



United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
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April 16, 2007

Colonel Paul L. Grosskruger
District Commander
U.S. Army Corps of Engineers
701 San Marco Boulevard, Room 372
Jacksonville, Florida 32207-8175

Service Federal Activity Code: 41420-2007-FA0313
Service Consultation Code: 41420-2007-F-0256
Corps Application No.: SAJ-2006-6338 (LP-MJW)
Formal Consultation Initiation Date: December 1, 2006
Applicant: Alfredo Rivero
County: Broward

Dear Colonel Grosskruger:

This document is the Fish and Wildlife Service's (Service) biological opinion for a multi-slip residential dock project in Broward County, Florida. The biological opinion addresses the potential effects of the proposed projects on the West Indian (= Florida) manatee (*Trichechus manatus*) (manatee), in accordance with section 7 of the Endangered Species Act of 1973, as amended (ESA) (87 Stat. 884; 16 U.S.C. 1531 *et seq.*), the Marine Mammal Protection Act of 1972, as amended (MMPA) (16 U.S.C. 1361 *et seq.*), and the provisions of the Fish and Wildlife Coordination Act of 1958, as amended (48 Stat. 401; 16 U.S.C. 661 *et seq.*).

This biological opinion was prepared based on information provided by the U.S. Army Corps of Engineers (Corps), the Corps' Reach Characterization Analysis, the *Florida Manatee Recovery Plan* (Service 2001a), the *South Florida Multi-Species Recovery Plan* (MSRP) (Service 1999), data supplied by the Florida Fish and Wildlife Conservation Commission (FWC), and other sources of information.

Broward County has not yet developed a Manatee Protection Plan (MPP) and is one of 13 coastal (= key) counties directed by the Governor and Cabinet to develop a MPP. The State's 1989 report recommended new or expanded commercial boating facilities in key counties should be limited to one powerboat slip per 100 linear feet of shoreline (the 1:100 ratio) until the county implements a State-approved MPP, including a boating facility siting component. Watercraft access projects consistent with a county's MPP provides levels of boater access and activities within the capacity of the manatee protection measures established. Projects not consistent with a MPP may exceed the capacity of these protective measures and, therefore, may result in incidental take of manatees. Countywide MPPs are identified in the *Florida Manatee Recovery Plan* (Service 2001) as a method for protecting manatees and manatee habitat.



The Service believes the proposed project is not consistent with the State's recommended 1:100 ratio for new watercraft access projects in a key county without a State-approved MPP and, therefore, may have an adverse effect on the manatee. A complete administrative record of this consultation is on file at the Service's South Florida Ecological Services Office in Vero Beach, Florida.

Consultation History

On November 24, 2006, the Corps issued a Public Notice for permit application number SAJ-2006-6338 (LP-MJW) for a proposed multi-family residential dock project. The Corps provided a determination of "may affect" for the endangered manatee.

FISH AND WILDLIFE RESOURCES

The proposed actions are not expected to significantly impact fish and wildlife habitat resources based on the information provided. Therefore, the Service does not object to the proposed action as it relates to fish and wildlife habitat resources.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The proposed actions are located within Reach 4 of the Corps' Reach Characterization Analysis. Vessels using the new multi-slip docks or residences would likely travel through the Atlantic Intracoastal Waterway (AIW) in Broward County, Florida.

The proposed actions involve new or expanded boating facilities described in the following table:

Applicant	Project	Shoreline (feet)	Existing Slips	New Slips	Slips/ 100 feet
Alfredo Rivera	Remove existing dock and construct new 3-slip dock with 4 wood mooring piles	70	1	2	4.3

Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. The Service has determined that the action area for this project includes the coastal waters of Broward County within Reach 4, the most likely travel route of watercraft leaving from this facility.

STATUS OF THE SPECIES/CRITICAL HABITAT

Species/Critical Habitat Description

The West Indian manatee is federally listed as an endangered species under the ESA (32 FR 4001) and the species is further protected as a depleted subpopulation under the MMPA.

Manatees are large fusiform-shaped mammals with skin that is uniformly dark grey, wrinkled, sparsely haired, and rubber-like. Manatees possess paddle-like forelimbs, no hind limbs, and a spatulate, horizontally flattened tail. Females have two axillary mammae, one at the posterior base of each forelimb. Their bones are massive and heavy with no marrow cavities in the ribs or long bones of the forearms (Odell 1982). Adults average about 10 feet in length and 2,200 pounds in weight, but may reach lengths of up to 15 feet (Gunter 1941) and weigh as much as 3,570 pounds (Rathbun et al. 1990). Newborns average 4 to 4.5 feet in length and about 66 pounds (Odell 1981). The nostrils located on the upper snout, open and close by means of muscular valves as the animals surface and dive (Husar 1977; Hartman 1979). A muscular flexible upper lip is used with the forelimbs to manipulate food into the mouth (Odell 1982). Bristles are located on the upper and lower lip pads (Marshall et al. 2000). Molars designed to crush vegetation form continuously at the back of the jaw and move forward as older ones wear down (Domning and Hayek 1986). The eyes are very small, close with sphincter action, and are equipped with inner membranes that can be drawn across the eyeball for protection. The ears are external, minute, with no pinnae. The anatomy of the internal ear structure suggests that they can hear sounds within a relatively narrow low-frequency range, that their hearing is not acute, and that they have difficulty in localizing sound (Ketten et al. 1992). However, Gerstein (1995) suggested that manatees may have a greater low-frequency sensitivity than other marine mammal species that have been tested.

Critical habitat for the Florida subspecies was designated in 1976 [50 CFR § 17.95(a)]. Critical habitat is described as the specific area within the geographic area occupied by the species, at the time it is listed under the provisions of section 4 of the ESA, which are found on those physical or biological features (*i.e.*, constituent elements): (1) essential to the conservation of the species; and (2) which may require special management considerations or protection [ESA § 3(5)(A)]. No specific primary or secondary constituent elements were included in the critical habitat designation. However, experts agree that essential habitat features for the manatee include seagrasses for foraging, shallow areas for resting and calving, channels for travel and migration, warmwater refuges during cold weather, and fresh water for drinking (Service 2001a).

Designated manatee critical habitat on the Atlantic Coast of Florida includes the waters of the AIW connecting rivers and bays from the Florida/Georgia border south to Key Largo in Monroe County, excluding those waters in Broward County, Florida. The Atlantic Subpopulation of manatees also uses critical habitat identified between Key Largo and mainland Miami-Dade County in Florida Bay.

Designated critical habitat on the west coast of Florida includes Crystal River in Citrus County, portions of the Little Manatee River in Hillsborough County; portions of the Manatee River in

Manatee County; portions of the Myakka River in Sarasota and Charlotte Counties; portions of the Peace River in Desoto and Charlotte Counties; portions of the Caloosahatchee River and all coastal waters in Lee County; and all coastal waters in Collier and Monroe Counties between Gordon's Pass (Collier County) and Whitewater Bay (Monroe County).

Life History

Manatees are herbivores that feed opportunistically on a wide variety of aquatic vegetation. Feeding rates and food preferences depend, in part, on the season and available plant species. Manatees frequently feed in waters 3 to 9 feet in depth where aquatic vegetation is abundant. Seagrasses appear to be a staple of the manatee diet in coastal areas (Ledder 1986; Provancha and Hall 1991; Kadel and Patton 1992; Koelsch 1997; Lefebvre et al. 2000). Manatees can remain submerged for several minutes with the longest submergence record lasting 24 minutes (Reynolds 1981).

Breeding takes place when one or more males (ranging from 5 to 22 individuals) are attracted to an estrous female to form an ephemeral mating herd (Rathbun et al. 1995). Mating herds can last up to 4 weeks, with different males joining and leaving the herd daily (Hartman 1979; Bengston 1981; Rathbun et al. 1995; Rathbun 1999). Permanent bonds between males and females do not form. During peak activity, the males in mating herds compete intensely for access to the female (Hartman 1979). Successive copulations involving different males have been reported. Some observations suggest that larger, presumably older, males dominate access to females early in the formation of mating herds and are responsible for most pregnancies (Rathbun et al. 1995). Although breeding has been reported in all seasons, Hernandez et al. (1995) reported that histological studies of reproductive organs from carcasses of males showed evidence of sperm production in 94 percent of adult males found between March and November. Females appear to reach sexual maturity by about age 5 but have given birth as early as age 4 (Marmontel 1995; Odell et al. 1995; O'Shea and Hartley 1995; Rathbun et al. 1995). Males may reach sexual maturity at 3 to 4 years of age (Hernandez et al. 1995). Manatees may live in excess of 50 years (Marmontel 1995), and evidence for reproductive senescence is unclear (Marmontel 1995; Rathbun et al. 1995).

Calf dependency usually lasts 1 to 2 years after birth (Hartman 1979; O'Shea and Hartley 1995; Rathbun et al. 1995; Reid et al. 1995). Calving intervals vary greatly among females, with an average birth cycle of 2 to 2.5 years. Intervals may be considerably longer depending on age and perhaps other factors (Marmontel 1995; Odell et al. 1995; Rathbun et al. 1995; Reid et al. 1995). Females that abort or lose a calf due to perinatal death (small manatees, less than 60 inches in length) (O'Shea and Hartley 1995), may become pregnant again within a few months (Odell et al. 1995) or even weeks (Hartman 1979).

Manatees often use secluded canals, creeks, embayments, and lagoons, particularly near the mouths of coastal rivers and sloughs, for feeding, resting, cavorting, mating, and calving (Marine Mammal Commission [MMC] 1986; MMC 1988). Manatees frequent coastal, estuarine, and riverine habitats and are capable of extensive north-south migrations. Based on telemetry, aerial surveys, photo-identification sighting records, and other studies over the past 20 years, manatee

distribution in the southeastern United States is better understood (Beeler and O'Shea 1988; O'Shea 1988; MMC 1984; MMC 1986; Lefebvre et al. 1989). In general, the data reveal that manatees exhibit opportunism, as well as predictable patterns in their distribution and movement.

They are able to undertake extensive north-south migrations with seasonal distribution determined by water temperature below 68 degrees Fahrenheit (20 degrees Celsius). Manatees depend on areas with access to natural springs, manmade warmwater refugia, vascular plants, and freshwater sources. Manatees normally migrate along shorelines and use deeper corridors to access shallow water feeding and resting areas. When ambient water temperatures drop below 68 degrees Fahrenheit in autumn and winter, manatees aggregate within the confines of natural or artificial warmwater refuges (Lefebvre et al. 1989) or move to the southern tip of Florida (Snow 1991). Most artificial refuges are created by warm water outfalls from power plants or paper mills. As water temperatures rise, manatees disperse from these winter aggregation areas. While some remain near their winter refuges, others undertake extensive migrations along both Florida coasts and far up rivers and canals. Many manatees return to the same warmwater refuges each year. However, some manatees use different refuges in different years, and others use two or more refuges in the same winter (Reid and Rathbun 1984; Rathbun et al. 1990; Reid et al. 1991). There are many lesser known, minor aggregation areas used as temporary thermal refuges. Most of these are canals or boat basins where warmwater temperatures persist as temperatures in adjacent bays and rivers decline.

Population Dynamics

The total population size of manatees in Florida is unknown. Annual synoptic surveys suggest a minimum population size in excess of 3,000 animals statewide. Adult manatee survival rates are considered to be the most important indicator of maintaining a stable and secure manatee population (Langtimm et al. 2004). Given the low reproductive rate described in the previous section, manatees would be slow to recover from extensive depletions of their numbers.

Long-term studies suggest four regional subpopulations of manatees in Florida: (a) the Northwest subpopulation encompasses the counties along the Gulf of Mexico from Escambia County east and south to Pasco County; (b) the Upper St. Johns River subpopulation occurs in the river from Palatka south; (c) the Atlantic subpopulation extends along the entire east coast from Nassau County south to Florida Bay and the Florida Keys in Monroe County and includes the St. Johns River north of Palatka; and (d) the southwest population encompasses counties along the Gulf of Mexico from Pasco County south to Whitewater Bay in Monroe County. These regional units are based primarily on documented manatee use of wintering sites and from radio-tracking studies of individuals' movements (Bengston 1981, Marine Mammal Commission 1988, Rathburn et al. 1990, Reid et al. 1991, Beck and Reid 1995, Rathburn et al. 1995, Reid et al. 1995, Deutsch et al. 1998, Service 2001, Weigle et al. 2001, Deutsch et al. 2003).

Status and Distribution

Based on telemetry studies, aerial surveys, photo-identification studies, and other research over the past 20 years, manatee distribution in the southeastern United States is better understood (Beeler and O'Shea 1988; O'Shea 1988; MMC 1984; MMC 1986; and Lefebvre et al. 1989). Florida manatees can be found in Florida waters throughout the year, and nearly all manatees use the waters of peninsular Florida during the winter months. In winter months, most manatees rely on warm water from industrial discharges and natural springs for warmth. In warmer months, they expand their range and occasionally are seen as far north as Rhode Island on the Atlantic Coast and as far west as Texas on the Gulf Coast.

Despite significant efforts dating back to the late 1970s and early 1980s, scientists have been unable to develop a statistically and scientifically repeatable means of estimating or monitoring trends in the size of the overall manatee population in the southeastern United States (O'Shea 1988; O'Shea et al. 1992; Lefebvre et al. 1995). Even though many manatees aggregate at warmwater refuges in winter and most, if not all, such refuges are known, direct counting methods (*i.e.*, by aerial and ground surveys) are unable to account for the number of animals that may be away from these refuges at any given time, the number of animals not seen because of turbid water, and other factors. The use of mark-resighting techniques to estimate manatee population size based on known animals in the manatee photo-identification database is also not a statistically and scientifically repeatable method.

It is possible, however, to monitor the number of manatees using the Blue Spring (Volusia County) and Crystal River (Citrus County) warmwater refuges. At Blue Spring (in the Upper St. Johns River Subpopulation), with its unique combination of clear water and confined spring area, it has been possible to count the number of resident animals by identifying individual manatees from scar patterns. The data indicate that this group of animals has increased steadily since the early 1970s when it was first studied. During the 1970s, the number of manatees using the spring increased from 11 to 25 (Bengston 1981). In the mid 1980s, about 50 manatees used the spring (Service 2001a), and by the winter of 1999-2000, the number had increased to 147 (Hartley 2001).

In the Northwest Subpopulation, the clear, shallow waters of Kings Bay (Citrus County) have made it possible to monitor the number of manatees using this warmwater refuge at the head of Crystal River. Large aggregations of manatees apparently did not exist there until recent times (Service 2001a). The first careful counts were made in the late 1960s. Since then, manatee numbers have increased significantly. From 1967 to 1968, Hartman (1979) counted 38 animals in Kings Bay. By 1981-1982, the maximum winter count had increased to 114 manatees (Powell and Rathbun 1984) and, in November 2000, the maximum count was 301 (J. Kleen, Service, personal communication).

In the Atlantic and Southwest subpopulations, no similar shallow, clear water areas are present that make it possible to monitor the number of manatees using warmwater refugia, although such refugia are present. In these locations, visual counts of those manatees that can be seen by aerial

surveys are the basis of the population estimates and estimates of adult survival and population growth.

The only data on population size include uncalibrated indices based on maximum counts of animals at winter refuges made within 1 or 2 days of each other. Based on such information in the late 1980s, the total number of manatees throughout Florida was originally thought to include at least 1,200 animals (Service 2001a). Because aerial and ground counts at winter refuges are highly variable depending on the weather, water clarity, manatee behavior, and other factors (Packard et al. 1985; Lefebvre et al. 1995), interpretation of these data to assess short-term trends is difficult (Packard and Mulholland 1983; Garrott et al. 1994).

Beginning in 1991, the State of Florida initiated a statewide, synoptic, aerial survey program to count manatees in potential winter aggregation areas during periods of severe cold weather (Ackerman 1995). The highest statewide minimum count from these surveys was 3,276 manatees in January 2001 with 1,520 individuals on the east coast and 1,756 individuals on the west coast. A more recent survey conducted on January 21-22, 2003, provides a minimum population estimate that includes 3,113 individuals with 1,814 and 1,299 manatees on the east and west coasts, respectively (<http://www.floridamarine.org>).

While aircraft synoptic surveys provide a “best estimate” of the minimum Florida manatee population size, there are no confidence intervals (derived through reliable, statistically based, population-estimation techniques) for these estimates. With the exception of a few places where manatees may aggregate in clear, shallow water, not all manatees can be seen from aircraft because of water turbidity, depth, surface conditions, variable times spent submerged, and other considerations (Lefebvre et al. 1995). While these results are of value in providing information on where manatees occur, likely relative abundance in various areas, and seasonal shifts in manatee abundance, they do not provide good population estimates nor can they reliably measure trends in the manatee population. Consequently, the *Florida Manatee Recovery Plan* (Service 2001a) concludes that “despite considerable effort in the early 1980s, scientists have been unable to develop a useful means of estimating or monitoring trends in size of the overall manatee populations in the southeastern United States.”

At the end of winter, manatees leave warmwater aggregation sites and head for warm weather use areas. There appears to be no significant spring aggregation areas on the west coast, although Charlotte Harbor was visited in the spring by almost half of 35 manatees radio-tagged at the Fort Myers Power Plant in Lee County in the early 1980s (Lefebvre and Frohlich 1986). During the summer, manatees can be found throughout Florida where water depths and access channels are greater than 1 to 2 meters (3.3 to 6.6 feet) (O'Shea 1988). Summer use areas are generally typified by extensive foraging resources. Seagrasses and other food sources occur throughout coastal Florida.

Reasons for Legal Protection

In 1967, both the Florida and Antillean subspecies of manatees (*T. manatus latirostris* and *T. manatus manatus*) were listed as endangered (32 FR 4061) and received Federal protection

with the passage of the ESA in 1973. Since the manatee was designated as an endangered species prior to enactment of the ESA, there was no formal listing package identifying threats to the species, as required by section 4(a)(1) of the ESA. However, since that time, threats to the manatee (discussed below) have been identified.

Manatees are also protected under the MMPA. The MMPA establishes, as national policy, maintenance of the health and stability of marine ecosystems and, whenever consistent with this primary objective, obtains and maintains optimum sustainable populations of marine mammals. It also establishes a moratorium on the taking of marine mammals, which includes harassing, hunting, capturing, killing, or attempting to harass, hunt, capture, or kill any marine mammal. Section 101(a)(5)(A) of the MMPA allows the Service, upon request, to authorize by specific regulation the incidental, unintentional take of marine mammals by persons engaged in identified activities within specific geographic areas, if the Service determines that such taking would have a negligible impact on the species or subpopulation. Since the manatee, which is comprised of the Florida and Antillean manatee subpopulations, is currently listed as “endangered” under the ESA, they are considered “depleted” under the MMPA.

Section 115(b) of the MMPA requires that conservation plans be developed for marine mammals considered “depleted.” In the case of the Florida manatee, the Service developed the initial recovery plan for the manatee in 1980. This initial plan focused primarily on manatees in Florida, but included Antillean manatees in the Commonwealth of Puerto Rico and the United States Virgin Islands. In 1986, the Service adopted a separate recovery plan for manatees in Puerto Rico. To reflect new information and planning needs for manatees in Florida, the Service revised the original plan in 1989 and focused exclusively on the Florida manatee. This first revision covered a 5-year planning period ending in 1994. The Service revised and updated the plan again in 1996, which again covered a 5-year planning period ending in 2000. In 1999, the Service initiated the process to revise the plan for a third time. An 18-member recovery team, consisting of representatives of the public, agencies, and groups that have an interest in manatee recovery and/or could be affected by proposed recovery actions, was established to draft the third revision. The latest manatee recovery plan, which also covers a 5-year planning period, was finalized in October 2001.

Threats

The two most significant threats to the Florida manatee population statewide are collisions with watercraft and the loss of warm water habitat. All other threats are relatively minor in comparison. Mortality from watercraft collisions accounts for 25 percent of all manatee mortalities statewide (Ackerman et al. 1995). Warm water is essential for manatee survival during cold weather. Prolonged exposure to cold water temperatures can result in debilitation and/or death due to “cold stress syndrome” (Bossart et al. 2002). However, when compared to all other threats, including the loss of warm water habitat, watercraft-related mortality poses the most serious long-term risk to the growth and resilience of the manatee population.

Other threats to manatees include crushing or entrapment in gates and locks, entanglement in ropes, lines, and nets, ingestion of fishing gear or debris, vandalism, poaching, and exposure to

red tide brevetoxin (Bossart et al. 1998). Red tide represents a major natural source of mortality for manatees in the Southeast region.

Manatee Protection Plans

Concerned with an increased number of manatee mortalities and boating accidents, the Governor and Cabinet directed the Florida Department of Natural Resources (DNR) in June 1989 to make recommendations for specific actions to protect the manatee and its habitat and to make the State's waterways safer for the boating public. DNR's final report, *Recommendations to Improve Boating Safety and Manatee Protection on Florida Waterways*, found that over 80 percent of all watercraft-related manatee mortality occurred in 10 counties: Brevard, Broward, Citrus, Collier, Miami-Dade, Duval, Lee, Martin, Palm Beach, and Volusia. Though watercraft-related mortality was not high for St. Lucie, Indian River, and Sarasota, these three counties were considered important areas as travel corridors as well as foraging and resting areas for manatees.

The Governor and Cabinet directed each of these 13 coastal (= key) counties to develop a MPP. The purpose of a MPP is to present a summary of existing information about manatee use and watercraft use within the county and to develop strategies to balance manatee protection, resource protection, waterway uses, boating facility siting, speed zones and signage, boating safety, and to educate the boating public. The final report recommended new or expanded boating facilities in these key counties should be limited to one powerboat slip per 100 linear feet of shoreline (the 1:100 ratio) until the county implements its State-approved MPP, which includes a boating facility siting component. Watercraft access projects that are consistent with a county's MPP provides a level of boater access and activity that is within the capacity of the manatee protection measures provided. Projects that are not consistent with a MPP may exceed the capacity of these protective measures and, therefore, may result in incidental take of manatees. Countywide MPPs are identified in the *Florida Manatee Recovery Plan* (Service 2001a) as a method for protecting manatees and manatee habitat.

Citrus County was the first county to have a State-approved MPP in 1991. The county's MPP identified actions that address manatee mortality and included a boating facility siting plan. The MPP also discussed conservation measures to protect manatee habitat. Subsequent to its approval, the State established regulatory speed zones for watercraft. The State of Florida subsequently approved MPPs for Collier County in May 1995 followed by Miami-Dade County in December 1995; Duval County in June 1999; Indian River County in August 2000 which was amended in February 2002 and in August 2004; St. Lucie County in March 2002; Martin County in June 2002; Brevard County in February 2003; Sarasota County in February 2004; Lee County in August 2004; and Volusia County in October 2005. The State is currently working with Broward County regarding the development of their MPP to address appropriate protection measures for manatees within the county and the inclusion of a boating facility siting component.

The Service believes that county MPPs are one of the best vehicles to address such issues as boating facilities (marinas, docks, boat ramps, dry storage areas); boating activity patterns; manatee information; a boat facility siting plan; manatee protection measures; and an education

and awareness program for the boating public. They are valuable planning tools and provide an excellent venue for local manatee protection efforts. In addition, it is our view that an effective MPP must contain components that address manatee protection areas (*e.g.*, manatee refuges), speed zone enforcement, funding for manatee protection efforts, and a reporting/monitoring element. Implementation of a State-approved MPP will have met State standards and addressed our concerns in maximizing benefits to the manatee while providing regulatory certainty to the public.

Analysis of the Species/Critical Habitat Likely to be Affected

Due to the increase in the number of slips resulting from the proposed action, the Corps has determined that the proposed project “may affect” the manatee. We concurred with the Corps’ determination and have performed a more complete analysis of the effects of the proposed action in order to determine whether or not the proposed activity is reasonably certain to result in the take of manatees through impacts to the Atlantic Subpopulation.

The construction of the proposed projects may affect the manatee by increasing watercraft and human presence in the action area, and by increasing the potential to adversely affect submerged aquatic resources (*i.e.*, seagrasses). This may disrupt, disturb, or delay manatee migration to warmwater refugia, freshwater drinking sources, and cause additional stress to manatees and calves present in the action area. An analysis of the project related effects and impacts to manatees and seagrasses will be considered further in the remaining sections of this document.

ENVIRONMENTAL BASELINE

This section analyzes all past and ongoing human and natural factors leading to the current status of the manatee in the action area. In 2000, Save the Manatee Club, other environmental groups, and several individuals filed suit in the District of Columbia against the Corps and the Service. Plaintiffs alleged violations of the ESA, the National Environmental Policy Act, the MMPA, and the Administrative Procedure Act, with regard to the Florida manatee, and alleged that the Clean Water Act Section 404 permitting of Florida boating facilities was responsible for watercraft-related manatee mortality in Florida’s coastal counties.

A settlement agreement was signed by all parties of the lawsuit on January 5, 2001, containing the following elements in which the Service agreed to complete and/or implement: (1) revision of the manatee recovery plan; (2) designation of manatee refuges and sanctuaries as manatee protection areas in peninsular Florida; (3) promulgation of a rule for incidental take of manatees under the MMPA; and (4) development of an interim guidance document to be used in section 7 consultations pending completion of the MMPA rule. The designation of refuges and sanctuaries as well as the interim strategy were short-term measures intended to address recent levels of mortality. A long-term solution to address historic levels of mortality depended on the development of small take regulations under the MMPA.

Based on an analysis of manatee mortality data, the Service identified four prerequisites necessary to ensure that incidental take would be unlikely to occur. These four prerequisites are:

(1) appropriate speed zones; (2) appropriate signage; (3) speed zone enforcement to prevent watercraft collisions with manatees from occurring as a result of the proposed project; and (4) placement of these measures prior to project implementation. If these prerequisites are not met, the Service believes that a new watercraft facility in this area would result in the incidental take of manatees and the Service would identify the area as an area with “inadequate protection.”

Within the range of the Atlantic Subpopulation, the Service designated in 2001 several locations as areas with “inadequate protection” including a portion of the Tomoka River and that reach of the Halifax River from and including the Tomoka Basin south to the Dunlawton Avenue Bridge in Volusia County; and all waters in the Banana and Indian Rivers, including their respective tributaries, from Haulover Canal south to the north end of the existing slow speed zone in the town of Grant in Brevard County. Since designating these waterways as “areas of inadequate protection” for the manatee, the Service has been working with the State, county, and city entities to ameliorate the watercraft collision threats specific to these regions.

Although many actions that the State has identified to reduce watercraft-related manatee mortality (*e.g.*, speed zones, increased State law enforcement, public education) apply to the manatee’s conservation throughout the species’ range in the State, other actions proposed by individual counties, cities, and other municipalities, and in some instances Federal and State agencies, are specific to designated areas. In addition to those approved by the State, manatee speed zones can be designated by both the county and city with the County Sheriff as well as City Police Department providing enforcement of these local zones within their respective jurisdictional boundaries. Specific Federal and State actions can include the establishment of refuges, sanctuaries, and parks with enforcement of speed zones within these areas.

ACTION AREA

We chose to use counties as the basic geographic analysis area because many factors important to manatee protection are provided at the county level. MPPs are produced by counties, manatee speed zones are designated by the State of Florida with county participation or by the county itself, and county sheriff’s departments provide enforcement within their boundaries. These factors make county-by-county and reach-by-reach review the most logical and manageable way to analyze data and provide recommended courses of action. The Service has determined that the action area for these projects include the coastal waters of Reach 4 in Broward County. Specifically, the action area is the most likely travel route of watercraft leaving this facility on the AIW and going to the Atlantic Ocean via the AIW and the Port Everglades inlet.

Status of the Species Within the Action Area

No designated manatee critical habitat is found within the action area. The critical habitat designation does not include specific primary or secondary constituent elements. However, important components of manatee critical habitat include areas of submerged vegetation for foraging, shallow areas for resting and calving, channels for travel and migration, warmwater refugia for cold weather events, and fresh water for drinking.

The Atlantic Subpopulation of manatees migrates through the waters of Broward County. Manatee distribution and dispersal patterns as well as numbers of individuals within an area can vary considerably from year-to-year and season-to-season. This variability in dispersal patterns is dependent on a variety of biotic and abiotic factors, such as warmwater discharges, freshwater sources, foraging areas, and mating season.

Manatee abundance in Broward County has been documented repeatedly through aerial surveys conducted from 1995 to 2002; however, the survey data do not indicate the number of manatees observed in Reaches 3 and 4. During January 2003, there were three synoptic aerial surveys covering Florida. A total of 1,695; 1,814; and 1,705 manatees were observed along the east coast of Florida. These surveys did not delineate how many manatees were observed within Broward County.

Results of aerial surveys and anecdotal evidence indicate that manatees exhibit seasonal movements within Broward County. Manatees respond to cool ambient temperatures during the winter by aggregating within deeper water such as power plant discharge sites. However, during mild winters (>68 degrees Fahrenheit ambient temperature), manatees may remain in the action area. Throughout the warm season, manatees are widely dispersed within the action area and known to use the large beds of seagrasses located throughout Broward County's waterways.

The nearest primary warmwater refugia to the project sites are the Florida Power and Light's Fort Lauderdale Power Plant and the Florida Power and Light Port Everglades Power Plant. Many of the artificial waterways (*i.e.*, manmade canals) in the action area are known to be used by manatees for resting and calving.

Factors Affecting Species Environment Within the Action Area

Watercraft

Commercial and recreational boat use in the action area is increasing. According to information provided by the State of Florida, the total number of registered vessels in Broward County since 2001 is as follows:

Year	2000	2001	2002	2003	2004	2005
Registered vessels	41,719	47,841	47,812	48,822	49,223	50,843

New watercraft resulting from the proposed project will likely travel within the waters of the AIW and connecting tributaries and residential canal systems in Broward County, Florida. The most likely effects to manatees caused by increased watercraft traffic are deaths or injuries from collisions with watercraft and alteration of seagrass beds used as feeding or resting areas.

Mortality

From January 1, 2000, through December, 2006, 24 manatees died as a result of a watercraft collision in the Broward County, Florida.

Year	2000	2001	2002	2003	2004	2005	2006
Broward County	2	4	3	5	1	2	7

Speed Zones

In October 1996, Florida Administrative Code 68C-22.010 established manatee speed zones on Broward County waterways. The zones were established for the purpose of regulating the speed and operation of motorboats within Broward County, including all associated and navigable tributaries, lakes, creeks, coves, bends, backwaters, canals, channels and boat basins, unless otherwise designated or excluded.

Watercraft speed zones within Broward County include “No Entry” zones, “Idle Speed” zones, “Slow Speed” zones, and “25 mph” zones, and areas of open water that are unregulated. Zone types and locations were based on manatee congregation data, manatee death data, watercraft usage data, and other manatee natural resource needs. The DEP and the Florida Inland Navigation District install and maintain speed zone signs in Broward County waters. The Broward County Department of Natural Resources is responsible for placement and maintenance of manatee signs throughout Broward County. Manatee speed zone areas are inspected by Broward County to ensure that adequate marking is present, and that no hazards to navigation exist. The zones were established for the purpose of regulating the speed and operation of motorboats within Broward County, including all associated and navigable tributaries, lakes, creeks, coves, bends, backwaters, canals, channels and boat basins, unless otherwise designated or excluded.

For a speed zone to be enforced the zone must be correctly signed and the signs must be in compliance with State-approved design parameters. Speed zone signs must be in compliance with State-approved design parameters (68D-23 Florida Administrative Code).

Enforcement

Enforcement of posted speed zones in Broward County is provided by the FWC, local city police officers, Broward County Sheriff deputies, and the U.S. Coast Guard. The FWC has 28 officers that patrol the waters of Broward County. Designated manatee speed zones are enforced by members of all duly authorized law enforcement agencies within the county. The U.S. Coast Guard and the Service also provide speed zone enforcement through special task force events.

Gorzelay (1998) monitored boater compliance in Lee County during 1997-1998. General trends and problem areas were identified in the report. Statistically significant comparisons between compliance levels and the presence and absence of law enforcement activities were determined. Specifically, Gorzelany demonstrated that “the presence of a law enforcement vessel influenced the speed and compliance of vessels.”

Education

Aside from enforcement, another factor influencing boater compliance is education. Boater education is an integral component of county MPPs. The purpose of a MPP is to present a summary of existing information about manatee use and watercraft use within the county and to develop strategies to balance manatee protection, resource protection, water resource uses, facility siting, speed zones, boating safety, and provide for public education.

In reviewing the baseline and to determine if speed zones or levels of enforcement were sufficient to minimize the likelihood of adverse effects to manatees, we looked at existing speed zones, levels of enforcement, manatee aggregation areas, warmwater refugia, freshwater sources, seagrass beds, and mortality data, as well as other biological factors. Based on this review, we focused on manatee mortality because this is the only form of take for which quantitative data are available. For Broward County, the result of all these factors (*i.e.*, zones in the right place with the appropriate signage for officers to enforce) is that between 1992 and 2005, 32 watercraft-related manatee deaths were recorded within Broward County, including 2 in 2000, 4 in 2001, 3 in 2002, 5 in 2003, 1 in 2004, 2 in 2005, and 7 in 2006.

We know that sublethal forms of take (such as injury and harassment) occur, but some of these forms are immeasurable. Sublethal injury to manatees due to boat interactions is a significant factor. On a continued basis, this type of injury could have an impact on maintaining a healthy and viable population. In that regard, most manatee carcasses examined bear scars from previous strikes with watercraft (Wright et al. 1995), and a significant number of living, but scarred, manatees exist. A photo-identification system and database of scarred manatees currently maintained by the Sirenia Project (Beck and Reid 1995) contain only individuals with distinct scars, the vast majority of which appear to have been inflicted by propeller blades or keels. This database now documents 1,184 living individuals scarred from collisions with boats. Most of these manatees (1,153, or 97 percent) have more than one scar pattern, indicating multiple strikes with boats. Carcasses examined at necropsy also bear healed scars of multiple past strikes by boats; one extreme case, recently noted by the FMRI, had evidence of more than 50 past boat collisions (O'Shea et al. 2001). The severity of these boat strikes, including completely severed tails, major tail mutilations, and multiple disfiguring dorsal lacerations, is thought by some manatee researchers to impact population processes by reducing calf production (and survival) in wounded females, although there are no reliable data to establish this cause and effect relationship. Overall, the full effects of harm to manatee population dynamics resulting from boat strikes remain largely unknown.

In addition to direct injury due to boat strikes, harassment by boats and swimmers may drive animals away from preferred sites thus altering manatee behavior and movement patterns. Significant and/or long-term harassment may require manatees to travel greater distances to feed or to reach warmwater refugia. Furthermore, some researchers are concerned that manatee calves can be separated from their mothers and some individuals may be driven from preferred warmwater refuges due to harassment.

Summary

Designated manatee critical habitat is not present within the action area. The action area contains seagrasses for foraging, shallow areas for resting and calving, channels for travel and migration, warmwater refugia for cold weather events, and fresh water for drinking. Seagrasses are distributed throughout the action area. Between 2000 and 2006, 24 watercraft-related manatee deaths were recorded in Broward County.

EFFECTS OF THE ACTION

This section includes an analysis of the direct and indirect effects of the proposed action on the manatee and its interrelated and interdependent activities.

Factors to be Considered

New watercraft access projects may have a number of direct and indirect effects on manatees and manatee habitat. Direct impacts include alteration of manatee habitat through dredge and fill activities associated with construction of the development and potential direct harm or harassment of manatees during construction activities. Anticipated direct impacts to habitat are addressed through modifications in the project design during the permit review process. Direct impacts to manatees during construction are dealt with through application of the *Standard Manatee Protection Construction Conditions* (Service 2001b), which are routinely included as conditions of Department of the Army permits issued for construction projects in manatee habitat.

Indirect effects include effects to manatees and manatee habitat caused by operation of the facility. Construction of new watercraft access projects may provide increased access by watercraft to areas frequented by manatees or may alter watercraft traffic patterns in such a way as to increase watercraft-manatee interactions. This may lead to increased harassment of manatees or increased watercraft collisions with manatees. Depending on the location of the project, construction of watercraft access projects may encourage boats to travel through important manatee habitat features such as submerged aquatic vegetation and warmwater refuges; thereby potentially altering manatee habitat and manatee habitat use patterns.

This project is in an area occupied by the manatee. The project is located on or near the AIW in Broward County within the southern portion of the geographic range of the Atlantic Subpopulation of the manatee. The timing of construction for the project as it relates to sensitive periods of the manatee's life cycle is unknown. Manatees may be found adjacent to the proposed construction footprint during the spring, summer, and fall. Due to cooler water temperatures generally present during mid-winter, there is a significantly lower likelihood that manatees will be adjacent to the construction footprint during this time. There is a high probability that during the cooler months manatees will be present at the Florida Power and Light – Port Everglades Power or at the Florida Power and Light – Fort Lauderdale Power Plant. The project would be constructed in a single, disruptive event, followed by perpetual activities, such as maintenance of the dock structures and watercraft ingress and egress. The entire construction sequence for each

project is expected to be completed in less than 3 months. Although users of watercraft associated with the project must operate at posted speeds within the action area, and must be cautioned about the possible presence of manatees, physical contact or harassment is still possible.

Analyses for Effects of the Action

The Corps has determined that the proposed project is located within the Broward County portion of Reach 4, as defined by the Corps' Reach Characterization Analysis. Furthermore, the Corps has determined that all projects within Reach 4 cause an increased risk to the manatee due to several reach characteristics including: (1) the very high extent of shallowness in high speed areas; (2) the very high dock and boating density; (3) the very high potential for watercraft traffic to cross manatee aggregation areas; and (4) the reach is very close to a manatee aggregation area.

Beneficial Effects - There are no known beneficial effects to manatees from the proposed activity.

Direct Effects - Direct effects are those effects that are caused by implementation of the proposed action, at the time of construction, and are reasonably certain to occur. The direct effects that this project will have on the manatee within the action area include noise from barge operation and construction equipment; in-water movement of construction equipment and work watercraft; placing and securing dock support structures and mooring piles; and barge ingress and egress to the construction site.

To reduce potential construction-related impacts to the manatee and critical habitat (where present), the Corps has agreed to include as a condition of the permit, and the applicant has agreed to implement as part of their construction, the *Standard Manatee Construction Conditions* (FWC 2005), which are as follows:

1. All personnel associated with the project shall be instructed about the presence of manatees and manatee speed zones, and the need to avoid collisions with and injury to manatees. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees which are protected under the MMPA, the Act, and the Florida Manatee Sanctuary Act.
2. All vessels associated with the construction project shall operate at "Idle Speed/No Wake" at all times while in the immediate area and while in water where the draft of the vessel provides less than a 4-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.
3. Siltation or turbidity barriers shall be made of material in which manatees cannot become entangled, shall be properly secured, and shall be regularly monitored to avoid manatee entanglement or entrapment. Barriers must not impede manatee movement.

4. All on-site project personnel are responsible for observing water-related activities for the presence of manatee(s). All in-water operations, including vessels, must be shutdown if a manatee(s) comes within 50 feet of the operation. Activities will not resume until the manatee(s) has moved beyond the 50-foot radius of the project operation, or until 30 minutes elapses if the manatee(s) has not reappeared within 50 feet of the operation. Animals must not be herded away or harassed into leaving.
5. Any collision with or injury to a manatee shall be reported immediately to the FWC Hotline at 888-404-FWCC. Collision and/or injury should also be reported to the Fish and Wildlife Service in Jacksonville (904-232-2580) for north Florida or Vero Beach (772-562-3909) for south Florida.
6. Temporary signs concerning manatees shall be posted prior to and during all in-water project activities. All signs are to be removed by the permittee upon completion of the project. Awareness signs that have already been approved for this use by FWC must be used. One sign measuring at least 3 feet by 4 feet which reads *Caution: Manatee Area* must be posted. A second sign measuring at least 8 1/2" by 11" explaining the requirements for "Idle Speed/No Wake" and the shut down of in-water operations must be posted in a location prominently visible to all personnel engaged in water-related activities.

With the incorporation of the above *Standard Manatee Construction Conditions* (Service 2001) into the project permit by the Corps, the Service believes that the construction of the proposed project will not directly affect the manatee.

Interrelated and Interdependent Actions - There are no interdependent or interrelated actions associated with the proposed activity that is expected to impact manatees.

Indirect Effects - Indirect effects are those long-term effects that are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. Authorizing a dock or marina or boat ramp in some manatee-inhabited areas indirectly affects manatees by increasing the likelihood of manatee mortality and injury resulting from collisions with new vessels associated with the permitted facility. Placement of watercraft access points has the potential to concentrate boating activities to that particular vicinity. If this area is frequented by manatees, the likelihood of watercraft collisions with manatees is increased proportional to the number of watercraft using the area, given that the boats are operating at a speed that could result in collisions with manatees. Also, take in the form of harassment from watercraft could increase in certain areas with the addition of more sublethal watercraft-manatee interactions. However, the likelihood of take is reduced if the adequate and appropriate regulatory measures (*i.e.*, designated manatee speed zones with the appropriate signage coupled with the necessary speed zone enforcement to prevent watercraft collisions with manatees from occurring as a result of the proposed project) are in place.

Watercraft-related manatee mortality was assessed for the action area. Between 2000 and 2006, 24 manatees died as a result of a watercraft collision in Broward County. Furthermore, the Service believes the vessels using the proposed facilities are reasonably certain to result in the

take of manatees in the form of harassment. As defined by the ESA, take is not just death and injury, but includes actions (= harassment) that create the likelihood of injury to manatees by significantly disrupting normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

As stated earlier, a MPP is one means of providing adequate planning to address effects of watercraft access projects on manatees and manatee habitat. Such plans provide a level of manatee protection commensurate with a certain level of boater access. Projects that are consistent with a State-approved MPP provide a level of boater access and activity that is within the capacity of the manatee protection measures provided in the plan. Projects that are not consistent with the approved MPP may exceed the capacity of the protective measures present and, therefore, may result in adverse effects to manatees.

Although Broward County is currently developing a MPP, the plan does not include a boating facility siting component and has not been approved by the State. Therefore, the Service believes that the facilities as proposed are not consistent with the State's recommended 1:100 ratio for new watercraft access projects in a key county without a State-approved MPP and, therefore, may have an adverse effect on the manatee.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions are not considered in this section because they require separate consultation under section 7 of the ESA. The Service has considered cumulative effects within the action area, and based on the above discussion, have not identified any additional cumulative effects beyond those already discussed in the Environmental Baseline.

However, based on the absence of the necessary measures to protect manatees (*e.g.*, a State approved MPP and limited enforcement of speed zones) in the project action area, the Service believes that the proposed actions are reasonably certain to result in the take of manatees in the form of additional deaths and injuries.

CONCLUSION

After reviewing the current status of the manatee, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's opinion that the action, as proposed, is not likely to jeopardize the continued existence of the manatee and are not likely to destroy or adversely modify designated critical habitat. However, the Service believes the proposed action may result in incidental take of manatees. The Service believes that county MPPs are one of the best vehicles to address such issues as boating facilities (marinas, docks, boat ramps, dry storage areas); boating activity patterns; manatee information; a boat facility siting plan; manatee protection measures; and an education and awareness program for the boating public. They are valuable planning tools and provide an excellent venue for local manatee protection efforts. Although Broward County is currently developing a MPP, the plan

does not include a boating facility siting component and has not been approved by the State. Therefore, the Service believes that the facility as proposed is not consistent with the State's recommended 1:100 ratio for new watercraft access projects in a key county without a State-approved MPP and, therefore, may have an adverse effect on the manatee. Therefore, the Service believes that the proposed action is reasonably certain to result in the take of manatees in the form of additional deaths and injuries.

INCIDENTAL TAKE STATEMENT

The Service anticipates that the proposed action is reasonably certain to result in the take of manatees. However, the Service is not including an incidental take authorization for marine mammals at this time because the incidental take of marine mammals has not been authorized under section 101(a)(5) of the MMPA and/or its 1994 Amendments. Following issuance of such regulations or authorizations, the Service may amend this biological opinion to include an incidental take statement for marine mammals, as appropriate.

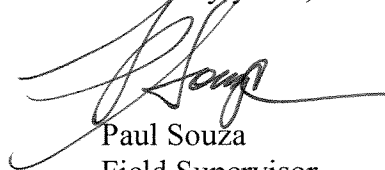
REINITIATION - CLOSING STATEMENT

This concludes section 7 consultations on the proposed issuance of Corps permit application SAJ-2006-6338 (LP-MJW).

As provided in 50 CFR § 402.15, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained and if: (1) the amount of incidental take is exceeded, (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered by this consultation, (3) the action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered by this consultation, or (4) a federally listed species or its critical habitat not addressed in this biological opinion may be affected by the action. In instances where incidental take occurs, any operations causing such take must cease pending reinitiation.

The above findings and recommendations constitute the report of the Department of the Interior. Thank you for your cooperation and effort in protecting fish and wildlife resources. If you have any questions regarding this project, please contact Winston Hobgood at 772-562-3909, extension 306.

Sincerely yours,

A handwritten signature in black ink, appearing to read 'Paul Souza', with a stylized flourish extending from the end.

Paul Souza
Field Supervisor
South Florida Ecological Services Office

cc:

Corps, Palm Beach Gardens, Florida (Justin Hughes)
FWC (BPSM), Tallahassee, Florida (Carol Knox)
Regional Solicitor, DOI, Atlanta, Georgia (Delores Young)
Service, Atlanta, Georgia (Noreen Walsh) electronic copy
Service, Jacksonville, Florida (Manatee Species Lead)

LITERATURE CITED

- Ackerman, B.B. 1995. Aerial surveys of manatee: A summary and progress report. Pages 13-33 in T.J. O'Shea, B.B. Ackerman, and H.F. Percival (eds.). Population Biology of the Florida Manatee. National Biological Service, Information and Technology Report No. 1. Washington D.C.
- Ackerman, B.B., S.D. Wright, R.K. Bonde, D.K. Odell, and D.J. Banowetz. 1995. Trends and patterns in mortality of manatees in Florida, 1974-1992. Pages 13-33 in T.J. O'Shea, B.B. Ackerman, and H.F. Percival, editors. Population Biology of the Florida Manatee. National Biological Service, Information and Technology Report No. 1. Washington, D.C.
- Beck, C.A. and J.P. Reid. 1995. An automated photo-identification catalog for studies of the life history of the Florida manatee. Pages 120-134 in T.J. O'Shea, B.B. Ackerman, and H.F. Percival (eds.). Population Biology of the Florida Manatee. National Biological Service, Information and Technology Report No. 1. Washington, D.C.
- Beeler, I.E. and T.J. O'Shea. 1988. Distribution and mortality of the West Indian manatee (*Trichechus manatus*) in the southeastern United States: A compilation and review of recent information. Prepared by the Fish and Wildlife Service for the U.S. Army Corps of Engineers. Document No. PB 88-207 980/AS. National Technical Information Service. Springfield, Virginia.
- Bengston, J.L. 1981. Ecology of manatees (*Trichechus manatus*) in the St. Johns River, Florida. Ph.D. Thesis. University of Minnesota, Minneapolis, Minnesota.
- Bossart, G.D., D.G. Baden, R.Y. Ewing, B. Roberts, and S.D. Wright. 1998. Brevetoxicosis in manatees (*Trichechus manatus latirostris*) from the 1996 epizootic: gross, histologic, and immunohistochemical features. Toxicologic Pathology Volume 26(2):276-282.
- Deutsch, C.J., R.K. Bonde, and J.P. Reid. 1998. Radio-tracking manatees from land and space: Tag design, implementation, and lessons learned from long-term study. Marine Technology Society Journal 32(1):18-29.
- Domning, D.P. and L-A.C. Hayek. 1986. Interspecific and intraspecific morphological variation in manatees (Sirenia: *Trichechus*). Marine Mammal Science 2(2):87-144.
- Florida Fish and Wildlife Conservation Commission. 2001. Manatees and Florida Power and Light's Fort Lauderdale and Port Everglades Power Plants. Tallahassee, Florida.
- Florida Fish and Wildlife Conservation Commission. 2005. *Standard Manatee Conditions for In-water Work* <<http://floridaconservation.org/psm/permit/construct.htm>>. Tallahassee, Florida.

- Florida Department of Highway Safety and Motor Vehicles. 2003. Boat registration statistics for 2002. Email Communication. February 21, 2003.
- Florida Office of Economic and Demographic Research. 2001. The Florida Legislature. Florida Population, Components and Change (1950-2000), (last modified March 27, 2001) <<http://www.state.fl.us/edr/index.html>>.
- Garrott, R.A., B.B. Ackerman, J.R. Cary, D.M. Heisey, J.E. Reynolds, III, P.M. Rose, and J.R. Wilcox. 1994. Trends in counts of Florida manatees at winter aggregation sites. *Journal of Wildlife Management* 58(4):642-654.
- Gerstein, E.R. 1995. The underwater audiogram of the West Indian manatee (*Trichechus manatus latirostris*). M.S. Thesis. Florida Atlantic University.
- Gunter, G. 1941. Occurrence of the manatee in the United States, with records from Texas. *Journal of Mammalogy* 22(1):60-64.
- Hartley, W. 2001. Electronic mail for B. Brooks, Service. February 14, 2001.
- Hartman, D.S. 1979. Ecology and behavior of the manatee (*Trichechus manatus*) in Florida. American Society of Mammalogists Special Publication No. 5.
- Hernandez, P., J.E. Reynolds, III, H. Marsh, and M. Marmontel. 1995. Age and seasonality in spermatogenesis of Florida manatees. Pages 84-97 in T.J. O'Shea, B.B. Ackerman, and H.F. Percival (eds.). Population Biology of the Florida Manatee. National Biological Service, Information and Technology Report No. 1. Washington, D.C.
- Husar, S.L. 1977. The West Indian manatee (*Trichechus manatus*). U.S. Fish and Wildlife Service. Wildlife Resource Report No. 7:1-22.
- Kadel, J.J. and G.W. Patton. 1992. Aerial studies of the West Indian manatee (*Trichechus manatus*) on the west coast of Florida from 1985-1990: A comprehensive 6-year study. Mote Marine Laboratory Technical Report No. 246.
- Ketten, D.R., D.K. Odell, and D.P. Domning. 1992. Structure, function, and adaptation of the manatee ear. Pages 77-95 in J. Thomas, R. Kastelein, and A. Supin (eds.). Marine mammal sensory systems. Plenum Press. New York, New York.
- Koelsch, J.K. 1997. The seasonal occurrence and ecology of Florida manatees (*Trichechus manatus latirostris*) in coastal waters near Sarasota, Florida. M.S. Thesis. University of South Florida.
- Landsberg, J.H. and K.A. Steidinger. 1998. A historical review of *Gymnodinium breve* red tides implicated in mass mortalities of the manatee (*Trichechus manatus latirostris*) in Florida, USA. Pp. 97-100 in Raguera, B., J. Blanco, M.L. Fernández, and T. Wyatt (eds.).

Harmful Algae. Xunta de Galicia and Intergovernmental Oceanographic Commission of UNESCO 1998.

- Ledder, D.A. 1986. Food habits of the West Indian manatee (*Trichechus manatus latirostris*) in south Florida. M.S. Thesis, University of Miami, Coral Gables, Florida.
- Lefebvre, L.W. and R.K. Frohlich. 1986. Movements of radio-tagged manatees in southwest Florida, January 1985 - March 1986. Unpublished report, U.S. Fish and Wildlife Service and Florida Department of Natural Resources, Gainesville, Florida.
- Lefebvre, L.W., T.J. O'Shea, G.B. Rathbun, and R.C. Best. 1989. Distribution, status, and biogeography of the West Indian manatee. Pages 567-609 in C.A. Woods (ed.). Biogeography of the West Indies: Past, Present, and Future. Sandhill Crane Press. Gainesville, Florida.
- Lefebvre, L.W., B.B. Ackerman, K.M. Portier, and K.H. Pollock. 1995. Aerial survey as a technique for estimating trends in manatee population size - problems and prospects. Pages 63-74 in T.J. O'Shea, B.B. Ackerman, and H.F. Percival (eds.). Population Biology of the Florida Manatee. National Biological Service, Information and Technology Report No. 1. Washington, D.C.
- Lefebvre, L.W., J.P. Reid, W.J. Kenworthy, and J.A. Powell. 2000. Characterizing manatee habitat use and seagrass grazing in Florida and Puerto Rico: Implications for conservation and management. Pacific Conservation Biology 5(4):289-298.
- Marine Mammal Commission. 1984. Marine Mammal Commission Annual Report to Congress 1983. Washington, D.C.
- Marine Mammal Commission. 1986. Habitat protection needs for the subpopulation of West Indian manatees in the Crystal River area of northwest Florida. Document No. PB86-200250, National Technical Information Service. Silver Spring, Maryland.
- Marine Mammal Commission. 1988. Preliminary assessment of habitat protection needs for West Indian manatees on the east coast of Florida and Georgia. Document No. PB89-162002, National Technical Information Service. Silver Spring, Maryland.
- Marine Mammal Commission. 1993. Marine Mammal Commission Annual Report to Congress 1992. Washington, D.C.
- Marmontel, M. 1995. Age and reproduction in female Florida manatees. Pages 98-119 in T.J. O'Shea, B.B. Ackerman, and H.F. Percival (eds.). Population Biology of the Florida Manatee. National Biological Service, Information and Technology Report No. 1. Washington, D.C.

- Marmontel, M., S.R. Humphrey, and T.J. O'Shea. 1997. Population Viability Analysis of the Florida Manatee (*Trichechus manatus latirostris*), 1976-1991. *Conservation Biology*. 11(2):467-481.
- Marshall, C.M., P.S. Kubilis, G.D. Huth, V.M. Edmonds, D.L. Halin, and R.L. Reep. 2000. Food-handling ability and feeding-cycle length of manatees feeding on several species of aquatic plants. *Journal of Mammalogy*. 81(3): 649-658.
- Nill, E.K. 1998. Florida manatee entanglement Report. U.S. Fish and Wildlife Service Contract No. 40181-98-M146.
- Odell, D.K. 1981. Growth of a West Indian manatee, *Trichechus manatus*, born in captivity. pp 131-140 in R. L. Brownell, Jr. and K. Ralls (eds). *The West Indian manatee in Florida. Proceedings of a workshop held in Orlando, Florida March 27-29, 1978.* Florida. Department of Natural Resources, Tallahassee, Florida.
- Odell, D.K. 1982. The West Indian manatee, *Trichechus manatus linnaeus*. Pages 828-837 in J.A. Chapman and G.A. Feldhammer (eds.). *Wild Mammals of North America.* Johns Hopkins University Press, Baltimore, Maryland.
- Odell, D.K. and J.E. Reynolds. 1979. Observations on manatee mortality in south Florida. *Journal of Wildlife Management* 43:572-5.
- Odell, D.K., G.D. Bossart, M.T. Lowe, and T.D. Hopkins. 1995. Reproduction of the West Indian manatee in captivity. Pages 192-193 in T.J. O'Shea, B.B. Ackerman, and H.F. Percival (eds.). *Population Biology of the Florida Manatee.* National Biological Service, Information and Technology Report No. 1. Washington, D.C.
- O'Shea, T.J., C.A. Beck, R.K. Bonde, H.I. Kochman, and D.K. Odell. 1985. An analysis of manatee mortality patterns in Florida 1976-1981. *Journal of Wildlife Management*. 49:1-11.
- O'Shea, T.J. 1988. The past, present, and future of manatees in the southeastern United States: Realities, misunderstandings, and enigmas. Pages 184-204 in Odum, R.R., K.A. Riddleberger, and J.C. Ozier (eds.). *Proceedings of the Third Southeastern Nongame and Endangered Wildlife Symposium.* Georgia Department of Natural Resources. Social Circle, Georgia.
- O'Shea, T.J., G.B. Rathbun, R.K. Bonde, C.D. Buergelt, and D.K. Odell. 1991. An epizootic of Florida manatees associated with a dinoflagellate bloom. *Marine Mammal Science*. 7(2):165-179.
- O'Shea, T.J., B.B. Ackerman, and H.F. Percival (eds.). 1992. Interim report of the technical workshop on manatee population biology. *Manatee Population Research Report No. 10.* Florida Cooperative Fish and Wildlife Research Unit. Gainesville, Florida.

- O'Shea, T.J. and W.C. Hartley. 1995. Reproduction and early-age survival of manatees at Blue Spring, Upper St. Johns River, Florida. Pages 157-170 in T.J. O'Shea, B.B. Ackerman, and H.F. Percival (eds.). Population Biology of the Florida Manatee. National Biological Service, Information and Technology Report No. 1. Washington, D.C.
- O'Shea, T.J., L.W. Lefebvre, and C.A. Beck. 2001. Florida Manatees: Perspectives on Populations, Pain, and Protection. Pages 31-43 in L.A. Dierauf and F.M.D. Gulland (eds.). CRC Handbook of Marine Mammal Medicine, 2nd edition. CRC Press. Boca Raton, Florida.
- Packard, J.M. and R. Mulholland. 1983. Analysis of manatee aerial surveys: a compilation and preliminary analysis of winter aerial surveys conducted in Florida between 1977 and 1982. Manatee Population Research Report No. 2. Florida Cooperative Fish and Wildlife Research Unit. Gainesville, Florida.
- Packard, J.M., R.C. Summers, and L.B. Barnes. 1985. Variation of visibility bias during aerial surveys of manatees. Journal of Wildlife Management 49(2):347-351.
- Powell, J.A. and G.B. Rathbun. 1984. Distribution and abundance of manatees along the northern coast of the Gulf of Mexico. Northeast Gulf Science 7(1): 1-28.
- Provancha, J.A. and M.J. Provancha. 1988. Long-term trends in abundance and distribution of manatees (*Trichechus manatus*) in the northern Banana River, Brevard County, Florida. Marine Mammal Science 4(4):323-338.
- Provancha, J.A. and C.R. Hall. 1991. Observations of associations between seagrasses and manatees in East Central Florida. Florida Scientist 54(2):87-98.
- Rathbun, G.B., J.P. Reid, and G. Carowan. 1990. Distribution and movement patterns of manatees (*Trichechus manatus*) in Northwestern peninsular Florida. Florida Marine Research Publication No. 48.
- Rathbun, G.B., J.P. Reid, R.K. Bonde, and J.A. Powell. 1995. Reproduction in free-ranging Florida manatees. Pages 135-156 in T.J. O'Shea, B.B. Ackerman, and H.F. Percival (eds.). Population Biology of the Florida Manatee. National Biological Service, Information and Technology Report No. 1. Washington, D.C.
- Rathbun, G.B. 1999. Sirenians. Pages 390-399 in Chapter 8: Behavior. J.E. Reynolds, III, and S.A. Rommel (eds.). Biology of Marine Mammals. Smithsonian Institution Press. Washington, D.C.
- Reid, J.P. and G.B. Rathbun. 1984. Manatee identification catalogue, October 1984 update. Unpublished progress report prepared by the U.S. Fish and Wildlife Service, Sirenia Project, Gainesville, Florida for the Florida Power and Light Company.

- Reid, J.P., G.B. Rathbun, and J.R. Wilcox. 1991. Distribution patterns of individually identifiable West Indian manatees (*Trichechus manatus*) in Florida. *Marine Mammal Science* 7(2):180-190.
- Reid, J.P., R.K. Bonde, and T.J. O'Shea. 1995. Reproduction and mortality of radio-tagged and recognizable manatees on the Atlantic Coast of Florida. Pages 171-191 in T.J. O'Shea, B.B. Ackerman, and H.F. Percival (eds.). *Population Biology of the Florida Manatee*. National Biological Service, Information and Technology Report No. 1. Washington, D.C.
- Reynolds, J.E. 1981. Behavior patterns in the West Indian manatee, with emphasis on feeding and diving. *Florida Scientist* 44(4):233-241.
- Runge, M.C., C.A. Langtimm, and W.L. Kendall. In Review. A stage-based model of manatee population dynamics. *Marine Mammal Science*.
- Snow, R.W. 1991. The distribution and relative abundance of the Florida manatee in Everglades National Park, an annual report, October 1, 1991. South Florida Research Center. Everglades National Park. Homestead, Florida.
- U.S. Fish and Wildlife Service. 1999. South Florida Multi-Species Recovery Plan. Atlanta, Georgia.
- U.S. Fish and Wildlife Service. 1996. Florida Manatee Recovery Plan, (*Trichechus manatus latirostris*), Second Revision. Atlanta, Georgia.
- U.S. Fish and Wildlife Service. 2001a. Florida Manatee Recovery Plan, (*Trichechus manatus latirostris*), Third Revision. Atlanta, Georgia.
- U.S. Fish and Wildlife Service. 2001b. Standard Manatee Protection Construction Conditions for Aquatic-Related Activities. Atlanta, Georgia.
- Wildlife Trust. 2001. 2001 Manatee Population Status Statement. March 2001.
- Wright, S.D., B.B. Ackerman, R.K. Bonde, C.A. Beck, and D.J. Banowetz. 1995. Analysis of watercraft-related mortality of manatees in Florida, 1979-1991. Pages 259-268 in T.J. O'Shea, B.B. Ackerman, and H.F. Percival (eds.). *Population Biology of the Florida Manatee*. National Biological Service, Information and Technology Report No. 1. Washington D.C.