement Ocean Steward

3) Partner with Other Agencies.

We will work closely with other agencies and organizations involved in the preservation and recovery of marine protected species to eliminate redundancy and provide a clear link between enforcement and management

4) Publicize Our Efforts.

We will stress the importance of the Coast Guard's role as part of a comprehensive management scheme and highlight our successful efforts to the public

Ocean Protector

The Ocean Protector Strategic Plan was a statement issued by the Commandant that outlined four steps that the Coast Guard would take to ensure the protection of the oceans and marine resources; it was superseded by the Ocean Steward and Ocean Guardian programs.

2.5 Briefly describe the Coast Guard and Auxiliary's roles in a hazardous materials incident.

The Coast Guard enforces the statutes, regulations, and international agreements governing the safe handling, stowage, and movement of hazardous cargoes on vessels in the navigable waters of the U.S. and at waterfront facilities.

The Coast Guard operates the National Response Center (NRC) around-the-clock to receive notification of pollution incidents and to ensure that information is passed on to the pre-designated Coast Guard or EPA On-Scene Coordinator for response.

These five elements are central to the Coast Guard's role:

- Assessing discharges and releases to ensure appropriate response
- Preventing spills whenever possible
- Ensuring that responsible parties clean up discharges of oil and releases of hazardous substances

- Mitigating the effects of spills that do occur; and
- Reducing the potential for spills or operational discharges outside U.S. waters to enter U.S. waters or foul U.S. coastlines

All personnel, including Coast Guard and Auxiliary members, who participate in any response to any suspected oil spill or possible hazardous materials release event are required by OSHA to have a level of training appropriate to their duties and responsibilities. In general, Auxiliarists should stay upwind and/or upstream of any spill or release. The most basic level of training is "First Responder Awareness," a four - hour basic course in the HAZWOPER (Hazardous Waste Operations and Emergency Response) series. First Responders are people who respond to a release of a hazardous material, recognize the situation as one that requires specialized assistance, and call for help. **Coast Guard Auxiliary members** may find themselves in this situation while on patrol and **are only authorized to observe and report**.

Source: IMSEP Study Guide

3.0 Maritime Transportation Security Act (MTSA)

3.1 What is the Maritime Transportation Security Act of 2002?

The Maritime Transportation Security Act of 2002 is an Act of Congress to address port and waterway security. President George W. Bush signed it into law on November 25, 2002.

This law is the U.S. implementation of the International Ship and Port Facility Security Code (ISPS). Its full provisions came into effect on July 1, 2004. It requires vessels and port facilities to conduct vulnerability assessments and develop security plans that may include passenger, vehicle and baggage screening procedures; security patrols; establish restricted areas; personnel identification procedures; access control measures; and/or installation of surveillance equipment. The Act creates a consistent security program for all the nation's ports to better identify and deter threats.

Developed using risk-based methodology, the MTSA security regulations focus on those sectors of the maritime industry that have a higher risk of involvement in a transportation security incident, including various tank vessels, barges, large passenger vessels, cargo vessels, towing vessels, offshore oil and gas platforms, and port facilities that handle certain kinds of dangerous cargo or service the vessels listed above.

MTSA also required the establishment of committees in all the nation's ports to coordinate the activities of all port stakeholders, including other federal, local and state agencies, industry and the boating public. These groups, called Area Maritime Security Committees, are tasked with collaborating on plans to secure their ports so that the resources of an area can be best used to deter, prevent and respond to terror threats.

The U.S. Coast Guard issued regulations to enact the provisions of the Act and to align domestic regulations with the maritime security standards of SOLAS (Safety of Life at Sea). The regulations are found in Title 33 of the Code of Federal Regulations, Parts 101 through 107. Part 104 contains vessel security regulations, including some provisions that apply to foreign ships in U.S. waters.

3.2 Describe why MTSA was created

The tragic events of September 11, 2001, substantially altered recognition of security risks to marine transportation, similar to changes in environmental risk that were recognized as the result of major pollution incidents.

3.3 Define each and explain its applicability to the MTSA:

a. Captain of the Port (COTP)

Captain of the Port (COTP) is a title held by a U.S. Coast Guard officer, usually the Commander of a United States Coast Guard Sector with the rank of Captain (O-6). Captain of the Port duties involve enforcing port safety and security and marine environmental protection regulations within their respective areas. This includes regulations for the protection and security of vessels, harbors, and waterfront facilities; anchorages; security zones; safety zones; regulated navigation areas; deepwater ports; water pollution; and ports and waterways safety.

To protect America's waterways, the Captain of the Port can initiate immediate enforcement actions such as detention of a vessel in port or ordering a vessel out of U.S. waters.

b. Cruise ship

A cruise ship or cruise liner is a passenger ship used for pleasure voyages, where the voyage itself and the ship's amenities are part of the experience, as well as the different destinations along the way.

Transportation is not the prime purpose, as cruise ships operate mostly on routes that return passengers to their originating port, so the ports of call are usually in a specified region of a continent.

For purposes of 33 CFR 101, (Navigation and Navigable Waters, Maritime Security: General), ***Cruise ship*** means any vessel over 100 gross register tons, carrying more than 12 passengers for hire which makes voyages lasting more than 24 hours, of which any part is on the high seas. Cruise ships do not include ferries that hold Coast Guard Certificates of Inspection endorsed for "Lakes, Bays, and Sounds," and transit international waters for only short periods of time on frequent schedules.

It is important that both staff and passengers understand what to look for and be aware of in their surroundings in order to help protect US waterways and maritime assets as well as the natural environment and its inhabitants, including humans, from not only the threat of terrorism, but any type of pollution from ships as well.

c. Facility

For purposes of 33 CFR 101, (Navigation and Navigable Waters, Maritime Security: General), **Facility** means any structure or facility of any kind located in, on, under, or adjacent to any waters subject to the jurisdiction of the U.S. and used, operated, or maintained by a public or private entity, including any contiguous or adjoining property under common ownership or operation.

d. Ferry

For purposes of 33 CFR 101, (Navigation and Navigable Waters, Maritime Security: (General) ***Ferry*** means a vessel which is limited in its use to the carriage of deck passengers or vehicles or both, operates on a short run on a frequent schedule between two or more points over the most direct water route, other than in ocean or coastwise service.

A ferry (or ferryboat) is a form of transportation, usually a boat, but sometimes a ship, used to carry (or ferry) primarily passengers, and sometimes vehicles and cargo as well, across a body of water.

Workers and passengers alike can assist with the identification and reporting of suspicious activities, objects and people to help prevent hazardous materials accidents.

e. Foreign vessel

A **foreign vessel** is a commercial vessel registered under another country's flag. The Coast Guard verifies that all foreign-flagged vessels operating in U.S. waters are in substantial compliance with international conventions, as well as all applicable U.S. laws/regulations and treaties.

Foreign vessels entering US ports and waterways may provide vehicles for the transport of either people or goods that might pose a threat to the safety and security of our nation. People who work in ports or who work/live adjacent to waterways used by foreign vessels are ideally placed to watch for suspicious activity, behavior and material either aboard, around or being loaded/off-loaded from such vessels and report this information to Law Enforcement (911), the Coast Guard or the NRC.

In addition, foreign vessels and their crews may not observe the same care and concern for the environment that our Federal and State laws require; diligent observation by people working or living in the area can help prevent pollution from ships' activity damaging habitats and waterways.

f. General shipyard facility
For purposes of 33 CFR 101 (Navigation and Navigable Waters, Maritime Security: (General), **general shipyard facility** means:

1) For operations on land: Any structure or appurtenance thereto designed for the construction, repair, rehabilitation, refurbishment, or rebuilding of any vessel, including graving docks, building ways, ship lifts, wharves, and pier cranes; the land necessary for any structures or appurtenances; and the equipment necessary for the performance of any function referred to in this definition; and

2) For operations other than on land: Any vessel, floating drydock, or barge used for, or a type that is usually used for, activities referred to in paragraph (1)

General shipyard facilities are locations where people and goods come and go continuously, and are therefore ideal places for terrorists to observe port and facility activities without being obvious by their presence. Those who work in such shipyards are aware of what is normal and what is not, and therefore can identify people, activity and objects that are out of place or suspicious; if properly trained, they can collect valuable information (i.e., "See Something, Say Something campaign") and report to law enforcement (911) or the NRC.

Reference: If You See Something, Say Something® | Homeland Security

g. Infrastructure

Infrastructure means facilities, structures, systems, assets, or services so vital to the port and its economy that their disruption, incapacity, or destruction would have a debilitating impact on defense, security, the environment, long-term economic prosperity, public health or safety of the port.

Consequently, these items need to be secure and free of the threat of terrorist activities and environmental damage that would disrupt their essential functions; people who work and live in the area know what is normal and what is not, and become a valuable asset through their ability to discern, observe and report or potentially harmful activity to law enforcement (911), Coast Guard, or the NRC.

h. Maritime Security (MARSEC) Level

Maritime security is concerned with the prevention of intentional damage through sabotage, subversion, or terrorism, and is one of the three basic roles of the United States Coast Guard. The others are Maritime Safety and Maritime Mobility.

There are **three main maritime security** activities conducted by the Coast Guard:

- Port Security
- Vessel Security

- Facility Security

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There are **three main maritime security** activities conducted by the Coast Guard:

- Port Security
- Vessel Security
- Facility Security

k. MARSEC Level 1

MARSEC Level 1 (Marine Security Level) means the level for which minimum appropriate security measures shall be maintained at all times.

This level of security represents everyday life in and around U.S. ports and waterways, and the minimum level of awareness through America's Waterway Watch by people working, living or playing in those areas.

l. MARSEC Level 2

MARSEC Level 2 means the level for which appropriate additional protective security measures shall be maintained for a period of time as a result of heightened risk of a transportation security incident.

With heightened risk comes the need for heightened awareness of one's surroundings: people, activities and objects that seem abnormal or out of place need to be reported to the NRC immediately.

m. MARSEC Level 3

MARSEC Level 3 means the level for which further specific protective security measures shall be maintained for a limited period of time when a transportation security incident is probable, imminent, or has occurred, although it may not be possible to identify the specific target.

In this circumstance, anyone with any information about suspicious activities or objects should report it to law enforcement (911) immediately–such information could help identify the threat and/or mitigate the incident and its effects on both people and the environment.

n. Passenger vessel

For purposes of 33 CFR 101 (Navigation and Navigable Waters, Maritime Security: (General), **Passenger vessel** means—

1) On an international voyage: a vessel carrying more than 12 passengers, including at least one passenger-for-hire; and

2) On other than an international voyage:

- A vessel of at least 100 gross register tons carrying more than 12 passengers, including at least one passenger-for-hire
- A vessel of less than 100 gross register tons carrying more than 6 passengers, including at least one passenger-for-hire
- A vessel that is chartered and carrying more than 12 passengers
- A submersible vessel that is carrying at least one passenger-for-hire; or
- A wing-in-ground craft, regardless of tonnage, that is carrying at least one passenger-for-hire

A passenger ship or vessel is a ship whose primary function is to carry passengers. Passenger ships include ferries, which are vessels for day or overnight short-sea trips moving passengers and vehicles (whether road or rail); ocean liners, which typically are passenger or passenger- cargo vessels transporting passengers and often cargo on longer line voyages; and cruise ships, which often transport passengers on round-trips, in which the trip itself and the attractions of the ship and ports visited are the principal draw.

Likewise, such vessels or staff/passengers may not adhere to the pollution laws and regulations while aboard the vessel or underway; if observed, this information should be reported to law enforcement (911), Coast Guard or the NRC, so that waterways remain safe and free of pollutants or hazardous materials.

o. Restricted areas

For purposes of 33 CFR 101 (Navigation and Navigable Waters, Maritime Security: General), **Restricted areas** mean the infrastructures or locations identified in an area, vessel, or facility security assessment or by the operator that require limited access and a higher degree of security protection. The entire facility may be designated as a restricted area, as long as the entire facility is provided with the appropriate level of security.

Restricted areas requiring additional appropriate security should not be accessible to the average individual; persons present in such an area who are not normally there should be very obvious to those who are authorized access, and their presence/activity should be reported immediately to law enforcement (911) and the Coast Guard.

p. Secure area

For purposes of 33 CFR 101 (Navigation and Navigable Waters, Maritime Security: General), **Secure area** means the area on board a vessel or at a facility or outer continental shelf facility over which the owner/operator has implemented security measures for access control in accordance with a Coast Guard-approved security plan.

q. Sensitive security information (SSI)

Sensitive Security Information (SSI) is a category of sensitive but unclassified information under the United States government's information sharing and control rules. SSI is information obtained in the conduct of security activities whose public disclosure would, in the judgment of specified government agencies, harm transportation security, be an unwarranted invasion of privacy, or reveal trade secrets or privileged or confidential information. Title 49 of the Code of Federal Regulations (CFR), Parts 15 and 1520, governs SSI.

People asking questions, taking photographs, or making drawings or notes about areas, facilities or activities should, under "See Something, Say Something" guidelines, be considered to have suspicious behavior and their presence reported to law enforcement (911). Auxiliarists need to be very discreet about the content of their conversations with others as well as the locations where those conversations may take place.

Reference: If You See Something, Say Something® | Homeland Security

r. TWIC

For purposes of 33 CFR 101 (Navigation and Navigable Waters, Maritime Security: General), **TWIC** is the acronym for Transportation Worker Identification Credential and means a valid, non-revoked transportation worker identification credential, as defined and explained in 49 CFR Part 1572.

Theoretically, this card should identify any worker who is authorized to be in specific areas performing specified duties or activities as belonging there, but, as with any identity system, there will be attempts to forge documents or steal them in order to gain unauthorized access to areas or facilities. Failure to produce a legitimate or accurate document should raise immediate questions and be reported to law enforcement and additionally as required by the USCG. Someone who does not look sufficiently like the person in the photograph should be suspicious as well as any evident tampering with the card, i.e. a potential replacement of the photo. A lack of agreement between the description and photo should also be questioned (height, weight, hair or eye color, age).

s. TWIC Program

For purposes of 33 CFR 101 (Navigation and Navigable Waters, Maritime Security: General), **TWIC Program** means those procedures and systems that a vessel, facility, or outer continental shelf facility (OCS) must implement in order to assess and validate TWICs when maintaining access control.

Obviously, strict adherence to the TWIC procedures and systems is required to maintain security; anyone seen or heard deviating from the process should be reported immediately to law enforcement and the Coast Guard.

3.4 Name 3 marine elements of the of the National Transportation System (33 CFR 101)

33 CFR 101 applies to vessels, structures and facilities of any kind, located under, in, on or adjacent to waters subject to the jurisdiction of the United States.

3.5 What part of the Maritime Security arena does each of the following cover?

a. 33 CFR 101

Maritime Security: General

- MARSEC Levels
- Communication (port-facility-vessel)
- Control measures for security

b. 33 CFR 103

Area Maritime Security:

- Designation of the Federal Maritime Security Coordinator
- Area Maritime Security Committee
- Area Maritime Security Assessment
- Area Maritime Security Plan

c. 33 CFR 104

Vessels:

- Vessel's security requirements
- Vessel Security Assessment (VSA) requirements
- Vessel Security Plan (VSP)

d. 33 CFR 105

Facilities

- Facility Security Requirements
- Facility Security Assessment (FSA) requirements
- Facility Security Plan (FSP)

3.6 What is the goal of MTSA?

The Act creates a consistent security program for all the nation's ports to better identify and deter threats.

4.0 Practical Application

Develop and present at least two Marine Environmental training sessions from the list of the following areas.

a. Sea Partners (general)

b. Good Mate (Public education or member Training)

c. Clean Marina

d. Aquatic Nuisance Species

4.1 Participate in, or otherwise support, a shoreline debris cleanup. Alternatively, visit a local marina to identify Best Management Practices and the environmental impacts from poor practices for fueling, sewage handling, potable water systems, vessel repair and safety using a clean marina checklist.

Background Material Needed to Complete the PQS

General Ecology Background

Biodiversity

A fundamental property of ecological systems is a certain mixture, or ***diversity,*** of living things: we cannot expect to find deer or ducks in the wild in the absence of the interconnected web of other plants and animals on which their lives depend. Biological diversity, or ***biodiversity,*** is a term that is now commonly used to describe the variety of living things and their relationships to each other and interactions with the environment.

The notion of biodiversity encompasses several different levels of biological organization, from the very specific to the most general. Perhaps the most basic is the variety of information contained in the genes of specific organisms, be they petunias or people. Different combinations of genes within organisms, or the existence of different variants of the same basic gene are the fundamental "stuff" of evolution. At the next level is the variety of different species that exist on the Earth, a concept that includes the relationship of different groups of species to each other. Biodiversity also describes the varied composition of ecosystems, and the variety of different sorts of ecosystems that are found in regions of study that biologists call ***landscapes***.

It has been clear for some time that at all of these levels of organization the rich biodiversity that has always characterized the natural world is today declining. The extinctions or threatened extinctions of many species are but the most visible and well-known manifestation of a deeper and more far-reaching trend. (Anthony C. Janetos, "Do We Still Need Nature? The Importance of Biological Diversity")

Climax Community and the Process of Succession

A climax community is one that has reached the stable stage. When extensive and well defined, the climax community is called a ***biome***. Examples are tundra, grassland, desert, and the deciduous, coniferous, and tropical rain forests. Stability is attained through a process known as ***succession***; whereby relatively simple communities are replaced by those more complex. Thus, on a lakefront, grass may invade a build-up of sand. Humus formed by the grass then gives root to oaks and pines and lesser vegetation, which displaces the grass and forms further altered humus. That soil eventually nourishes maple and beech trees, which gradually crowd out the pines and oaks and form a ***climax community***. In addition to trees, each successive community harbors many other life forms, with the greatest diversity populating the climax community.

Similar ecological zonings occur among marine flora and fauna, dependent on such environmental factors as bottom composition, availability of light, and degree of salinity. In other respects, the capture by aquatic plants of solar energy and inorganic materials, as well as their transfer through food chains and cycling by means of microorganisms, parallels those processes on land.

The early 20th-century belief that the climax community could endure indefinitely is now rejected because climatic stability cannot be assumed over long periods of time. In addition, non-climatic factors, such as soil limitations, can influence the rate of development. It is clear that stable climax communities in most areas can coexist with human pressures on the ecosystem, such as deforestation, grazing, and urbanization. Polyclimax theories stress that plant development does not follow predictable outlines and that the evolution of ecosystems is subject to many variables.

(http://www.infoplease.com/ce6/sci/A0857880.html)

Ecology

In Greek, "oikos" means “the home”, the place where we live, and ***ecology*** means the science of how all living creatures interact within our home - our environment; ecology is also defined as the study of the relationships of organisms to their physical environment and to one another.

Ecosystem

An ecosystem is formed by the interaction of a community of organisms with their environment. Examples of marine ecosystems include habitats like estuaries and seagrass beds.

Environment

The environment consists of air, water, minerals, organisms, and all other external factors both ***abiotic*** (non-living) and ***biotic*** (living) that surround and affect a given organism at any time.

Niche

A niche is the position or function of an organism in a community of plants and animals.

Food Chain and Web of Life (Food Web)

A food chain consists of a series of organisms interrelated in their feeding habits, the smallest being fed upon by a larger one, which in turn feeds a still larger one, etc.

The web of life is the web-like relationship between organisms that depend on each other, both up and down the food chain as well as laterally among organisms at the same level in the food chain.

Marine/Aquatic Ecology Background

Biological Stratification

The tendency for organisms to collect in zones based on water conditions such as temperature, pressure and salinity is known as ***biological stratification***.

Eutrophication

Natural ***eutrophication*** is the process by which lakes gradually age and become more productive. It normally takes thousands of years to progress. However, humans, through their various cultural activities, have greatly accelerated this process in thousands of lakes around the globe. Cultural or anthropogenic "eutrophication" is water pollution caused by excessive plant nutrients.

Humans add excessive amounts of plant nutrients (primarily phosphorus, nitrogen, and carbon) to streams and lakes in various ways. Runoff from agricultural fields, field lots, urban lawns, and golf courses are one source of these nutrients. Untreated or partially treated, domestic sewage is another major source. Sewage was a particular source of phosphorus in lakes when detergents contained large amounts of phosphates. The phosphates acted as water softeners to improve the cleaning action, but they also proved to be powerful stimulants to algal growth when they were washed or flushed into lakes. These algal blooms lead to oxygen depletion and resultant fish kills. Many native fish species disappear, to be replaced by species more resistant to the new conditions. Beaches and shorelines are fouled by masses of rotting, stinking algae.

Water Stratification (Column)

Vertical stratification, or layering of waters of different density, occurs in a variety of marine environments when colder, saltier water underlies warmer and fresher water. This condition can be sustained only in deeper waters because wind and tidal motions usually are sufficient to keep shallow water from stratifying.

Chesapeake Bay

Stratification occurs in the mainstream of Chesapeake Bay and lower portions of the major tidal tributaries, where it isolates the deep layer of water from the atmosphere. As dissolved oxygen in this deep layer is depleted by decaying organic material (dead algae that sink after peak production), stratification does not permit replenishment of the dissolved oxygen from the atmosphere. This leads to the extremely low oxygen levels observed in these deeper waters.

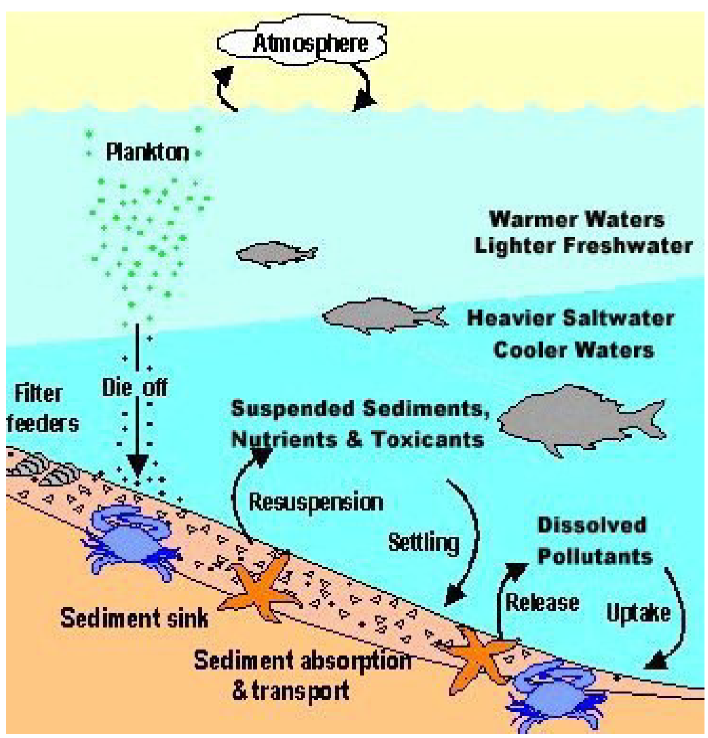

Figure 1. Schematic diagram of physical, chemical, and biological processes interacting in estuaries. Source: Redrawn from USEPA, 1987

Salinity, temperature, and depth are the primary factors that affect the physical behavior of estuarine waters. Warmer, lighter freshwater flows seaward over a layer of saltier and denser water flowing in from the ocean. This stratification varies within any season depending on the rainfall and air temperature. Stratification usually intensifies in the spring as the amount of freshwater increases due to melting snow and frequent rain. Stratification is maintained through the summer due to warming of surface waters and intense rainfall. Maximum reductions of dissolved oxygen in estuarine bottom waters occur during the late summer.

The degree of water column stratification is determined by the difference in density between surface and bottom water, and is categorized by low, moderate, and high stratification. Summer data on stratification in Chesapeake Bay are depicted in Figure 2. Most estuarine waters in the Mid-Atlantic Region exhibit little or no stratification. However, deeper portions of Chesapeake Bay do become highly stratified. The Delaware Estuary has areas of moderate stratification, while Delmarva coastal bays typically are not stratified due to their shallow depths.

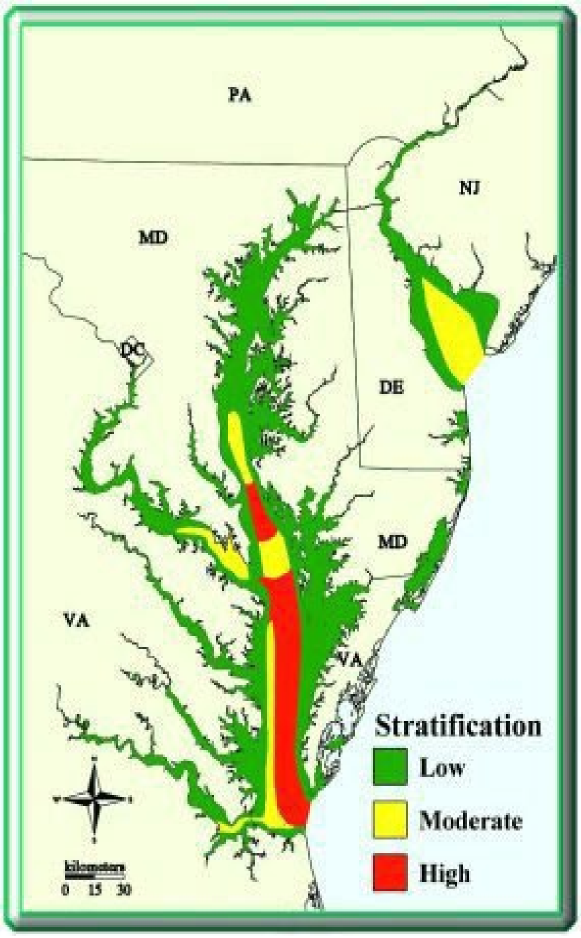

Figure 2. Summer water column stratification in Mid--- Atlantic estuarine waters as observed in 1990- 93. Categories are low (green), moderate (yellow), and high (red) stratification.

Sigma-t is the measure used in physical oceanography to describe water density. It is a measurement of the density that a parcel of water with a given temperature and salinity would have at the surface (i.e., at atmospheric pressure), and is expressed as (density- 1) * 1000. The degree of water column stratification is determined from the difference in sigma-t between surface and bottom waters. The three categories used to summarize stratification are low (sigma-t difference less than 1), moderate (sigma-t difference between 1 and 2), and high (sigma-t difference greater than 2) stratification.

Corpus Christi Bay

Another example of the environmental effects of water stratification is Corpus Christi Bay. Long-term studies by UTMSI in Corpus Christi Bay show that hypoxic (low oxygen conditions below 2 mg per liter) events were noted each summer since 1988 in bottom waters in portions of the bay. The hypoxia occurs only in the summer when temperatures and salinities are high, and the water column is stratified. Several processes are thought to be related to the onset of hypoxia, including water column stratification and organic matter decomposition. The most likely explanation for hypoxia in Corpus Christi Bay is water column stratification. This is surprising because the estuary is well mixed, shallow and windy, and has a low tidal range.

To test and quantify these conditions, the Coastal Bend Bays Foundation (CBBF) funded research to sample the hypoxic area in Corpus Christi Bay. The area south of Shamrock Island was sampled every three weeks between 3 May and 26 August 1994. Between June and July 1994, hypoxia was found in this area and was linked to water column stratification. The hypoxic area extended south from Shamrock Island for about 2 miles. In July 1996, sampling was performed to study the spatial extent and biological effects of the hypoxia. Hydrographic sampling over a broad area was performed by the Marine Environmental Science class, and biological sampling was performed by UT graduate student Christine Ritter. Ritter sampled 10 stations, five within the hypoxic area and 5 outside the hypoxic area.

In 1996, the real extent of the hypoxic zone was relatively small. The area with hypoxia roughly formed a triangle with three points between the Oso Bay inlet to Corpus Christi Bay, Shamrock Island, and southeast of Corpus Christi Bay. There was a gradient of increasing salinity from Oso Bay to the Ship Channel and Port Aransas. The distribution of saline bottom waters indicates that the source of the hypersaline water was Oso Bay, where water from the Laguna Madre is used for cooling the Central Power and Light power plant and is sent to a cooling pond that discharges into Oso Bay. There was twice as much oxygen in the control regions (non-hypoxic) as in the hypoxic areas. This had a large effect on productivity in those sediments, as indicated by a biomass standing stock that was 14 times greater in sediments with normal oxygen levels. There was a corresponding 500% decrease in density and species number in the hypoxic sediments.

The cause of the hypoxia is water column stratification. There was a large difference in surface and bottom water salinity. Temperature was constant throughout the water column at both stations, so the differences in the water masses were driven by the influx of salty water of the same temperature as the Bay water. The dividing line where the salinity changed rapidly was at 6 feet below the surface at both stations. The salinity was similar in the surface water of both stations, and constant throughout the water column at the non-hypoxic station. In the lower half of the water column, the salinity decreased by about 2 parts per thousand (ppt) in the normal station, but increased by about 5 ppt at the hypoxic station. Oxygen levels decreased continuously at the non-hypoxic station from 5.6 mg per liter (mg/l) to 3.6 mg/l. At the hypoxic station, oxygen was constant at 5.3 mg/l above the dividing line, but decreased to 1.9 mg/l below the dividing line.

The differences in the structure of the water mass indicate that a layer of hypersaline bottom water is causing the stratification, and that the oxygen is being depleted from the bottom water mass which is not mixing with the surface. It is interesting that the conventional wisdom that suggests open bays are well mixed because of high winds and shallow depths is simply not always true. The hypoxic events appear to be limited to a short duration during summer and to a small part of Corpus Christi Bay. The events appear to be due to altered circulation patterns in the bay. (Montagna, P., "Hypoxia in Corpus Christi Bay," in *Bay Foundation News*, Published by the Coastal Bend Bays Foundation, December 1996.)

Another example of water stratification occurs in the Georges Bank. The first intensive U.S. GLOBEC/Georges Bank process-oriented study was conducted during winter-summer, 1995. Called the Stratification Study, the field effort included a coordinated set of physical and biological measurements designed to test the central hypothesis that the spring development of vertical stratification and reduced wind---driven mixing over the southern flank of Georges Bank strongly influences the distribution of the zooplankton food supply, thus influencing the vital rates and survival of cod and haddock during their planktonic early life stages.

The physical environment on the southern flank of Georges Bank during spring is characterized by the development of density and thermal stratification. This stratification has been shown to have a significant influence on the feeding and survival of larval cod and haddock (Buckley and Lough 1987). The timing and intensity of stratification are likely to be affected by the climate change anticipated in the NW Atlantic.

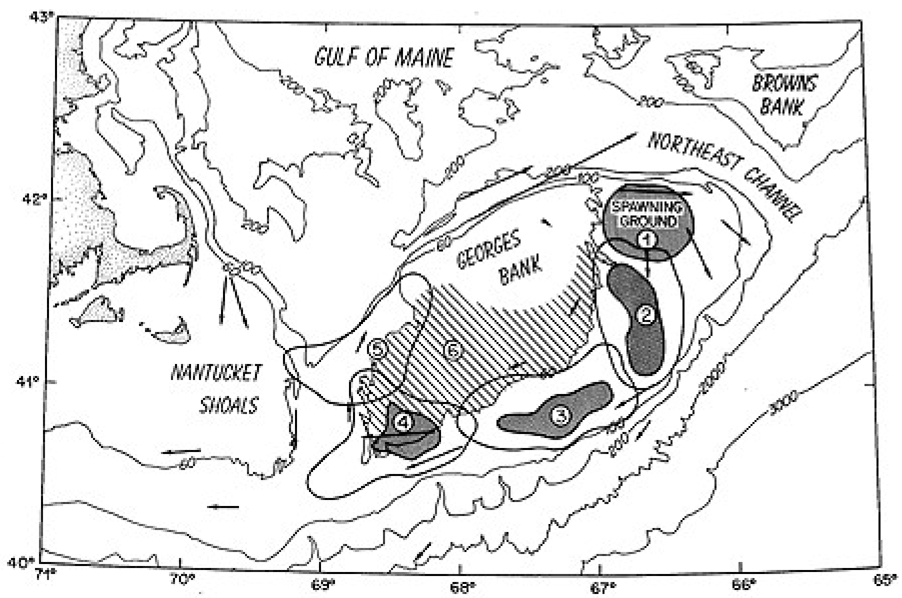

Fig. 3: Seasonal stratification in the Georges Bank

The development of stratification is controlled by a balance between solar insolation, which warms and reduces the density of the surface layer, and mixing induced by tidal currents and surface wind stress. On the deeper portions of Georges Bank stratification begins to develop in the spring, while in the shallow central region strong tidal currents keep the water column well mixed year-round. Spawning of cod and haddock stocks on Georges Bank occurs in late winter and spring on the northeastern part of the Bank. The developing eggs and larvae are carried south and west in the mean flow along the southern flank of the Bank as the seasonal stratification begins to develop (Fig. 3).

In the well-mixed region cod and haddock larvae have been observed to grow more slowly and to be in poorer physiological condition, as measured by an RNA/DNA ratio, than larvae at a stratified site on the southern flank of the bank. The difference in condition is believed to be due to a reduced concentration and vertically more homogeneous distribution of prey at the well-mixed site in comparison to the stratified site. The sensitivity of the larvae to temporal variability in stratification, such as that caused by wind events, is not known, but is hypothesized to be important. In other areas the dissipation of biological structure by wind events has been shown to be detrimental to larval fish feeding and growth.

Stratification also can have negative implications for the feeding of larvae and zooplankton. Recent theoretical and observational studies hypothesize that certain levels of turbulence enhances encounter rate between predators and prey and promotes growth of the predator. Models of climate change suggest that the NW Atlantic in the future may be characterized by warmer temperatures, increased precipitation and river runoff (Manabe and Stouffer 1980), and reduced wind stress (Manabe and Wetherald 1980). These factors may result in changes in the characteristic development of stratification on Georges Bank. For example, at warmer temperatures the nonlinearity in the equation of state of seawater would result in more buoyancy per unit of heat input to the surface water. Even subtle changes in the relationship between buoyancy and heat input might have significant effects on the timing and character of the stratification process and on the availability of food organisms to larval fish.

A simple, one-dimensional model of stratification (which includes wind stress, tidal mixing, surface heating, and uses canonical parameter values from the literature) suggests that an increase in the winter water temperature from 4°C to 8°C would result in an earlier and stronger development of stratification during the spring. Though preliminary, this result suggests that climate-induced changes in stratification would be of a magnitude known to be important to the growth and survival of larval fish.

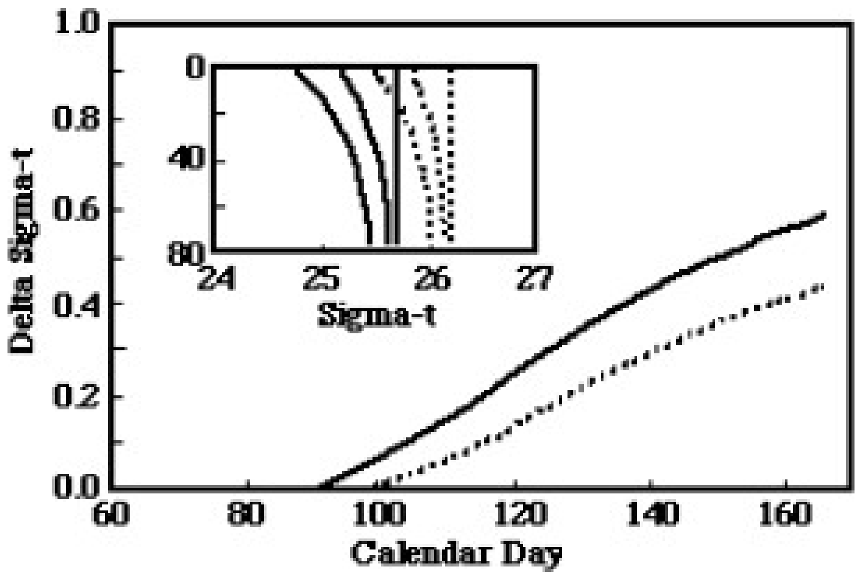

Fig. 4: Development of Georges Bank stratification measured by changes in Sigma-T.

Lake Sammamish

A good example of Thermal Stratification in a freshwater setting was documented in a study of Lake Sammamish in Washington State. The most notable seasonal changes in temperate lakes such as Union, Washington and Sammamish are associated with the establishment and breakdown of thermal stratification of the water column. Thermal stratification refers to the establishment of distinct density layers of water at different depths. The layers form when temperature differences in the water column increase, resulting in increased differences in the density of the water at different depths. The greater the temperature difference, the greater the density difference between the layers, which increases the resistance of the layers to mix together. Stratification of the water column results from a balance between the mixing energy of the wind and the resistance of the waters with different temperatures and densities to mixing.

Thermal stratification in Lake Sammamish follows a definite annual pattern, with variations in the timing and absolute temperatures related to the specific weather patterns of the year. The primary internal characteristics that determine the response are basin shape, mean and maximum depth, fetch (the distance wind can travel in a straight line over the surface), and relative exposure to wind. The primary external factors are solar radiation, air temperature, humidity, and stability of the air above the lake. All of these processes, which account for heat flow into or out of the lake occur at or near the surface.

In order to quantify some of these differences, water is sampled at every five meters from 1 m below the surface to just above the bottom. This vertical stratification of sampling effort is used to help explain changes observed in the overall water quality of the lake. In winter, lake waters are uniformly cold from the surface to the bottom (5 to 7 C°), and are close to its temperature of maximum density (3.98 C°). Because of the uniform temperature the density of the water is nearly uniform. With little or no density difference throughout the water column, the lake is easily mixed to the bottom. When the lake mixes completely in this unstratified state, concentrations of dissolved oxygen (DO) at different depths are uniformly high, as oxygen absorbed from the atmosphere is carried to the lowest depth of the lake by the mixing.

By March, the surface begins to warm and in April, the sequential increase in temperature from the top to the bottom of the water column is evident. In April, there is not always a defined thermocline. (A layer where temperatures drop abruptly is called the Thermocline.) The onset of stratification in spring is driven by the increased direct absorption of solar radiation as day length increases, and the redistribution of heat into deeper water by wind mixing. The surface water heats more quickly than the deeper portions of the water column because the surface receives more solar energy. As the surface water is warmed, it becomes less dense than deeper water, and the thermal resistance to mixing with the cooler, denser, deeper strata increases. The difference in temperature and density between the strata partially isolates the two layers from one another. The surface layer, or ***epilimnion***, is a warm, turbulent layer floating on a cooler, denser, and relatively undisturbed bottom layer called the ***hypolimnion***.

These two layers are separated by a transition zone referred to as the ***metalimnion***. The depth of the epilimnion often increases during early stratification as this layer gains heat, but transfer of this heat to the lower strata decreases as the temperature difference between strata increases, and therefore the density differential and resistance to mixing increases. As this resistance to mixing increases, the hypolimnion becomes increasingly isolated from the surface layer and the atmosphere and the transfer of heat from the surface to the bottom water decreases. A result of the isolation of the hypolimnion is that the temperature of this layer does not significantly increase from winter temperatures. The stability and persistence of these strata are determined by the net transfer of heat and wind mixing between the different layers.

In late fall or early winter, the stratification of the water column breaks down as day length decreases, and heat transfer from the lake to the atmosphere increases resulting in decreased water temperatures. In the fall, this heat loss from the water lags behind heat loss from the air and in the winter, heat increase in the water lags behind increase in air temperature during daylight hours; this is because water loses and gains heat more slowly than air. These conditions often result in the formation of surface fogs on the lake due to condensation when warm moist air meets a cooler surface. As the temperature of the epilimnion approaches the temperature of the lower water layers the densities become equal, and only small amounts of wind energy are sufficient to mix the layers together. The slow decrease in the temperature of the surface layer results in the penetration or lowering of the thermocline and a progressive mixing of the hypolimnion into the epilimnion. Once the differences in temperature and density are nearly equal, the lake will often be completely mixed in a matter of hours by a short windy period or storm. This mixing is referred to as the fall overturn. Any material that has accumulated in the hypolimnion over the summer stratification period will be mixed throughout the water column.

The establishment and breakdown of thermal stratification set the stage for many of the other chemical and biological cycles that combine to determine the overall quality of Lake Sammamish. Inputs of oxygen, sunlight penetration, accumulation of dissolved substances and the distribution of biota are often different in the thermally isolated portions of the lake. The result of the vertical differences are that many of the limnological parameters that define the water quality of Lake Sammamish differs with depth, and the degree of these differences, like the stratification observed in the lake varies seasonally.

The low concentrations of DO in the hypolimnion of Lake Sammamish could have a number of ecological effects. Internal loading of phosphorus under anoxic conditions can increase the amount of primary production in the lake. Another impact is the reduction of habitat available for aerobic organisms. Many invertebrates require higher concentrations of DO than are found at the sediment water interface in July through October, and a reduction in the number of these organisms is a reduction in the available amount of food for fish in the lake. Not only is the potential food supply of in-lake fish reduced, but the actual amount of habitat available to them is reduced, since they are unable to survive in the low DO concentrations found below 15-20 m in late summer. The Chinook salmon that are returning to the Issaquah hatchery during September are not dependent on in-lake food sources but do require concentrations of DO greater than 4 mg/l, which restricts them to depths less than about 15 m. They also prefer temperatures about 16-18 C^{o}, which occurred below 5-10 m. These constraints may restrict the habitat available to the returning fish to a layer of water only about 10 m deep, rather than the 25-30 m depths of the lake. Coupled with the low stream flows due to the absence of rain in September, the longer holding time in the lake adds additional stress to these fish.

Water (Hydrologic) Cycle

The ***hydrologic cycle*** is the cycle whereby water moves through the environment. This cycle takes place in the ***hydrosphere***, the region containing all the water in the atmosphere and on the surface of the earth. The cycle is the movement of water through this hydrosphere.

The hydrologic water cycle is divided into five parts.

- Condensation
- Infiltration
- Runoff
- Evaporation
- Precipitation

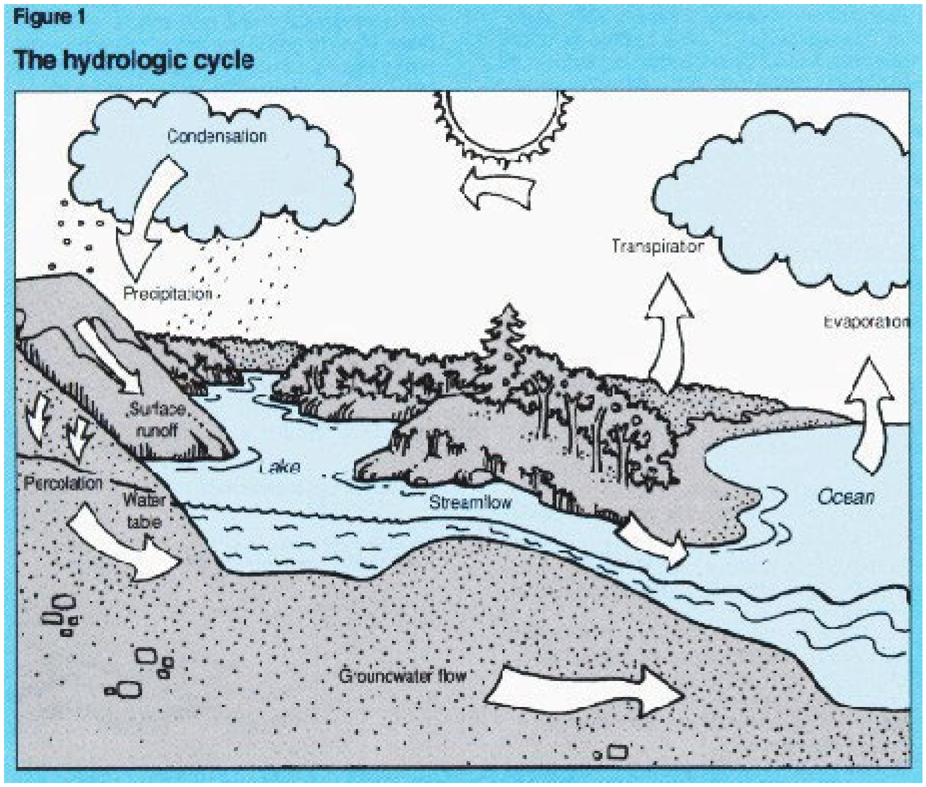

Fig. 5: Hydrologic Cycle

The process begins with ***condensation***, when water vapor condenses in the atmosphere to form clouds. Condensation occurs when the temperature of the air or earth changes. Water changes states when temperatures fluctuate. When the air cools enough, water vapor has to condense on particles in the air to form clouds. This process is very noticeable on plants as they dew in the morning.

As clouds form, winds move them across the globe, spreading out the water vapor. Eventually, the clouds can no longer hold the moisture and it is released in the form of **precipitation**, which can be snow, rain, hail, etc.

The next three stages: infiltration, runoff, and evaporation occur simultaneously. ***Infiltration*** occurs when precipitation seeps into the ground. This depends a lot on the permeability of the ground. Permeability is the measure of how easily something flows through a substance. The more permeable the ground is, the more precipitation seeps into the ground. If precipitation occurs faster than it can infiltrate the ground, it becomes ***runoff***. Runoff remains on the surface and flows into streams, rivers, and eventually large bodies such as lakes or the ocean. Infiltrated groundwater moves similarly as it recharges rivers and heads towards large bodies of water.

As both of these processes are happening, the power of the sun is driving this cycle by causing ***evaporation***. Evaporation is the change of liquid water to a vapor. Sunlight aids this process as it raises the temperature of liquid water in oceans and lakes. As the liquid heats, molecules are released and change into a gas. Warm air rises up into the atmosphere and becomes the vapor involved in condensation.

Considering that so little of the water on earth is potable for people, it is amazing that the supply has survived as long as it has. The hydrologic cycle continues to move water and keep sources fresh. It is estimated that 100 million billion gallons a year are cycled through this process.

Zone of Light Penetration

The marine environment is stratified vertically and horizontally; the key factors that change are light penetration, temperature, nutrients and oxygen content. The horizontal zones that extend from the shore are the ***littoral*** or ***intertidal*** zone, the ***sublittoral*** or ***neritic*** zone, and the ***pelagic*** or ***open water*** zone. ***Pleuston*** are the organisms that live in the thin surface layer existing at the air---water interface of a body of water. The water column is stratified by light penetration; photosynthesis occurs in the upper ***euphotic*** water layer, to a depth of 25 meters from the surface, and below is the ***disphotic*** or ***aphotic*** zone. The vertical regions that extend downward from the intertidal zone are the ***benthic*** region, the continental slope or ***bathyl*** region, the deep-sea floor or ***abyssal plain***, and the deep ocean trenches or ***hadal*** region. Each zone or region has different characteristics; photon penetration, available nutrients, oxygen content and temperature differentials create specific microbial niches.

Estuaries have high nutrients and high sunlight energy. Consequently, they are the most productive marine ecosystems. The range of saline concentrations creates three types of niches: freshwater, brackish water, and saline water. Each niche is occupied by organisms that are adapted for those conditions. This form of ecological partitioning reduces exploitative competition and enhances the growth of different types of biological communities. Similarly, the continental shelf and the coral reefs are areas of high productivity due to high nutrients and photon energy, but without the extreme salinity gradient.

Conversely, the ocean zones are not as highly productive except for the pleuston layer, where there is adequate light for bacteria that are primary producers. The pelagic offshore zone does not have enough nutrients at the surface to support significant microbial growth. The primary producers lose and sink to the deep benthic zone. The benthic zone, rich in nutrients, does not have enough light energy to support primary productivity.

Water Quality Parameters

Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand is a measure of how much dissolved oxygen is being consumed as microbes break down organic matter. A high demand, therefore, can indicate that levels of dissolved oxygen are falling, with potentially dangerous implications for the ecosystem's biodiversity.

High biochemical oxygen demand can be caused by:

- high levels of organic pollution, usually due to poorly treated wastewater
- high nitrate levels, which trigger high plant growth

Both result in higher amounts of organic matter. When this matter decays, the microbiological activity uses up the oxygen. Biochemical oxygen demand is therefore one of the main parameters used in the Urban Wastewater Treatment Directive for controlling discharges. Unsurprisingly, large rivers – where wastewater plants are more likely to be located – registered higher levels of oxygen demand than smaller rivers. Improvements in wastewater management saw biochemical oxygen demand fall in all sizes of rivers during the early 1990s. However, levels have begun increasing slightly more recently in all but the smallest rivers.

Dissolved Oxygen (DO)

Dissolved oxygen analysis measures the amount of gaseous oxygen (O_2) dissolved in an aqueous solution. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement), and as a waste product of photosynthesis.

Adequate dissolved oxygen is necessary for good water quality. Oxygen is a necessary element to all forms of life. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As dissolved oxygen levels in water drop below 5.0 mg/l, aquatic life is put under stress. The lower the concentration of DO, the greater the stress. Oxygen levels that remain below 1---2 mg/l for a few hours can result in large fish kills.

Nitrification

Nitrification is the process by which ammonia is converted first to nitrites (NO_2---) and then to nitrates (NO_3---). This process naturally occurs in the environment, where it is carried out by specialized bacteria. Ammonia is produced by the breakdown of organic sources of nitrogen. Nitrogen is the fourth most abundant element in living things, being a major constituent of proteins and nucleic acids. Municipal wastewaters contain large amounts of organic wastes, so the wastewater will have a high concentration of ammonia. With this high concentration of ammonia, the wastewater would harm downstream ecosystems if released. Ammonia is toxic to aquatic life at these concentrations, and the nitrification process requires oxygen (ammonia contributes to the BOD of the wastewater) so it will use up the oxygen needed by other organisms. It is desirable to transform the ammonia as part of the waste treatment process, where aeration and other conditions, such as temperature, can be controlled.

The nitrification process is carried out by two different types of bacteria. ***Nitrosomonas*** carry out the first step of the process, producing nitrite. The resulting nitrite is then converted to nitrate by ***Nitrobacters***. These reactions, although thermodynamically favorable, occur slowly. The rate of these reactions seems to be limited by the slow growth rates of the bacteria involved. Most nitrifying bacteria are autotrophic, with carbon dioxide serving as their carbon source. These reactions are not very efficient metabolically, so yields are typically low.

The rates of nitrification reaction are highly dependent on a number of environmental factors. These include the substrate and oxygen concentration, temperature, pH, and the presence of toxic or inhibiting substances. The kinetics can be described with the Monod expression, and in most cases the rate is limited by the first step, the oxidation of the ammonia. At steady state, the amount of NO_2--- present is usually small.

Temperature Dependency: Like all microbes, nitrifying bacteria are temperature sensitive. Rapid changes in temperature do not produce rapid changes in growth rates. A slow adaptation period, with a lower than expected rate follows such changes. Theoretical models for maximum growth rates of the form usually approximate the observed rates of reaction for temperatures from about 0 to 20 °C. At higher temperatures the growth rate does not increase and by 35° C, the growth rate begins to rapidly fall off toward zero.

Oxygen Concentration: Nitrifying bacteria are especially sensitive to low oxygen concentrations.

pH Dependency: pH has a strong effect on nitrification rates. The reactions occur fastest when pH is from 8 – 9, although if the bacteria exist in flocs or films, the pH at the cell surface will be lower than the bulk pH due to the production of H+ ions. The exact mechanisms by which pH affects the reaction rates are not fully understood, although it is believed that inhibitions, particularly from the neutral NH_3 and HNO_2 species, become important.

Inhibiting Substances: Many substances can potentially inhibit the nitrification reactions. Metals are particularly strong inhibitors of the reactions. When exposed to more than one inhibitor, the extent of inhibition increases greatly.

NOTE: Other water quality parameters such as pH, salinity, suspended solids, temperature, turbidity and Coliform bacteria are discussed within the PQS Task section of the Study Guide.

Environmental Protection Laws and Regulations Administered by the USCG and EPA (Reference: Volume 9, Marine Safety Manual, COMDTINST M16000.14)

APPS (Act to Prevent Pollution from Ships of 1980)

The Act to Prevent Pollution from Ships (33 USC 1901---1915) implements MARPOL in the United States. It prohibits the discharge of oil, hazardous liquid substances carried in bulk, hazardous substances carried in packaged form, and garbage from vessels in the waters subject to the jurisdiction of the United States.

ABA (Abandoned Barge Act 1992)

The act prohibits the abandonment of barges over 100 gross tons, provides a civil penalty for up to $1,000 per day for abandonment allows the Coast Guard to remove a barge that is abandoned, but provides no funds to enact removal, and requires the numbering of all undocumented barges over 100 gross tons. A Commandant Instruction established standards for dealing with vessels posing a substantial threat to the environment. A computerized inventory is under development. An amendment to the Abandoned Barge Act is being developed to narrow the scope of the Coast Guard's removal authority.

CVA (Clean Vessel Act of 1992)

Passed in 1992, the Clean Vessel Act (CVA) provided $40 million for states to construct and maintain pump-out and dump station facilities, and for educational outreach and public awareness programs. The Act was reauthorized in 1998, extending the grant program through 2003 and providing an additional $50 million for states to create alternatives to the overboard disposal of recreational boater sewage.

The CVA was designed for the construction of pump-out facilities through financial incentives to local marinas. For details of the Act, see https://www.ecfr.gov/current/title- 50/chapter-I/subchapter-F/part-85

MPRSA (Marine Protection, Research, and Sanctuaries Act of 1972)

Under the National Marine Sanctuaries Act (also known as Title III of the Marine Protection, Research and Sanctuaries Act of 1972), as amended, the Secretary of Commerce is authorized to designate discrete areas of the marine environment as National Marine Sanctuaries to protect distinctive natural and cultural resources whose protection and beneficial use require comprehensive planning and management. The National Marine Sanctuary Program is administered by the Sanctuaries and Reserves Division of the National Oceanic and Atmospheric Administration (NOAA).

The mission of the National Marine Sanctuary Program is to identify, designate, and manage areas of the marine environment of special national significance due to their conservation, recreational, ecological, historical, research, educational, or aesthetic qualities. The goals of the Program are to provide enhanced resource protection through conservation and management of the Sanctuaries that complements existing regulatory authorities; to support, promote, and coordinate scientific research on, and monitoring of, the site---specific marine resources of the Sanctuaries; to enhance public awareness, understanding, appreciation, and wise use of the marine environment; and to facilitate, to the extent compatible with the primary objective of resource protection, multiple uses of the National Marine Sanctuaries.

The Act provides authority for the comprehensive and coordinated conservation and management of these marine areas. It provides for civil penalties for violations of the Act, or regulations or permits issued under it and for civil suits to recover damages if sanctuary resources are injured or destroyed (Sources: Year of the Ocean Discussion Papers 1998; NOAA Office of Ocean and Coastal Resource Management).

NISA (National Invasive Species Act of 1996)

In 1996, NANPCA (Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990) was up for reauthorization, and Congress passed the National Invasive Species Act of 1996 (NISA). The most important aspect of this legislation was that it expanded the ballast water introduction issue from a Great Lakes issue to a national one. Zebra mussels are seen as the "poster child" of invasive species due to the national attention received, but there are other regions of the United States that have suffered equally detrimental effects due to other types of aquatic invasive species.

NISA created national voluntary guidelines so that any boats entering U.S. ports from outside our

Exclusive Economic Zone (EEZ), should exchange ballast on the open seas prior to port entry, unless it would put the ship and/or its crew in danger. If the rate of compliance was found to be inadequate, or if vessel operators failed to submit mandatory ballast water reports to the USCG, the voluntary guidelines would become mandatory within three years. These guidelines went into effect on July 1, 1999 and the Coast Guard reported back to Congress in 2002.

OPA 90 (Oil Pollution Act of 1990)

Congress passed the Oil Pollution Act of 1990 in direct response to the Exxon Valdez oil spill. Although intended for large commercial vessels, the law does affect recreational boaters. Specifically, the law states that in the event of a spill, the owner or operator of a vessel can be held financially accountable for cleanup cost and associated damage to the environment. In addition, civil penalties of several thousand dollars can be imposed against an individual for failing to report a spill.

OPA requires reporting and cleanup of all oil and hazardous substance spills. For a summary of OPA and a link to the full text of the Act, see https://www.uscg.mil/Mariners/National-Pollution-Funds-Center/About_NPFC/OPA/

PTSA (Port and Tanker Safety Act of 1978)

The Ports and Waterways Safety Act of 1972 was amended by the PTSA, Public Law 95---474. Under the PTSA, Congress found that navigation and vessel safety, as well as protection of the marine environment, are matters of major national importance and that increased vessel traffic in the nation's ports and waterways creates a substantial hazard to life, property or the marine environment. In addition, increased supervision of vessel and port operations was deemed necessary in order to (1) reduce the possibility of vessel or cargo loss, or damage to life, property, or the marine environment; (2) prevent damage to structures in, on, or immediately adjacent to the navigable waters of the U.S. or the resources within such waters; (3) ensure that vessels operating in the navigable waters of the U.S. shall comply with all applicable standards and requirements for vessel construction, equipment, manning, and operational procedures; and (4) ensure that the handling of dangerous articles and substances on the structures in, on, or immediately adjacent to the navigable waters of the U.S. is conducted in accordance with established standards and requirements. Under the PTSA, it was also determined that advance planning is critical in determining proper and adequate protective measures for the nation's ports and waterways and the marine environment, with continuing consultation with other federal agencies, state representatives, affected users and the general public, in the development and implementation of such measures.

The PTSA provided broader regulatory authority over regulated and non-regulated areas. It also provided for improvements in the supervision and control of all types of vessels operating in navigable waters of the U.S., and in the safety of foreign or domestic tank vessels that transport or transfer oil or hazardous cargoes in ports or places subject to U.S. jurisdiction. The PTSA also reflects certain tank vessel standards and requirements accepted internationally, specifically those developed by the International Conference on Tanker Safety and Pollution Prevention (Source: Year of the Ocean Discussion Papers 1998). PWSA (Ports and Waterways Safety Act of 1972)

The Ports and Waterways Safety Act stated that navigation and vessel safety and protection of the marine environment are matters of major national importance. It ensured that the handling of dangerous articles and substances on the structures in, on, or immediately adjacent to the navigable waters of the United States is conducted in accordance with established standards and requirements. For details, see https://www.navcen.uscg.gov/ports-and-waterways-safety-system

The Ports and Waterways Safety Act (PWSA), as amended by the Port and Tanker Safety Act of 1978 (PTSA), Public Law 95- 474, and the Oil Pollution Act of 1990 (OPA), was designed to promote navigation, vessel safety, and protection of the marine environment. Generally, the PWSA applies in any port or place under the jurisdiction of the U.S., or in any area covered by a negotiated international agreement applicable under the same section. Title 33 CFR 2.05---30 defines waters subject to the jurisdiction of the U.S. as navigable waters, other waters on lands owned by the U.S., and waters within U.S. territories and possessions of the U.S.

The PWSA authorizes the U.S. Coast Guard (USCG) to establish vessel traffic service/separation (VTSS) schemes for ports, harbors, and other waters subject to congested vessel traffic. The VTSS applies to commercial ships, other than fishing vessels, weighing 300 gross tons (270 gross metric tons) or more. The OPA amended the PWSA to mandate that appropriate vessels must comply with the VTSS.

Refuse Act

The Refuse Act of 1899 was our nation’s first significant environmental legislation. It prohibits throwing, discharging or depositing any refuse matter of any kind (including trash, garbage, oil and other liquid pollutants) into the waters of the United States.