Chapter 2

Florida's Coast: A National Treasure

2.0 Introduction

Of all the states and provinces in continental North America, Florida is the most intimately linked with the sea. The entire state lies within the coastal plain, with a maximum elevation of about 120 meters above sea level, and no part of the state is more than 100 km from the Atlantic Ocean or the Gulf of Mexico (Webb 1990). With the exception of Alaska, Florida has the longest coastline of any state in the United States, with open estuaries and tidal wetlands that cover vast areas (Livingston 1990). These unique characteristics shape Florida's environmental identity and underscore the importance of employing relevant tools in coastal protection decision-making processes.

The State of Florida relies on its coastal waters to provide a variety of economic and social benefits to state residents and visitors, alike. Coastal ecosystems in Florida (including marine, near-shore, and estuarine environments) support a variety of sport and commercial fisheries which contribute significantly to the state's economy. Indeed, Florida ranks as one of the leading commercial fishing states in terms of the value of its annual fish catch, with shrimp, lobsters, and scallops being the most important fisheries. Marine environments within the state provide essential transportation links, support a variety of water-dependent facilities, and offer an array of recreational opportunities that attract millions of visitors to the state each year.

2.1 Physical Features of Florida's Coast

Florida has one of the most extensive coastlines in the United States. The marine coastline in the state spans almost 2,200 km, with a tidal shoreline that covers over 13,000 km (NOAA 1975). Florida's coastal systems are unique due to a combination of climatological and physiographic features which occur no where else. Livingston (1990) suggested that essentially all of the inshore marine habitats in the state could be classified as estuarine, primarily due to the prevalent influence of upland runoff in these areas. The Florida coastline is characterized by a variety of major embayments, marsh and mangrove systems that directly front the sea, and by numerous, partially enclosed, brackish water basins (Comp and Seaman

1985). A diversity of natural habitats are found within these areas, including seagrass beds, tidal flats, tidal marshes, soft sediments, hard substrates, shellfish beds, and a variety of transitional zones (Livingston 1990).

The Atlantic coast of Florida, from the St. Mary's River to Biscayne Bay (560 km), is characterized by a high energy shoreline with long stretches of continuous barrier islands (Comp and Seaman 1985). This region has few direct sources of freshwater inflow to the ocean and is marked by an extensive system of high salinity lagoons. The major estuaries on the Atlantic coast are the St. Johns River and Indian River estuaries and Biscayne Bay. Collectively, these estuaries cover a water surface area of almost 2,000 square kilometers.

Excluding the Florida Keys, the Gulf of Mexico coast of Florida extends some 1,350 km from Florida Bay to Perdido Bay. In general, estuaries along the west coast are located behind low energy barrier islands or at the mouths of rivers that discharge into salt marshes or mangrove-fringed bays (Comp and Seaman 1985). NOAA (1990) identified a total of fourteen major estuaries along Florida's Gulf coast, covering an estuarine water surface area of more than 5,000 square kilometers.

Coastal and estuarine sediments of Florida span a significant geochemical range, from silica- and aluminum-rich sediments of northeastern and northwestern Florida to carbonate-rich sediments of south Florida and the Florida Keys. The geochemistry of estuarine sediments in northern and central Florida reflects the siliceous, aluminous composition of presently eroding uplands of the southeastern United States. In contrast, the calcium carbonate-rich coastal sediments of Florida Bay and the Florida Keys are formed as the remains of diverse marine flora and fauna slowly accumulate in these estuarine waters. The remains of marine plants and animals create virtually all of the sediment volume in this part of Florida, with a minor terrestrial sediment input from riverine and salt marsh systems such as the Everglades.

2.2 Biological Features of Florida's Coast

The brackish water habitats that ring the Florida mainland are vital to the state's natural plant and animal communities. Florida's coastal environments are comprised of myriad salt marshes, mangrove forests, and open water communities that support a diverse array of aquatic and terrestrial organisms (Comp and Seaman 1985).

The salt marshes of Florida, which cover approximately 170,000 ha of land, are coastal ecosystems with communities of non-woody, salt-tolerant plants occupying intertidal zones that are occasionally or periodically inundated with salt water (Montague and Wiegert 1990). These areas provide such beneficial features as sediment stabilization, storm protection, aesthetic values, and wildlife habitat. The rate of primary productivity in salt marshes is among the highest of the world's ecosystems. This productivity forms the basis of aquatic and terrestrial food webs that include many unique and economically important plant and animal species.

Estuaries are dominant features along the Florida coastline. Estuaries are among the most productive natural systems and their role in sustaining the health and abundance of marine fishes, shellfish, and wildlife has long been recognized (NOAA 1990). The importance of estuarine habitats for marine fishes and invertebrates is emphasized by the fact that up to 97.5% of the total commercial fisheries catch in the Gulf of Mexico is comprised of species that are dependant on estuaries during some portion of their life cycle (Comp and Seaman 1985). The Gulf of Mexico coastline supports one of the most productive fisheries in the world, with shrimp, oysters, lobsters, scallops, clams, and menhaden being the most important commercial species. While the Atlantic coast fishery is somewhat less important than Gulf coast fisheries, substantial quantities of shrimp, crab, clams, and menhaden are harvested on an annual basis.

In addition to diverse and abundant fisheries, Florida's coastal areas support a wide variety of plant and animal species. Wetland habitats are utilized by numerous species of wading birds, waterfowl, raptors, and a variety of mammalian species. All of these organisms are dependent, to a greater or lesser extent, on the productivity of Florida's coastal waters. In turn, the aquatic organisms that support the impressive communities of higher organisms are dependent on coastal sediments to provide feeding, spawning, and rearing habitats.

2.3 Anthropogenic Influences on Florida's Coast

Environmental management and pollution control issues affecting Florida's coast differ from those affecting coastal areas in other portions of the United States. While there are many common issues, land uses in Florida differ significantly from those in other states. In the northeastern and northwestern portions of the United States coastal ecosystems are influenced by myriad point sources of pollution, primarily from municipal and industrial sources. For example, Hudson River/Raritan Bay (New York) and Chesapeake Bay (Virginia/Delaware) contain more point sources of pollution than any other estuarine areas in the nation (NOAA 1990). Similarly, areas like Puget Sound (Washington) and San Francisco Bay (California) are highly industrialized, with large quantities of effluents discharged into receiving water systems (NOAA 1990). In addition, these systems are often adjacent to older, highly populated cities, which exacerbates the stresses on coastal waters.

Florida ranks fourth among states in terms of population, with nearly 13 million persons in 1990 (USDC 1990). This population was expected to increase by nearly 4% by the year 1992 (USDC 1990). Most of the population of the state currently resides near the coast and population densities in these areas are predicted to increase by over 30% in the next 20 years (Culliton *et al.* 1990). As indicated by FDEP coastal contaminants surveys, non-point discharges are the major sources of contaminants to coastal waterbodies. If population and land use trends continue, inputs of contaminants to coastal waters due to the deposition of atmospheric pollutants and stormwater runoff from urban and suburban areas are likely to

escalate. Likewise, the capacity of municipal wastewater treatment plants will have to increase to accommodate the needs of the burgeoning population. Coastal waters may be used as receiving water systems for many of these point and non-point source discharges.

Manufacturing has traditionally played a smaller role in the Florida economy than in the economy of other states (Fernald 1981). For this reason, Florida's coastal waters are not severely influenced by industrial effluents. Nonetheless, Farrow (1990) indicated that 615 billion gallons of industrial effluent were released into Florida's coastal waters in 1982. The sources of these effluents included the pesticides, organic chemicals and plastics industries, and a variety of other discharges. Of these, the pulp and paper industry may be of particular importance in certain areas of Florida due to its discharges of toxic and bioaccumulative substances into coastal waters (Farrow 1989).

Florida is second (after North Carolina) among southeastern states with respect to the economic value of its agricultural production (Fernald 1981) and is renowned for its production of citrus fruits. While Florida has an excellent climate for the culture of agricultural products, it is dominated by sandy soils with relatively low fertility (Ewel 1990). As such, maintenance of high rates of productivity necessitates the application of large quantities of fertilizers and pesticides. The combination of high irrigation rates, high soil porosity, and low organic content in the soil enhances the potential for the mobilization of many agricultural chemicals. Overland or subsurface transport of many of these substances could ultimately lead to the contamination of coastal waters.

While municipal, industrial and agricultural sources probably represent the major inputs of contaminants to coastal ecosystems, other sources of contamination in Florida's coastal waters may include leachates from landfill sites, dredge and fill activities, and the operation of ships and pleasure craft. Together, anthropogenic influences in estuarine and nearshore marine environments represent a potential hazard to the health and integrity of coastal ecosystems. Ongoing monitoring of environmental conditions provides a means of assessing the nature and extent of environmental contamination and a basis for managing the valuable resources that currently exist in Florida's coastal ecosystems.

2.4 Sediment Quality Issues and Concerns

Natural resource protection is one of the most important goals in managing Florida's coastal waters. These resources include wetlands, floodplains, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife. Habitats that support the production of fish and wildlife are of fundamental importance and have been identified as natural resources that require special consideration for protection and enhancement (Comp and Seaman 1985).

Maintenance and enhancement of the diversity and abundance of biological resources in coastal ecosystems in Florida requires an integrated approach to environmental management. Implementing an integrated environmental management system is dependent on the development of a comprehensive understanding of the fate and effects of environmental contaminants. While many contaminants are released into the aqueous component of coastal ecosystems, not all of these substances dissolve easily in water. For instance, hydrophobic substances tend to adhere (or adsorb) to particulate matter that becomes deposited on the bottom. This tendency for many toxic substances to form associations with sediments can result in elevated concentrations of certain contaminants in bed sediments. Elevated levels of sediment-associated contaminants may represent hazards to ecosystem integrity by affecting aquatic organisms directly or by limiting the use of those resources by human consumers.

Sediments contaminated with toxic substances have been found in coastal areas throughout the world. Bolton *et al.* (1985) reported that metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and DDT were chemicals of major concern at a number of marine and estuarine sites in America. A more recent evaluation, using data collected in the National Status and Trends Program (NSTP), has confirmed that bed sediments at sites within the Hudson-Raritan estuary, Boston Harbor, Long Island Sound, and San Francisco Bay are highly contaminated with an assortment of toxic substances (Long and Morgan 1990).

While concerns over contaminated coastal sediments in the United States have been focused primarily in the northeast and on the west coast, the results of recent studies are beginning to indicate that sites in the southeast have also been affected by anthropogenic activities. For example, Long and Morgan (1990) reported that sites in St. Andrews Bay were highly contaminated with pesticides, metals, PCBs, and PAHs (i.e., levels of contaminants in sediment equalled or exceeded the concentrations that were frequently or always associated with toxic effects). These contaminants have also been detected at levels of concern at sites in the vicinity of Miami, Jacksonville, Daytona Beach, Tampa Bay and Pensacola Bay (MacDonald 1994; Long *et al.* 1991).

Sediment-associated contaminants have been connected with a wide range of impacts on the plants and animals that live within and upon bed sediments. Acute and, in some cases, chronic toxicity of sediment-associated contaminants to algae, invertebrates, fish, and other organisms have been measured in laboratory toxicity tests. Field surveys have identified more subtle effects of environmental contaminants, such as the development of tumors and other abnormalities in bottom feeding fish (Goyette *et al.* 1988; Malins *et al.* 1985). In addition, many of these substances can accumulate in fish and shellfish tissues. At elevated levels, these contaminants represent hazards to sensitive wildlife species that rely on these organisms for food. Furthermore, bioaccumulation may result in impairments to human uses of coastal ecosystems. In many areas of North America, health departments have advised residents to limit their consumption of seafood. For example, the Florida Department of Health and Rehabilitative Service and the Florida Department of Agriculture and Consumer Services (Mercury Technical Committee 1991) have issued a health advisory on consumption of shark

meat based on mercury levels in samples of sharks obtained in retail markets. In addition, observations of elevated mercury levels in Florida freshwater fish have resulted in the issuance of health advisories that recommended avoidance of fish consumption in specified state waterbodies.

2.5 Sediment Quality: An Indicator of Ecosystem Health

While evaluations of sediment quality are often used to address site-specific management needs, sediment quality is also used as a sensitive indicator of overall environmental quality. Sediments influence the environmental fate of many toxic and bioaccumulative substances in aquatic ecosystems. As such, sediments integrate contaminant inputs over time and may also represent long-term sources of contamination. In addition to the physical and chemical relationships between sediments and contaminants, sediments are of fundamental importance to benthic communities in terms of providing suitable habitats for essential biological processes (such as, spawning, incubation, rearing, etc.). Therefore, sediments provide an essential link between chemical and biological processes. By developing an understanding of this link, environmental scientists are developing assessment tools and conducting monitoring programs that enable them to make rapid and accurate evaluations of the state of the environment and the health of aquatic ecosystems.