Sea Turtle Management Strategy
2016

Estero Bay Aquatic Preserve

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1. INTRODUCTION

Sea turtles are a modern representative of organisms that have been around for hundreds of millions of years. Due to coastal development, fisheries impacts and oceanic pollutants, sea turtles are in global decline. Through collaborative efforts in research, public education and protective regulations, this decline can be slowed and potentially reversed but it will require steps to protect their habitats and food sources. The jurisdiction and authority in regulating sea turtle populations in Florida waters falls with the Florida Fish and Wildlife Conservation Commission (FWC). FWC issues permits for activities involving marine turtles in Florida under authority granted to the state through cooperative agreements with the U.S. Fish and Wildlife Service and National Marine Fisheries Service under Section 6 of the Endangered Species Act (ESA). The Estero Bay Aquatic Preserve Sea Turtle Management Strategy will assist in establishing and maintaining guidelines for stakeholders to work cooperatively to conserve resources vital to sea turtle survival.

1.1 ESTERO BAY AQUATIC PRESERVE

1.1.1 DEP and FCO

The Florida Department of Environmental Protection (DEP) serves to protect, conserve and manage Florida's natural resources and enforces the state’s environmental laws. The DEP is the lead agency for environmental management and stewardship, and it plays an integral role in protecting Florida’s air, water and land. The Florida Coastal Office (FCO) is a unit within the DEP that manages more than four million acres of submerged lands and select coastal uplands. In coordination with the National Oceanic and Atmospheric Administration (NOAA), the FCO manages three National Estuarine Research Reserves (NERR), the Florida Keys National Marine

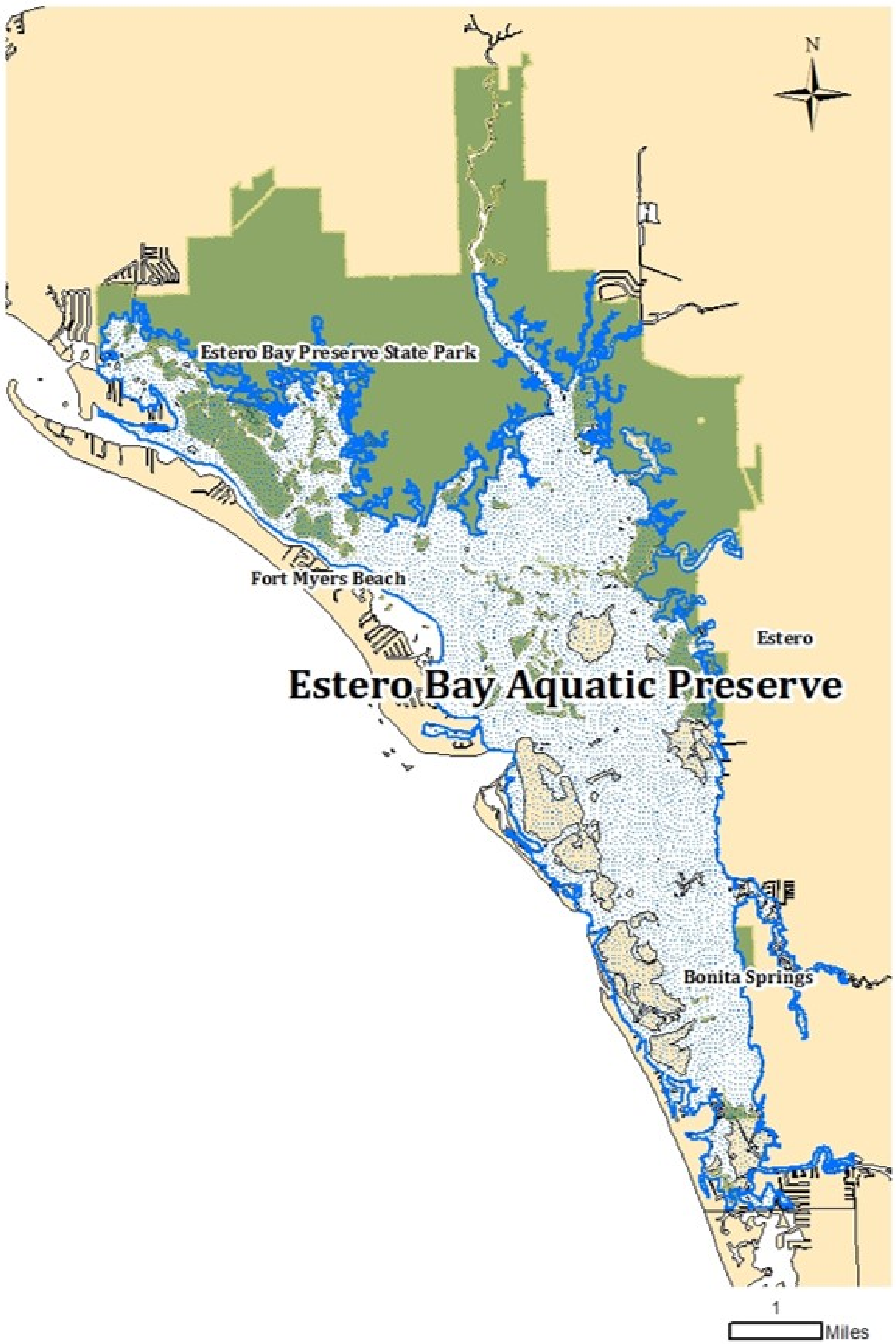
Sanctuary and the Coral Reef Conservation Program, as well as 41 aquatic preserves across the state.

1.1.2. General Description

Estero Bay Aquatic Preserve is a shallow-water estuary that protects a wide variety of aquatic ecosystems, including seagrass beds, mangrove islands, salt marshes, tidal flats and oyster reefs. It is Florida's first aquatic preserve and has been protected since 1966. A local citizens group, the Lee County Conservation Association (LCCA), recognized its ecological and recreational value and worked with political forces in the State Capitol to create what was then called an "offshore preserve." Initially, the preserve consisted of the northern portion of Estero Bay. Following the Florida Aquatic Preserve Act of 1975, the boundary was extended to the southern half of the bay in 1983 (§258.39, Florida Statute (F.S.)). Today the preserve encompasses more than 11,000 acres of submerged lands. The LCCA later worked to protect upland areas surrounding the aquatic preserve, which are now Estero Bay Preserve State Park, also encompassing 11,000 acres. This land aids in buffering against watershed pollutants that drain into Estero Bay. The estuary also benefits from protection due to its designation as an Outstanding Florida Water (OFW) (pursuant to §403, F.S. and Chapter 62-302, Florida Administrative Code (F.A.C.)).

1.1.3. Geographic Location

Estero Bay Aquatic Preserve is located in Lee County, approximately 10 miles south of Fort Myers. It is located among three municipalities: the Town of Fort Myers Beach, City of Bonita Springs and Village of Estero, and unincorporated areas of Lee County, including San Carlos Park and south Fort Myers (Map 1). Several freshwater tributaries feed into the bay from the north and the east. These include Cow Creek, No Name Creek, Hendry Creek, Ten Mile Canal, Mullock Creek, Estero River, Mud Creek, Halfway Creek, Spring Creek and Imperial River. The southern and western areas of the bay exchange waters with the Gulf of Mexico through the Matanzas, Hurricane, Big Carlos, Big Hickory and New Passes.



Map 1. Map of Estero Bay Aquatic Preserve

1.1.4. Watershed and Hydrology

The watershed of Estero Bay is approximately 595 square miles. Many smaller rivers and creeks, as well as sheet flow across the landscape, feed the estuary. Historically, Estero Bay basin consisted of low-lying topography and slow-moving water flow, allowing rainfall to provide a constant input of fresh water into the bay. This drainage pattern has made the bay extremely sensitive to changes in upland discharge and activities such as agriculture and urban development. Portions of the bay's tributaries outside of the aquatic preserve are designated as "special waters" within the OFW classification. This is the highest level of protection for water quality that a body of water can receive.

Estero Bay is a very shallow estuary, with an average depth of three feet. Major flushing takes place through tidal forces from the Gulf of Mexico. The water characteristics throughout the bay naturally vary due to daily, seasonal and long term conditions of surrounding uplands and contributing water sources. This variability makes the estuary ecosystem among the most dynamic habitats on earth. Salinity, temperature and flow vary greatly depending on tide stage, season and location. Furthermore, the geomorphology of Estero Bay has served to create distinct regions within the estuary that possess their own characteristics with limited mixing between zones. Diverse hydrologic barriers such as mangrove islands, oyster bars and mudflats have helped to create different sub-basins within the bay.

The salinity of the bay is highly dependent upon the time of year, not only due to natural input from heavy rainfalls during the wet season (May-October) but also due to surges of freshwater input from the release of overflow in Lake Okeechobee by the U.S. Army Corps of Engineers. The excess fresh water is released into the Caloosahatchee River, among others, which flows into the northern portion of Estero Bay indirectly through San Carlos Bay. These pulses of fresh water have a shock effect in the estuarine ecosystem, rapidly lowering salinity and carrying large nutrient loads that support the growth of algae and harmful algal blooms (HABs). During the dry season, lake water is withheld which deprives the estuary of much needed freshwater input, causing salinity to rise to potentially dangerous levels. These disruptions of the naturally occurring conditions within the estuarine ecosystem can cause loss of critical estuarine habitat and biological communities (SFWMD, 2008).

1.1.5. Climate

The climate of Southwest Florida is subtropical, with temperature primarily influenced by latitude and ocean conditions. Average annual maximum temperature is 83.6 degrees Fahrenheit (F), and minimum is 64.5 degrees F (Fort Myers station #083186, 1/1/1892 to 4/30/2012). Weather in southwest Florida is a dichotomy between wet and dry seasons. About 60-72% of annual rainfall occurs between the months of May and October, and precipitation averages over 8 inches per month (tropical storms can bring in as much as 6-10 inches in one day) (Beever, 2008) (Scarlatos, 1988). During the wet season, when land temperatures are warmer than water temperatures, warm air rises off the heated landscape causing moist air to flow onshore and the subsequent development of daily thunderstorms. In contrast, during the dry season (November-May), water temperatures are typically warmer than land temperatures and cause an offshore breeze, suppressing rainfall.

Over the past century, the Earth's average temperature has risen 1.4 degrees F, and is projected to rise another 2-11.5 degrees F over the next century (EPA, 2012). Temperatures within the greater Charlotte Harbor region, which has a northern boundary at Lemon Bay, and extends south to Estero Bay, have increased approximately 2 degrees F over the past 40 years (Leary, 2010). In South Florida, a predicted decrease in precipitation, along with an increase in storm severity due to warmer ocean temperatures, will increase salinity levels in estuaries, coastal wetlands and tidal rivers. Temperature, salinity, acidity and sea level changes will cause alterations in the natural ranges of fishes and marine species. Habitat shifts or local extirpation of keystone species, such as seagrasses and red mangroves, will have undeniable consequences for estuarine ecosystems as these organisms provide food, shelter and sediment stabilization within the environment.

1.1.6. Natural Communities

Estero Bay Aquatic Preserve falls within the subtropical biogeographic zone with ten natural communities identified within the bay: algal beds, beach dunes, blackwater streams, coastal berms, mollusk reefs, ruderal, salt marshes, seagrass beds, sponge beds and mangrove swamps. Of these communities, six are listed as S2 by the Florida Natural Areas Inventory (FNAI), which indicates they are imperiled in Florida due to rarity: algal bed, beach dune, blackwater stream, coastal berm, seagrass bed and sponge bed. The communities of beach dunes, mollusk reefs, seagrass beds, sponge beds and mangrove swamps are essential to the health and survival of sea turtles within Estero Bay.

Beach Dunes

Beach dunes are wind-deposited foredunes and wave-deposited upper beach that are sparsely to densely vegetated with pioneer species. The only pocket of beach dune within Estero Bay Aquatic Preserve is within Lovers Key State Park. Dune habitat on Big Hickory Island and Bonita Beach are adjacent to the preserve. These areas are located within the nesting ranges of two sea turtle species: loggerhead (*Caretta caretta*) and green (*Chelonia mydas*).

Mollusk Reefs

Mollusk reefs are expansive concentrations of sessile mollusks occurring in intertidal and subtidal zones to a depth of 40 feet. In Estero Bay these environments are dominated by the American Oyster (*Crassostrea virginica*). Large complex oyster reefs found in the northeastern portion of the bay and small isolated reefs occurring southward (Schmid, 2009) serve as foraging areas for juvenile Atlantic Kemp's ridley turtles (*Lepiochelys kempii*).

Seagrass Beds

Seagrass beds are expansive stands of vascular plants that occur in subtidal zones where wave energy is moderate. They have a high level of productivity and play an integral role in the estuarine ecosystem. It is common for 100 species of fish to be associated with seagrasses in a single region (Hemminga & Duarte, 2000). Listed species such as the Florida manatee (*Trichechus manatus latirostris*) as well as the Atlantic green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), Atlantic hawksbill (*Eretmochelys imbricata*), Atlantic Kemp's ridley and the Atlantic loggerhead sea turtles, are known to rely heavily on seagrass communities.

Sponge Beds

Sponge beds are dense populations of sessile invertebrates of the phylum Porifera, class Demospongiae, confined primarily to the subtidal zones. While only small patches of sponge bed exist in Estero Bay, sponges have shown to be an important food source for hawksbill turtles, which forage in benthic environments once they reach maturity (Bjorndal, 1997).

Mangrove Swamps

Mangrove swamps occur along flat, intertidal and supratidal shorelines of low wave energy. Many organisms including birds, fish and crustaceans use mangrove swamps during their lifecycle. Crabs, which are prey to many turtle species in the bay including the juvenile Atlantic Kemp's ridley, use the mangroves as a protective habitat (Hogarth, 1999).

1.1.7. Estuarine Ecosystems

The estuarine environment is able to support a wide variety of organisms due to its dynamic habitat characteristics and seasonal cycles. This ecosystem provides nesting and roosting habitat for birds, a hunting ground for terrestrial animals, as well as a foraging area and nursery for many adult and juvenile marine species. The estuary also plays an integral role in the stability of both coastal and marine ecosystems. Understanding and protecting the imperiled species that rely heavily on estuaries is vital to preserving these ecosystems across the globe.

1.2 SEA TURTLES IN ESTUARINE ECOSYSTEMS

While the behavior and migrations of sea turtles in the world's oceans are still poorly understood, five species are listed as using or historically having used Estero Bay and the surrounding area as habitat: Atlantic green, Atlantic loggerhead, Atlantic Kemp's ridley, leatherback and the Atlantic hawksbill sea turtles (DEP, 2014). The ecological role of a sea turtles in the estuary environment is largely dependent on the species and diet. Atlantic green turtles, which feed primarily on vegetation including seagrasses as adults, are important herbivores in benthic foraging areas (Hemminga & Duarte, 2000). Rate and severity of grazing affects many aspects of seagrass biology including quality, rate of production and biomass (Bjorndal & Jackson, 2003). Seagrass also supports a variety of other organisms from animals living on the stems and leaves, to those that move freely beneath the canopy (Hemminga & Duarte, 2000). Therefore, the health of the seagrass as a result of the presence of herbivore populations plays a key role in maintaining the estuarine ecosystem. Consequently, the Atlantic Kemp's ridley turtle (*Lepidochelys kempii*) feeds largely on portunid crabs and bivalves during its juvenile stage (Ogren, 1989). These crabs are found living among the prop roots in mangrove swamps as well as foraging on mollusk reefs, such as oyster reefs. As carnivores, or secondary consumers within the ecosystem, these sea turtles help to maintain healthy prey populations at subsequent trophic levels.

In the surrounding uplands and beaches, loggerhead sea turtles nest annually, introducing nutrients and energy into the nesting beach communities. Nutrients left in the nest, in the form of eggshells, amniotic fluid and even developing eggs that fail to hatch, either enter the food chain as detritus, are consumed by predators or are absorbed by plant roots (Bouchard & Bjorndal, 2000). The presence of sea turtles at many life stages within and around Estero Bay Aquatic Preserve is an integral part of the local ecosystems.

1.3 SPECIES MANAGEMENT STRATEGY PURPOSE AND GOALS

In order to preserve and protect sea turtle populations, the Department of Environmental Protection's Florida Coastal Office, in conjunction with FWC and local species experts, have developed a wildlife management strategy for sea turtles in Estero Bay. Management strategy development begins with review of resource information from historical data, research and monitoring, and includes input from area stakeholders and members of the general public. Each management strategy is evaluated periodically and revised as necessary to meet the species' current needs. Intended to be used by local governments and organizations seeking to maintain and/or rebuild the integrity of sea turtle populations within southwest Florida, the strategy includes scientific information about the existing conditions of the species and management strategies, both current and future, to respond to those conditions.

1.4 PUBLIC INVOLVEMENT

Stakeholder participation is an important component of creating a practical and inclusive management strategy, and their involvement is encouraged in the process. Development of this strategy starts with an initial draft composed by staff on relevant biological and historic data. Next, an advisory committee of area stakeholders is organized and public meetings are held to engage stakeholders and the public in gathering comments and feedback on the draft. Reasonable notice of such meetings must be given, and the minutes of the meeting must be recorded. Comments and concerns are incorporated into the final draft, and additional public meetings are held when necessary.

2. SEA TURTLE BIOLOGY

Sea turtles are long-lived and slow-growing reptiles that make long migrations between foraging and nesting habitats (Musick & Limpus, 1997). While nesting occurs terrestrially, the remainder of their life history is distinctly tied to marine and estuarine habitats. Over decades, sea turtles enter different growth stages during which their habitats and diets may change drastically.

2.1 LIFECYCLE

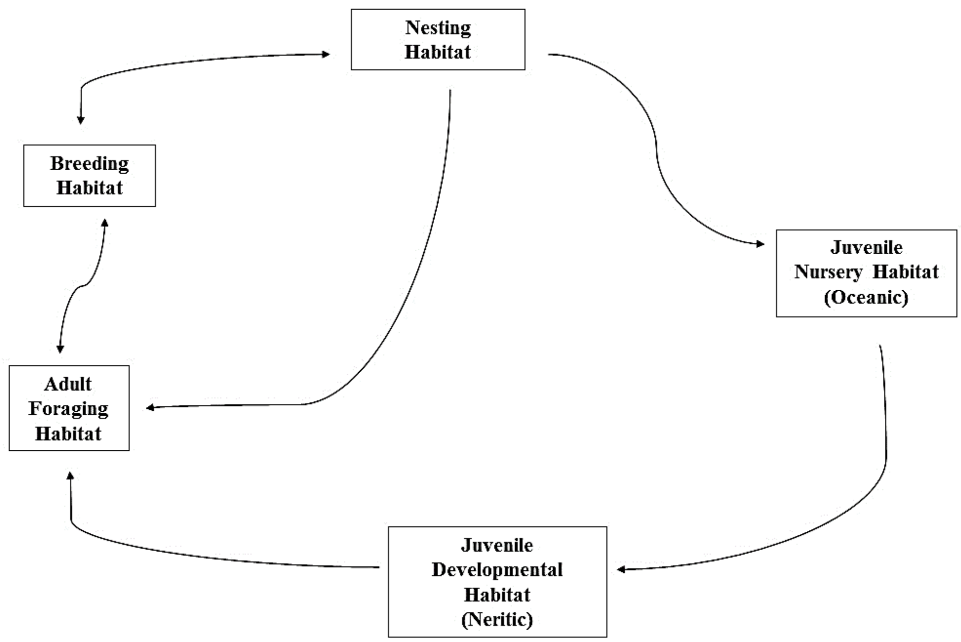


Figure 1. Model of habitat migrations within the sea turtle lifecycle, adapted from Musick & Limpus, 1997. Oceanic refers to a depth of 200 m. or more, neritic refers to the area between the low tide mark and a depth of 200 m.

The lifecycle of a sea turtle goes through very distinct stages that occupy many different ecological roles in various habitats from the nesting beach to the open ocean (Figure 1). Clutches typically emerge at night prompted by the temperature gradient created by cooling sands (Miller, 1997). This adaptation protects the turtles from the sun and decreases their chances of becoming prey to terrestrial and aquatic predators. In Florida, raccoons have historically been the greatest natural predator of sea turtle hatchlings and eggs. Other predators include the fish crow, gray fox, coyote, ghost crab, vulture, fire ants, carnivorous fish and many others (Scott, 2004). Coyotes are emerging as major predators to eggs and hatchlings throughout the Florida coast.

Once they reach the ocean, they spend the next stage of their life in a juvenile nursery habitat. The environment is usually pelagic, or oceanic. New evidence suggests that the young turtles are active swimmers within ocean currents, seeking shelter and foraging in vegetation such as *Sargassum* rafts (Carr, 1986) (Putman & Mansfield, 2015).

Most sea turtle species leave the pelagic nurseries and migrate to coastal, neritic foraging and developmental habitats at 20-50 cm. in carapace length, with the exception of leatherbacks which migrate at 110-120 cm. While in this developmental stage, some species exhibit seasonal migrations to offshore habitats in response to declining water temperatures during winter. These coastal habitats protect the young turtles from larger predators such as large sharks (Musick & Limpus, 1997). Numerous juveniles of the Atlantic Kemp's ridley sea turtle utilize Estero Bay during this life stage (Schmid, 2009).

Female sea turtles lay multiple clutches of eggs in a season and spend the time in between nesting periods resting in a shallow water inter-nesting habitat near the nesting beach (Zbinden, Aebischer, Margaritoulis, & Arlettaz, 2007). In the United States, Florida has the highest number of annual sea turtle nests, with 40,000-70,000 nest excavations each year. The majority of nests belong to loggerhead and green turtles with some leatherback and hawksbill nests (Scott, 2004). Clutch size is predominantly species-dependent (Table 1). After the nesting season, females return to their adult foraging habitats (Scott, 2004). Similar to other reptiles, sea turtles experience temperature-dependent sex determination. The nest temperature during a thermosensitive period of development heavily influences the sex ratio of the hatchlings. Warmer nest temperatures will result in a high proportion of females than cooler temperatures, which favor males (Godley, Broderick, Glen, & Hays, 2002). Following a species-specific incubation period, a new generation of hatchlings emerge to begin the sea turtle lifecycle.

Species	Age at sexual maturity (years)	Incubation period (days)	Number of eggs per clutch	Clutches per season	Remigration interval (years)
Loggerhead Turtle	20-30[1]	53-80	112.4	3.49	2.59
Kemp's ridley turtle	11-12	48-56	110.0	1.80	1.50
Green turtle	20-50	45-75	112.8	2.93	2.86
Leatherback turtle	13-14	60-75	81.5	6.17	2.28
Hawksbill turtle	3-4	60-75	130.0	2.74	2.90

Table 1. Reproductive characteristics of marine turtles. Adapted from Miller, 1997 and Scott, 2004.

2.2 SPECIES

Listed here are the sea turtle species identified as using the waters surrounding Estero Bay during their lifecycle.

[1] Instances have been recorded of loggerheads reaching maturity at 10 years, though this is not common (Scott, 2004).

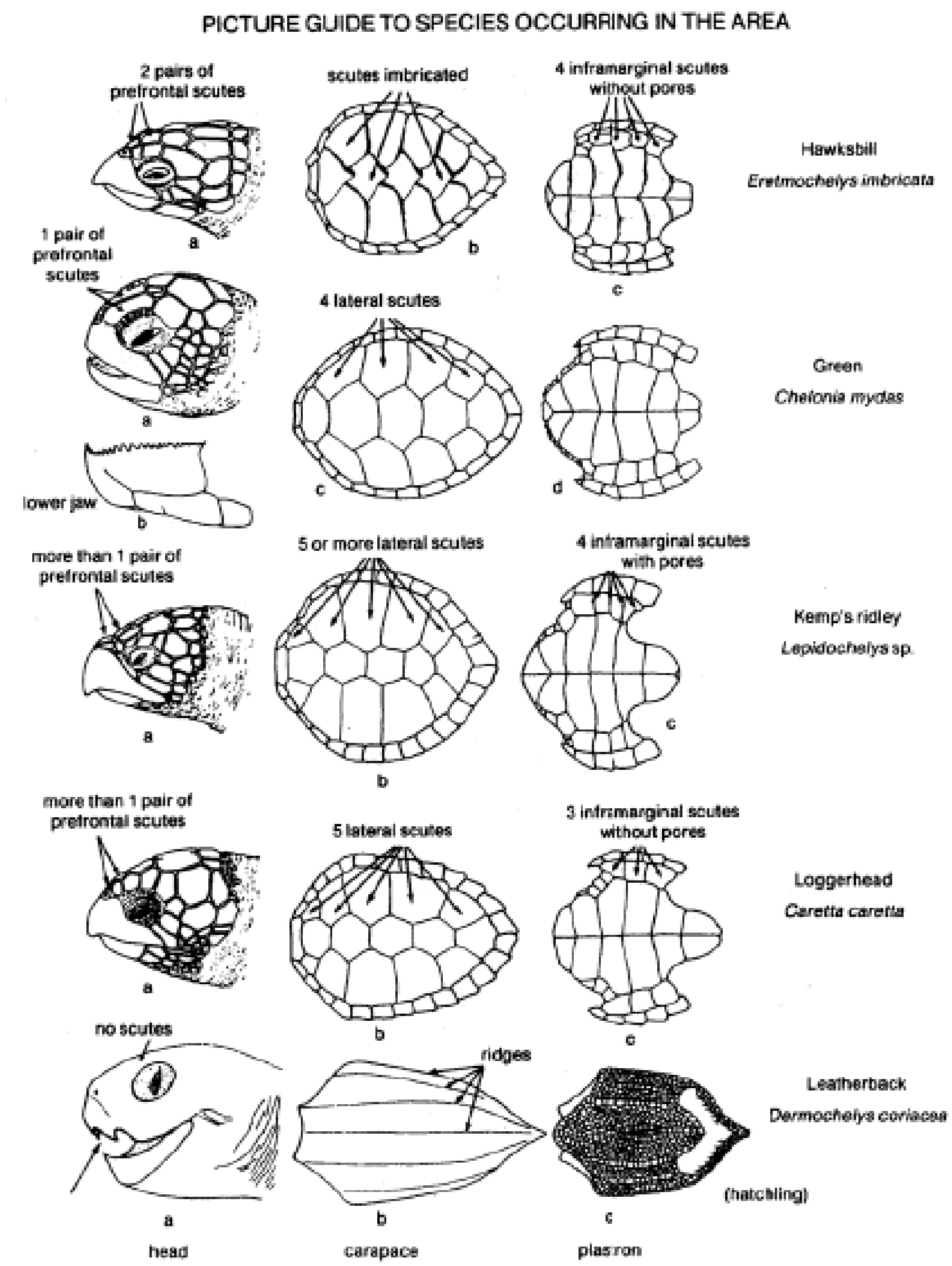


Figure 2. Morphological distinctions between sea turtle species *(FWC, 2007)*

2.2.1. Loggerhead Sea Turtle (*Carretta carretta*)

Status

Vulnerable (Casale & Tucker, 2015).[2]

Description

Loggerheads can be distinguished by their reddish brown carapace and large head relative to carapace size (up to 25 cm wide) (Scott, 2004). Dorsal and lateral head scales and dorsal scales of the flipper are also reddish brown. The unscaled skin of the integument is light brown dorsally and light to medium yellow ventrally. The plastron is also light to medium yellow. The carapace is often covered with commensal organisms. Mean straight carapace length (SCL) is 92 cm. and the corresponding weight is 116 kg. (NMFS & USFWS, 2008). The species has at least five lateral scutes, 11-12 marginal scutes and five vertebral scutes on the carapace. There are three to four pairs of bridge scutes on the plastron. The plastron also has three inframarginal scutes without pores (Figure 2) (FWC, 2007). A hatchling carapace is 4.1-4.8 cm. long, variable in color and has three keels. The keels disappear with age (Scott, 2004).

Distribution

The Loggerhead inhabits temperate and tropical regions of the Atlantic, Pacific and Indian Oceans. The majority of nesting occurs in the western rims of the Atlantic and Indian oceans. In South Florida, there are greater than 10,000 nesting females each year. Smaller nest aggregations occur on beaches across the globe including the Caribbean, South Africa, Australia and Japan (NMFS & USFWS, 2008).

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[2] The Northwest Atlantic subpopulation, which include turtles nesting on Florida's coast, are listed as Least Concern (Casale & Tucker, 2015).

Diet

Hatchling loggerheads have been found with stomach contents of sargassum floats, leaf parts and snails associated with sargassum rafts. As pelagic juveniles, their diet includes salps, jellyfish, amphipods and crabs. In benthic environments, loggerheads feed on a wide variety of invertebrates including whelks, conchs, horseshoe crabs, bivalves and anemones. Diets have also been shown to change seasonally; turtles feed on sea pens in the spring and shift to crabs when they become more abundant in the fall (Bjorndal, 1997).

2.2.2. Green Sea Turtle (*Chelonia mydas*)

Status

Endangered (Seminoff, 2004).

Description

The adult green turtle carapace is brown, ranging from tan to dark brown or olive. The carapace often bears a mottled pattern. The green turtle has one pair of prefrontal scutes between the eyes. On average, carapace length ranges from 90-122 cm., and adults may weigh up to 204 kg. There are four costal scutes on each side the carapace and four scutes on the bridge of the plastron (Figure 2). Hatchlings have a dark carapace and white plastron. They range from 4.1-6 cm. in carapace length. The "green" in the common name comes from the color of the body fat which is removed to make soup (Scott, 2004).

Distribution

Green sea turtles inhabit tropical and subtropical waters worldwide. Hatchlings are thought to be open-water animals, traveling in major oceanographic circulation patterns. In the western Atlantic, juveniles use estuaries as far north as Long Island Sound as developmental summer habitat, then travel south in winter to escape dropping temperatures (Musick & Limpus, 1997).

Nests have been recorded in over 80 countries, and green turtles live in the coastal areas of more than 140 countries. In the U.S., the green turtle is found in the Gulf of Mexico and the Atlantic Ocean north to Massachusetts. Several areas along the Gulf and Atlantic coasts of Florida are important foraging areas.

Diet

In the pelagic habitat, green turtles are believed to be associated with sargassum rafts and assumed to be omnivores with a tendency toward carnivory. When they enter the benthic foraging habitats as sub-adults, they shift to an herbivorous diet. These turtles feed primarily on seagrasses and algae, playing a large role in the seagrass ecosystem (Bjorndal, 1997). As grazers, green turtles influence the health and productivity of the seagrass beds, which sustain a multitude of other animals within the environment.

2.2.3. Atlantic Kemp's Ridley Turtle (*Lepidochelys kempi*)

Status

Critically Endangered (MTSG, Lepidochelys kempii, Kemp's Ridley, 1996).

Description

The Atlantic Kemp's ridley turtle has a plastron that is white as a sub-adult and yellow at maturity. The carapace is grey in young turtles and turns to an olive-green in adult turtles. This species is the smallest of the five found in Florida's waters. The average carapace length is 64 cm., and weight of mature females can range from 39-49 kg. (Pritchard & Marquez, 1973). The carapace consists of five vertebral scutes and five paired costal scutes. There are usually four bridge scutes and a small interanal scute on the plastron (Scott, 2004). There are more than one pair of prefrontal scutes between the eyes (Figure 2) (FWC, 2007). Adults bare a single claw on each front flipper (Pritchard & Marquez, 1973). Hatchlings are 3.8-4.4 cm. long and have a uniformly dark grey coloring (Scott, 2004).

Distribution

The range of the Atlantic Kemp's ridley turtle is associated with the Gulf of Mexico. Some experts believe that the entire lifecycle takes place within the Gulf, at least for some proportion of the population (Ogren, 1989). Breeding occurs almost exclusively on the coast of Tamaulipas, Mexico, near Rancho Nuevo (known as *arribada*, or arrival, to the locals) (Pritchard & Marquez, 1973). The shallow coastal waters of the Gulf serve as year-round foraging areas, with the possible seasonal migration to warmer off-shore areas when coastal temperatures drop (Ogren, 1989).

Diet

During the early pelagic stages of life, Atlantic Kemp's ridleys feed at the surface. After reaching 20 cm. in carapace length, they migrate to shallow coastal waters to begin benthic foraging (Bjorndal, 1997). In this habitat, they feed primarily on portunid crabs, bivalves and other invertebrates (Ogren, 1989). It is thought that the distribution of the Atlantic Kemp's ridley is correlated with the distribution of all major crab species consumed and their habitats (mud, sand, oyster shell and turtle grass, *Thalassia*) (Bjorndal, 1997) (Ogren, 1989).

2.2.4. Atlantic Hawksbill Turtle (*Eretmochelys imbricata imbricata*)

Status

Critically endangered (Mortimer & Donnelly, 2008).

Description

The carapace of the Atlantic hawksbill turtle displays a radiating tortoiseshell pattern that is more distinct in juveniles than older individuals. The coloring can be mottled green, red-brown or black. The skin is usually yellow in color. The species name is derived from the sharp, beak-like structure of the snout. Slightly larger than the Atlantic Kemp's ridley, the hawksbill carapace length ranges from 76-89 cm. in adults, and they weigh between 43-75 kg. There are two pairs of prefrontal scutes between the eyes. There are four paired costal scutes on the carapace, and the carapace scutes are imbricated (Figure 2). The plastron has four inframarginal scutes without pores (FWC, 2007). Individuals also have two prefrontal plates between the eyes and two claws on each flipper. Hatchlings are 3.8-4.4 cm. long and both carapace and plastron are black or dark brown (Scott, 2004).

Distribution

Hawksbills are generally more associated with warm, tropical waters than other marine turtles. However, they move north when foraging during the summer months and in the United States have been recorded up the Atlantic coast (Scott, 2004). Juvenile developmental habitats are shallow coral reefs and mangrove estuaries, and individuals remain in these foraging areas as adults (Musick & Limpus, 1997). The largest aggregations of nesting hawksbills are in Queensland, Australia. In the Gulf of Mexico, nesting occurs on Mexico's Yucatan peninsula and in very small numbers on Florida coasts (Scott, 2004).

Diet

This species' principal food source is sponges. Hawksbills commonly forage over coral reefs, seagrass pastures and mangrove-lined bays. Individuals may undergo a period of omnivory before specializing on sponges. It has also been noted that gravid females ingest coral and calcareous algae, possibly as a source of calcium to support egg production (Bjorndal, 1997).

2.2.5 Atlantic Leatherback Turtle (*Dermochelys coriacea coriacea*)

Status

Vulnerable (Wallace, Tiwari, & Girondot, 2013).

Description

The leatherback does not have a solid, bony shell as other marine turtles do. Instead, there is a loose bony internal structure that is covered by rubbery skin. The color is typically dark brown or black. Sporadic markings of white or pink may be present. In females, the crown of the head often has a pink coloring. The largest of all sea turtles, leatherbacks have a maximum carapace length of 188 cm., and may weigh more than 916 kg. There are no scutes on the face or body. There are seven anterior-posterior ridges that extend the length of the carapace and five down the plastron (Figure 2) (FWC, 2007). Hatchlings are 6-7.5 cm. long and have prominent light markings. Neonate leatherbacks are covered in small scales which are lost after several months (Scott, 2004).

Distribution

This species is the most wide-ranging of marine turtles. They remain pelagic from hatchlings to adults, and their behavior in the open ocean is largely a mystery. Seasonally, they move to temperate coastal habitats to forage (Musick & Limpus, 1997). Large adults have been found in feeding areas as far north as the subarctic waters of Newfoundland and Nova Scotia. Several adaptations equip them for cold-water habitats including a heat-exchanging network of blood vessels in their large flippers and a thick layer of insulating oils and fats. Most nesting occurs in tropical beaches worldwide, with small colonies in Southeast Florida (Scott, 2004).

Diet

Leatherbacks feed primarily on jellyfish but also salps and other gelatinous organisms, migrating long distances to foraging grounds. They feed throughout the water column and have been recorded diving to great depths (Bjorndal, 1997). The pointed cusps and sharp jaws of the turtle act as teeth to assist in eating the gelatinous prey, and the throat is covered in backwards pointed papillae which protect the turtle from jellyfish stings.

3. THREATS TO SEA TURTLES

Nearly all species of marine turtles are listed on the IUCN Red List as Endangered or Vulnerable, with the only exception being the Australian flatback turtle (*Natator depressus*) (MTSG, 1995). Sea turtle populations are declining globally due to anthropogenic factors that threaten the ecosystems on which they depend (Wyneken, 1988).

3.1 ANTHROPOGENIC THREATS

3.1.1. Nesting Beaches

On the nesting beach, habitat loss and destruction affects many stages of the sea turtle lifecycle. Mortality of eggs and pre-emergent hatchlings within the nest is increased by the use of beach cleaning equipment common on many U.S. beaches (Mann, 1977). This equipment, especially mechanical rakers, can also cause ruts in the sand which may hinder or trap emergent hatchlings moving towards the ocean. Turtle nests are also impacted by the uncovering of eggs by cleaning equipment and wild and domesticated animals (Lutcavage, Plotkin, Witherington, & Lutz, 1997). Both the eggs and nesting females are collected in illegal harvests, which occur more commonly outside of the U.S. (NMFS & USFWS, 2008).

Nesting females are affected by beach armoring, which refers to hardened structures placed parallel to the shore to protect upland property from erosion. These barriers can reduce the nesting habitat, causing females to nest in lower-elevation sand, which is exposed to more dangers from the surf, or over-crowding in available nesting sites (Lutcavage, Plotkin, Witherington, & Lutz, 1997).

Both females and hatchlings are adversely affected by artificial lighting on nesting beaches (Witherington, 1992). Artificial lighting disrupts critical behaviors that are thought to be influenced by lighting cues, such as nest-site selection. The result is reduced nesting on lighted beaches which may otherwise be suitable habitat (Lutcavage, Plotkin, Witherington, & Lutz, 1997). If a female does emerge on an artificially-lit beach, nesting behaviors can be abandoned or abbreviated, reducing nesting success. Post-oviposition orientation can also be disrupted by lighting and hinder a female's ability to return to the sea (Witherington & Martin, 1996).

Artificial lights also affect hatchling mortality by disorienting their sea-finding behavior post-emergence. Numerous evidence exists to suggest that visual cues play a strong role in their orientation towards the ocean (Witherington & Martin, 1996). When artificial light is present, hatchlings move towards the light sources, as opposed to the ocean, and eventually succumb to dehydration, predation and exhaustion (Lorne & Salmon, 2007).

Other nesting-beach concerns include human presence, which can disturb natural behaviors, as well as beach debris that can obstruct the hatchlings' path to the ocean. Oil and tar deposits in the sand may alter the development of embryos within the nest (Lutcavage, Plotkin, Witherington, & Lutz, 1997).

3.1.2. Oceanic Habitats

Sea turtles inhabit the open ocean largely during the first few post-hatchling years, but also throughout their lifecycle during migrations and foraging in some species. In this habitat, the largest threat is from incidental capture in fisheries (NRS, 1990). Oceanic juveniles are caught in both longline and driftnet fishing lines and subsequently die due to anoxia and inhalation of sea water (NMFS & USFWS, 2008).

Damaged or lost gear that pollutes the ocean is an indirect impact by both commercial and recreational fishing. Oceanic turtles become entangled in monofilament lines and plastic bags, among many other things. This entanglement can result in restricted movement, leaving the turtles unable to feed or flee, and may result in drowning (Lutcavage, Plotkin, Witherington, & Lutz, 1997). Pelagic hatchlings spend their first few years in the open ocean in sargassum rafts, which form at a convergence, where different bodies of water come together. These convergences also gather debris floating in the ocean including plastics and other trash. Young turtles live and forage in these rafts, which may result in the ingestion of plastics that are intertwined with the vegetation (Carr, 1986).

Other threats in the oceanic environment include oil and tar pollution, which gather at the same convergent zones that build sargassum rafts. If these pollutants are present at the ocean surface, petroleum vapors are introduced into the turtle’s lungs when breaching the surface to breathe. Ingestion of tar balls mistaken for food introduces the toxins to the intestine (Lutcavage, Plotkin, Witherington, & Lutz, 1997).

3.1.3. Neritic Habitats

Adult and sub-adult marine turtles forage in coastal, neritic habitats. A 2007 report by the FWC found that 15% of all turtle strandings between 1980 and 2007 were the result of propeller wounds, though this number is thought to be an underrepresentation. In southwest Florida, the greatest number of strikes were reported for loggerheads and Atlantic Kemp's ridleys. While boat strikes also occur in large numbers in off-shore waters, FWC reported that turtles in coastal habitats were twice as likely to be struck by a boat propeller than those offshore.

Another large mortality source to sea turtles is from shrimping trawls. Trawls are large nets towed along the bottom, behind the shrimping vessel. Turtles foraging or resting near the bottom, in the path of the trawl, are taken into the net with the shrimp. Prior to protective regulations, it was reported that 5,000-50,000 loggerheads and 500-5,000 Atlantic Kemp's ridleys were killed annually as a direct result of shrimp trawl drownings (NRS, 1990). Nearshore dredging activities have also caused sea turtle deaths in Florida and Georgia (Lutcavage, Plotkin, Witherington, & Lutz, 1997).

Oil pollution and debris ingestion have similarly high frequency and high mortality in the neritic habitat as the oceanic zones, with plastics coming from both recreational boats as well as beaches and rivers. In bays and estuaries, entanglement in loose fishing line as well as active crab and lobster traps have occurred. Also in these coastal habitats, pollution from industrial and agricultural waste as well as urban runoff may result in the bioaccumulation of pesticides and heavy metals in the sea turtle's body (Lutcavage, Plotkin, Witherington, & Lutz, 1997).

3.2 BIOLOGICAL THREATS

Wild sea turtle populations face threats and challenges from their natural environment as well. Cutaneous fibropapillomatosis is a major epizootic disease. While it was first recorded in the green turtle, is does affect a variety of sea turtle species. Because the majority of cases affect green turtles, it has been designated green turtle fibropapillomatosis (GTFP). Since its first recording in Florida waters in 1938, GTFP has now been recognized in sea turtles worldwide.

Juveniles, especially individuals inhabiting near-shore waters close to human populations or areas with low water flow appear to be most affected (George, 1997). The disease causes growth of three types of legions: fibromas, cutaneous papillomas and fibropapillomas. The growth of these lesions externally may result in an inability to feed or move properly. Internal growth may result in physiological complications that lead to death. This cause of GTFP has been linked to the herpesvirus and seems to be restricted to transmission within populations (Jones, Ariel, Burgess, & Read, 2015).

Other environmental threats decreasing sea turtle survivability are hypothermic stunning resulting from rapid water temperature changes. Shallow water ecosystems, such as lagoons and estuaries, are most susceptible to extreme temperature drops. At a temperature of 10 degrees (C), motor function ceases and at 5-6 degrees (C), death occurs. Many turtle species exhibit seasonal migrations from coastal feeding areas in order to avoid cooling waters, but in some instances an animal may not be able to escape (George, 1997). It has been reported that some juvenile Atlantic Kemp's ridley turtles are carried too far north by ocean currents in the North Atlantic and die due to exposure to cold temperatures (Ogren, 1989).

4. RESOURCE MANAGEMENT

4.1 REGULATIONS

In Florida, hawksbills, leatherbacks and Atlantic Kemp's ridley turtles are currently endangered, while loggerheads and green turtles are listed as threatened (NOAA, 2016). All five species of sea turtle are protected under the federal Endangered Species Act of 1978 and Florida's Marine Turtle Protection Act (§379.2431, F.S.). This statute protects adult marine turtles, hatchlings, eggs and nests found on Florida beaches and in coastal waters. The take, possession, disturbance and sale, among other things, of marine turtles by unauthorized parties is strictly prohibited and punishable by law within this statute. The F.A.C. also contains lighting ordinances that are in effect in Lee County and the unincorporated cities of Fort Myers Beach, Bonita Springs and Sanibel within Lee County (62B-55, F.A.C.). These ordinances require that measures be taken to reduce negative effects of artificial lighting on nesting sea turtles and hatchlings on the beach (see section 3.1.1., above). On Fort Myers Beach, code enforcement conducts weekly checks for lighting ordinance infractions. Additionally, all beach furniture must be removed from the beach during the nesting season, and beach combing or raking must take place after nesting surveys have been conducted (Eve Haverfield, pers. comm.). While regulatory authority of sea turtle populations falls with FWC, the Estero Bay Aquatic Preserve manager may hold a permit issued by FWC to assist in strandings, recovery and releases of deceased and injured sea turtles.

4.2 NEST MONITORING

Sea turtle nesting occurs in nearly all coastal counties in Florida. A cooperative effort between FWC and the U.S. Fish and Wildlife Service established the Statewide Nesting Beach Survey in 1979. This ongoing program collects information on the distribution and abundance of sea turtle nesting across Florida. This program works in conjunction with the Index Nesting Beach Survey, which maintains consistent survey effort over time to allow for comparisons in nesting between years. At the time of this plan’s publication, sea turtle nest monitoring on the beaches surrounding Estero Bay Aquatic Preserve was conducted by Lovers Key State Park while Turtle Time, Inc., a non-profit, all volunteer organization, monitored Estero Island, Big Hickory Island, Little Hickory Island and Bunche Beach. All survey data are reported to FWC. These surveys consist of marking nests and inventorying nest contents. Survey data suggests that nest densities are increasing, with five nests occurring on Fort Myers Beach in 1989, and 73 nests recorded in 2015 (Eve Haverfield, pers. comm.).

4.3 SEAGRASS

Seagrass is an important resource in the sea turtle lifecycle for many species. Green turtles feed primarily on seagrass. Hawksbills have also been known to forage in seagrass beds while Atlantic Kemp's ridley turtles feed on crabs that live among the seagrasses. In 1950, Estero Bay contained an estimated 3,769 acres of seagrasses. In 2006, the estimated acreage was 3,298 (Gray & Beever, 2009). A 2014 report by the South Florida Water Management District (SFWMD) recorded 3,683 acres of seagrass coverage in Estero Bay. SFWMD conducts aerial surveys and GIS analyses to estimate the extent of seagrass coverage both in Estero Bay and surrounding waters. Ideally, these aerial surveys would be conducted every two years to closely assess restoration efforts.

Seagrass species vary in their biological and environmental requirements and tolerance thresholds. Water quality changes, therefore, can effect seagrass species range, distribution and makeup. As those species distributions change, ramifications can trickle through the food web, affecting floral, faunal and algal species.

The staff at Estero Bay Aquatic Preserve conduct biannual seagrass surveys to monitor the health of the seagrass beds within the bay. The surveys are done across five fixed transects in February and August during the dormant and growing seasons, respectively. This schedule captures the annual minimum and maximum seagrass densities. Data are published in the Florida Fish and Wildlife Research Institute's (FWRI) Seagrass Integrated Mapping and Monitoring Program Report.

4.4 WATER QUALITY

Estero Bay Aquatic Preserve measures water quality throughout the bay with two main programs: Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network (CHEVWQMN) and through YSI extended deployment system sondes (datasondes). In the CHEVWQMN program, seven established sites are monitored monthly by trained volunteers. The data serve to identify areas of concern within the aquatic preserve, make regulatory decisions on submerged lands and surrounding areas, set a baseline for estuary conditions and educate the public on water quality and trends. The parameters measured include wind speed, water surface conditions, tide, depth, color, clarity, temperature, salinity, dissolved oxygen, pH, nitrogen levels, phosphorus, chlorophyll a, turbidity and fecal coliform bacteria. The data are uploaded into the Charlotte Harbor Water Atlas online database and STORET national database for use by private citizens and local, state and federal agencies. Through this program, HAB samples are collected and sent to FWC and FWRI.

The Aquatic Preserve staff and volunteers also maintain three fixed localities at which datasondes are deployed in one-month collection periods as part of their continuous water quality monitoring program. These sondes collect data on temperature, specific conductivity, salinity, dissolved oxygen, depth, pH and turbidity in 15-minute increments. This program aims to look at long-term conditions and changes in Estero Bay. The data assist in interpreting changes in indicator organisms and bay communities, as well as furthering our understanding of anthropogenic impacts on the waters within the bay.

There are also ongoing monitoring efforts in Estero Bay in conjunction with the Lee County Environmental Laboratory (LCEL) since 1991 and tributary monitoring with DEP’s Division of Environmental Assessment and Restoration (DEAR) since 2003.

4.5 OYSTERS

Oyster reefs are an important foraging habitat for many marine animals, including crabs. *Callinectes similis,* or the lesser blue crab, is a species widespread throughout the coastal Gulf waters and a prey species for Atlantic Kemp's ridley sea turtles (Spotila, 2004). Oyster reefs also play a large role in maintaining the water quality within the bay ecosystem through filter feeding of microalgae. In Estero Bay Aquatic Preserve, staff and volunteers are working to map the oyster reef habitats within the bay and are conducting surveys to determine live oyster density, foraging species and average shell size for each reef system.

4.6 IN-WATER RESEARCH ACTIVITIES

Currently, no marine turtle tracking programs occur within Estero Bay. In South Florida, however, tracking activities are conducted by the Conservancy of Southwest Florida (CSF), the Sea Turtle Conservancy (STC) and Inwater Research Group (IWRG).

5. INTEGRATIVE STRATEGIES

The goal of this management strategy is to create collaborative relationships with stakeholders and develop programs to be implemented within Estero Bay to conserve resources and reduce harmful impacts on sea turtle populations. Stakeholders involved in this project are listed in Appendix A. When funding and personnel are available, the following strategies are to be addressed as future projects to work towards the goal of monitoring, maintaining and protecting sea turtle populations within the bay. An outline of these programs can be found in Appendix B.

5.1 IN-WATER RESEARCH ACTIVITES

Anecdotal evidence has shown a persistent presence of juvenile Atlantic Kemp's ridley turtles in Estero Bay. Further research is needed to address the size and distribution of that population, as well as to assess other species that are coming into the bay and the resources they are using. A study of this nature would begin with interviewing local fishermen, tour guides and individuals using the bay to collect data on the location and time of turtle sightings. Using this information to focus search efforts, staff and volunteer teams can be deployed on the water to do sight-surveys. Data should be collected on location, time, season, water and weather conditions at time of sighting as well as species and probable life-stage if possible.

This program is a great way to get volunteers, local merchants and citizens recreationally using the bay involved in sea turtle conservation. There are many citizen-science smartphone applications that collect and log data using GPS points received from community members.[3] Ideally, an app would be created to aid boaters and fishermen in identifying sea turtle species and uploading geographic data on the location of their sighting.

Once enough preliminary data is collected to establish a monitoring program for areas of turtle aggregation, efforts can be focused on in-water capture and tagging techniques. These activities may only be conducted by persons who have the appropriate state and federal permits. Also, a proposal of the activities must be reviewed by the agencies that issue these permits. Data from this program can identify the most commonly used locations and resources within Estero Bay so that management efforts can address areas of most concern. Information gathered by these tracking activities can also be made available to FWC and other interested partners to aid in large-scale research and conservation efforts.

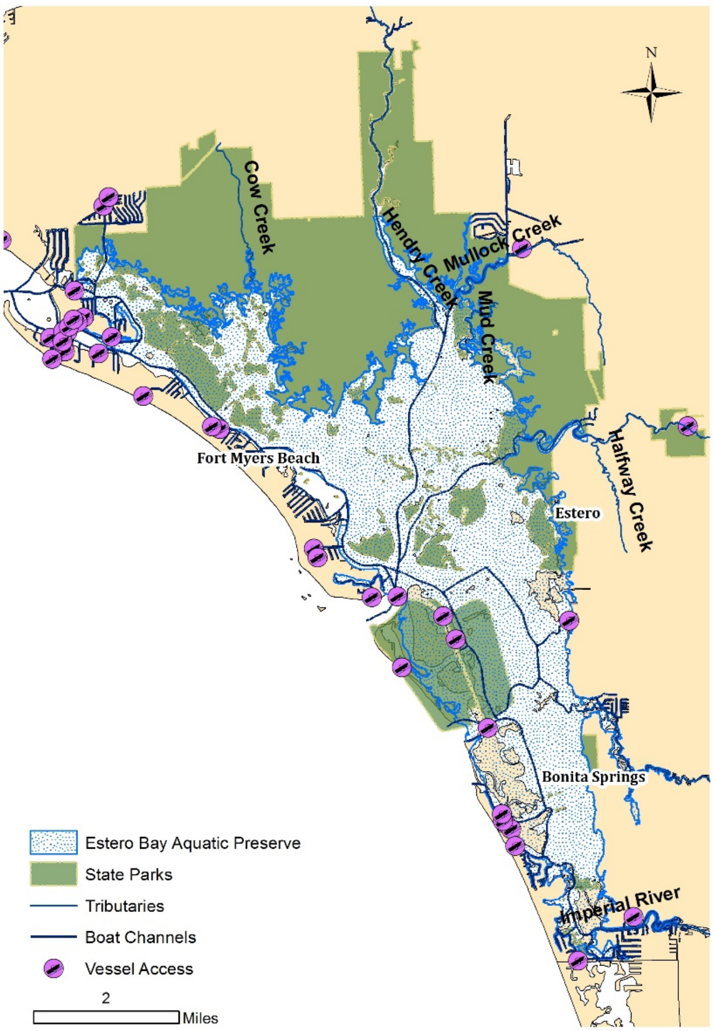
[3] Examples of smartphone applications include: ‘Marine Debris Tracker’, ‘What’s Invasive’ and ‘Secchi’

5.2 DECREASING MARINE DEBRIS

Ingestion and entanglement of marine debris is a major risk to wildlife in areas of large-scale coastal development and recreation. Many objects such as trash, fishing line and plastic bags pose a threat to sea turtles in Estero Bay. In order to reduce harmful effects, educational talks should be presented to the public to address ecological issues as an effort to involve the community in open discussion of the problems that Estero Bay faces. Space for these talks can be made available at the Estero Bay Aquatic Preserve field office. Suggested topics can be found in Appendix B.

Within Estero Bay, there are six canoe/kayak launches, 11 public boat ramps, 12 marinas and 24 personal watercraft (PWC) and boat rental operators (Map 2). An effective way to inform the public would be to develop educational materials about sea turtle hazards. Possible topics should include monofilament fishing line, mortality by boat strikes, proper conduct when encountering an injured sea turtle and reducing plastic waste in the water. For more information, see Appendix B.

Another way to work directly towards reducing debris in the water is to create alternatives to bringing disposable items on boats and kayaks. Plastic bags, for example, are widely used and often found entangled in mangroves and other environments. One effort to counteract this issue could entail encouraging reusable bags instead of plastic bags. Events to help raise awareness about the issue in the community could be enhanced with the support of a grant or local company to develop and distribute reusable bags printed with educational information about sea turtles.



Map 2. Geographic location of public vessel access point within Estero Bay Aquatic Preserve

5.3 INCREASING PUBLIC AWARENESS

Because the area receives more than one million tourists each year, public outreach is crucial to raise awareness of environmental issues and responsible use of these natural resources. A partnership with a local film company can result in public service announcements (PSAs) to help educate residents and visitors on local television and radio stations. This effort could leverage even more local buy-in by engaging students in the PSA development process. Informative video segments could be aired in the lobby of rental operators and on local hotel channels. An infographic could be developed for printing in local newspapers to further augment the outreach effort.

Stranding statistics indicate that boat strikes in coastal waters are highly correlated to reproductive activities. Public outreach efforts should be focused during nesting season when sea turtles are at a greater risk.

Another opportunity to reduce negative effects of human-sea turtle interactions is to retrofit lighted docks within Estero Bay with turtle-friendly amber LED lights. Most of the docks within the bay are not lit, but those with lights are largely privately owned. Moving forward with turtle-friendly lights would largely be a public education and awareness campaign to encourage residents to modify their property. Residents could also be encouraged to participate in FWC's Wildlife Lighting Certification Program designed to inform the public and businesses on reducing light pollution in wildlife habitats.

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Appendix A: Stakeholders

Name	**Organization**	**Contact**
Kelly Sloan	Sanibel Captiva Conservation Foundation	ksloan@sccf.org
Eve Haverfield	Turtle Time, inc.	Caretta1@comcast.net
Jeff Schmid	Conservancy of Southwest Florida	JeffS@Conservancy.org
Brie Ochoa	Florida Fish & Wildlife Conservation Commission	Brie.Ochoa@my.fwc.com
Gloria Beauchamp	Lovers Key State Park	Gloria.beauchamp@dep.state.fl.us
Katie Moses	Lovers Key State Park	Catherine.Moses@dep.state.fl.us
Tom James	Pelican Media, LLC.	tom@pelicanmedia.tv
Melynda A. Brown	Charlotte Harbor Aquatic Preserves	Melynda.A.Brown@dep.state.fl.us
Jim Beever	Southwest Florida Regional Planning Council	jbeever@swfrpc.org
Heather Stafford	Florida Coastal Office	Heather.Stafford@dep.state.fl.us
Terry Cain	Lee County	tcain@leegov.com
Jonathan Meyer	Estero Bay Preserve State Park	Jonathan.C.Meyer@dep.state.fl.us
Kristen Sella	Florida Fish & Wildlife Conservation Commission	Kristen.Sella@MyFWC.com

Appendix B: Goals, Objectives, Strategies

When funding and personnel are available, the following strategies are to be addressed as future projects to work towards the goal of monitoring, maintaining and protecting sea turtle populations within the bay.

Goals, Objectives, Strategies	**Activity**	**Partners**	**Time**	**Cost**	**Possible Funding Sources**	**Follow Up**
Goal 1	Monitor sea turtles in Estero Bay					
Objective 1	Gather information on species and abundance of turtles in the bay					
Strategy	Collect anecdotal data on sea turtle presence within the bay					
Strategy	Conduct in-water surveys to document sea turtle presence					
Strategy	Establish radio tracking programs					
Strategy	Create an 'App' that allows citizens to log GPS coordinates of turtle sightings					
Goal 2	Reduce marine debris in Estero Bay					
Objective 1	Discourage boaters from taking plastic bags on the water					
Strategy	Work with partners to create reusable bags	Local grocers				
Strategy	Create program at Lovers Key boat ramp to trade in plastic bags for reusable bags	Lovers Key State Park				
Strategy	Present regular educational talks to the public on ecological issues within the bay					

Goals, Objectives, Strategies	Activity	Partners	Time	Cost	Possible Funding Sources	Follow Up
Goal 3	Reduce harmful anthropogenic effects to turtles					
Objective 1	Reduce harmful effects of artificial light to turtles within the bay					
Strategy	Encourage energy-efficient, amber LED lights fitted to docks	Turtle Time, Inc.				
Strategy	Encourage participation in the Wildlife Lighting Certification Program	FWC				
Objective 2	Reduce injury to sea turtles by monofilament line					
Strategy	Develop educational displays to post at boat ramps	Lovers Key State Park				
Strategy	Present regular educational talks to the public on ecological issues within the bay	Lovers Key State Park				
Strategy	Organize volunteer removal of line	Estero Bay Buddies				
Goal 4	Reduce sea turtle boat strikes					
Objective 1	Enhance public awareness of turtle presence					
Strategy	Develop educational displays to post at boat ramps	Lovers Key State Park				
Strategy	Work to inform the public on proper protocol when encountering an injured turtle	FWC				
Strategy	Present regular educational talks to the public on ecological concerns within the bay	Lovers Key State Park				
Goal 5	Educate the public on sea turtle conservation					

Goals, Objectives, Strategies	Activity	Partners	Time	Cost	Possible Funding Sources	Follow Up
Objective 1	Create media to inform the public on sea turtle conservation issues					
Strategy	Create PSA's and videos highlighting sea turtle conservation issues	Pelican Media Local high schools				
Strategy	Create rack cards detailing how to reduce impacts on sea turtles					
Strategy	Develop a recurring infographic to be published in local newspapers	Lovers Key State Park, Turtle Time, Pelican Media				
Goal 6	Conserve resources used by sea turtles in Estero Bay					
Objective 1	Conserve and restore natural resources in Estero Bay					
Strategy	Continue seagrass monitoring program		Biannually			
Strategy	Support collection of aerial imagery over seagrass areas	SFWMD, DEP, Lee County, Florida Gulf Coast University (FGCU), Sanibel Captiva Conservation Foundation (SCCF)	Biannually	$12,000/ $1,500	WCIND, SFWMD, SWFWMD, Lee County	See Sea Grass Protection Plan
Strategy	Continue oyster mapping program and implement restoration programs	The Nature Conservancy, Charlotte Harbor National Estuary Preserve, SCCF, FGCU	Continuous			
Strategy	Continue monitoring water quality throughout the bay	Charlotte Harbor Aquatic Preserve	Continuous			