III. AFFECTED ENVIRONMENT

The primary source of information for this chapter is derived from the Recovery Plan (USFWS 2000) and Population Biology of the Florida Manatee (O'Shea *et al.* 1995). A more comprehensive overview of manatee population biology, behavior and physiology, as well as threats to the species, conservation efforts and recovery actions, is found in these two documents.

A. Status of Manatee Habitat in Florida

1. Warm Water Refugia/Natural Springs

Manatees exhibit opportunistic, 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. When ambient water temperatures drop below 20° C (68° F) in autumn and winter, manatees aggregate within the confines of natural and artificial warm water refuges (Lefebvre *et al.* 2001) 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. The largest winter aggregations (maximum count of 100 or more animals) are at refuges in Central and Southern Florida. The northernmost natural warm water refuge used regularly on the west coast is at Crystal River and at Blue Springs in the St. Johns River on the east coast.

Most manatees return to the same warm water refuges each year; however, some use different refuges in different years and others use two or more refuges in the same winter (Reid and Rathbun 1984, 1986; Rathbun *et al.* 1990; Reid *et al.* 1991; Reid *et al.* 1995). Many lesser known, minor aggregation sites are used as temporary thermal refuges. Most of these refuges are canals or boat basins where warmer water temperatures persist as temperatures in adjacent bays and rivers decline.

During mild winter periods, manatees at thermal refuges move to nearby grassbeds to feed, or even return to a more distant warm season range (Deutsch *et al.* 2000). For example, manatees using the Riviera Power Plant in Palm Beach County feed in adjacent Lake Worth and in Jupiter and Hobe Sound, 19 to 24 kilometers (12 to 15 miles) to the north (Packard 1981); animals using the Port Everglades Power Plant feed in grass beds in Biscayne Bay 24 to 32 kilometers (15 to 20 miles) to the south (MMC 1988); animals in Kings Bay feed on submerged aquatic vegetation along the mouth of the Crystal River (Rathbun *et al.* 1990). Manatees at Blue Spring leave the spring run to feed on freshwater aquatic plants along the St. Johns River and associated waters near the spring (Bengston 1981; MMC 1986).

One of the greatest threats to the continued existence of the Florida manatee is the stability and longevity of warm water refuges. Historically, the subtropical manatee relied on the warm temperate waters of south Florida and on natural warm water springs scattered throughout their range as buffers to the lethal effects of cold winter temperatures. The natural northern winter distribution limit for manatees was roughly the Caloosahatchee River on the Gulf coast and the St. Sebastian River on the Atlantic coast. With the advent of industrial plants and their associated warm-water discharges, manatees have expanded their winter range to include these sites as refuges from the cold. Today,

the artificial warm water distribution limit is now Tampa Bay and Brevard County, with some manatees found at warm water sites as far north as southern Georgia.

In the absence of these sources of warm water, manatees are vulnerable to cold temperatures and can die from both hypothermia and prolonged exposure to cold. Based upon recent synoptic survey data, just under two-thirds of the population of Florida manatees rely on industrial sites, which are now made up almost entirely of power plants (FWC unpublished data).

Loss of artificial and natural warm water refuges could greatly reduce the winter carrying capacity of habitats north of the St. Sebastian River on the Atlantic coast and the Caloosahatchee River on the Gulf coast. The availability of warm water refuges for manatees is uncertain if minimum flows and levels are not established for the natural springs on which many manatees depend, and as deregulation of the power industry in Florida occurs. The potential decrease in warm water carrying capacity is the single-most significant threat facing the long-term survival and recovery of this endangered species.

A prominent natural cause of death in some years is exposure to cold. Following a severe winter cold spell at the end of 1989, at least 46 manatee carcasses were recovered in 1990; cause of death for each was attributed to cold stress. Exposure to cold is believed to have caused many deaths in the winters of 1977, 1981, 1984, 1990, 1996, and 2001, and have been documented as early as the 19th century (Ackerman *et al*. 1995; O'Shea *et al.* 1985; FWC unpublished data).

Overall, industrial warm water refuges have been a benefit to manatees inasmuch as they have: (1) reduced the frequency of cold-related deaths by providing reliable sources of warm water during the winter; (2) reduced the incidence of juvenile, cold-weather related mortality in south Florida; and, (3) provided additional winter refuges and foraging sites which supplant heavily-stressed wintering sites in south Florida. While these sites have clearly benefitted the species, they also pose a significant risk. For example, during periods of extreme cold, some power plants are unable to provide sufficient warm water to meet the manatees' physiological needs. Plants are also vulnerable to winter shutdowns due to equipment failures and needed maintenance and, in the long-term, have a limited life span. Older power plants are less cost-effective to operate, and market economics will increasingly play a more significant role in the plants' operating schedules (USFWS 2000).

Alterations to both natural and industrial warm water refuges will significantly affect the manatee's ability to tolerate and withstand the cold. In the absence of stable, long-term sources of warm water and winter habitat, large numbers of manatees may succumb to the cold. Given the magnitude of the problem, the outright loss of these numbers of animals could significantly affect recovery efforts. The power industry and wildlife managers and researchers are currently working together to secure the manatee's winter habitat. As part of efforts to recover the manatee, a multiagency Warm Water Task Force is now investigating strategies to protect these sites, including their spatial arrangement and long-term management implications for manatees.

Prior to the use of industrial, once-through cooling systems associated with the production of electricity and paper production in the 1940's and 1950's, Florida manatees relied upon natural, warm water springs and temperate, warm waters in south Florida as buffers against the cold. In the face

of human disturbance at these natural sites, manatee use patterns were altered and industrial sites became a part of their wintering strategies. Today, a little less than two-thirds of the manatee population winters at industrial warm water sites.

In the past, Florida's landscape included innumerable springs that discharged warm water from the Floridan aquifer and other subsurface sources of water. Human expansion into Florida, including early aboriginal colonization and European settlement, targeted these springs as sources of drinking water and food. Significant, initial manatee disturbance at the springs was probably related to manatee hunting. Other early human activities in the vicinity of the springs included fishing and boating and the use of wells within spring recharge areas.

Subsequent activities in the springs and respective recharge areas further altered these sites. Dams and boat facilities were built in the springs, spring runs, and adjoining waterbodies and industrial and consumptive use of aquifer waters reduced flows. The introduction of pollutants (such as pesticides, herbicides, and human and animal waste) into the aquifer and spring waters eliminated and/or altered the make-up of aquatic communities within these areas. As a result, many springs dried up, others were made inaccessible to manatees, and important winter foraging sites disappeared. Continued use of aquifer waters, in the face of an increasing human population in Florida, continues to threaten the availability and suitability of spring waters to manatees.

Today, manatees use Blue Spring, De Leon Springs, Silver Glen Spring, Salt Springs, and other spring areas in the upper St. Johns River. On Florida's northwest coast, manatees primarily winter in the Kings Bay spring complex in Crystal River, at Homosassa Spring, in Manatee Springs, Fanning Springs, Weeki Wachee Spring, and at other lesser springs. Springs in southwest Florida include Sulphur Spring in Tampa Bay and Warm Mineral Springs in Charlotte Harbor. There are currently no known spring areas in southeast Florida used by manatees.

Due to continued adverse cumulative effects, the State, through its water management district offices, is setting minimum flow and level (MFL) standards for waterbodies throughout the state. These waterbodies include springs, including sites used by manatees. The SJWMD is currently preparing an MFL for Blue Spring (the MFL is based on manatee use of the spring run); this is the only site used by manatees where an MFL is being prepared. Other significant wintering sites are not being addressed, although the water management district offices have been encouraged to prioritize these areas.

The Service and its Habitat Working Group recovery partners are involved in MFL working groups, are reviewing spring management plans, and are revising the habitat criteria described in the Recovery Plan.

2. Seagrass

The Florida manatee lives in freshwater, brackish, and marine habitats. Submerged, emergent, and floating vegetation are their preferred food. 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). Packard (1984) noted two feeding methods in coastal seagrass beds: (1) rooting, where virtually the entire plant is consumed; and (2) grazing, where exposed grass blades

are eaten without disturbing the roots or sediment. Manatees may return to specific seagrass beds to graze on new growth (Koelsch 1997; Lefebvre *et al.* 2000).

Shallow grass beds with ready access to deep channels are preferred feeding areas in coastal and riverine habitats. In the upper Banana River, Provancha and Hall (1991) found spring concentrations of manatees grazing in beds dominated by manatee grass (*Syringodium filiforme*). They also reported an apparent preference for manatee grass and shoalgrass (*Halodule wrightii*) over the macroalga *Caulerpa* spp. Along the Florida-Georgia border, manatees feed in salt marshes on smooth cordgrass (*Spartina alterniflora*) by timing feeding periods with high tide (Baugh *et al.* 1989; Zoodsma 1991).

Seagrass habitat important to manatee feeding is affected by human activities. Dredge and fill activities, polluted runoff, propeller scarring, and other actions have resulted in the loss of vegetated areas. In Tampa Bay, for example, it is estimated that more than 80 percent of the seagrass community has been destroyed by human activity (Lewis 1986). Efforts are in place and are being made to protect, enhance, and restore the manatee's aquatic environment. There are many existing Federal, State, and local government regulations in place to minimize the effects of human activities on manatees and their habitat (*e.g.*, CWA, Rivers and Harbors Act, ESA, Fish and Wildlife Coordination Act [FWCA], CZMA, etc.). Even though efforts are being made to improve this environment and to maintain those resources that are vital to the manatee, the long-term, cumulative effects of anthropogenic activities on manatee habitat are beginning to weigh more heavily in manatee conservation decision making, particularly given that Florida's human population is projected to double in the next 30 years with the majority of new residents occupying the coastal areas.

Human-related activities adversely affect coastal and riverine resources of importance to the Florida manatee. In particular, coastal and riverine property development, stormwater runoff, upland agricultural activities, increased sewage discharge, and aquatic recreational and commercial activities decrease water quality and lead to reductions in the quantity and quality of aquatic plant communities.

These activities increase erosion and sediment transport in nearshore waters which, in turn, increases turbidity and sediment deposition in aquatic plant communities. These factors decrease light penetration and smother seagrasses. Channelization alters salt and fresh water inputs into these habitats and either changes the species composition of affected aquatic communities or destroys them. Stormwater runoff and its constituent pollutant elements also eliminate and alter these communities– herbicides, pesticides, increased nutrient loading from septic systems, and other inputs are directly and indirectly involved in the loss of plants. Lastly, prop scarring from boats is also thought to have a significant effect on grass beds.

Many of these activities have been curtailed in Florida. There are Federal, State, and local government efforts in place to reduce runoff and programs in place to stop the discharge of harmful pollutants into manatee habitats. Some efforts to replant sites are also taking place. Boat speed regulations in grass beds are helping to minimize the loss of grasses to prop scarring. As a result,

the rate of seagrass loss in many areas has slowed and many affected areas are experiencing a resurgence. While these results are encouraging, Florida's lost aquatic communities are far from being recovered and the threats posed by an increasing human population in coastal and riverine areas will continue to challenge the integrity of these systems.

3. Other Important Habitats

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 1986, 1988). In estuarine and brackish areas, natural and artificial fresh water sources are sought by manatees. As in winter, manatees often use the same summer habitats year after year (Reid *et al.* 1991; Koelsch 1997).

Natural wintering sites have been affected by human activities (USFWS 2000). Winter habitat in south Florida has been altered (*e.g.*, shoreline areas have been rip-rapped and bulkheaded, sources of warm water have been diverted and/or capped, foraging and resting sites have been eliminated, etc.). Important springs in the northern area of the species' range have also been altered; demands for water for residential, industrial, and agricultural purposes from the aquifer have diminished spring flows, as have paving and water diversion projects in spring recharge areas. Nutrient loading (*e.g.*, nitrates) from residential and agricultural sources has promoted the growth of alga and clouded water columns, thus reducing available winter forage in these refuges.

4. Manatee Designated Critical Habitat

The West Indian manatee was listed as endangered throughout its range for both the Florida and Antillean subspecies (*T. manatus latirostris* and *T. manatus manatus*, respectively) in 1967 (32 FR 4061) and received Federal protection with the passage of the ESA in 1973. It should be noted that 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. Critical habitat was designated in 1976 for the Florida subspecies (50 CFR Part 19.95(a)). This was one of the first ESA designations of critical habitat for an endangered species and the first for an endangered marine mammal. Much has been learned about manatee distribution and habitat use in the decades since the 1976 designation of manatee critical habitat, and the Service's current Recovery Plan identifies the need to assess and revise critical habitat for this population. This task will be addressed in the future in a separate ESA action.

5. Description of Manatee Habitat in the Four Manatee Stocks in Florida

Following is a detailed description of manatee habitat in each of the four stocks developed by the Service from existing Geographic Information System (GIS) coverages in Florida (see Appendix J).

Table 4 provides a summary by acres of manatee habitat, by stock. This information will be utilized in the Environmental Consequences section for alternative comparison purposes.

a. Northwest Stock

The NW Stock encompasses 18 counties, extending from Hernando County on the southern end to the Florida/Alabama border at the northwestern end. The area is relatively sparsely populated and contains high quality manatee habitat. Manatee usage in this area is limited during the winter due to cold weather events. There are over 852,100 acres of open water in this area, of which 2,130 acres are designated manatee critical habitat. An estimated 622,560 acres of seagrass are located in this area, of which 73,330 acres have light to severe prop scarring by watercraft. Finally, there are 4,810 acres of known manatee aggregation habitat in the area at Crystal River and Homosassa Springs.

b. Upper St. Johns River Stock

The USJ Stock is a relatively small area which includes portions of five counties adjoining the St. Johns River. This region is also relatively sparsely populated, and manatee habitat is considered high quality. There is an estimated 115,980 acres of open water in this region, of which over one-half (65,170 acres) is manatee designated critical habitat. Manatee aggregation habitat consists of 210 acres located at Blue Springs.

c. Atlantic Stock

The Atlantic Stock includes 16 counties on Florida's Atlantic coast, extending from the Florida/Georgia border south to the Florida Keys. This region contains almost 1.8 million acres of open water, of which 435,390 acres are manatee designated critical habitat. There are 13 identified manatee aggregation areas in this region encompassing 29,550 acres of habitat. Lastly, this region contains almost 1.5 million acres of seagrass, of which 49,070 acres have been lightly to severely damaged by watercraft prop scarring.

d. Southwest Stock

The SW Stock encompasses 12 counties from Pasco County on the north to Monroe County (Whitewater Bay) on the south. There are an estimated 957,370 acres of open water in this region, of which an estimated 601,140 acres (62.7 percent) are designated manatee critical habitat. The region also contains 22,330 acres of manatee aggregation habitat and 185,890 acres of seagrass, of which 51,230 acres have been lightly to severely damaged by watercraft prop scarring.

Table 4. Summary, by Acres, of the Habitat Characteristics of the Four Manatee Stocks

Stock	Open Water Habitat	Critical Habitat	Seagrass	Damaged Seagrass	Aggregation Habitat
NW	852,100	2,130	622,560	73,330	4,810
USJ	115,980	65,170	No Data	No Data	210
Atlantic	1,797,330	435,390	1,448,210	49,070	29,550
SW	957,370	601,140	185,890	51,230	22,330

B. Current Status of the Florida Manatee Population

1. Florida Manatee Distribution

After Spanish occupation, Florida's human population steadily increased, and manatees probably were taken in greater numbers. Commercial and subsistence hunting, particularly in the 1800s, probably further reduced the manatee population. Based on telemetry, aerial surveys, photo-identification sighting records, and other studies over the past 20 years, manatee distribution in the southeastern U.S. is now well known (MMC 1984, 1986; Beeler and O'Shea 1988; O'Shea 1988; Lefebvre *et al.* 2001).

Based on the highest minimum winter counts for each stock during the 2001 synoptic surveys (3,276 individuals), the number of manatees on the east and west coasts of Florida appears to be approximately equal. Within both the east and west coast segments of the Florida manatee population, documented movements suggest that at least some loosely formed subpopulations exist, which may constitute useful management units (USFWS 2001). Four subgroups were identified, which tend to return to the same warm water refuge(s) each winter and have similar nonwinter distribution patterns. For example, on the east coast, a core group of more than 100 manatees uses the Blue Spring warm water refuge in the upper St. Johns River. Radio-tracking studies (Bengston 1981) and other information (Beeler and O'Shea 1988; MMC 1988) suggest that most manatees wintering at Blue Spring tend to remain in the area identified as the USJ Stock and consist of approximately 3 percent of the population. The lower St. Johns River, the east coast, and the Florida Keys are considered to represent the Atlantic Stock, based on the results of long-term radio tracking and photo-identification studies (Beck and Reid 1995; Reid *et al.* 1995; Deutsch *et al.* 1998). This subgroup consists of approximately 43 percent of the population.

On the west coast, Rathbun *et al.* (1995) reported that of 269 recognizable manatees identified at the Kings Bay and Homosassa River warm water refuges in northwest Florida between 1978 and 1991, 93 percent of the females and 87 percent of the males returned to the same refuge each year. Radio-tracking results suggest that many animals wintering at Crystal River disperse north in warm seasons to rivers along the Big Bend coast, particularly the Suwannee River (Rathbun *et al.* 1990). This area is designated as the NW Stock and consists of approximately 12 percent of the population. The existence of more or less distinct subgroups in the southwestern half of Florida (*i.e.*, from Tampa

Bay south) is debatable. It is possible that manatees using warm water refuges in Tampa Bay, the Caloosahatchee River, and Collier County may be somewhat discrete groups; however, given available data, the Recovery Team chose to identify them as one group, the SW Stock. This subgroup consists of approximately 42 percent of the population.

2. Estimating Manatee Population Size and Trends

Despite considerable effort in the early 1980s, scientists have been unable to develop a useful means of estimating or monitoring trends in the size of the overall manatee population in the southeastern U.S. (O'Shea 1988; O'Shea *et al*. 1992; Lefebvre *et al.* 1995). Even though many manatees aggregate at warm water refuges in winter and most if not all such refuges are known, direct counting methods (*i.e.*, by aerial and ground surveys) have been unable to account for uncertainty in the number of animals that may be away from these refuges at any given time, the number of animals which are 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 also has been impractical, as the proportion of unmarked manatees cannot be estimated.

The only data on population size have been uncalibrated indices based on maximum counts of animals at winter refuges made within one or two days of each other. Based on such information in the late 1980s, the total number of manatees throughout Florida was known to be at least 1,200 animals (Reynolds and Wilcox 1987). 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 analyses for temporal trends is difficult (Packard and Mulholland 1983; Garrott *et al*. 1994). Strip-transect aerial surveys are used routinely to estimate dugong population size and trends (Marsh and Sinclair 1989); however, they are difficult to adapt to manatees because of the species' much more linear (coastal and riverine) distribution. This survey method was tested in the Banana River, Brevard County, and recommended for use in that area to monitor manatee population trends (Miller *et al*. 1998). This approach may also have utility in the Ten Thousand Islands-Everglades area, where manatee population size and distribution are poorly understood.

Beginning in 1991, the former Florida Department of Natural Resources (FDNR) initiated a Statewide aerial survey program to count manatees in potential winter habitat during periods of severe cold weather (Ackerman 1995). These surveys are much more comprehensive than those used to estimate a minimum population during the 1980s. The highest two-day minimum count of manatees from these winter synoptic aerial surveys and ground counts is 3,276 manatees in January 2001. The highest east coast of Florida count is 1,756 and highest on the west coast is 1,520, both in 2001. However, the manatee counts of March 2002, when weather conditions were less favorable, resulted in a total count of 1,796. The FWC stated in their March 6, 2002, press release that the "low count merely reflects the poor visibility during the count, not a dramatic change in the manatee population." Due to the nearly ideal conditions for the 2001 synoptic survey, the results of that survey are considered the best available estimate of the current minimum population size (3,276) (see Appendix Q - Synoptic Surveys).

It remains unknown what proportions of the total manatee population were counted in these surveys. No Statewide surveys were done during the winters of 1992-93 or 1993-94 because of the lack of strong midwinter cold fronts. These uncorrected counts do not provide a basis for assessing population trends.

However, trend analyses of temperature-adjusted aerial survey counts show promise for providing insight to general patterns of population growth in some stocks (Garrott *et al*. 1994, 1995; Craig *et al.* 1997; Eberhardt *et al.* 1999).

It has been possible to monitor the number of manatees using the Blue Spring and Crystal River warm water refuges. At Blue Spring, with its unique combination of clear water and a 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 (Beeler and O'Shea 1988), and in the winter of 1999-2000, the number increased to 147 (Hartley 2001).

On the west coast of Florida, the clear, shallow waters of Kings Bay have made it possible to monitor the number of manatees using the warm water refuge in Kings Bay at the head of the Crystal River. Large aggregations of manatees apparently did not exist there until recent times (Beeler and O'Shea 1988). The first careful counts were made in the late 1960s. Since then, manatee numbers have increased significantly. In 1967 to 1968, Hartman (1979) counted 38 animals in Kings Bay. By 1981 to 1982, the maximum winter count increased to 114 manatees (Powell and Rathbun 1984) and in December 1997, the maximum count was 284 (Buckingham *et al.* 1999). Both births and immigration of animals from other areas have contributed to the increases in manatee numbers at Crystal River and Blue Spring. Three manatee sanctuaries in Kings Bay were established in 1980, an additional three were added in 1994, and a seventh in 1998. The increases in counts at Blue Spring and Crystal River are accompanied by estimates of adult survival and population growth that are higher than those determined for the Atlantic coast (Eberhardt and O'Shea 1995; Langtimm *et al.* 1998; Eberhardt *et al.* 1999).

While aircraft synoptic surveys provide a "best estimate" of manatee population size, there are no estimates or confidence intervals for the size of the Florida manatee population that have been derived by reliable, statistically based, population-estimation techniques. A *census* is a complete count of individuals within a specified area and time period (Thompson *et al.* 1998). A *survey*, in contrast, is an incomplete count. 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. Thus, results obtained during typical manatee synoptic surveys yield unadjusted partial counts. 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 Recovery Plan concludes: "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 U.S." (USFWS 2001).

3. Population Models

Population models employ mathematical relationships based on survival and reproduction rates to calculate population growth and trends in growth. A deterministic model using classical mathematical approaches and various computational procedures with data on reproduction and survival of living, identifiable manatees suggest a maximum growth rate of about 7 percent per year (not including emigration or immigration) (Eberhardt and O'Shea 1995). This maximum was based on studies conducted between the late 1970s and early 1990s in the well protected winter aggregation area at Crystal River and did not require estimates of population size. The analysis showed that the chief factor affecting the potential for population growth is survival of adults.

Estimated adult survival on the Atlantic coast (a larger region with less protection) has suggested a very slow or no population growth over a similar period. This modeling shows the value of using survival and reproduction data obtained from photo-identification studies of living manatees to compute population growth rates with confidence intervals, providing information which can be used to infer long-term trends in the absence of reliable population size estimates. However, collection of similar data has been initiated only recently for other areas of Florida (notably from Tampa Bay to the Caloosahatchee River beginning in the mid-1990s), and none is available over much of the remaining areas used by manatees in southwest Florida.

Population viability analysis (PVA) is a stochastic modeling approach (a model in which random events, such as red tide and extremely cold winters, are incorporated), which varies potential scenarios impinging on reproduction and survival over long periods, and predicts responses in population growth. A PVA was carried out for manatees based on age-specific mortality rates computed from the age distribution of manatees found dead throughout Florida from 1979 through 1992 (Marmontel *et al.* 1997). This method of computing survival rests on certain assumptions that were not fully testable; yet, results point out the importance of adult survival to population persistence.

Given population sizes that may reflect current abundance, the PVA showed that if adult mortality as estimated for the study period were reduced by a modest amount (*e.g.*, from about 11 percent to 9 percent), the Florida manatee population would likely remain viable for many years. However, the PVA also showed that slight increases in adult mortality would result in extinction of manatees over the long term.

The above review demonstrates that the basis for Statewide population size "estimates" of any kind is scientifically weak and unsuitable for computing population trends in manatees. The weight of scientific evidence suggests that population increases over the last two decades is strong for two protected aggregation areas (NW and USJ stocks). New population analyses, based on more recent (since 1992) information, are not yet available in the peer-reviewed literature. These analyses will be fundamental to management decisions that are more relevant to the contemporary situation.

4. Research

The Service, in cooperation with the USGS and FMRI, is proposing new research initiatives regarding the management and recovery of the manatee, as follows:

1) Enhanced photo-identification of individuals for adult survival and mothers with calf for southwest Florida. Photo-identification data currently provide the only statistically valid estimates of manatee survival and reproductive rates and have the potential of providing for assessment of boating impacts. We expect these data to be a critical tool for monitoring Florida's manatee population for at least the next 10 years;

2) Integration of population modeling efforts for MMPA, measurable biological goals and Florida listing criteria. The model developed by USGS for Service in the MMPA rulemaking (Appendix I) can be modified to make the calculations required for assessment of manatee status against the state's listing criteria. USGS would take the lead on the modeling, and would work with FMRI on additional analyses required for estimation of parameters. FMRI and USGS would work together to insure that the model addresses the needs of the agencies and concerns of reviewers, and would collaborate on dissemination of the information.

In conjunction with this work, USGS would work on development of this modeling structure for use by the Service in its upcoming assessments of manatee status. Specific products would include an assessment of manatee status against the current quantitative recovery criteria and guidance to the Recovery Team about the adequacy of those criteria. This work would likely be integral to the next revision of the Recovery Plan. These modeling needs will be continuing, as will needs for quantitative assessments of the effects of management actions. USGS expects to continue to take the lead role in providing this technical capability to Federal and State management partners.

3) Development and implementation of a statistical framework for distributional and synoptic surveys (statewide). Currently, there are no statistically valid statewide aerial survey programs. There are three systematic sources of error in aerial surveys and without needed sampling and estimation protocols, estimates of abundance and trends are unreliable. Three ongoing studies seek to develop validated protocols to make inferences regarding changes in manatee distribution patterns or population size: (1) the Tampa Bay study to define environmental variables affecting visibility of manatees and to calibrate counts during the state synoptic surveys conducted by FMRI and USGS; (2) the Fort Myers Power Plant study to model behavior and detectability assumptions into analyses of long-term count data conducted by Purdue University and Mote Marine Laboratory; and (3) the Ten Thousand Islands NWR double observer, fixed-transect surveys to estimate abundance and trends conducted by USGS and Service. We propose to more fully address issues associated with the State's traditional synoptic surveys. We also propose to redirect efforts to expedite analysis and reporting of the Ten Thousand Islands NWR research. In addition, we will use the Ten Thousand Islands NWR data to evaluate a new approach to estimate changes in distribution of manatees using the proportion of area occupied (PAO) statistic.

C. Factors Affecting the Florida Manatee Population

1. Manatee Mortality

Data on manatee deaths in the southeastern U.S. have been collected since 1974 (O'Shea *et al.* 1985; Ackerman *et al.* 1995; FWC unpublished data). Data from 1976 through 2000 were used in the following summary, as carcass collection efforts were more consistent following that year. Figure 2 indicates a clear increase in manatee deaths over the last 25 years, 6.0 percent per year exponential

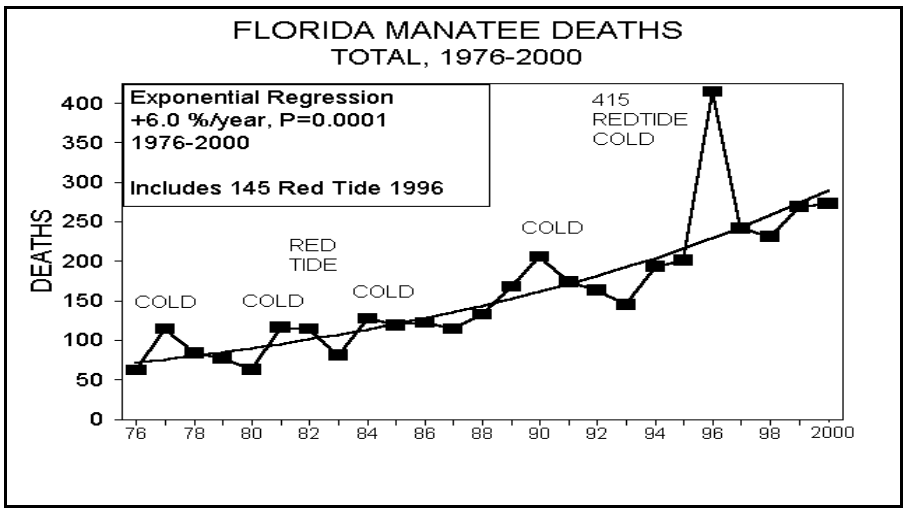

Figure 2. Florida manatee deaths from 1976 to 2000 with an exponential regression of +6.0% per year (FWC, unpublished data).

regression between 1976 and 2000 (USFWS 2001). Most of the increase can be attributed to increases in watercraft related and perinatal deaths (MMC 1993). However, it is unclear whether this represents a proportional increase relative to the overall population of manatees. The Service notes that the reported rate of increase in manatee mortality, and watercraft related mortality in particular, is greater than the likely rate of population increase (Ackerman unpublished data).

Human-related causes of death include watercraft collisions, manatees crushed in water control structures and navigational locks, and a variety of less-common causes such as entanglement in or ingestion of fishing gear. Human-related causes of death accounted for at least 31 percent of deaths between 1976 and 2000 (USFWS 2001). Cause of death of approximately 30 percent of the carcasses within that same time period were classified as "undetermined" because they were too decomposed, the cause was forensically difficult to determine, or on rare occasions the carcass was verified but not recovered. See Appendix H for manatee mortality statistics due to all causes between 1974 and 2002.

Quiet backwaters have been made more accessible to human activities, and increasing levels of vessel traffic have made manatees increasingly vulnerable to boat collisions in travel corridors. Manatees seem to have adapted to some of these changes. For example, industrial warm water discharges and deep-dredged canals or basins are now used as wintering sites, stormwater pipes and freshwater discharges in marinas provide manatees with drinking water, and the imported exotic plant, hydrilla (*Hydrilla verticillata*), which has replaced native aquatic species, has become an important food source at wintering sites. While manatees may adapt to some changes, some activities clearly can have an adverse effect on the species.

a. Watercraft Related Mortality

The Recovery Plan (2001) states that the most significant problem presently faced by manatees in Florida is death or serious injury from boat strikes. From 1976-2000, collisions with watercraft have accounted for an average of 24 percent of known manatee deaths in Florida annually, with 30 percent in 1999, 29 percent in 2000 (USFWS 2001), 25 percent in 2001, and 31 percent in 2002 (FWC unpublished data). During the past five years (1997 to 2001), watercraft related deaths have been the highest on record. An analysis of injuries to 406 manatees killed by watercraft and recovered between 1979 and 1991 found that 55 percent were killed by impact, 39 percent were killed by propeller cuts, 4 percent had both types of injuries, either of which could have been fatal, and unidentified specifics of the collision had caused 2 percent of the mortalities (Wright *et al*. 1995). In 2002, watercraft related manatee mortality reached an all time high of 95 individuals, representing 31 percent of the total mortality (305 individuals) for that year.

Approximately 75 percent of all watercraft related manatee mortality has taken place in 11 Florida counties (Brevard, Lee, Collier, Duval, Volusia, Broward, Palm Beach, Charlotte, Hillsborough, Citrus, and Sarasota) (Florida Marine Research Institute Manatee Mortality Database 2000). Manatee mortality has continued to climb steadily. Average annual mortality in the 1990s (227.9) was nearly twice that of the 1980s (118.2), and this trend continued in 2000, when 273 dead manatees were recorded. Total mortalities over the past four years have averaged 45 percent higher than in the early 1990s. When the record high total of 1996 is added (the year in which the red tide die-off inflated total mortality to 416 animals), average annual mortality over the past five years has been nearly 60 percent greater than in the early 1990s (draft Marine Mammal Commission Annual Report to Congress 2000).

The continuing increase in the number of recovered dead manatees throughout Florida has been interpreted as evidence of increasing mortality rates (Ackerman *et al.* 1995). Between 1976 and 2000, the number of carcasses collected in Florida increased at a rate of 5.8 percent per year, and deaths caused by watercraft strikes increased by 7.2 percent per year (Figure 3). Because the manatee has a low reproductive rate, a decrease in adult survival due to watercraft collisions could contribute to a long-term population decline (O'Shea *et al.* 1985). It is believed that a 1 percent change in adult survival likely results in a corresponding change in the rate of population growth or decline (Marmontel *et al.* 1997).

Collisions with watercraft are the largest source of human-related manatee deaths. Data collected during manatee carcass salvage operations in Florida indicate that a total of 979 manatees (from a

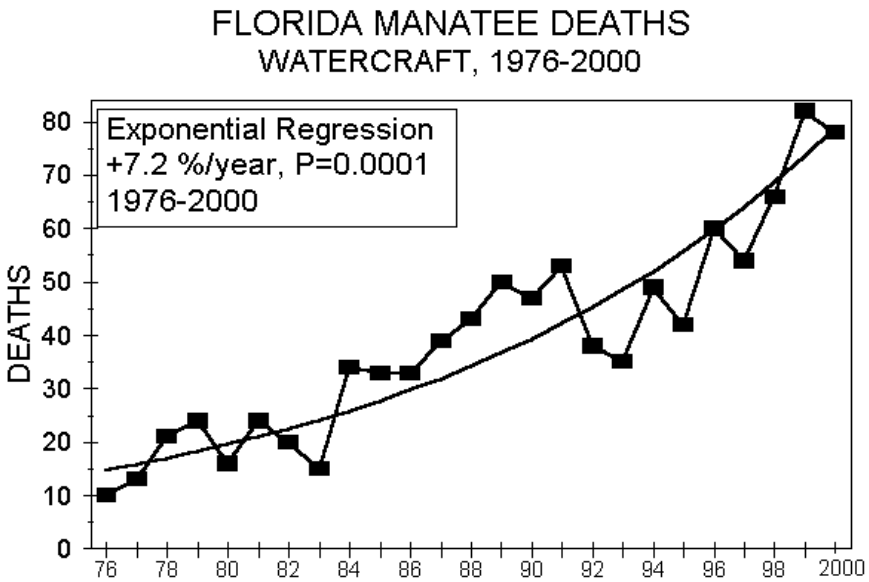

Figure 3. Florida manatee watercraft deaths from 1976 to 2000 with an exponential regression increase of 7.2% per year (FWC, unpublished data).

total carcass count of 4,021) are confirmed victims of collisions with watercraft since 1976. This number may not accurately represent the actual number of watercraft related mortalities since many of the mortalities listed as "undetermined causes" show evidence of collisions with vessels. Collisions with watercraft comprise approximately 24 percent of all manatee mortalities since 1976.

The last five years have been record years for the number of watercraft related mortalities, and watercraft related deaths have become a larger proportion of total mortality. Since 1998, watercraft related deaths have represented about 30 percent of all mortality, a 5 percent increase compared to the early 1990s. During the 1980s and 1990s the manatee population apparently grew; however, if population growth rate levels off and manatee mortality continues to increase, a decline in abundance is inevitable (Marine Mammal Commission Annual Report to Congress 2000).

i. Watercraft Related Manatee Mortality by Stock

Northwest Stock

Between 1974 and 2001 a total of 43 manatee carcasses were recovered which were attributable to watercraft collisions, of which 29 carcasses (67 percent) were recovered in Citrus County, and six carcasses (14 percent) were recovered from Levy County. Between 1980 and 1999, watercraft related mortality has increased at a rate of 10.8 percent per year, while carcasses recovered as a result of all causes of mortality (153 individuals) have increased at a rate of 5.5 percent per year. Although overall deaths are considered low, watercraft related deaths in the NW Stock are considered to be increasing rapidly (see Appendix P).

Upper St. Johns River Stock

Between 1974 and 2001 a total of 35 manatee carcasses were recovered which were attributable to watercraft collisions, of which17 carcasses (48.5 percent) were recovered from the St. Johns River and its tributaries in Volusia County and 10 carcasses (28.5 percent) were recovered from Putnam County. Between 1980 and 1999, watercraft related mortality has increased at a rate of 1.6 percent per year, while carcasses recovered as a result of all causes of mortality (79 individuals) have increased at a rate of 2.6 percent per year. Overall deaths are considered low and watercraft related deaths in the USJ Stock are considered to be increasing slowly.

Atlantic Stock

Between 1974 and 2001 a total of 572 manatee carcasses were recovered which were attributable to watercraft collisions, of which 191 carcasses (33 percent) were recovered in Brevard County and 82 carcasses (14.3 percent) were recovered from Duval County. Between 1980 and 1999, watercraft related mortality has increased at a rate of 5.5 percent per year, while carcasses recovered as a result of all causes of mortality (1,659 individuals) have increased at a rate of 6.9 percent per year. Overall deaths are considered high and watercraft related deaths in the Atlantic Stock are considered to be increasing moderately.

Southwest Stock

Between 1974 and 2001 a total of 418 manatee carcasses were recovered which were attributable to watercraft collisions, of which 150 carcasses (35.8 percent) were recovered in Lee County and 108 carcasses (25.8 percent) were recovered from Collier County. Between 1980 and 1999, watercraft related mortality has increased at a rate of 7.1 percent per year, while carcasses recovered as a result of all causes of mortality (1,358 individuals) have increased at a rate of 4.8 percent per year. Overall deaths are considered high and watercraft related deaths in the SW Stock are considered to be increasing rapidly.

b. Mortality at Water Control Structures and Locks

The next largest human-related cause of manatee deaths is entrapment or crushing in water control structures and navigational locks and accounts for 4 percent of the total mortality between 1976 and 2000 (Ackerman *et al.* 1995; FWC, unpublished data). These deaths were first recognized in the 1970s (Odell and Reynolds 1979), and steps have been taken to eliminate this source of death. In 2002, five manatee carcasses were recovered in gates and locks, three of which were in Miami-Dade County, one in Palm Beach County, and one in Glades County.

Beginning in the early 1980s, gate-opening procedures were modified; annual numbers of deaths initially decreased after this modification. However, the number of deaths subsequently increased, and in 1994, a record 16 deaths were documented. An ad hoc interagency task force was established in the early 1990s and now includes representatives from the SFWMD, Corps, Service, Miami-Dade Department of Environmental Research Management (Miami-Dade DERM), FWC, and DEP. This

group meets several times a year to discuss recent manatee deaths and develop measures to protect manatees at water control structures and navigational locks. The overall goal is to eliminate completely structure-related deaths.

c. Other Known Causes of Human-Related Manatee Mortality

Other known causes of human-related manatee deaths include poaching and vandalism, entanglement in shrimp nets, monofilament line (and other fishing gear), entrapment in culverts and pipes, and ingestion of debris. These account for 3 percent of the total mortality from 1976 to 2000. Together, deaths attributable to these causes have remained constant and have accounted for a low percentage of total known deaths, *i.e.*, about 4 percent between 1976 and 1980, 3 percent between 1981 and 1985, 2 percent between 1986 and 1991, and 2 percent between 1992 and 2000 (Ackerman *et al*. 1995; FWC, unpublished data). Entrapment in shrimp nets has been the largest component of this catch-all category. Eleven deaths were probably related to shrimping activities from 1976 to 1998 (seven in Florida, four in other states; Nill 1998). These deaths have become less common since regulations on inshore shrimping, the 1995 Florida Net Ban regulations, and education efforts about protecting manatees were implemented.

d. Natural Causes of Manatee Mortality

Natural causes of death include disease, parasitism, reproductive complications, and other nonhuman-related injuries, as well as occasional exposure to cold and red tide (O'Shea *et al.* 1985; Ackerman *et al.* 1995). These natural causes of death accounted for 17 percent of all deaths between 1976 and 2000 (FWC unpublished data). Perinatal deaths accounted for 21 percent of all deaths in the same period.

A prominent natural cause of death in some years is exposure to cold. Following a severe winter cold spell at the end of 1989, at least 46 manatee carcasses were recovered in 1990; cause of death for each was attributed to cold stress. Exposure to cold is believed to have caused many deaths in the winters of 1977, 1981, 1984, 1990, 1996, and 2001, and have been documented as early as the 19th century (Ackerman *et al*. 1995; O'Shea *et al.* 1985; FWC unpublished data).

In 1982, a large number of manatees also died coincidentally with a red tide dinoflagellate (*Gymnodinium breve*) outbreak between February and March in Lee County, Florida (O'Shea *et al.* 1991). At least 37 manatees died, perhaps in part due to incidental ingestion of filter-feeding tunicates that had accumulated the neurotoxin-producing dinoflagellates responsible for causing the red tide. In 1996, from March to May, at least 145 manatees died in a red tide epizootic over a larger area of southwest Florida (Bossart *et al.* 1998; Landsberg and Steidinger 1998). Although the exact mechanism of manatee exposure to the red tide brevetoxin is unknown in the 1982 and 1996 outbreaks, ingestion, inhalation, or both are suspected (Bossart *et al.* 1998). The critical circumstances contributing to high red tide-related deaths are concentration and distribution of the red tide, timing and scale of manatee aggregations, salinity, and timing and persistence of the bloom (Landsberg and Steidinger 1998). It is difficult to manage for these rare but catastrophic causes of mortality.

2. Harassment

In addition to direct mortality, manatees may be harassed, injured, or otherwise harmed as a result of interactions with boats, barges and larger vessels, water control structures, locks, stormwater pipes, marine debris, and fishing gear. In some cases manatees are also harmed by vandals.

Sublethal injury to manatees due to boat interactions is a significant factor in 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 Florida Marine Research Institute, 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.

Traumatic injuries as a result of boat strikes are also a major concern for manatee care and rehabilitation facilities. Records maintained at the Sirenia Project since the late 1970s document rescue and rehabilitation attempts for 109 cases (69 of which died) directly linked to boat strike injuries, accounting for about 20 to 30 percent of the annual number of manatee rescues. The incidence of wounding by boats in Florida manatees is probably unparalleled in any marine mammal population in the world. For example, seals and sea lions recovered along the California coast from 1986 to 1999 showed boat propeller damage in only 0.1 percent of 6,196 live stranded individuals of six species (Goldstein *et al.* 1999).

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 warm-water refugia. In addition, some researchers are concerned that manatee calves can be separated from their mothers and some individuals may be driven from preferred warm water refuges due to harassment.

3. Watercraft Usage in Florida

Human use of the waters of the southeastern U.S. has increased dramatically as a function of residential growth and increased visitation. This phenomenon is particularly evident in the State of

Florida. The population of Florida has grown by 124 percent since 1970 (6.8 million to 15.2 million, U.S. Census Bureau) and is expected to exceed 18 million by 2010, and 20 million by the year 2020. According to a report by the Florida Office of Economic and Demographic Research (2000), it is expected that, by the year 2010, 13.7 million people will reside in the 35 coastal counties of Florida. In a parallel fashion to residential growth, visitation to Florida has increased dramatically. It is expected that Florida will have 83 million visitors annually by the year 2020, up from 48.7 million visitors in 1998. In concert with this increase of human population growth and visitation is the increase in the number of watercraft that travel Florida waters. In 2001, 943,611 vessels were registered in the State of Florida. This represents an increase of 42 percent since 1993. The Florida Department of Community Affairs estimates that, in addition to boats belonging to Florida residents, between 300,000 and 400,000 boats registered in other States use Florida waters each year.

The FWC Division of Law Enforcement reported that in 1999, more than one million vessels used Florida's waterways, including over 829,000 State-registered vessels and about 300,000 out-of-State vessels. Boating continues to increase in Florida as evidenced by just over 943,600 State-registered vessels (FWC 2002a) and more than 400,000 out-of-State vessels for 2001. At the same time, watercraft related manatee mortality and increasing mortality trends have been documented since collection of manatee mortality data began in 1974.

The relationship between registered vessels and watercraft related manatee deaths (Figure 4) demonstrates that since records were kept beginning in 1976, as the number of registered vessels increases so does manatee mortality.

4. Corps Watercraft Access Permitting

As discussed earlier, the Corps section 10/404 permit program is the primary Federal authorization required for the construction of docks, marinas and boat ramps in Florida. Following is a summation of Corps watercraft access related permitting activity from 1988 to September 2002 for 32 counties with recorded watercraft related mortality in Florida. A detailed discussion of Corps watercraft access related permitting activity for this period is found in Chapter V. Environmental Consequences in the Socioeconomic Impacts section for each alternative analyzed in detail.

During the four-year-nine-month period between 1998 and September 2002, an estimated 27,082 boat slips were permitted in this 32 county area, including residential, commercial, marinas, and State Programmatic General Permit (SPGP) boat slips. The average number of boat slips permitted per year was 5,110.

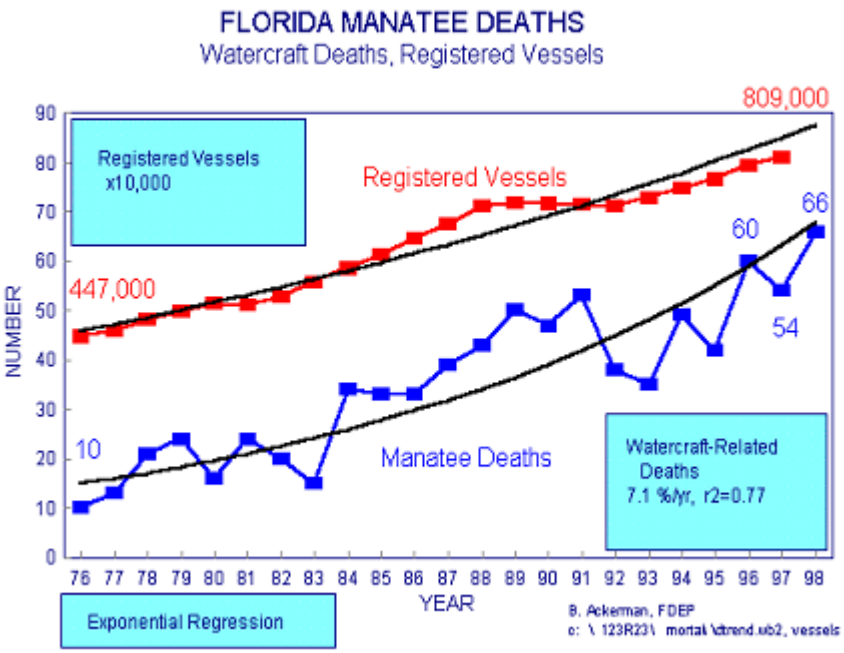

Figure 4. Florida manatee watercraft deaths from 1976 to 1998 with an exponential regression increase of 7.1 percent per year compared to registered vessels (FWC, unpublished data).

Prior to the filing of the lawsuit in January 2000 (*Save the Manatee Club et al.* v. *Ballard et al.*), between 1998 and 1999, an average of 18 new or expanded marinas were permitted in the four manatee stocks each year, adding an average of 710 dock slips per year. From 1989 to 1999, permits issued under the State Programmatic General Permit were estimated to account for about 3,600 dock slips per year, and Corps residential permits accounted for approximately 1,500 dock slips per year. For all permit types, prior to the law suit, it is estimated that approximately 7,000 dock slips were permitted annually in the 32 affected counties.

In the 2001 to 2002 time period (after the law suit and subsequent revision of the permit process), an average of 1,580 multi-slip dock slips were permitted each year, and 1,640 single-family dock slips were permitted each year for a total of 3,220 slips permitted in the affected counties each year on average.

i. Effects of the Proposed Rule on Corps of Engineers Watercraft Related Access Permitting in the Four Manatee Stocks

Northwest Stock

Corps permit applications are reviewed by the Service on a case-by-case basis. Currently, the Service has not found that there is a reasonable certainty that incidental take is likely to occur as a result of

watercraft access permits in this stock. The Service has not recommended denial of any Corps watercraft related access permit application based on section 7 reviews under the ESA.

Upper St. Johns River Stock

Corps permit applications are reviewed by the Service on a case-by-case basis. Currently, the Service has not found that there is a reasonable certainty that incidental take is likely to occur as a result of watercraft access permits in this stock. The Service has not recommended denial of any Corps watercraft related access permit application based on section 7 reviews under the ESA.

Atlantic Stock

Corps permit applications are reviewed by the Service on a case-by-case basis. Currently, the Service occasionally finds that there is a reasonable certainty that incidental take is likely to occur as a result of watercraft access permits in this stock. The Service has recommended denial of approximately eight percent of all Corps watercraft related access permit applications in this stock based on section 7 reviews under the ESA.

Southwest Stock

Corps permit applications are reviewed by the Service on a case-by-case basis. Currently, the Service occasionally finds that there is a reasonable certainty that incidental take is likely to occur as a result of watercraft access permits in this stock. The Service has recommended denial of approximately 37 percent of all Corps watercraft related access permit applications in this stock based on section 7 reviews under the ESA.

D. Efforts to Conserve the Current Manatee Population

1. Efforts by the Federal Agencies

a. <u>The Fish and Wildlife Service</u>

i. Litigation

In 2000, a lawsuit was filed against the Service and the Corps (*Save the Manatee Club et al.* v. *Ballard et al.*). Allegations from SMC and twenty-one various environmental organizations charged the Service and the Corps for violating the Federal statutes that protect the Florida manatee. Specific demands in the lawsuit included a revision of the Recovery Plan, the development of adequate biological opinions, the preparation of Environmental Impact Statements, and the assessment of cumulative effects of development projects in manatee habitats. In January 2001, an agreement to settle the Federal lawsuit was made among all involved parties. Under terms of the Settlement Agreement, the Service agreed to adhere to certain time frames for completing several manatee conservation activities. These activities included: consideration of new Federal manatee protection

areas, consideration of regulations that would allow for incidental take of manatees under the MMPA, and revision of the Recovery Plan. Additionally, the Service and the Corps agreed to revise procedures for reviewing permit applications involving construction of boating facilities in manatee habitat.

ii. ESA Interim Strategy for Manatees/MMPA Incidental Take Regulation for the Florida Manatee

In 2001, the Service published the "Endangered Species Interim Strategy for Manatees" as guidance until the promulgation of incidental take regulations under the MMPA. This guidance facilitated section 7 reviews of Federal actions. Specifically, the interim guidance applied to actions that may result in increased watercraft access in Florida. This process identified conditions that allowed the Service to determine when a proposed watercraft access facility would possibly have an adverse indirect effect on manatees.

On January 22, 2003, the Service's Director issued a memorandum concerning "Consultation Procedures to be Followed for All Watercraft-related Access Activities Occurring within Peninsular Florida." This memorandum is a management directive which required that the formal section 7 consultation procedures (50 C. F. R. 402.14) shall be used until May 5, 2003, for every proposed watercraft related activity within peninsular Florida that "may affect" manatees.

iii. Manatee Protection Areas

A major focus of manatee recovery efforts involves the establishment of manatee protection zones by both Federal and State agencies. These zones facilitate a reduction in the number of manatees harassed or struck and/or killed by watercraft in Florida by restricting boat speed and access in certain high use manatee areas. The reduction of boat speed affords manatees time to move away from approaching watercraft, thus reducing the chances of collision. Areas with limited access prevent the disturbance of manatees caused by waterborne activities.

The Service continues to focus efforts on identifying areas that currently lack adequate protection (see Appendix O). To address this situation, the Service has coordinated with Federal, State, and local managers and planners, law enforcement officers, and researchers involved in manatee protection. Five meetings were held with these parties in each quadrant of the State of Florida and coastal Georgia. Approximately 150 potential sites were identified as a result of these meetings. Following this effort, the Service hosted six public information meetings throughout the State to solicit public comments and suggestions regarding these sites. As a result, the Service published a Notice of Proposed Rulemaking in 2001 naming 16 areas identified for additional protection. This was followed with a Notice of Rulemaking, published in the Federal Register on December 31, 2001, informing the public that the Service would designate manatee refuges in the Barge Canal and Sykes Creek in Brevard County. The remaining sites would receive Federal designation as either a refuge or sanctuary by December 2002. To date, the State has adopted rules in 24 counties. Where appropriate, the Service endorses State rules and has the latitude to enforce these areas when they are appropriately marked.

On November 8, 2002, we published a final rule in the Federal Register designating 13 manatee protection areas in eight Florida counties. In addition to the areas already designated, the Service will publish a proposed rule to designate three areas in five Florida counties as Federal manatee protection areas. The Service agreed to submit to the Federal Register, by March 31, 2003, a proposed rule for the designation of additional manatee protection areas in the Caloosahatchee River, the St. Johns River, and the Halifax River/Tomoka River. The three locations proposed as refuges are located in Lee, Volusia, Duval, St. Johns, and Clay counties. The Service also agreed to forward its final decision on these sites to the Federal Register by July 31, 2003. One area in Citrus County, one in Pinellas County, and two in Hillsborough County are designated as manatee sanctuaries in which all waterborne activities would be prohibited, with exceptions for adjoining property owners. The remaining nine areas located in Citrus, Hillsborough, Sarasota, Charlotte, De Soto, Lee, and Brevard counties are designated as manatee refuges in which certain waterborne activities are prohibited or regulated. We also withdrew the South Gandy Navigation Channel Manatee Refuge from our rule because Pinellas County has more comprehensive measures in place at this site. Waterborne activities are prohibited within the sanctuaries and watercraft are required to proceed at "idle speed" or "slow speed" (as specified) within the refuges. Exceptions are provided to allow adjacent public and private land owners vessel and maintenance access, subject to any permitting requirements. Publication of this final rule meets the requirements of the *Save the Manatee Club et al* v. *Ballard et al.* Settlement Agreement and ensures compliance with the related U. S. District Court ruling and orders.

iv. Law Enforcement Initiatives

Compliance in manatee protection zones is another important aspect of manatee recovery; it is thought that with better compliance, fewer manatees will die. To promote compliance, Service law enforcement officers implemented new task force initiatives throughout the State. In peninsular Florida the USCG also participated in law enforcement activities. The Service partnered with the FWC to conduct boater compliance surveys throughout the State of Florida. This collaborative effort determined the effectiveness of law enforcement initiatives and monitored boat compliance within manatee protection zones. Data indicated that boaters seemed to behave similarly to car drivers, responding to the presence of law enforcement with significant increases in compliance and decreases in speed. Results from this study will assist in future guidelines for Federal and State law enforcement divisions regarding increased compliance in manatee protection zones. Currently in Florida, the Service's Office of Law Enforcement employs two full-time personnel whose responsibilities focus solely on manatee protection, a Special Agent Manatee Enforcement Coordinator based in Orlando and a Law Enforcement Manatee Biologist based in Jacksonville. The office conducts monthly enforcement protection details conducted over three-day periods focusing on those counties where human-caused manatee boat strike mortalities are the highest. In FY 2001, funds were used by NWRs to fund four refuge officers at NWRs in Florida, which included Lake Woodruff NWR, Crystal River NWR, Ten Thousand Islands NWR, and Merritt Island NWR. The hiring of these new refuge officers enables the Service to continue to increase its efforts to protect the manatee.

Since December 2001, law enforcement efforts were conducted in Lee County where six enforcement details were conducted identifying 217 violations; Collier County, where three law enforcement details identified 219 violations; Brevard County, where three law enforcement details identified 196 violations; and, one law enforcement detail each in Sarasota and Volusia counties identifying 48 violations. Law enforcement details are conducted utilizing all six Special Agents assigned to the Northern Florida subdistrict, supplemented by four full-time Division of Refuge Manatee Enforcement Officers, as well as additional Special Agents and Refuge Officers from other duty stations.

Additionally, Refuge Officers (11) assigned to Chassahowitzka NWR, Ten Thousand Islands NWR, J.N. "Ding" Darling NWR, Arthur R. Marshall Loxahatchee NWR, Lake Woodruff NWR, and Merritt Island NWR, routinely engage in manatee protection efforts within and adjacent to their boundaries.

Beginning in November 2002, Service officers will engage in "Operation Sea Cow" in Miami-Dade County, and nine subsequent monthly details in the above counties, as well as in those federally established Manatee Refuges and Sanctuaries. Additionally, the Special Agent Law Enforcement (LE) Coordinator and three Refuge Manatee Enforcement Officers will conduct biweekly, two-day saturation patrols in those counties where mortalities continue at increased levels. With this obligation, there exists a concomitant responsibility for court appearances of five days per month for the LE Coordinator and two days a month for all other officers assigned to these efforts.

v. National Wildlife Refuges

Florida's coastal and riverine NWRs are used by hundreds of manatees. Refuge managers engage in species management activities to promote the welfare of manatees both on and around the refuge. Refuges are also active participants in law enforcement initiatives, enforcing manatee protection zones, minimizing harassment, and other activities. Visitors are provided with opportunities to observe and interact with manatees at the refuges and sanctuaries.

The Crystal River NWR (CRNWR) was established specifically for the protection of the Florida manatee. It is located within Kings Bay at the headwater of the Crystal River which flows into the Gulf of Mexico. More than 300 manatees use this area for warm water during the winter months. Currently CRNWR manages the seven sanctuaries in Kings Bay that protect approximately 40 acres of essential manatee habitat. These sanctuaries are in effect from November 15 through March 31. Due to the large number of boaters, recreational divers, snorkelers, and swimmers that seek out manatees, the refuge staff regulates marine activities, marks and maintains the sanctuary boundaries, and promotes compliance through law enforcement and education. All local dive shops are under a Special Use permit issued by the refuge. The permit requires that all visitors view the "Manatee Manners" video and receive the leaflets that contain rules and regulations for swimming with manatees.

CRNWR conducted nine aerial surveys throughout the 2000-01 winter season. The number of manatees sighted ranged from 316-386 individuals. CRNWR currently conducts the only ongoing, long-term field studies of manatees (including year-round aerial surveys) undertaken by the Service.

During 2001, refuge staff responded to 18 different reports of manatees in distress. Additionally, other refuges around the State of Florida participate in manatee recovery. The Merritt Island NWR maintains a manatee viewing area, the J.N. "Ding" Darling NWR partners with a Fort Myers manatee viewing and education center, the Ten Thousand Islands NWR (TINWR) conducts manatee aerial surveys, and the Hobe Sound NWR and the Florida Panther NWR have developed manatee education and outreach programs.

vi. Habitat Management

Essential manatee habitat includes foraging and freshwater sites, travel corridors, resting, cavorting and calving areas, and warm water refuges. These areas are heavily influenced by human activities and must be properly managed to support species recovery. Human impacts include: destruction of seagrass beds, the modification of drinking sites (including new, artificial sites such as stormwater runoff pipes and ditches, process water, etc.), the diversion of river courses, damming, construction of canals, and shoreline bulkheading. Waterborne activities such as boating have altered corridors and manatee use areas. Historical warm water refuges used by wintering manatees have also been modified. Recent concerns over spring flows have been addressed including the reduction and/or loss due to groundwater withdrawals, the impacts to recharge areas and the alteration in ambient waters from development activities. Furthermore, winter distribution patterns of manatees have changed with the addition of industrial warm water outfalls.

To ensure that these changes do not have a significant, adverse effect on manatees, many State and Federal permitting programs and planning groups address such concerns. The Service relies on section 7 (consultations under the ESA) and the FWCA to minimize the effect of construction on valuable manatee use areas. An interagency group ensures that aquatic plant control activities are balanced with the needs of manatees at wintering sites. Efforts to restore grassbeds have been addressed through coastal program activities. A Habitat Working Group is scheduled to convene in 2002 to address other habitat concerns.

Natural and industrial warm water refuge issues are being addressed through interim and long range planning. Extant industrial warm water discharges are made safe for manatees through the use of MPPs, as defined in National Pollution Discharge Elimination System (NPDES) permit conditions. While the future status of these sites is unknown, it is apparent that some will be eliminated and others may operate in some diminished capacity. To address these concerns, the Service organized a Warm Water Task Force to review the current network of sites and develop plans for future changes. In 2001, the Warm Water Task Force agreed to develop an adaptive management planning approach to minimize the adverse effects of these changes on manatees.

The Service was also involved in State activities focused on protecting warm water sites. As a member of the State appointed Springs Task Force, the Service assisted in drafting the management plan for Florida springs. Additionally, the Service worked closely with the SJWMD to establish minimum flow levels at Blue Spring, a primary warm water refuge for manatees located in the upper St. Johns River.

vii. Water Control Structures

Water control structures are a persistent source of human-related manatee mortality. An interagency task force was developed to find solutions to reduce the number of animals killed in these structures. Efforts include refitting flood control gates with pressure sensitive devices and navigation lock doors with acoustic sensors to stop gate and lock closures when manatees are present. Since 1997, four flood gate structures (10 gates) and two navigation locks have been equipped with these devices. Efforts appear to be beneficial, as only one manatee death was documented as a result of a water control structure in 2001.

viii. Manatee Entanglements

Every year manatees become entangled in monofilament fishing line, crab trap float lines, and other types of fishing gear. As a result of such entanglement, many manatees are rescued, treated, and released back into the wild. Severe entanglement cases result in amputation (*e.g.*, a pectoral flipper), permanent captivity, or even death. In 2001, 15 manatees were rescued due to entanglements in monofilament, float lines, and crab pots. An Entanglement Working Group (EWG), led by Service staff, was developed to address manatee entanglement issues. This past year, the Service coordinated a derelict crab trap cleanup within the Merritt Island NWR, developed a monofilament brochure to encourage monofilament recycling, and participated in monofilament cleanups and recycling efforts. In conjunction with Midwest Research Institute, the Service assisted in the development of a monofilament/recycling website and will participate in a series of educational workshops scheduled for 2002. The workshops will be a multiagency effort focusing on promoting the new recycling website and instructing the public on how to start their own recycling program.

ix. Manatee Rescue, Rehabilitation, and Release Activities

Service biologists coordinate with the FWC on the manatee rescue, rehabilitation, and release program (Program) to treat injured and distressed animals. The Program participates in recovery efforts by assisting with distressed manatees and reintroducing them into the wild and by producing outreach materials which focus on the Florida manatee.

In 2001, a total of 66 manatees were rescued, of which 49 were brought into captivity and 17 were treated in the field and released. Reasons for rescue included boat strikes (23), entanglements (15), cold stress (11), abandoned calves (8), and other various causes (7), including one unknown. Of the 49 animals brought into captivity, 30 died as a result of their injuries or illnesses; one manatee captured the previous year died during 2001. At year's end 51 manatees, in 11 facilities, were in captivity for treatment, including those receiving long-term care; of these, 26 individuals are females and 25 are males. The Program released 22 captive manatees this year, 15 of which were rescued during 2001. The Service authorizes 18 private organizations and works with several other State and Federal organizations to participate in the Program. The coordination of this Program is through the Service's Interagency Oceanaria Working Group. The group provides input on rescue and release planning and captive animal care. Two interagency oceanaria meetings took place during 2001; the spring meeting was held in Puerto Rico, which hosted a diverse group of Sirenian researchers from all over the world, and the fall meeting was held at Miami Seaquarium. In 2001, a steering

committee, the Conservation Consortium for Rehabilitated Manatee Monitoring, was formed to coordinate post-release monitoring. The Service designed an electronic database to facilitate data entry and storage for the Program; this is the first of its kind to be implemented for endangered species management in the Service.

The Program brings vast exposure to manatees and the problems which they face in Florida. Rescues and releases often get exposure from multimedia. The captive program allows for hundreds of thousands of people to see a manatee who often would not otherwise have the opportunity. The facilities that house these animals do an outstanding job of interpreting the challenges that manatees face and consistently promote a constituency for recovery efforts. As a result, the Program is one of the Service's most effective outreach tools which promote manatee protection and conservation.

x. Recovery Planning

The third revision of the Recovery Plan was completed on October 30, 2001. This revision addresses specific criteria necessary for manatee reclassification to threatened and eventually delisting. The criteria set benchmarks and targets (as defined in the five listing criteria) to evaluate the success of various conservation measures to remove existing and future threats to recovery. The Service is proposing to reconvene the Recovery Team. In addition, on-going meetings for several subteams (*e.g.*, Habitat Committee, Warm Water Task Force) continue.

xi. Education and Outreach

Service outreach efforts to inform stakeholders and concerned citizens are generally handled through the Jacksonville Field Office's Public Affairs Officer. Service manatee outreach and education efforts include preparing written responses to those seeking information on the manatee, the production and distribution of educational brochures, and presentations to various organizations, and public meetings. Refuge outreach programs are particularly effective in teaching visitors about manatees and manatee conservation.

xii. Interim Strategy

A Notice of Availability for the draft interim strategy was published in the Federal Register on March 14, 2001. The document reflected the conditions under which the Service could determine that a proposed dock, ramp, or marina is unlikely to have adverse effects on manatees or their habitat. The conditions and measures within the draft document to protect the manatee were developed using the best scientific and commercial data available.

The draft interim strategy provided guidance to individuals, local governments, State agencies, and Federal agencies for incorporating conservation measures into their project designs so that the proposed projects would not likely cause incidental take of the manatee. Under this interim strategy, the Service will evaluate projects, on a case-by-case basis, to determine if the following prerequisites are in place prior to project implementation: (1) adequate speed zones exist in the area; (2) signage of these zones is adequate; and (3) speed zone enforcement in these areas is sufficient to prevent watercraft collisions from occurring as a result of the project.

In the draft interim strategy, the Service outlined two options as conservation measures through which permit applicants may increase enforcement and reduce the effects of a proposed watercraft access facility. In one option, an applicant could contribute to a conservation fund, such as the Manatee Conservation Fund with the National Fish and Wildlife Foundation. Such a fund will receive contributions and fund enforcement proposals in the same manatee risk area as the watercraft access project. The Service and the applicant will coordinate management of the funds to achieve manatee conservation and recovery. In the second option, a permit applicant may elect to establish an agreement directly with a local law enforcement agency to increase enforcement in the vicinity of the proposed watercraft access project.

In some situations and locations, other conservation measures besides increased law enforcement may possibly be employed to address the indirect effects of watercraft access projects on manatees. Such other methods could include designating manatee speed zones, improving the signage of existing speed zones, providing law enforcement equipment, or other measures committed to in an agreement or plan that the Federal action agency and the Service believe reduces the potential for incidental take from increased watercraft traffic to an unlikely to occur level.

During the public comment period, the State of Florida, through the FWC, reorganized their Division of Law Enforcement patrol structure. The FWC reorganized 293 existing law enforcement officers to increase and improve enforcement of manatee protection laws, including manatee speed zones. In addition, the FWC reassigned 23 law enforcement officers to on-the-water patrol duty and proposed to hire 25 new officers to increase the level of enforcement attention toward manatee protection. Furthermore, the State allocated $2 million for those officers willing to work overtime which translates into additional hours of manatee protection. As a result of this law enforcement initiative, the State requested that the Service withdraw the contribution requirement for increased law enforcement as a conservation measure in the draft interim strategy.

The Service considered the State's initiative and removed the need for implementation of the contributions for increased law enforcement. Based on the Service's analysis, the State's initiative will cover approximately 37,000 watercraft access projects (*i.e.*, boat slips) annually over 32 coastal counties where manatees occur. On average, the construction of approximately 5,000 slips is authorized annually in Florida's waters. With the State's initiative, law enforcement will be provided up-front and on a guaranteed annual basis versus a temporarily distributed deployment of efforts under the draft interim strategy. This increased, early-on deployment prior to MMPA regulations promulgation is far superior to the phased-in deployment that would have occurred under the draft interim strategy. The State's initiative will result in a more effective means to address the indirect effects of watercraft access projects on manatees.

With the exception of one county, the State's law enforcement initiative and commitment effectively staffed manatee-inhabited waters with the necessary allocation of law enforcement officers, thereby eliminating the need for the Service to assess a contribution or fee from permit applicants as a conservation measure to minimize manatee mortality. The Corps will continue to consult with the Service to ensure that the four factors mentioned above are fulfilled prior to applicants receiving a permit for their project.

The draft interim strategy was revised to account for the State's law enforcement initiative. As the underpinning of the Service's final interim strategy, the State's law enforcement efforts were provided up-front and are guaranteed on an annual basis. This large, early-on deployment of officers prior to MMPA regulations promulgation is far superior to the phased-in deployment of enforcement under the Service's draft interim strategy. The final interim strategy was published in the Federal Register on August 21, 2001. The effectiveness of the State's committed efforts will be evaluated on a continuing basis by comparing watercraft related manatee mortality data in areas to previous rates of mortality. If the Service and the FWC determine at any time that these enforcement efforts are not meeting their intended objectives, then the agencies will coordinate their efforts to rectify the situation. Monitoring implementation and effectiveness will determine the need to continue, to extend the scope of, to change elements of, and/or to add new components to the enforcement.

Watercraft access projects are permitted by the Corps which cumulatively increases vessel access to manatee habitat, thereby increasing the risk of manatee-watercraft collisions and disruption of manatee behavior. Watercraft access facilities are defined as marinas, ramps, launches, slips, docks, dry storage facilities, moorings, and similar structures. From January 1, 2001, to January 1, 2002, the Service concurred with the Corps' "not likely to adversely affect" determination for 3,625 new watercraft access slips in the 32 counties affected/encompassed by the interim strategy. The addition of new watercraft into Florida's waters has the potential to adversely affect manatees.

The Service Director's Policy Memorandum, dated January 22, 2003, altered how the Service implements the section 7 consultation process for manatees. This memorandum requires that the Service enter formal consultation during watercraft access permit review (*e.g.*, Corps section 10/404 permit) when the permitting agency concludes "may effect, not likely to adversely affect." Previous to this memorandum, the Service could concur with "not likely to adversely affect" determinations and conclude section 7 consultation informally. Thus, at the current time, the Service has prepared and will continue to prepare Biological Opinions through the formal consultation procedures for all watercraft access permit requests where the Federal action agency concludes a "may effect."

xiii. Standard Manatee Protection Construction Conditions

Direct effects of watercraft access facilities on manatees and essential features of manatee habitat (such as seagrasses), including those arising from the location, design, and construction of facilities, and dredging and filling, will be addressed at the time of the Service's review of a permit application. In analyzing such effects, including those on seagrasses and other important features of manatee habitat, the Service will analyze the extent to which such effects are addressed by county MPPs, State review, and other protective conservation measures, such as Standard Manatee Protection Construction Conditions to protect manatees during construction. Standard construction conditions have been used throughout the range of the manatee for more than a decade and have proven to reduce the effects to manatees within the facility footprint.

b. U.S. Geological Survey, Biological Resources Division, Sirenia Project

The Sirenia Project is part of USGS's Florida Caribbean Science Center, a federally funded group dedicated to integrated science, promoting collaboration, and sharing of expertise nationwide. The

Sirenia Project consists of a team of biologists committed to long-term research on the West Indian manatee in Florida and the Caribbean. The team collaborates with other scientists including those from other USGS centers, State and Federal partners, and other organizations. During 2001, the Project was involved in many research activities associated with various aspects of manatee conservation and biology. The Manatee Individual Photo-Identification System (MIPS) continued to document individual manatees on Florida's east and northwest coasts and in St. John's River system. This 20+ year database includes the specific identity and feature description data, photographic images, and over 23,000 sighting records and reproductive histories of almost 1,500 individual manatees. This year the MIPS database was converted to an Access-based relational database to facilitate analysis with new state-of-the-art mark-resighting statistical models. This new design for MIPS allowed for the analysis to estimate adult survival rates for the subpopulations in the northwest Gulf coast, Blue Spring/St. John's River, and the Atlantic coast. Collaboration with population statisticians continue to address manatee population dynamics. A model is currently under development to use parameter estimates from the MIPS database to estimate population growth rates and to assess how growth rates would change with variations in any of the vital rates.

An adaptive management model was initiated to address manatee population dynamics, specifically, manatee responses to changes in power plant operations. A monitoring program was designed and implemented in Brevard County at the Florida Power and Light Company (FPL), Canaveral Power Plant, and the Reliant Energy Power Plant. This program will assist in gathering data for a provisional adaptive resource management model using photo-identification data. The Sirenia Project also initiated a collaboration with Mote Marine Laboratory and Florida Marine Research Institute to conduct a comparative study at FPL, located in Fort Myers.

The Sirenia Project continued its strip-transect aerial surveys work with the Service in the TINWR. Data from these surveys are being analyzed to determine if manatee density and distribution in nearshore waters of the TINWR and the Everglades National Park change as response to restoration of natural hydrologic patterns in southwest Florida.

Manatees were captured in Port of the Islands near Everglades City and fitted with radio tags to track individual movements. This effort is part of a five-year study initiated in FY2000, to assess the impact of hydrologic restoration on estuarine communities of southwest Florida. It is suggested that manatee distribution, relative abundance, habitat use, and movement patterns will be affected by current and future restoration projects.

Other research activities in which the Sirenia Project was involved included characterizing benthic habitat and manatee grazing activity in Puerto Rico and analyzing mitochondrial DNA to extract information on manatee population genetics and information on manatee phylogeography. In addition to research, the Sirenia Project team spent a great amount of time and effort organizing a Manatee Population Ecology and Management Workshop held in the spring 2002. Sirenia Project biologists had extensive involvement in the Service Rescue, Rehabilitation, and Release Program including participation interagency meetings, workshops, and manatee rescues and releases.

The Department of the Interior is committed to increasing funding for manatee research in future, as discussed in B.4. above.

2. Efforts by the State of Florida

a. FWC - Florida Marine Research Institute

The Endangered and Threatened Species Section, responsible for manatee research, is headquartered at the FMRI in downtown St. Petersburg. All carcasses are retrieved by field station staff located in Port Charlotte, Jacksonville, Melbourne, and Tequesta, and the pathobiology laboratory is in St. Petersburg. The information gained through FMRI's carcass salvage and rescue continues to be a crucial component in providing insight to manatee health, life history, general and reproductive biology, and providing data to assist in developing population models. Under the Service's Manatee Rescue, Rehabilitation, and Release Program, FWC staff participated in the rescue of 66 animals and releases of 22 rehabilitated animals.

Aerial surveys were conducted throughout the year to acquire information on manatee distribution, relative abundance, and use of habitat types. The Statewide "synoptic" aerial survey of manatees conducted on January 5-6, 2001, yielded a record high count of 3, 276 individuals. The extreme and sustained record-breaking cold weather in January was thought to attribute to this high count, bringing manatees to congregate at warm water sites. Intensive aerial surveys were flown during the winter to assess the accuracy of counts at the Tampa Bay power plants. Replicate aerial counts were conducted to calibrate survey procedures and better track manatee trends. Time/depth recorders were utilized for the first time to document the percent of time manatees spend at the surface. Sightings from aerial surveys were entered into a GIS program to assess manatee distribution and facilitate management decisions. Population models designed to estimate trends in stock population size are being developed based on information obtained from aerial surveys, mortality data, life history, and ecology studies.

Information on how manatees use coastal habitat in Florida is critical in determining what resources the population requires to expand and grow. The placement of satellite and radio transmitters on manatees enables researchers to follow individual manatee movements and obtain details about behavior, migratory routes, and preferred habitats. Three rehabilitated manatees were tagged and monitored by FMRI in 2001. In addition, four manatees were tagged in Warm Mineral Spring as part of a behavior and habitat use study, and five animals were tagged at TECO Power Plant in Tampa to assist in a calibration study.

Life history information is essential in formulating an assessment of manatee population dynamics and recovery. FMRI staff utilizes photo-identification, passive integrated transponders (PIT tags), and ultrasound measurements to acquire long-term data and survival of individuals, reproductive capability of mature females, and the health of wild manatees. Currently, the west-central and southwest MIPS catalogue maintained by FMRI contains over 3,300 images and 7,500 sightings, representing 700 manatees. FMRI staff conducted a photo-identification study for its fifth consecutive year at Big Bend Power Plant in Apollo Beach, Florida. A remote PIT tag reader was built and tested at a winter aggregation site. Modifications to this device are necessary before it can be used successfully.

Understanding how the human population affects the manatee is crucial for recovery. Factors such as pollution, population growth, habitat modification and destruction, marine recreation and various causes of mortality are all related to human activities. Human-dimension studies have been developed to assess the effectiveness of various types of manatee protection messages. FMRI, in collaboration with several partners, initiated work on the characterization of recreational boating in Charlotte Harbor; results from this assessment will assist managers in decisions regarding manatees in the area. A baseline Statewide study was completed on boater compliance within speed zones. Results indicated an average rate of 50 percent compliance where speed zones were posted. FMRI staff also assisted in the three-year study comparing education and regulation as tools for manatee protection. Results indicated that normative influences and law enforcement had the strongest effect on motivating boater decisions. Additionally, FMRI participated in the Statewide manatee speed zone task force which aimed to increase compliance in manatee speed zones, both in the presence and absence of law enforcement.

b. FWC - Bureau of Protected Species Management

The Bureau of Protected Species Management (BPSM) in Tallahassee serves as the management component of the FWC marine mammal program. BPSM is responsible for the planning and implementation of management activities involved in the protection and recovery of the Florida manatee, for implementing tasks of the Federal recovery plan, and serving as the FWC's primary liaison with other Federal, State, and local governments. Protection activities are implemented in four general ways: (1) State rules are developed, (2) MPPs are developed and implemented with the assistance of local governments, (3) permit applications for resource development are reviewed and commented upon, and (4) Floridians and visitors are educated on how manatees and their habitat can be protected.

To increase law enforcement effectiveness, the FWC, reorganized their Division of Law Enforcement patrol structure. The FWC reorganized 293 existing law enforcement officers to increase and improve enforcement of manatee protection laws, including manatee speed zones. In addition, the FWC reassigned 23 law enforcement officers to on-the-water patrol duty and proposed to hire 25 new officers to increase the level of enforcement attention toward manatee protection. Furthermore, the State allocated $2 million for those officers willing to work overtime which translates into additional hours of manatee protection.

In April 2001, FWC voted to approve a Settlement Agreement with Save the Manatee Club, *et al.* The agreement called for FWC to proceed with additional manatee protection rulemaking in many areas around the State. The first phase of the agreement identified 16 areas for possible additional protection. The investigation of these areas was initiated by BPSM staff. Additional speed boat sign posting and amendments to existing manatee protection zones continued to be a priority for BPSM. Staff also participated in a southwest public forum on manatee protection which brought together various government officials to address issues regarding future manatee protection in south Florida. Staff continued to issue permits for commercial and professional fishing guide activities in several counties. Furthermore, BPSM continued its coordination and involvement with Federal, State, and local law enforcement agencies, reviewed permits and drafted agency opinions, participated in the

interagency task force to eliminate structure-related manatee mortality, assisted in manatee habitat characterization, assessment, and protection, distributed data and technical support, and conducted education and outreach activities centered on manatee biology, ecology, and conservation.

3. Efforts by Private Partners

a. Captive Program

The captive program relies on three main facilities (SeaWorld, Lowry Park Zoo, and Miami Seaquarium) to assist and conduct manatee rescue, rehabilitation and release. These partners house manatees for acute, critical, and long-term care.

SeaWorld, located in Orlando, Florida, participated in over 20 manatee rescues and 11 releases during 2001. The manatee exhibit at SeaWorld provides funding for various research projects by the promotion of manatee license plates and decals. Lowry Park Zoo, located just west of Tampa, Florida, participated in approximately 13 rescues and 7 releases this past year. A Manatee Hospital Boardwalk offers guests the opportunity to view behind-the-scenes work in Lowry's manatee area. Miami Seaquarium, located in Miami, Florida, contributed to nearly ten rescues and seven releases during 2001. In October, the Seaquarium hosted the semi-annual Interagency/Oceanaria Meeting. The Dolphin Research Center, located in the middle of the Florida Keys, assisted in over ten rescues, participated in several releases, and served as verifier for dozens of manatee calls.

Other partners house manatees for acute and long-term care. These include the Mote Marine Laboratory, The Living Seas, SeaWorld-San Diego, Columbus Zoo and Aquarium, Cincinnati Zoo and Botanical Garden, and South Florida Museum/Parker Museum. Manatee World Incorporated serves as a local verifier when needed in southwest Florida.

b. Other Recovery Activities

Other partners participate in a variety of recovery activities that promote education and conservation for the Florida manatee. SMC is the leading nonprofit organization dedicated exclusively to the protection of manatees and their habitat. They have an extensive volunteer base, provide numerous avenues of education and outreach, and afford financial assistance to manatee studies both in and out of the U.S. The Miami-Dade DERM responded to numerous manatee phone calls and assisted FWC with carcass recovery. The Miami-Dade DERM staff attends bimonthly law enforcement agency meetings to discuss manatee protection concerns and requests additional enforcement needs when necessary. FPL has been involved in manatee protection for over 25 years. Their contributions include the production of many manatee information materials, conducting various educational programs, sponsoring aerial surveys, and funding research and development projects aimed at identifying solutions to industrial warm water sources.

4. Efforts by Local Governments

In October, l989, the Governor and Cabinet directed 13 "key" counties to develop MPPs. The FWC encourages county MPPs to be adopted as an amendment to the counties' comprehensive plans. The

individual components–boat facility siting, etc., must be compatible with local policies and ordinances while addressing manatee concerns. Additionally, many county governments have implemented manatee protection areas at the county level.

FWC-approved plans are in place for Citrus, Collier, Dade, Duval, Indian River, and St. Lucie counties. Brevard, Broward, Lee, Martin, Palm Beach, Sarasota, and Volusia counties have plans currently under various phases of development. A current summary of MPPs is found in Table 5.

The various components of an MPP include:

1. an inventory of boat facilities (marinas, docks, boat ramps, dry storage areas, etc.);
2. an assessment of boating activity patterns;
3. manatee sighting and mortality information;
4. a boat facility siting plan (to determine the best areas for new marinas, boat ramps, etc.);
5. manatee protection measures, such as boating speed regulations in areas with high boat and manatee usage;
6. information on aquatic preserves, Outstanding Florida Waters, ports, manatee refuges, etc. within the county;
7. an education and awareness program for the public and boaters, divers, and school children; and
8. water quality and habitat protection program (including land acquisition and aquatic plant control plans for manatee areas).

5. Technological Measures

Funds appropriated by the Florida Legislature for the Florida Manatee Avoidance Technology initiative administered by FWC is designed to develop technology to reduce the number of manatees struck by boats. Current research focuses on technology to alert manatees to the presence of boats, technology to alert boaters to the presence of manatees, and hull or propulsion-system design modifications that would minimize injuries to the animals in the event of a collision. Funded studies are designed to explore technology that has not previously been applied to the manatee/boat collision problem, including concepts related to voice recognition, sonar, and infrared technology. Currently, there are six such studies underway. In addition to the projects funded by FWC, the FMRI will be working with Florida Atlantic University to begin testing a device that may alert manatees to oncoming boats.

Work in the manatee avoidance technology field is just beginning. Data must be collected and analyzed before the success of any of these forms of technology can be determined. The hope is to quickly evaluate the effectiveness of the proposed solutions, and if appropriate, assist in making these technologies available to the public at acceptable costs and risks. The goal is to reduce mortalities from watercraft, which account for approximately 30 percent of manatee deaths annually. With legislative support, funding research into manatee avoidance will hopefully result in new tested and proven technologies which reduce watercraft/manatee collisions.

Table 5. Status of Manatee Protection Plans in Florida.

MPP Status and Availability - 13 Key Counties - May 2002				
	Separate Marina Siting Study	**Boating Activity Study**	**Manatee Protection Plan**	**FWC Manatee Protection Rule**
BREVARD	In Draft MPP	Yes	Oct. 2000 Draft	Yes
BROWARD	No	No	Partial Plan 4/92 Comp. Plan amend. 2001	Yes
CITRUS	Yes	Yes - for part of county	Approved 1991 Revised 1997	Yes
COLLIER	Yes	In MPP	Approved 1995	Yes
DADE	No	Yes	Approved 1995	Yes
DUVAL	No	Yes	Approved 6/99	Yes
INDIAN RIVER	No	Yes	Approved 8/00; Amended and Approved 2/02	Yes
LEE	Yes	Yes	Draft Plan	Yes
MARTIN	Yes, approved 6/01 and 3/02	Yes	Draft - 3/02 approval	Yes
PALM BEACH	Yes	Yes	No	Yes
SARASOTA	Yes	Yes	Under FWC Contract	Yes
ST. LUCIE	Yes	Yes	Approved 3/02	Yes
VOLUSIA	Yes (Phase II) Under Review by FWC (4/02)	Yes	Partial Plan approved 2/01	Yes