CHAPTER 7: FACTORS AFFECTING LISTED SPECIES IN PLAN AREA

Sea turtles nesting on the County's beaches, as elsewhere in Florida, face a variety of natural and human-related threats (NMFS and USFWS 1991b and 2008). Natural threats include nest depredation and beach erosion. Various anthropogenic threats to nesting habitat include beach armoring, beach nourishment, coastal construction, artificial lighting, increased human presence on the beach at night, beach cleaning, recreational beach equipment, beach vehicular driving, and poaching. Threats to turtles in the water include oil and gas exploration, dredging, marina and dock development, debris entanglement, commercial fisheries, boats, power plant entrapment, and ingestion of marine debris (National Research Council 1990). Most pertinent to this HCP are impacts associated with coastal development and beachfront construction activities.

CBM within the Plan Area are also subjected to a variety of natural and anthropogenic threats (USFWS 1987). The most serious natural threats to the subspecies' long-term persistence include habitat loss due to storm events. Humans negatively influence CBM through beach driving, trespassing and littering in the dunes, fragmentation or elimination of habitat through coastal development and construction, shoreline protection measures, artificial lighting, and the introduction of free-roaming and predatory feral cats.

Additionally, a wide variety of natural and human-induced impacts potentially occur to threatened, endangered, and migratory birds along the beaches of Walton County. Natural erosion of nesting habitats and anthropocentric disturbances such as pedestrian or vehicular traffic, beach cleaning, free-roaming cats and dogs, and habitat loss due to beachfront development, can negatively affect birds. Birds utilizing the Plan Area might also be affected by trash on the beach, artificial lighting, and the eggs and/or young may be unintentionally crushed by vehicular traffic.

Because piping plovers only utilize Florida's beaches as wintering or migratory habitat, the loss and degradation of nesting habitat due to development, shoreline stabilization, natural predators, and free roaming pets, as has been documented in more northern Atlantic Coast states, is not an issue in Walton County (USFWS, 1988b). However disturbance of plovers in their resting and feeding habitats may occur.

While in Florida, typically from September through March, the piping plover is only mildly receptive to interaction with humans and is less tolerant of close interaction than many other shorebirds, such as sanderlings and ruddy turnstones. Upon approach, the piping plover will evade perceived threats by retreating on the ground to more distant locations (often seeking camouflage protection in sparsely vegetated dune areas) or may take to the air in search of sandy beach areas that appear free from disturbance. Free roaming pets may also cause birds to take flight.

Natural Events

Erosion Caused by Storms

Natural erosion of the beach can result in both direct and indirect impacts to listed species within the Plan Area. Direct impacts include the reduction and/or elimination of the nesting habitat for sea turtles and the foraging habitat for piping plovers. Erosion can also wash away the primary habitat for CBM and increase their susceptibility to overwash and drowning (USFWS 1987).

Erosion, inundation, and accretion appear to be the major abiotic factors negatively affecting incubating sea turtle egg clutches (NMFS and USFWS 2008). Short-term erosion events (e.g., storms) are a natural phenomenon throughout the tropics and subtropics where both the number of turtle nests and the amount of storm activity vary considerably from year to year. Turtles have evolved a strategy to offset episodic impacts to hatchling productivity by laying large numbers of eggs and distributing their nests both spatially and temporally (Milton *et al.* 1994). Thus, rarely is the total annual reproductive output of a particular nesting beach impacted by a storm event. However, chronic erosion exacerbated by human activities along the coastline can result in a permanent reduction in both the quantity and quality of available nesting habitat leading to long-term impacts to productivity (Milton *et al.* 1994). During erosion events, nests deposited closest to the water's edge may be completely washed out. Nests incubating higher on the beach can be uncovered or inundated with seawater during unusually high tides, both of which can reduce reproductive success.

Turtle nests that are not washed out of the beach may suffer reduced reproductive success as the result of tidal inundation. Eggs saturated with seawater are particularly susceptible to embryonic mortality (Bustard and Greenham 1968, Milton *et al*. 1994, Martin 1996). Accretion of sand above incubating nests may also result in egg and hatchling mortality. Lower berm elevations after a storm can reduce the amount of dry sand above the water table. Egg chambers constructed on these narrow, eroded berms often lie partially below the water table, resulting in partial or total mortality of the clutch (Robbin Trindell, FWC, *pers. comm.*) Although occasional overwash of nests on Hutchinson Island, Florida, appeared to have had minimal effect on reproductive success, prolonged or repeated exposure to tidal inundation resulted in fewer emergent hatchlings (Ernest and Martin, 1993). Ehrhart and Witherington (1987) reported that 17.5 percent of the loggerhead nests deposited in their Brevard County, Florida, study area did not emerge due to erosion, accretion, and storm surge. Within Walton County, 19 nests have been completely washed out since 2000 (SWTW unpublished data 2007). This represents about eight percent of the total nests deposited since that time. The majority (10) of the washouts occurred during 2005, a year that was notable for the passage of Hurricane Dennis.

Overwash associated with severe storm events can significantly alter beach mouse habitat and also cause direct mortality (USFWS 1987). An estimated 75 percent of the primary dune habitat at Fort Morgan State Park (Alabama) was lost as a result of Hurricane Elena

in 1984 (USFWS 1986). Although the reproductive strategy of the CBM is generally tailored to quickly recover from severe storm events, it is also dependent on the availability of back dune habitat within which the mice can take temporary shelter and obtain food resources until primary dunes have recovered. CBM depend not only on the conservation of the line of primary dunes, but also sufficient back dune (scrub habitat) in order to survive episodic storm events and avoid extinction. Habitat fragmentation and isolation of beach mouse populations renders them susceptible to even a single tropical storm event. As an example, the Perdido Key beach mouse was thought to have been extirpated from the Gulf Islands National Seashore following the passage of Hurricane Frederick in 1979 (Meyers 1983).

As mentioned, storm-induced erosion can cause the reduction and/or loss of foraging habitat for the piping plover and other migratory birds. Reduction of foraging intertidal habitat was documented on Dauphin and Little Dauphin Islands following Hurricane Elena (Johnson and Baldassarre 1988). Hurricane Katrina removed an estimated 85 percent of sand from the beach and dunes of the Chandeleur Islands, an area consistently used by over-wintering piping plovers (USGS unpublished data 2006). These losses are typically temporary, although population responses may be impaired if total remaining habitat is sparse relative to baseline levels (USFWS 1996). Severe winter storms are also thought to directly contribute to piping plover mortality (Fussell 1990).

Predation

Depredation of sea turtle eggs and hatchlings by natural and introduced species occurs on almost all nesting beaches. The most common predators in the State of Florida are ghost crabs (*Ocypode quadrata*), fire ants (e.g., *Solenopsis invicta*), raccoons (*Procyon lotor*), feral hogs (*Sus scrofa*), foxes (e.g., *Urocyon cinereoargenteus*) and armadillos (*Dasypus novemcinctus*). Given the low numbers of sea turtle nests within Walton County, each nest is marked and monitored daily for signs of predation. Available data suggest that predation is minimal. According to the South Walton Turtle Watch (SWTW), only three loggerhead nests out of 248 combined nests for all species have been depredated on County beaches since 2000 (SWTW unpublished data 2007). Thus, only about one percent of nests in recent times have been destroyed by predators. Foxes were implicated in all three instances. Free roaming dogs and cats, as well as coyotes have also been reported to dig into sea turtle nests, although none were successful in reaching the eggs.

Beach mice have a number of natural predators including snakes, owls, herons, bobcats, skunks, foxes, and raccoons. Some studies have suggested that the impact of natural mammalian predators alone is relatively insignificant (Frank and Humphrey 1996). However, predation pressure from both natural and non-native predators may result in the extirpation of fragmented, local populations of beach mice in a very short time. There is no available data regarding natural predation rates of beach mice within the Plan Area.

The Recovery Plan for the Piping Plover Atlantic Coast Population (USFWS 1996) lists foxes, skunks, raccoons, opossums, crows, ravens, gulls, grackles, American kestrels, peregrine falcons, and ghost crabs as natural predators of piping plover chicks and eggs.

Over-wintering adult piping plovers within the Plan Area are less susceptible to predation than are their eggs and chicks in their summer nesting areas. Although undoubtedly natural predation of adult plovers does occur at over-wintering sites, the USFWS does not consider it to be a significant factor affecting their survival.

Human-related Activities

Human Beach Usage

According to the Beaches of South Walton Tourist Development Council (TDC), County beaches attract about 2.3 million visitors per year. The presence of humans in general and the various activities they undertake at the beach can have both direct and indirect effects on listed species within the Plan Area. Principal effects of human presence on the beach include disturbances to nesting sea turtles, disturbances to nesting, resting, and foraging shorebirds, and physical degradation of habitat of all covered species.

Until a nesting sea turtle begins laying eggs, she may be frightened back into the ocean by human activity and lighting on the beach (McFarlane 1963). It is not known if the fright response has a long-term negative effect on nesting success. Once a turtle leaves the beach, she may return to the same location or select a new site later that night or the following night. However, repeated interruption of nesting may cause a turtle to place her nest in a sub-optimal incubation environment (Murphy 1985). The extent to which heavy nighttime beach use by humans may cause a turtle to abandon its historical nesting range is not known.

Little information is available on the potential impacts of typical beach visitors on adult and hatchling sea turtles on the beaches of Walton County. Visitors using flashlights or lanterns on the beach at night during the nesting season can cause nesting turtles to leave the beach and hatchlings to become temporarily disoriented. Direct harassment may also cause adult turtles to abandon nesting efforts (Johnson *et al*. 1996). Although illegal, handling, playing with, or collecting hatchling sea turtles may potentially occur on County Beaches. This may cause desiccation and fatigue and reduce the survivorship of hatchlings once they are released into the surf.

Deep holes dug on the beach may impede nesting turtles during their nesting ascent onto local beaches and trap hatchlings as they migrate from the nest to the Gulf. As discussed later, recreational furniture left on the beach overnight poses similar problems.

It is unlawful for beach visitors to be in the dune vegetation or to disturb sea turtle nests, hatchlings, or adults. Nevertheless, uninformed beachgoers, particularly children, have been reported digging into nests on other Florida beaches in search of eggs and/or hatchlings, presumably out of curiosity. On other Florida beaches, human poaching of turtle nests has been a problem (Ehrhart and Witherington 1987). However, there have been no confirmed reports of nest poaching within Walton County since 2000.

Impacts of beachgoers to sea turtles are often indirect. Research has shown that human footprints on the beach can interfere with the ability of hatchlings to reach the ocean (Hosier *et al*. 1981), and heavy pedestrian traffic may possibly compact sand over unmarked nests. Visitors are generally sympathetic to hatchlings that are having difficulty crawling to the ocean and may pick them up and release them into the surf. The negative impacts of this activity may include some loss of imprinting to the beach (LeBuff 1990) and an inability to establish a seaward direction during the hatchlings' offshore migration (Lohmann and Lohmann 1994).

The most apparent problem to CBM caused by beachgoers is physical damage to dune structure and vegetation caused by walking on the dunes (Frank and Humphrey 1996). Although pedestrian beach access within Walton County is largely controlled via public and private dune crossovers, foot traffic through the dunes can occur. Footpaths through the dune fragment CBM habitat. Like all oldfield mice, CBM construct and maintain burrows along the primary dune system. Because the escape tunnels of these burrows generally rise from the nest chamber to just below the surface of the dune, they are extremely vulnerable to crushing via trampling by humans. Coastal dunes on public lands are theoretically protected from pedestrian traffic (F.A.C. 62D-2 2.013(2)), however there are no such regulations protecting the dune environment on private lands.

Frank and Humphrey (1996) found that beach mice were regularly attracted to refuse containers placed directly on the beach in St. Johns County, Florida. The mice would often enter the drainage holes in the bottoms of the containers. The researchers found that by mounting the containers on posts and elevating them above the ground, the attraction of the cans was reduced. However, beach mice will forage on refuse in the vicinity of the trash containers, even if the cans are elevated. Garbage on the beach draws beach mice away from the dune and onto other portions of the beach, thus placing the mice at risk. Trash may also attract predators of beach mice. These potential impacts demonstrate the importance of effective trash management.

Pedestrians on the beach can potentially harass resting or foraging piping plovers and may deter them from using otherwise suitable habitat (USFWS 1996). Numerous studies have demonstrated that piping plovers preferentially select beaches that are relatively free of human disturbance (Burger 1991; Hoopes 1993; Elias-Gerkin 1994). Other studies indicate that human disturbance reduces the amount of time that piping plovers spend feeding (Johnson and Baldassare 1988, Haig 1992), which could limit an individual's ability to survive its lengthy migration. Upon approach, piping plovers and other shorebirds will evade perceived threats by taking to the air in search of areas that appear free from disturbance. Such flights require an unnatural expenditure of energy. Other activities related to human presence that may be disturbing to plovers include fireworks (Howard *et al*. 1993) and the flying of kites (Hoopes *et al*. 1992).

Vehicles on Beach

The different types of vehicles and vehicular activities within the HCP Plan Area can be partitioned into the following categories:

- Public safety operations, such as those involving lifeguards, emergency vehicles, and law enforcement vehicles;
- Public vehicular access;
- Commercial vendors;
- Routine beach maintenance and sanitation;
- Activities necessary to implement the terms and conditions of the HCP and ITP (e.g., protected species monitoring, HCP management, etc.);
- Code enforcement;
- Planned coastal construction projects properly permitted by local, State, and/or Federal regulatory agencies, such as seawall repairs, beach nourishment, and restoration;
- Emergency shoreline protection projects properly permitted by local, State, and/or Federal regulatory agencies; and
- Non-routine beach maintenance and sanitation, such as storm cleanup and removal of hazardous materials, debris and/or obstacles from the beach that pose a public health or safety risk following storms and other unforeseen circumstances.

Table 5 summarizes the estimated vehicular use of Walton County beaches. The frequency with which these various vehicular activities occur on County beaches is highly variable. Certain activities, such as lifeguard access, trash collection, and Sheriff's Department patrols, occur on a daily basis. Vehicular trips for code enforcement activities occur on average about twice per week with peak usage during the summer, while non-HCP related environmental vehicular trips occur on average about five times per year. Non-routine services that require vehicular access include such activities as sign and boardwalk maintenance, removal of discarded beach furniture and safety hazards, planting of dune vegetation, placement of lifeguard stands, storm damage assessment, emergency service, and various public works projects. These activities occur throughout the year on an as-needed basis. For example, the Public Works Department occasionally accesses the beach with vehicular equipment to manually open closed beach connections (inlets) between the Gulf and coastal dune lakes to allow drainage and/or water exchange. This particular activity is authorized under a FDEP Joint Coastal Permit.

The TDC services over 400 trash receptacles on the beach 365 days a year. This maintenance activity is accomplished using 1 to 2 ton trucks. Other activities involving vehicles include, but are not limited to, safety sign maintenance, boardwalk maintenance, removal of recreational furniture left on the beach, flag pole maintenance, filling in large holes left by beach visitors, removal of obstacles that pose a human health or safety hazard, and assisting with deployment of lifeguard stands and boxes. Vehicles and equipment used for these activities include a tractor, a Bob Cat, rakes, lifts, and trailers, depending on specific needs.

Commercial vendors are permitted to utilize all-terrain vehicles to assist in the setting up and breaking down of vending sites. The types of vehicles used for these services include light trucks, all-terrain vehicles, tractors, and cranes. Rental and leased beach furniture

and recreational equipment are stored overnight in boxes located near the dune line. Vendors use vehicles to deploy and retrieve these storage boxes at the beginning and end of each tourist season.

Table 5. Summary of Vehicular Use on Walton County Beaches.

Type of Activity	Estimated Frequency	Vehicle Type
Sheriff's Patrol	3-4 Trips Daily	Light Truck, All-Terrain Vehicle
Lifeguard	Daily	Light Truck, All-Terrain Vehicle
Trash Collection	Daily	Light Truck
Code Enforcement	Twice Per Week Primarily During Tourist Season	Light Truck
County Environmental	Five Times Per Year	Light Truck
County Building Dept.	A Few Times Per Year	Light Truck
Beach Maintenance	Occasional	Trucks, Tractors, Bobcats, Lifts, and Trailers
Public Works Projects	Occasional	Trucks, Excavators, Tractors
Commercial	Daily	All-Terrain Vehicle
Public	Unknown[1]	Light Truck

[1] The frequency of public driving on the beach is unknown; however, the County issued 972 beach driving and 65 vessel launch permits from June 2007 to June 2008.

Public vehicular use of the beach is governed by County Ordinance 2003-07, which requires that a County permit be obtained for beach driving. Beach driving permits are restricted to Walton County property owners and immediate family members and driving is limited to designated areas from sunrise to 10:00 PM. There are currently two designated limited access beach driving areas. They are located within the vicinities of Grayton Beach and Inlet Beach (Figure 3). Permitted vehicles at Grayton Beach are provided with an approximately 1,270-foot (387-m) long driving area. An approximately 66-foot (20-m) wide vehicular access point is available to the public for launching watercraft at Inlet Beach. In the one-year span from June 2007 to June 2008, 972 beach driving permits and 65 vessel launch permits were issued to County residents.

In Walton County all sea turtle monitoring activities are conducted on foot, and thus there is no potential for vehicular impacts. However, there may be other types of scientific monitoring and studies that could occasionally require vehicular access to County beaches.

Vehicular activities on the beaches of Walton County have the potential to impact sea turtles, CBM, and piping plovers, as discussed below. As summarized in Table 6, adult, hatchling, and live stranded sea turtles, including post-hatchling washbacks, may be run over by vehicles. Eggs in incubating nests may be crushed by the weight of vehicles. Additionally, vehicle lights at night might deter nesting turtles from emerging from the

Table 6. Potential Vehicular Impacts to Protected Species Within the Plan Area.			
Life History Stage	**Type of Impact**	**Impact Description**	**Minimization Measures**
Adult Sea Turtles, Shorebirds, and Beach Mice	Direct	Vehicles may run over listed species	• Do not allow general public to operate vehicles on beach at night • Limit public driving hours and locations • Limit nighttime vehicle operations to public safety, sea turtle monitoring, and other official activities required to implement the HCP • Limit routine nighttime operation of authorized vehicles to the extent practicable • Require authorized vehicles to operate at slow speed • Avoid driving on or near dunes • Require training of HCP personnel to review beach driving procedures • Implement procedures to protect nesting sea turtles from vehicular impacts during rare daytime nesting events
		Vehicle headlights may frighten turtles from the beach or deter others from emerging from the ocean	• Do not allow general public to operate vehicles on beach at night • For vehicles authorized to conduct nighttime operations, turn off headlights when vehicles are at rest • Require training of new personnel to review nighttime operation procedures
		Vehicles may flush resting or foraging shorebirds	• Avoid driving through flocks of shorebirds • Require training of new HCP personnel to review standard vehicle operation procedures • Establish protected shorebird areas with limited vehicular access

Table 6.
(Continued)

Life History Stage	Type of Impact	Impact Description	Minimization Measures
Adult Sea Turtles, Shorebirds, and Beach Mice	Indirect	Vehicles may degrade habitat	• Confine public traffic to marked driving areas • Prevent driving and parking near the dune • Close off known locations where vehicles illegally travel through dune habitat when accessing the beach from upland properties • Limit operation of authorized vehicles in soft-sand areas of the beach to the extent practicable • Require restoration of dune and beach habitat following coastal construction activities
		Vehicles may compact sediments	• Require beach maintenance and sanitation vehicles to operate near the waterline where possible and/or use light-weight vehicles with wide, low-pressure tires • Do not allow heavy construction equipment on the beach during the sea turtle nesting season, except for emergency or unusual situations as authorized by the ITP

Table 6.
(Continued)

Life History Stage	Type of Impact	Impact Description	Minimization Measures
Sea Turtle Eggs	Direct	Vehicles may run over nests and crush eggs	• Survey for new nests before vehicular traffic is allowed on the beach each day • Conspicuously mark sea turtle nests so they can be avoided • Do not allow heavy construction equipment on the beach during the sea turtle nesting season, except for emergency or unusual situations as authorized by the ITP
Sea Turtle Eggs	Indirect	Vehicles may compact sediments over a nest and thereby affect gas exchange within the egg chamber	• Survey for new nests before vehicular traffic is allowed on the beach • Conspicuously mark sea turtle nests so they can be avoided
		Vehicles may deposit contaminants (e.g., oil, coolants, etc.) on the sand that may affect the incubation environment	• Confine public traffic to marked vehicle access areas

Table 6.
(Continued)

Life History Stage	Type of Impact	Impact Description	Minimization Measures
Sea Turtle Hatchlings	Direct	Vehicles may compact sediments over a nest and impede hatchling emergence	• Survey for new nests before public traffic is allowed on the beach • Conspicuously mark sea turtle nests so they can be avoided
		Vehicles may run over hatchlings as they migrate from the nest to sea	• Do not allow general public to operate vehicles on beach at night • Limit nighttime vehicle operations to public safety, sea turtle monitoring, and other official activities required to implement the HCP • Limit routine nighttime operation of authorized vehicles to the extent practicable • Require authorized vehicles to operate at slow speed • Require headlights to be turned on at night when authorized vehicles are moving so hatchlings can more easily be seen • Require training of new HCP personnel to review nighttime operation procedures • Implement procedures to protect hatchlings from vehicular impacts during rare daytime hatching events

Table 6.
(Continued)

Life History Stage	Type of Impact	Impact Description	Minimization Measures
Sea Turtle Hatchlings	Indirect	Vehicle headlights may disorient hatchlings as they travel from the nest to sea	• Do not allow general public to operate vehicles on beach at night • For vehicles authorized for nighttime operations, turn off headlights when vehicles are at rest • Require training of HCP personnel to review nighttime operation procedures
		Vehicles may leave ruts that impede a timely migration from the nest to sea	• Limit public traffic to designated areas of the beach • Limit operation of authorized vehicles in soft-sand areas of the beach to the extent practicable • Encourage the use of light-weight vehicles with wide, low-pressure tires for beach maintenance activities • Implement a program to remove ruts from in front of nests nearing hatching • Do not allow heavy construction equipment on the beach during the sea turtle nesting season, except for emergency or unusual situations as authorized by the ITP
Stranded Sea Turtles	Direct	Vehicles may run over a live stranded turtle	• Implement procedures to report sea turtle strandings and protect live stranded turtles from vehicular impacts

ocean, frighten nesting females already on the beach, and/or disorient emergent hatchlings during their crawl from the nest to the Gulf. A secondary effect of vehicular traffic on the beach is the potential for compacting sediments under the weight of cars, trucks, and heavy equipment. Compaction is an important consideration for sea turtle conservation, because if sediments are too compact, a female turtle may have difficulty excavating an egg chamber of adequate depth or dimensions (Raymond 1984, Ryder 1990, Carthy 1994, Ernest and Martin 1999). She may also have to dig more often before finally constructing a suitable egg chamber, or she may abandon the nesting attempt altogether. Increased energy expenditures during the course of nesting may place a higher reproductive cost on that individual. Additionally, if the chamber is poorly constructed, the fate of the eggs may be affected. For example, if the chamber is too shallow, eggs are more susceptible to erosion, predation, and disturbance from activities on the beach.

In a cursory assessment of the impact of beach driving, Fletemeyer (1995) found that sediment compaction levels in Volusia County were higher in two areas routinely driven on than in nearby non-driving areas. However, it is unclear what steps were taken in that study to isolate driving effects from other physical beach variables that influence compaction (e.g., sediment type, tidal influence, etc.). In a related assessment, Fletemeyer (1995) repeatedly drove an SUV over a section of beach where public driving was prohibited. Although he found that compaction values were greater after the vehicle made its passes than before, the highest values obtained were well below those typically regarded as detrimental to sea turtle nesting by the FWC and USFWS (500 psi).

It is widely reported that vehicular ruts left in the sand create obstacles for hatchlings attempting to reach the ocean. Upon encountering a vehicle rut, hatchlings may be misoriented along the vehicle track, rather than cross over it to reach the water. Apparently hatchlings become diverted, not because they cannot physically climb out of the rut (Hughes and Caine 1994, Arianoutsou 1988), but because the sides of the track cast a shadow that disrupts their sea-finding ability (Mann 1977). At least two studies have confirmed hatchling disorientation by vehicular ruts (Cox *et al.* 1994, Hosier *et al.* 1981). In one study, tire ruts were found to cause nearly 21 percent of hatchling turtles to invert (flip over). If hatchlings are trapped or detoured by vehicle ruts, they are at greater risk to predators, fatigue, and desiccation. Live and desiccated turtles have been found trapped in deep vehicle ruts (LeBuff 1990).

Little information is documented about the direct and indirect impacts that beach driving might have on CBM or other subspecies of beach mice. Most of the impacts to beach mice due to vehicular driving are probably indirect, insofar that mice primarily occupy dune habitat that is off limits to vehicles. However, it is possible that a vehicle driving on the beach at night could run over a foraging mouse. Another direct impact of public vehicles on the beach is that headlights may frighten or disrupt nocturnal CBM activities.

Indirect impacts to CBM include habitat degradation, deposition of contaminants, and other indirect effects associated with vehicular access to remote beach regions. Frank and Humphrey (1996) reported that regular beach driving can degrade habitat for beach

mice by pruning back pioneering beach vegetation and thereby prohibiting seaward dune growth on the upper beach. The only segment of beach in Walton County where a known beach mouse population and public beach driving overlap is in the vicinity of Grayton Beach State Park. Vehicle traffic within the known distribution of the other two CBM populations (i.e., Topsail Hill Preserve and Deer Lake State Parks) is minimal, consisting solely of infrequent trips made by law enforcement or emergency service personnel.

The FWS considers unrestricted use of motorized vehicles to be a serious threat to piping plovers and their habitats (FWS 1996). Vehicles on the beach have the potential to run over over-wintering piping plovers and can degrade piping plover foraging habitat and/or disrupt normal behavior patterns. At least one study has documented direct mortality of adult plovers as a result of being run over by vehicles (Melvin *et al*. 1994). Zonick (2000) found that the density of certain types of vehicles on the beach was negatively correlated with the abundance of roosting plovers on the beach. Wheeler (1979) demonstrated that vehicles driving on the beach have an adverse effect on the abundance of the infauna essential for piping plover foraging requirements. Vehicles can crush wrack into the sand, thus making it unavailable for cover or as foraging habitat (Hoopes *et al*. 1992). Vehicles that drive close to the dune can destroy pioneering dune vegetation that may also provide important plover habitat (Elias-Gerkin 1994).

Beach Management Activities

A variety of beach activities, including weddings, fireworks displays, and surfing contests, on County beaches are regulated under the Beach Activities Ordinance (2003-07). For example in 2008, Walton County issued 275 permits for beach weddings involving the temporary placement of chairs and tables on the beach. These events, if improperly conducted and managed, have the potential for physically impacting unmarked sea turtle nests and disturbing dune habitat. Fireworks are disruptive to sea turtle nesting, may disorient hatchlings, frighten resting shorebirds, and disturb the nocturnal activities of beach mice. Thirty (30) permits for fireworks displays were issued by Walton County in 2008 and many more fireworks were likely detonated without the required permits.

Another activity permitted by the County is the burning of bonfires on the beach. As for fireworks, bonfires can be disruptive to the normal behavior of sea turtles, shorebirds and beach mice. Emerging sea turtle hatchlings may actually be drawn into the fires with fatal consequence. The County's Code Enforcement Department issued 17 annual permits for bonfires in 2008. However, the Sheriff's Department also issues similar 2-3 night permits to renters and tourists. The exact number of the latter is not known, but it is assumed to be considerable.

The County issues permits and regulates the sale, rental, and leasing of recreational equipment and services on the beach through its Beach Activities Ordinance (2003-07). Approximately 30 permits are issued for beach vending activities each year. Services/equipment provided by the vendors include rental of beach chairs and umbrellas, parasail and jet ski concessions, rental of beach towels, sale of drinks, snacks, suntan

lotion, and water rides. These daily activities, which occur during the height of the sea turtle nesting season have the potential to physically impact unmarked sea turtle nests and degrade dune habitat. If vendor equipment is set up too early, sea turtle crawls may be obliterated prior to the daily arrival of the sea turtle monitoring personnel.

The County allows vendors who rent or lease recreational beach furniture to place temporary storage boxes on the beach to store their equipment overnight. Placement of these structures is regulated by Section 10 of County Ordinance 2003-07, which states the boxes "…must be placed as far landward as possible but seaward of the [dune] vegetation lines". However, each vendor may have 10-15 storage boxes. Consequently, their placement preempts a considerable amount of potential nesting habitat and could affect natural accretion of dune habitat.

Artificial Lighting

Both nesting and hatchling sea turtles are adversely affected by the presence of artificial lights near the beach (Witherington and Martin 2000). Experimental studies have clearly demonstrated that bright lights can deter adult female turtles from emerging from the ocean to nest (Witherington 1992). Thus, not surprisingly, many researchers have noted a relationship between the amount of lighted beach development and sea turtle nest densities. For example, Mattison *et al.* (1993) noted that emergences of nesting turtles in Broward County, Florida, were reduced in areas where lighted piers and roadways were near the beach. In areas where a glow of artificial light is present behind the dune, loggerhead turtles prefer to nest in the darker areas silhouetted by tall buildings and dune vegetation (Salmon *et al.* 1995a).

Although there is a tendency for turtles to prefer dark beaches, many do nest on lighted shores. As noted by Witherington and Martin (2000), in doing so, they place the lives of their offspring at risk. Artificial lighting can impair the ability of hatchlings to properly orient to the ocean once they leave their nests. Hatchlings have a tendency to orient toward the brightest direction. On natural undeveloped beaches, the brightest direction is almost always away from elevated shapes and their silhouettes (e.g., dune, vegetation, etc.) and toward the broad open horizon of the sea. On developed beaches, the brightest direction is often away from the ocean and toward lighted structures. Hatchlings, unable to find the ocean or delayed in reaching it, are likely to incur high mortality from dehydration, exhaustion, or predation (Carr and Ogren 1960, Witherington and Ehrhart 1987, Witherington and Martin 2000). Hatchlings lured into lighted parking lots or toward street lights are often crushed by passing vehicles (McFarlane 1963, Philibosian 1976, Peters and Verhoeven 1994, Witherington and Martin 2000).

Sea turtle monitoring personnel in Walton County reported that hatchlings emerging from 78 of the 499 (16 percent) sea turtle nests (all species combined) documented on County beaches between 1997 to 2007 were disoriented by artificial lighting. This number is conservative, because not all nests documented during that period produced hatchlings (many were lost to erosion). The number of nests disoriented each year has varied considerably; the highest percentage of nests disoriented (31.6%) was reported in 2007

(Figure 8). Mortality from these events can be severe: of the 291 disoriented hatchlings documented in 2007, only 40 (14 percent) were able to eventually reach the Gulf of Mexico.

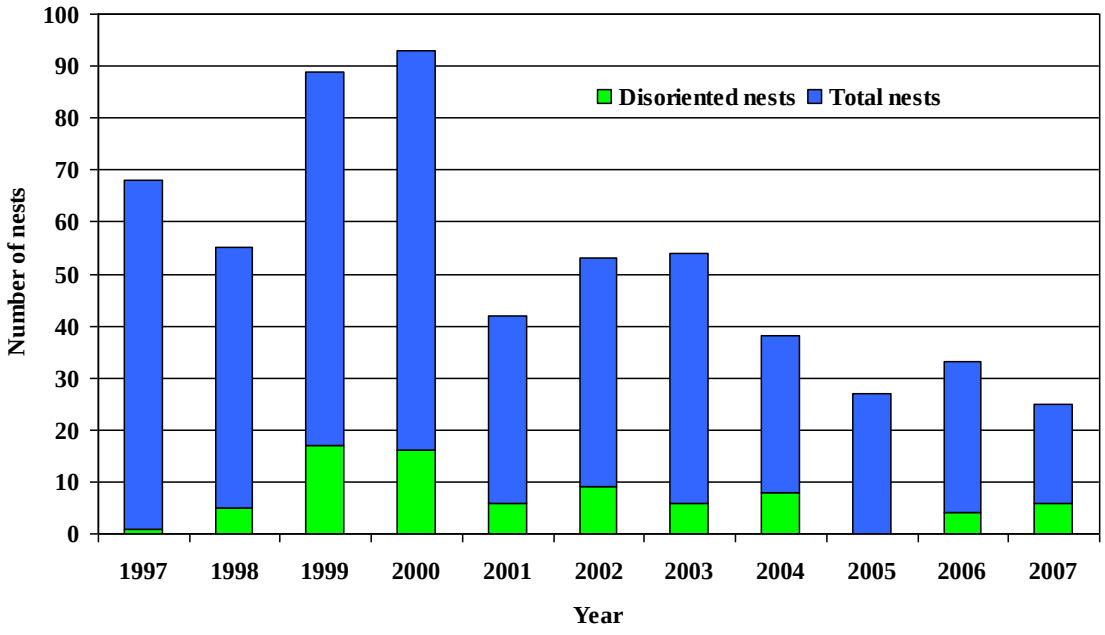
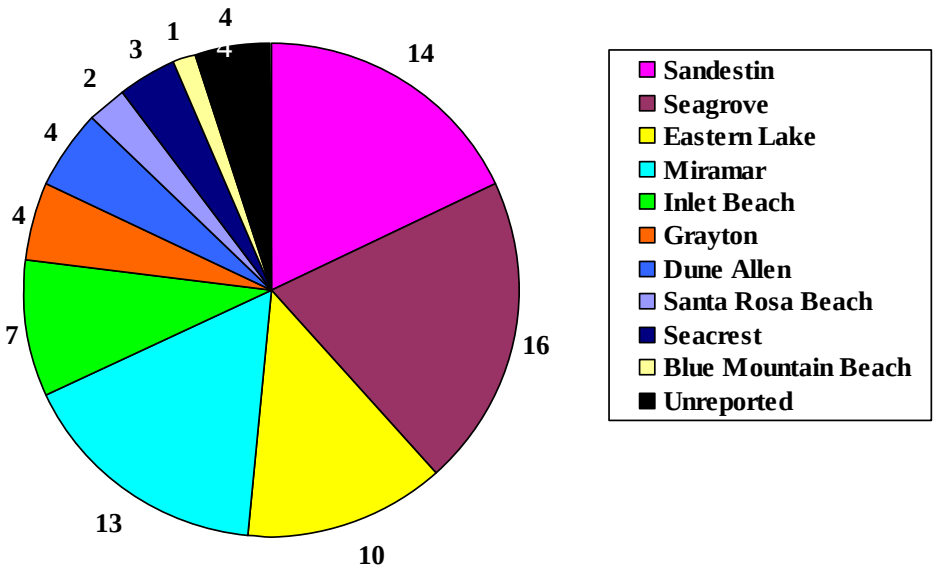


Figure 8. Number of nests, all species combined, from which emergent hatchlings are disoriented each year by artificial beachfront lighting, 1997-2007. Source: FWC, 2008.

Figure 9. Location of hatchling disorientations in Walton County, 1997-2007. Source: FWC, 2008.



Historical disorientations have been concentrated primarily within the unincorporated areas of Miramar Beach and Sandestin in the western portion of the County, and Seagrove and Eastern Lake within the east-central portion of the County (Figure 9). A variety of light sources have been implicated in hatchling disorientation within the County, including interior and exterior lights associated with single-family homes, condominiums, and restaurants; street lights; overall sky glow; and vehicle headlights.

Beach mice are nocturnal and are most active on the darkest nights between the new and half moon (Blair 1951). Accordingly, artificial light can potentially influence the natural foraging patterns and movements of CBM. Beach mice generally avoid areas of artificial lighting or reduce the amount of time spent foraging in lighted areas (Bird 2004). Additionally, CBM are more easily seen in lighted areas, and thus, are likely more susceptible to predation.

Due to their sensitivity to artificial lighting, both hatchling sea turtles and CBM could be affected by beach bonfires. County ordinance 2003-07 regulates the use of fires on County beaches. The ordinance stipulates that no fires are allowed within 100 ft (30.5 m) of a marked sea turtle nest or within 50 ft (15.2 m) of the dune vegetation line, and the fire must be contained within a County-issued burn barrel. Individuals who wish to have a fire on the beach must first receive a permit from the County Beach Activity Coordinator. The permit is valid for a 24-hour period. Owners of property adjacent to the beach can obtain a single permit, but must notify the Beach Activity Coordinator whenever a fire will be burned. Beachfront property owners are exempt from having to use burn barrels. On average, about 17 permits are issued each year to persons wanting to have a bonfire on the beach.

Free Roaming Pets and Feral Animals

Free roaming dogs and cats have been documented to predate nests and hatchling turtles within Florida (NMFS and USFWS 1991a and 2008). Within Walton County, observers identified a dog digging into a loggerhead nest in 2000, although the eggs were not damaged in that instance (SWTW, unpublished data). Animals on the beach at night also have the potential to disrupt nesting activities and hatchling migration to the ocean. In 2000, SWTW personnel documented a cat with a hatchling in its mouth (Sharon Maxwell, SWTW, *pers. comm.* 2006).

Predation by feral cats is considered to be one of the most serious threats to beach mouse populations. Predation of CBM by cats has been documented by Van Zant and Wooten (2003). Free roaming pets and feral animals can be devastating to beach mice populations through direct predation and harassment (Bowen 1968, Linzey 1978). Feral cat predation is believed to have been responsible for the extirpation of a population of the Alabama beach mouse on Ono Island (Holliman 1983). Frank and Humphrey (1996) determined that cat predation was a significant factor affecting the long-term persistence and population numbers of other subspecies of beach mouse. In a single experiment, Frank (1996) demonstrated that the population of the Anastasia Island beach mouse

(*Peromyscus polionotus phasma*) increased approximately 20 percent after a sweeping cat control program was initiated at a State park in St. Johns County, Florida. Consequently, there is a general consensus among experts that control of free roaming domesticated and feral cats in beach mouse habitat is an essential management strategy in reducing the subspecies' vulnerability to extinction.

Beach-dwelling birds are not well adapted to co-exist with feral and/or free roaming domesticated cats, which have evolved specifically to hunt birds and are much more nimble than most of their natural predators. Feral cats can catch and kill piping plovers, and are thought to be significant plover predators at some over-wintering sites (Goldin *et al*. 1990, Post 1991). Dogs on the beach can greatly disturb shorebirds, particularly when they are unrestrained by a leash. One study suggests that plover disturbance behavior stimulated by dogs was significantly greater than that caused by pedestrians (Hoopes 1993). Disturbed plovers often fly away, requiring an expenditure of energy and reducing the time the birds spend foraging (Burger 1991).

Regulations concerning domesticated animals on the beach are contained within County Ordinance 2008-24. Dogs other than sight, hearing impaired, or other service animals are prohibited from the beaches in Walton County unless the owner has a County permit. The permit allows leashed dogs on the beach between 4:00 PM and 8:00 AM of the following day during Daylight Savings Time, and between the hours of 3:00 PM and 9:00 AM of the following day during Standard Time. Only Walton County real property owners and permanent residents may obtain a permit. However, beachfront residents whose property extends onto the sandy beach are exempt from these regulations.

Despite the regulations noted above, it is reported that a local group(s) has established and maintains cat feeding stations at various public beach access points along the County's beaches. The USFWS reports that the group has conducted trapping operations in the Seaside community to capture, neuter, and then release the cats back into the coastal environment (J. Moyers, St. Joe Timberlands Co., *pers. comm.* 2009, as conveyed by L. Patrick, USFWS). Although these operations may help control the expansion of cat colonies, they perpetuate the colonies by creating a dependence on human feeding.

Physical Structures

Permanent physical structures constructed on the beach or dune can potentially impact sea turtles and beach mice. There are several wooden overlook pavilions in Walton County that have been constructed directly on the primary dune that are associated with community developments. The County must also periodically construct ADA-compatible beach crossovers at public access points. Because they are configured to accommodate wheel chairs and similar transport devices for the handicapped, they typically extend onto the dry sandy beach and therefore cover otherwise suitable sea turtle nesting habitat. Public and private pedestrian dune crossovers are common throughout the County. If placed low enough on the beach, these types of structures provide obstacles to nesting sea

turtles and hatchlings attempting to reach the ocean. Stairs of dune walkovers similarly pose obstacles to nesting turtles. The structures also preempt or degrade primary habitat for the CBM through the elimination of forage material and facilitation of erosion. Construction of pavilions and dune walkovers is regulated by Section 4.02.06 of the Walton County Land Development Code (LDC), which contains restrictions on the amount of existing vegetation that can be disturbed and stipulates that structures must be constructed to allow for animal movements.

Recreational Equipment

Individual beachgoers, resorts, and commercial vendors utilize and store a variety of recreational equipment on the beaches of Walton County. Items typically brought to the beach include tents, umbrellas, beach chairs of all types, and inflatable boats. The use of these types of equipment is particularly high within the western portion of the County between Topsail Hill Preserve State Park and the Okaloosa County Line.

The use and storage of recreational equipment on sea turtle nesting beaches can hamper or deter nesting by sea turtles and trap and/or impede hatchlings during their nest to sea migration. The recovery plan for the Northwest Atlantic loggerhead sea turtle (NMFS and USFWS 2008) indicates "the documentation of non-nesting emergences (also referred to as false crawls) at these obstacles is becoming increasingly common as more recreational beach equipment is left on the beach at night". The recovery plan cites documented reports of adult turtles being trapped under heavy wooden lounge chairs and cabanas, eggs being destroyed by beach umbrellas penetrating the egg chamber, and hatchlings being hampered during emergence by equipment inadvertently placed on top of the nest. The extent to which recreational equipment is impacting turtles in Walton County is unknown; however, the SWTW has indicated that it is a significant factor in sea turtle nesting success (S. Maxwell, SWTW, *pers. comm*. 2006).

Impacts to CBM or piping plovers due to the presence of recreational equipment on the beach have not been documented in Walton County. Damage to dune vegetation caused by the placement of recreational equipment could contribute to CBM habitat loss or degradation. Beach chairs or other equipment, if present in sufficient density, could potentially preempt foraging habitat for the piping plover.

The placement and storage of recreational equipment within Walton County is regulated by County Ordinance 2003-07. Section G of the ordinance states that "it shall be unlawful for beach chairs, umbrellas, tents, and other such personal articles to be on the beach in such a manner that they interfere with beach maintenance, nesting turtles, or emergency vehicles. To minimize impacts to nesting turtles and emerging hatchlings, the ordinance declares that it is unlawful to leave these articles on the beach overnight (sunset to sunrise). Nonetheless, public beachgoers have in the recent past routinely left or discarded items on the beach and vendors often begin setting up equipment on the beach before sunrise (S. Maxwell, SWTW, *pers. comm*. 2009). To reduce the incidence of these "unlawful" activities, the TDC recently instituted the "Leave No Trace" public awareness campaign. Any item left on the beach at night is now tagged, and the property

considered abandoned 24 hours after tagging, at which time it may be removed from the beach. No information is currently available on the effectiveness of this campaign in reducing or eliminating overnight storage of recreational equipment.

Shoreline Protection

Armoring

Approximately 18 percent (149 mi; 240 km) of Florida's beaches are armored (Schroeder and Mosier 2000). Seawalls, rock revetments, and other types of armoring structures are constructed to prevent both landward retreat of the shoreline and inundation or loss of upland property by wave action or flooding (Kraus and McDougal 1996). Although these structures can be effective in protecting beachfront property during certain storm conditions, they do little to promote or maintain sandy beaches.

Armoring structures may affect all of the species covered under this HCP insofar as they can influence the natural shoreline processes and the physical beach environment. However, current understanding of these effects is incomplete. It is clear that seawalls prevent long-term recovery of the beach/dune system (i.e., building of the back beach) by physically prohibiting dune formation by wave uprush and wind-blown sand. However, reported topographic effects seaward and adjacent to seawalls often vary and conflict between project sites (Kaufmann and Pilkey 1979, Pilkey *et al*. 1984, Kraus and McDougal 1996). Much of the controversy surrounding these effects can be attributed to the difficulty in distinguishing what Pilkey and Wright (1998) term "active" and "passive" erosion. Active erosion results from the interaction of an armoring structure with local coastal processes. Passive erosion relates to the natural tendencies of the shoreline (e.g., erosion or accretion) at a site prior to the presence of a structure.

Erosion of adjacent downdrift beaches can occur if the updrift wall acts as a jetty and impounds sand (Kraus 1988, Tait and Griggs 1990). Additionally, seawalls can cause wave reflection and scour, processes that accelerate erosion seaward of the structure and steepen the offshore profile (Pilkey *et al.* 1984). Sand can move alongshore past a seawall, but it is not clear if the longshore sediment transport rate changes (Kraus and McDougal 1996). Pilkey *et al.* (1984) contend that the intensity of longshore currents does increase in front of seawalls and this hastens removal of beach sand. Most likely, the extent to which any of these potentially harmful effects may be realized is largely dependent upon a structure's physical position on the beach relative to the surf zone (Kraus 1988, Tait and Griggs 1990). The closer a seawall is to the surf zone, the greater its potential for altering shoreline processes.

Both temporary and permanent structures on the beach can induce changes in the nesting habitat of sea turtles. Beaches seaward of seawalls and other armoring structures are typically narrower than natural unarmored beaches (Pilkey and Wright 1988). On eroding shorelines, poorly designed and sited seawalls may increase swash velocity, duration and elevation, thereby accelerating erosion in front of the structure (Plant and Griggs 1992, Terchunian 1988). Additionally, buried portions of a seawall may alter

beach porosity, permeability, beach groundwater elevation, and beach slope variability. Collectively, these changes in beach characteristics can diminish the quality of the beach as nesting habitat for sea turtles.

Considerable anecdotal information exists to support this contention. However, there have been few experimental studies designed specifically to assess the impacts of armoring structures on sea turtle nesting. Mosier (1998) and Mosier and Witherington (2000) recorded the behavior of nesting turtles in front of seawalls and adjacent unarmored sections of beach. Both studies reported that fewer sea turtles made nesting attempts on beaches fronted by seawalls than on adjacent beaches where armoring structures were absent. Of those turtles that did emerge in the presence of seawalls, proportionally fewer nested. Additionally, Mosier (1998) found that turtles on armored sections of beach tended to wander greater distances than those that emerged on adjacent natural beaches. It is unknown if this additional energy expenditure might reduce annual reproductive output.

Studies by Mosier (1998) and Mosier and Witherington (2000) indicate that seawalls diminish nesting success and may create suboptimal nesting habitat for sea turtles. Seawalls can effectively eliminate a turtle's access to upper regions of the beach thereby causing them to nest closer to the water (Witherington *et al*. In Prep.). Consequently, nests on armored beaches were generally found at lower elevations than those on non-walled beaches. Lower elevations subject nests to a greater risk of repeated tidal inundation and erosion and can potentially alter thermal regimes, an important factor in determining the sex ratio of hatchlings (Mrosovsky and Provancha 1989, Mrosovsky 1994, Ackerman 1997, Delpech and Foote 1998).

High tides frequently reach the base of armoring structures, particularly during spring tides and storm events. Thus, nests deposited seaward of these structures are often subject to tidal inundation. For this reason, nests on some armored nesting beaches have to be relocated each year to a more suitable incubation environment (EAI 2010). The negative effects of seawalls become more pronounced the closer the seawalls are to the surf zone. Thus, the quality of beach habitat seaward of armoring structures on eroding sections of coastline can be expected to diminish as the shoreline recedes.

The potential effects of armoring structures on nesting and reproductive success are summarized in Table 7. In addition to those effects discussed above, impacts can occur if the installation of structures takes place during the sea turtle nesting season. During construction, incubating eggs in unmarked or missed turtle nests may be crushed, smothered, unearthed or otherwise damaged. Vibrations and water runoff from jetting operations during installation of structures can also damage nests. Nests relocated from the construction area may suffer movement-induced mortality if not properly handled. Equipment and materials left on the beach overnight may effectively eliminate, or prevent nesting adults from reaching, otherwise suitable nesting habitat. Those same materials, as well as holes, ruts and construction debris on the beach, may entrap both adult and hatchling turtles. Removal of temporary structures following an erosion event may induce impacts similar to those occurring during initial construction.

Once a structure is in place, it can continue to cause problems for sea turtles. For example, hatchlings have been trapped in holes or crevices of exposed riprap and geotextile tubes. Both nesting turtles and hatchlings have been entangled or entrapped in the debris of failed structures. There have also been reports of injuries to nesting turtles that have been able to climb onto a seawall via adjacent properties and have subsequently fallen off (FWC, unpublished data).

As the extent of armoring on beaches increases, the probability of a nesting turtle encountering a seawall or depositing a nest in sub-optimal habitat increases. Additionally, the displacement of nests from armored locations may increase the density of nests in a dwindling number of suitable nesting sites thereby increasing the potential for density-dependent nest mortality (e.g., turtles digging up existing nests).

Comparatively little research has been done to document the effects of coastal armoring on beach mice. However, coastal armoring presumably can have long-lasting, harmful impacts on CBM populations through habitat destruction and fragmentation, particularly if one group of mice becomes disconnected from another, thereby creating genetically isolated subpopulations. Frank and Humphrey (1996) summarize the potential impacts, "Habitat fragmentation resulting from the isolation of subpopulations can reduce population viability through both demographic and genetic mechanisms." Frank (1996) documented the isolation of two populations of beach mice within St. Johns County, Florida as a result of the construction of a concrete seawall fronted by rock revetment.

Aside from the permanent effects attributed to coastal armoring, the introduction of construction equipment and materials into beach mouse habitat has the potential to crush mice and their burrows, destroy forage material, and contribute to erosion.

Effects to piping plovers from coastal armoring are primarily related to habitat loss and degradation. Seawalls and revetments that are placed close to the surf zone have the potential to alter the natural coastal processes and accelerate erosion of the beach, thus reducing the amount of foraging habitat that is available to shorebirds. Construction vehicles have the potential to run over shorebirds and, if present within the intertidal areas of the beach, can temporarily disrupt the availability of plover prey.

Beach Nourishment

Due to the uncertainty regarding the effects of armoring structures on the beach ecosystem, beach nourishment has received preferential treatment as a means of combating erosion and providing shoreline protection. Beach nourishment typically involves the dredging of sand from inlets or offshore borrow areas and placing it on an eroded section of coastline. Inland sand sources may also be used. State and County rules require that the introduced material be of compatible and comparable physical nature to the native sand it replaces.

Table 7. Potential Impacts of Shoreline Protection Activities on Sea Turtles Within the Plan Area.		
LIFE HISTORY STAGE	**PERIOD OF IMPACT**	**POTENTIAL IMPACTS**
Eggs	Construction	Eggs may be crushed, unearthed or otherwise destroyed during construction activities (e.g., heavy equipment, excavation, pile driving, water jetting, etc.).
		Eggs may be buried beneath sand placed on the beach, resulting in mortality of developing embryos.
		Developing embryos may suffer movement-induced mortality during relocation or lost to wash out.
	Post Construction	Eggs may be deposited in sub-optimum incubation environment. Nests deposited at lower elevations on the beach are more likely to suffer detrimental effects from repeated tidal inundation.
Hatchlings	Construction	Hatchlings may be trapped beneath equipment, supplies and/or construction debris on the beach.
		If large quantities of sand are placed over incubating nests, hatchlings may not be able to escape from the nest.
		The migration of hatchlings to the ocean may be impeded by equipment/supplies on the beach. Holes and ruts left on the beach by construction activities may trap or misdirect hatchlings, increasing energy expenditures and susceptibility to predation.
		Construction lighting may disorient hatchlings.
	Post Construction	Holes, crevices, and deteriorating materials associated with structures composed of riprap, sand bags and geotextile tubes may trap or entangle hatchlings.
Nesting Females	Construction	Construction lighting and/or construction activities may deter nesting females from emerging onto the beach and reduce nesting success.
		Females may become entangled or trapped in building equipment and materials while searching for a nest site.
		Disturbed soil and holes left overnight in the construction areas may trap or topple nesting females or deter females from nesting.
	Post Construction	Fewer nesting females may emerge on beaches fronted by seawalls.
		Nesting success of turtles emerging on beaches fronted by seawalls may be reduced.
		Adult females contacting armoring structures in search of nesting sites may engage in increased wandering, which may increase overall energy expenditures.
		If sand and dunes build up along the sides of a seawall (e.g., along the tie-back) nesting turtles may be able to crawl onto or behind the structure. Injuries have been reported for turtles that fall off these walls while trying to return to the ocean (FWC, unpublished data).

The westernmost five miles of Walton County was nourished during the winter of 2006/2007 to provide protection to upland properties and restore the economic potential of the beach. Walton County currently has an initiative to nourish an additional 12.8 mi (20.6 km) of beach within the eastern portion of the County as part of the proposed Phase II Beach Restoration for the 30-A Corridor project. However, this project has yet to be permitted and fully-funded.

Although beach nourishment is generally viewed as a more environmentally friendly solution to shoreline protection than armoring, it too has potential for impacting sea turtles. It can affect the sea turtle reproductive process in a variety of ways. Although nourished beaches may provide a greater quantity of nesting habitat, the quality of that habitat may be less suitable than pre-existing natural beaches. Sub-optimal nesting habitat may decrease nesting, place an increased energy burden on nesting females, result in abnormal nest construction, and reduce the survivorship of eggs and hatchlings. A thorough review of the processes associated with each of these potential effects was presented by Crain *et al.* (1995).

Most nourishment projects on heavily nested beaches are planned to proceed outside of the main portion of the nesting season to minimize incidental take of turtles. However, in the Florida panhandle, including Walton County, beach nourishment projects are often conducted during the nesting season where impacts are more likely. Adult turtles emerging to nest may be disturbed by construction lighting and/or prevented from reaching nesting habitat by pipes, equipment, and other obstacles on the beach. Nesting turtles may also be frightened from the beach by the movement of equipment and personnel at night. Those nests that are deposited within the project area have to be moved out of harms way and that process often results in reduced reproductive success (Moody 1998). Nests that go undiscovered by monitoring personnel may be crushed by construction equipment or buried during deposition of dredged materials on the beach.

Nourished beaches tend to differ in several important ways from natural beaches. They are typically wider, flatter, more compact, and the sediments are wetter than those on natural beaches (Nelson *et al.* 1987, Ackerman *et al.* 1991, Ernest and Martin 1999). On severely eroded sections of beach, where little or no suitable nesting habitat previously existed, nourishment can result in increased nesting (Ernest and Martin, 1999). However, on most beaches, nesting success typically declines for the first one or two years following construction, even though more habitat is available for turtles (Trindell *et al.* 1998). Reduced nesting success on nourished beaches has been attributed to increased compaction of sediments, scarping, and changes in beach profile (Nelson *et al.* 1987, Crain *et al.* 1995, Davis *et al.* 1994, Lutcavage *et al.* 1997, Steinitz *et al.* 1998, Ernest and Martin 1999). Compaction presumably inhibits nest construction, while scarps often cause female turtles to return to the ocean without nesting or deposit their nests seaward of the scarp where they are more susceptible to tidal inundation.

Beach nourishment can affect the incubation environment of sea turtle nests by altering the moisture content, gas exchange, and temperature of sediments (Ackerman *et al.* 1991, Ackerman 1997, Parkinson and Magron 1998). The extent to which the incubation

environment is altered is largely dependent on the similarity of the nourished sands and the natural sediments they replace. Consequently, results of studies assessing the effects of nourishment on reproductive success have varied among study sites.

Very little information is available to determine the effects of beach nourishment on CBM or other beach mice. The recovery plan for the CBM (USFWS 1987) indicates that deposition of sand along existing beach areas has the potential to destroy beach mouse habitat. Presumably, the heavy equipment required during these projects could also disturb the CBM, crush burrows, degrade the primary dune system, and/or diminish food resources by disturbing natural dune vegetation. Alteration or destruction of dune habitat may occur during construction of beach access corridors for project vehicles and equipment.

The recovery plan for the piping plover Atlantic Coast population (USFWS 1996) lists beach nourishment as a potential threat to over-wintering plovers. Placement of fill material on the beach can degrade shorebird habitat and has the potential to temporarily disrupt the food supply of plovers and other shorebirds (Hayden and Dolan 1974; Peterson *et al*. 2000). Construction equipment on the beach has the potential to disturb or run over resting and foraging birds. The extent to which recent beach nourishment activities in Walton County have impacted piping plovers is unknown.

Incidental take of sea turtles, beach mice, and piping plovers associated with beach nourishment projects is authorized under the Federal permits issued for such projects. Minimization of impacts is established during consultations among the applicable Federal agencies as stipulated in Section 7 of the ESA. Consequently, environmental impacts associated with beach nourishment projects undertaken by the County will be addressed independently of this HCP.

Vegetation Planting and Sand Fences

Sand fencing and the planting of vegetation, most notably sea oats, are commonly used within Walton County as a means of stabilizing the foredune. Sand fences have been known to trap hatchling turtles and act as barriers to nesting turtles (National Research Council 1990). However, all sand fences are permitted by the FDEP through the CCCL program. The design and placement of these fences are regulated through these permits to avoid negative impacts on turtles. Insofar as sand fencing and native vegetation planting tend to promote dune formation and provide a source of cover and forage, respectively, they likely have a net benefit to CBM.

Coastal Construction

In addition to shoreline protection activities, there are a variety of other types of coastal construction activities, each of which may affect listed species within the Plan Area. These include, but are not limited to, the following:

- Construction of new and repair/maintenance of existing commercial and residential structures;
- Installation of utility cables; and
- Installation and/or repair of public infrastructure.

The majority of Walton County's beachfront within the Plan Area has been developed. Coastal development is thought to be the primary threat contributing to the endangered status of the CBM (Holler 1992, Humphrey 1992, USFWS 1987). Placement of permanent residential and commercial real estate within the beach dune and coastal scrub areas consumes primary CBM habitat and acts as a barrier to natural repopulation. Development also fragments CBM into disjunct populations and interrupts gene flow between populations. This typically results in a loss of genetic diversity and renders each smaller population more vulnerable to extinction through chance environmental events.

Aside from the permanent loss of CBM habitat attributed to coastal development, temporary construction-related impacts may potentially occur to CBM, sea turtles, and piping plovers. Construction activities may alter sea turtle nesting habitat and plover and CBM foraging habitat. Direct mortality of sea turtle eggs, hatchlings, and/or nesting females, over-wintering plovers, and CBM can result from construction activities. Turtle eggs and CBM burrows may be crushed, unearthed, or otherwise destroyed during construction activities (e.g., heavy equipment, excavation, pile driving, water jetting, etc.). Eggs in undetected and unmarked nests may be buried beneath sand placed on the beach, resulting in mortality of developing embryos. If large quantities of sand are placed over incubating nests, hatchlings may not be able to escape from the nest. Hatchlings may be trapped beneath equipment, supplies, and/or construction debris on the beach.

Section 4.02 of the Walton County LDC provides protection to coastal resources through regulation of construction within the Coastal Protection Zone (CPZ). The CPZ is defined as "1) the area seaward of the landward toe of the primary dune ridge or the area seaward of a line 50 feet landward of the crest of the primary dune when the toe cannot be determined; or 2) twenty-five feet landward of the top of the higher bluff regions where no primary dune exists". Development within the CPZ is limited by County Code to "…those activities which are presumed to have insignificant adverse effect on resources within the Zone".

All coastal construction seaward of the State's CCCL requires a FDEP permit that incorporates measures for the protection of sea turtles. Similar safeguards for all federally listed species are contained within Federal ESA permits or consultations issued for coastal construction projects conducted below the MHWL.

Climate Change

The varying and dynamic elements of climate science are inherently long term, complex and interrelated. Regardless of the underlying causes of climate change, glacial melting and expansion of warming oceans are causing sea level rise, although its extent or rate

cannot as yet be predicted with certainty. At present, the science is not exact enough to precisely predict when and where climate impacts will occur. Thus, although we may know the direction of change, it may not be possible to predict its precise timing or magnitude. Furthermore, these impacts may take place gradually or episodically in major leaps.

According to the Intergovernmental Panel on Climate Change Report (IPCC 2007), warming of the earth's climate is "unequivocal," as is now evident from observations of increases in average global air and ocean temperatures, widespread melting of snow and ice, and rising sea level. The IPCC Report (2007) describes changes in natural ecosystems with potential wide-spread effects on many organisms, including marine mammals and migratory birds. The potential for rapid climate change poses a significant challenge for fish and wildlife conservation. Species' abundance and distribution are dynamic, relative to a variety of factors, including climate. As climate changes, the abundance and distribution of covered species within the Plan Area may also change. Because of their endemic nature, beach mice are perhaps the most susceptible to these changes.

Sea level rise will result in increased erosion rates along sea turtle nesting beaches (Titus and Narayanan 1995). This could particularly impact areas with low-lying beaches where sand depth is a limiting factor, as the sea will inundate nesting sites and decrease available nesting habitat (Daniels *et al*. 1993, Fish *et al*. 2005, Baker *et al*. 2006). The loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis *et al*. 2006, Baker *et al*. 2006).

Depending on the extent and rate of climate change and the frequency and intensity of storms over the term of the ITP, the threats posed by storm-induced erosion described earlier in this chapter may intensify.