PART I. INTRODUCTION

The Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.) (ESA), establishes policies and procedures for identifying, listing and protecting species of wildlife that are endangered or threatened with extinction. The ESA defines an "endangered species" as "any species which is in danger of extinction throughout all or a significant portion of its range." A "threatened species" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."

The West Indian manatee, *Trichechus manatus*, was listed as endangered throughout its range for both the Florida and Antillean subspecies (*T. manatus latirostris* and *T. manatus manatus*) 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, *Trichechus manatus latirostris* (50 CFR Part 17.95(a)). This was one of the first ESA designations of critical habitat for an endangered species and the first for an endangered marine mammal.

The Secretary of the Interior is responsible for administering the ESA's provisions as they apply to this species. Day-to-day management authority for endangered and threatened species under the Department's jurisdiction has been delegated to the U.S. Fish and Wildlife Service (FWS). To help identify and guide species recovery needs, section 4(f) of the ESA directs the Secretary to develop and implement recovery plans for listed species or populations. Such plans are to include: (1) a description of site-specific management actions necessary to conserve the species or population; (2) objective measurable criteria which, when met, will allow the species or populations to be removed from the List; and (3) estimates of the time and funding required to achieve the plan's goals and intermediate steps. Section 4 of the ESA and regulations (50 CFR Part 424) promulgated to implement its listing provisions, also set forth the procedures for reclassifying and delisting species on the federal lists. A species can be delisted if the Secretary of the Interior determines that the species no longer meets the endangered or threatened status based upon these five factors listed in Section 4(a)(1) of the ESA:

(1) the present or threatened destruction, modification, or curtailment of its habitat or range;
(2) overutilization for commercial, recreational, scientific, or educational purposes;
(3) disease or predation;
(4) the inadequacy of existing regulatory mechanisms; and
(5) other natural or manmade factors affecting its continued existence.

Further, a species may be delisted, according to 50 CFR Part 424.11(d), if the best scientific and commercial data available substantiate that the species or population is neither endangered nor threatened for one of the following reasons: (1) extinction; (2) recovery; or (3) original data for classification of the species were in error.

West Indian manatees also are protected under the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 U.S.C. 1461 *et seq*.). The MMPA establishes, as national policy, maintenance of the health and stability of marine ecosystems, and whenever consistent with this primary objective, obtaining and maintaining optimum sustainable populations of marine mammals. It also establishes a moratorium on the taking of marine mammals, which includes harassing, hunting, capturing, killing, or attempting to harass, hunt, capture, or kill any marine mammal. Section 101(a)(5)(A) of the MMPA allows FWS, upon request, to authorize by specific regulation the incidental, unintentional take of marine mammals by persons engaged in identified activities within specific geographic areas, if FWS determines that such taking would have a negligible impact on the species or stock. Since the West Indian manatee, which is comprised of the Florida and Antillean manatee stocks, is currently listed as “endangered” under ESA, they are thus considered “depleted” under the MMPA. Section 115(b) of the MMPA requires that conservation plans be developed for marine mammals considered “depleted.” Such plans are to be modeled after recovery plans required under section 4(f) of the ESA, as described above. The purpose of a conservation plan is to identify actions needed to restore species or stocks to optimum sustainable population levels as defined under the MMPA. Thus, in the case of the Florida manatee, this plan addresses conservation planning under MMPA and recovery planning under the ESA.

FWS developed the initial recovery plan for the West Indian manatee in 1980. This initial plan focused primarily on manatees in Florida, but included Antillean manatees in Puerto Rico and the United States Virgin Islands. In 1986, FWS adopted a separate recovery plan for manatees in Puerto Rico. To reflect new information and planning needs for manatees in Florida, FWS revised the original plan in 1989 and focused exclusively on the Florida manatee. This first revision covered a 5-year planning period ending in 1994. FWS revised and updated the plan again in 1996, which again covered a 5-year planning period ending in 2000. In 1999, FWS initiated the process to revise the plan for a third time. A 18-member recovery team (see Acknowledgment Section), consisting of representatives of the public, agencies, and groups that have an interest in manatee recovery and/or could be affected by proposed recovery actions, was established to draft this revision.

In the 20 years since approval of the original recovery plan, a tremendous amount of knowledge of manatee biology and ecology has been obtained, and significant protection programs have been implemented, through the guidance provided by the recovery planning process. This third revision of the Florida Manatee Recovery

Plan reflects many of those accomplishments, addresses current threats and needs, and specifically addresses the planning requirements of both the ESA and MMPA through 2006. This plan was developed with the assistance of the Florida Manatee Recovery Team. Henceforth in this document, unless otherwise specified, the term "manatee" refers to *Trichechus manatus latirostris*, the Florida manatee subspecies of the West Indian manatee.

OVERVIEW

In the southeastern United States, manatees occur primarily in Florida and southeastern Georgia, but individuals can range as far north as Rhode Island on the Atlantic coast (Reid 1996), and probably as far west as Texas on the Gulf coast. This population appears to be divided into at least two somewhat isolated areas, one on the Atlantic coast and the other on the Gulf of Mexico coast of Florida and into two regional groups on each coast: Northwest, Southwest, Atlantic, and Upper St. Johns River (Fig. 1).

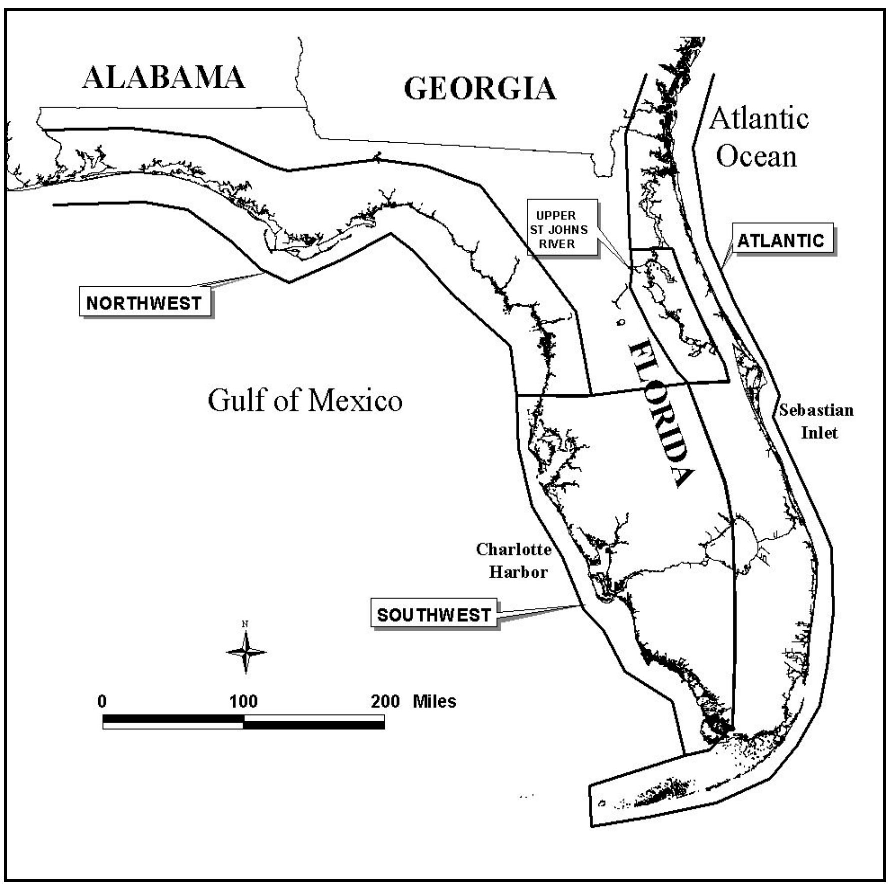

Figure 1. Florida manatee generalized regions: Northwest, Southwest, Upper St. Johns River and Atlantic coast.

Florida manatees have a low level of genetic diversity (Garcia-Rodriguez *et al*. 1998). Historical accounts and archeological evidence of manatees prior to the first half of the 20th century are poor and often contradictory (Domning *et al*. 1982; O'Shea 1988). The record indicates that manatees probably are almost as geographically widespread today as they were historically; however, they appear to be less abundant in many regions (Lefebvre et al. 2001). They were hunted by pre-Columbian societies, but the extent to which they were taken is unclear. After Spanish occupation, Florida's human population increased, and manatees probably were taken in greater numbers. Commercial and subsistence hunting, particularly in the 1800s, probably reduced the population significantly. In 1893, the State of Florida passed legislation prohibiting the killing of manatees.

The major threats faced by manatees today are many fold. Collisions with watercraft account for an average of 24 percent (%) of known manatee deaths in Florida annually (1976-2000), with 30% in 1999 and 29% in 2000. Deaths attributed to water control structures and navigational locks represents 4% of known deaths. The future of the current system of warm-water refuges for manatees is uncertain as deregulation of the power industry in Florida occurs, and if minimum flows and levels are not established and maintained for the natural springs on which many manatees depend. There are also threats to habitat caused by coastal development throughout much of the manatee's Florida range. Florida's human population has grown by 130% since 1970 (6.8 to 15.7 million) and is expected to exceed 18 million by 2010 and 20 million by the year 2015 (Florida Office of Economic and Demographic Research 2000). It is also projected that by 2010, 13.7 million people will reside in the 35 coastal counties (Florida Office of Economic and Demographic Research 2000). There are also threats from natural events such as red tide and cold events. The challenge for managers has increasingly become how to modify human, not manatee, behavior (Reynolds 1999). Yet, since the first Manatee Recovery Plan in 1980, well-coordinated interagency and non-governmental efforts to recover the Florida manatee have been extraordinary, making recovery an achievable goal (Domning 1999).

Based on the highest minimum count of the southeastern United States manatee population (Table 1), Florida manatees constitute the largest known group of West Indian manatees anywhere in the species' range. Outside the United States, manatees occur in the Greater Antilles, on the east coast of Mexico and Central America, along the North and Northeastern coast of South America, and in Trinidad (Lefebvre *et al*. 2001). In most of these areas, remaining populations are believed to be much smaller than the United States population and are subject to poaching for food, incidental take in gillnets, and habitat loss. Manatee protection programs in many countries are not well organized or supported and, in this context, protection of the Florida population takes on international significance.

Table 1. Estimates of manatee life history traits and related statistics. Except as noted, information was obtained from O'Shea *et al*. 1995.

Life-history trait		**Data**
Maximum determined age		59 years
Gestation		11-14 months
Litter size		1
% twins	Blue Spring	1.79%
	Crystal River	1.40%
Sex ratio at birth		1:1
Calf survival	Blue Spring	60%
	Crystal River	67%
Annual adult survival	Atlantic coast	90%
	Blue Spring	96%
	Crystal River	96%
Age of first pregnancy (female)		3-4 years
Mean age at first reproduction (female)		5 years
Age of spermatogenesis (male)		2-3 years
Proportion pregnant	Salvaged carcasses	33%
	Blue Spring (photo-ID)	41%
Proportion nursing - 1st-year calves during winter	Mean	36%
	Blue Spring	30%
	Crystal River	36%
	Atlantic coast	38%
Calf dependency		1.2 years
Interbirth interval		2.5 years
Highest number of births		May-September
Highest frequency in mating herds		February-July
No. verified carcasses in Florida[a]		4,043 (1974-2000)
No. documented in ID catalog		>1,200 (1975-2000)
Highest minimum count (aerial surveys)[a]		3,276 in Jan 5-6, 2001

[a] Data provided by the Florida Marine Research Institute, FWC.

A. TAXONOMY

The West Indian manatee, *Trichechus manatus* Linnaeus, 1758, is one of four living species of the mammalian Order Sirenia. The other three sirenians are the West African manatee (*T. senegalensis*), the Amazonian manatee (*T. inunguis*), and the dugong (*Dugong dugon*). All four species are aquatic herbivores listed as endangered or threatened throughout their ranges by FWS. A fifth species, Steller's sea cow (*Hydrodamalis gigas*), existed in sub-Arctic waters of the Bering Sea. Hunted to extinction within 27 years of its discovery in 1741, Steller's sea cow was a toothless sirenian that fed on kelp and reached lengths of up to 8 m (26 ft) (Reynolds and Odell 1991).

Two subspecies of West Indian manatee are now recognized: the Florida manatee, *T. manatus latirostris*, which occurs in the southeastern United States, and the Antillean manatee, *T. manatus manatus*, found throughout the remainder of the species' range. The Florida manatee was first described by Harlan (1824) as a separate species, *Manatus latirostris*. Later, Hatt (1934) recognized Florida manatees as a subspecies of *T. manatus* Linnaeus. Although subsequent researchers (Moore 1951; Lowery 1974) questioned the validity of the subspecies status, Domning and Hayek (1986) carefully examined morphological characteristics and concluded that the distinction was warranted. The historical ranges of the two subspecies may overlap on the coast of Texas, where the origin of occasional strays (from Florida or Mexico) is uncertain.

B. SPECIES DESCRIPTION

West Indian manatees are massive fusiform-shaped animals with skin that is uniformly dark grey, wrinkled, sparsely haired, and rubber-like. Manatees possess paddle-like forelimbs, no hind limbs, and a spatulate, horizontally flattened tail. Females have two axillary mammae, one at the posterior base of each forelimb (Fig. 2). Their bones are massive and heavy with no marrow cavities in the ribs or long bones of the forearms (Odell 1982). Adults average about 3.0 m (9.8 ft) in length and 1,000 kg (2,200 lbs) in weight, but may reach lengths of up to 4.6 m (15 ft) (Gunter 1941) and weigh as much as 1,620 kg (3,570 lbs) (Rathbun *et al*. 1990). Newborns average 1.2 to 1.4 m (4 to 4.5 ft) in length and about 30 kg (66 lbs) (Odell 1981). The nostrils, located on the upper snout, open and close by means of muscular valves as the animals surface and dive (Husar 1977; Hartman 1979). A muscular flexible upper lip is used with the forelimbs to manipulate food into the mouth (Odell 1982). Bristles are located on the upper and lower lip pads. Molars designed to crush vegetation form continuously at the back of the jaw and move forward as older ones wear down (Domning and Hayek 1986). The eyes are very small, close with sphincter action, and are equipped with inner membranes that can be drawn across the eyeball for protection. Externally, the ears are minute with no pinnae. Internally, the ear structure suggests that they can hear sound within a relatively narrow low frequency range, that their hearing is not acute, and that they have difficulty in localizing sound (Ketten *et al*. 1992). This indirect "structured" evidence is not entirely concordant with actual electro physiological measurements. Gerstein (1995) suggested that manatees may have a greater low-frequency sensitivity than the other marine mammal species that have been tested.

Figure 2. Mother manatee nursing a calf. (*Photograph by G. Rathbun*)

C. POPULATION BIOLOGY

Information on manatee population biology was reviewed during a technical workshop held in February 1992 (O'Shea *et al.* 1992). The objectives of the workshop were to synthesize existing information, evaluate the strengths and weaknesses of current data sets and research methods, and make recommendations for future research, particularly for constructing new population models (O'Shea *et al*. 1995). The population and life history information published in the workshop proceedings suggests that the potential long-term viability of the Florida manatee population is good, provided that strong efforts are continued to curtail mortality, ensure warm-water refuges are protected, maintain and improve habitat quality, and offset potential catastrophes (Lefebvre and O'Shea 1995).

The value of maintaining long-term databases was emphasized in the 1992 workshop. The collection of manatee reproduction, sighting history, life history, carcass salvage, and aerial survey data has continued, and improved techniques for estimating trends in important population characteristics have been developed.

Such measures include estimation of adult manatee survival (probabilities based on photo-identification) (Langtimm *et al*. 1998), determination of population trends from aerial survey data (Craig *et al*. 1997; Eberhardt *et al*. 1999), and development of population models (Eberhardt and O'Shea 1995). Population modeling will be an ongoing process that evolves as databases and modeling tools improve.

POPULATION SIZE 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 United States (O'Shea 1988; O'Shea *et al*. 1992; Lefebvre *et al.* 1995). Even though many manatees aggregate at warm-water refuges in winter (Fig. 3) 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.

Figure 3. Manatee aggregated during a winter cold front at a power plant warm-water outfall in Titusville, Florida. (*Photograph by B. Bonde*)

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.

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 (Fig. 4); the highest east coast of Florida count is 1,756 and highest on the west coast is 1,520, both in 2001. 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 mid-winter 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 regions (Garrott *et al*. 1994, 1995; Craig *et al.* 1997; Eberhardt *et al.* 1999).

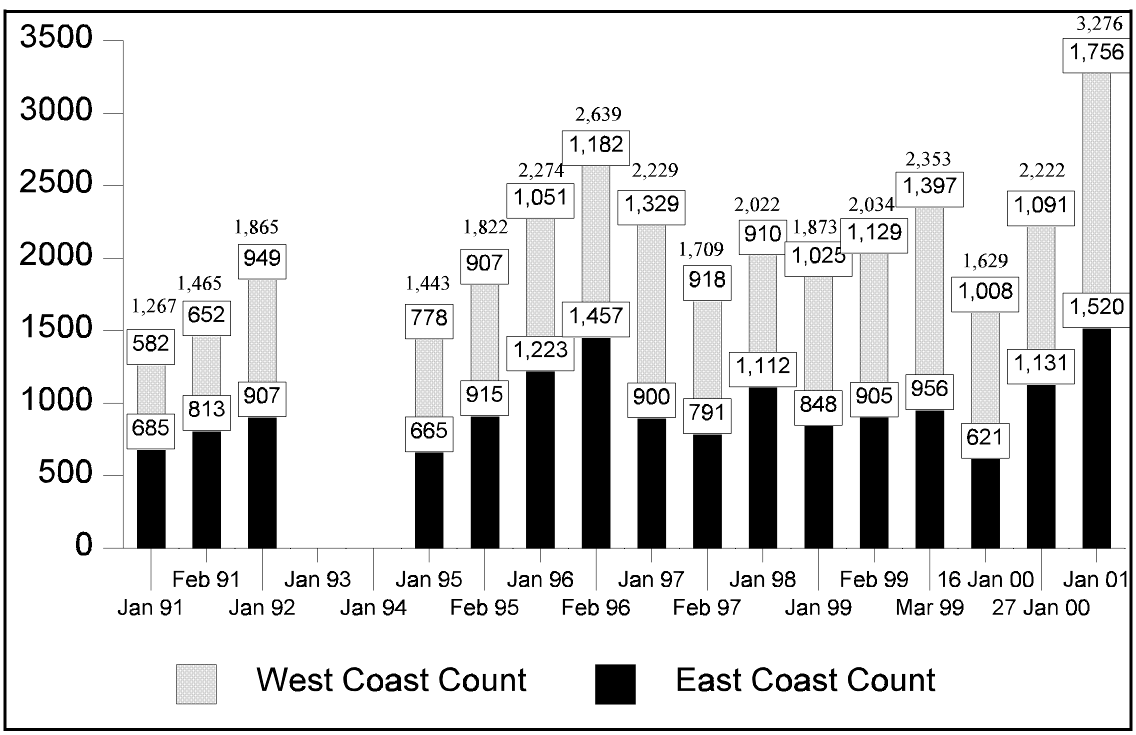

Figure 4. Manatee synoptic survey total, West coast, and East coast counts, 1991-2001 (FWC, unpublished data).

On a more limited basis, 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 (Bengtson 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).

OPTIMUM SUSTAINABLE POPULATION The MMPA defines the term "optimum sustainable population" (OSP) for any population stock to mean "the number of animals which will result in the maximum productivity of the population or species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element." By regulation (50 CFR 216.3), the OSP is further defined as a range of population sizes between the maximum net productivity level (MNPL) and the carrying capacity (K) of the environment, under conditions of no harvest. The MNPL is defined as the population level producing "the greatest net annual increment in population numbers or biomass resulting from additions to the population due to reproduction and/or growth less losses due to natural mortality."

Pursuant to the MMPA, stocks are to be maintained within their OSP ranges. Just as we are uncertain of the Florida manatee's population size and trend, we are uncertain whether the population is currently below or within its OSP level. Even in the regions where population growth has been documented (Northwest and Upper St. Johns River), we do not know if maximum productivity has yet been achieved.

The MNPL has been estimated only for a few marine mammal species, and is generally treated as a percentage of carrying capacity. Carrying capacity varies over time and space, and is likely to be artificially reduced by a growing human population. Loss of artificial and natural warm-water refuges, for example, could greatly reduce the winter carrying capacity of habitats north of the Sebastian River on the Atlantic coast and the Caloosahatchee River on the Gulf coast. The Recovery Team recognizes the importance of conserving important manatee habitat, and emphasizes the need for sufficient quantity and quality of habitat within each region of the Florida manatee's range to permit sustained manatee population growth from current population levels. Key habitat types include those that are used for the following essential manatee activities: (1) thermoregulation at warm-water refuges; (2) feeding, reproduction and shelter; and (3) travel and migration.

DETERMINATION OF POPULATION STATUS The quality of the long-term database of scarred manatees "captured" by photography (Fig. 5) at winter-aggregation sites, combined with advances in mark-recapture (resighting) statistical models and computer programs, has allowed statistically valid estimates of adult manatee survival rates (Pollock *et al.* 1990; Lebreton *et al.* 1992; Pradel and Lebreton 1993, cited in Langtimm *et al*. 1998; Langtimm *et al.* 1998; White and Burnham 1999). Additional models have been developed that will allow estimation of the proportion of females with calves (Nichols *et al.* 1994). These statistical techniques allow the examination of vital rate variation over time or in association with specific environmental factors. They provide "Goodness-of-Fit" tests of the data to the models to assess bias in the estimates, and provide confidence intervals to assess the precision of the estimates. The application of these techniques to the manatee photo-identification (photo-ID) data provides statistical robustness (Langtimm *et al.* 1998) that has not yet been achieved with trend analyses of aerial survey data (Lefebvre *et al.* 1995; Eberhardt *et al.* 1999) or carcass recovery data (Ackerman *et al.* 1995). Furthermore, population size changes only after there has been a change in survival and/or reproductive rates (or emigration/immigration). Thus, directly monitoring survival and reproduction rates can provide immediate information on probable trends in abundance and gives managers specific information that can help them design realistic plans to achieve species recovery, reclassification, and eventual removal from the List of Endangered and Threatened Wildlife.

The previous recovery plan (FWS 1996) identified the need for a population status working group to assess manatee population size and trends. The first meeting of the Manatee Population Status Working Group (MPSWG), a subcommittee of the Recovery Team, was held in March 1998. The goals of the MPSWG are to: (1) assess the status of the Florida manatee population; (2) advise FWS on population recovery criteria for determining when recovery has been achieved (see Appendix A); (3) provide interpretation of available information on manatee population biology to managers; (4) make recommendations concerning needed research directions and methods; and (5) obtain rigorous external review of manatee population data, conclusions, and research methods by independent researchers with expertise in population biology. The Manatee Population Ecology and Management Workshop, scheduled for April 2002, is a forum that will address these goals and will specifically include a panel of independent experts to review research progress and to make recommendations on how to improve integration of population models with management.

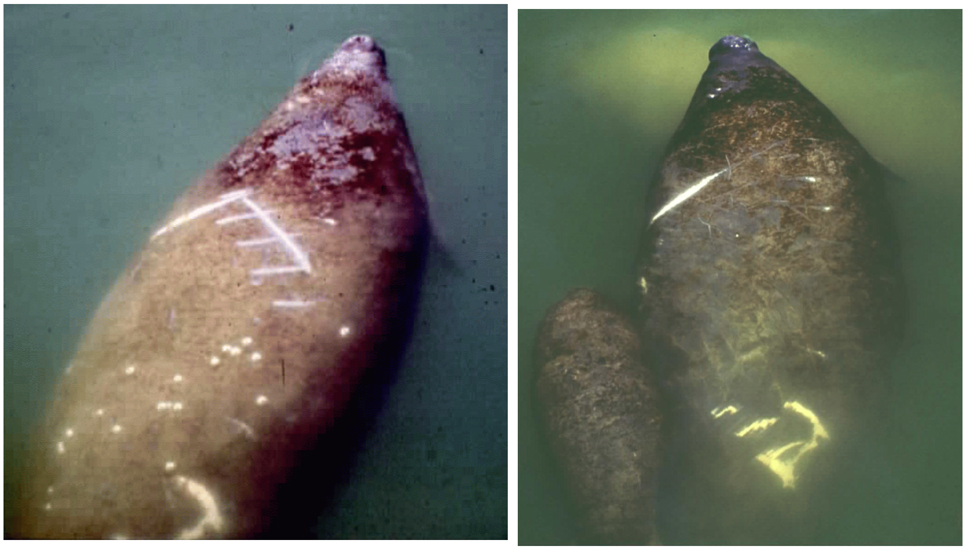

Figure 5. Catalogued female Florida manatee SB 79 was first documented on May 1, 1993 with a large calf (not shown on left). Documented with her third calf (right) on August 15, 1997. These photographs illustrate how injuries/scars appear to change as they heal or as they are altered by new features. This individual uses the Ft. Myers/Charlotte Harbor area during the winter and Sarasota Bay during the warmer months. Estimated to be at least 13 years old, she has given birth to calves in 1992, 1994, 1997, and 2000. (*Photographs by J. Koelsch*)

In order to develop quantitative recovery criteria, the MPSWG reviewed the best available published information on manatee population trends, and determined that analysis of status and trends by region would be appropriate. Based on the highest minimum winter counts for each region between 1996 and 1999 (Fig. 4 and Fig. 6), 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. Four subgroups were identified, which tend to return to the same warm-water refuge(s) each winter (Fig. 1) and have similar non-winter distribution patterns. For example, on the east coast, a core group of more than 100 manatees use the Blue Spring warm-water refuge in the upper St. Johns River. Radio-tracking studies (Bengtson 1981) and other information (Beeler and O'Shea 1988; Marine Mammal Commission 1988) suggest that most manatees wintering at Blue Spring tend to remain in the area identified as the **Upper St. Johns River Region** (Fig. 1). The lower St. Johns River, the east coast, and the Florida Keys are considered to represent the **Atlantic Region** (Fig. 1), based on the results of long-term radio tracking and photo-ID studies (Beck and Reid 1995; Reid *et al.* 1995; Deutsch *et al.* 1998).

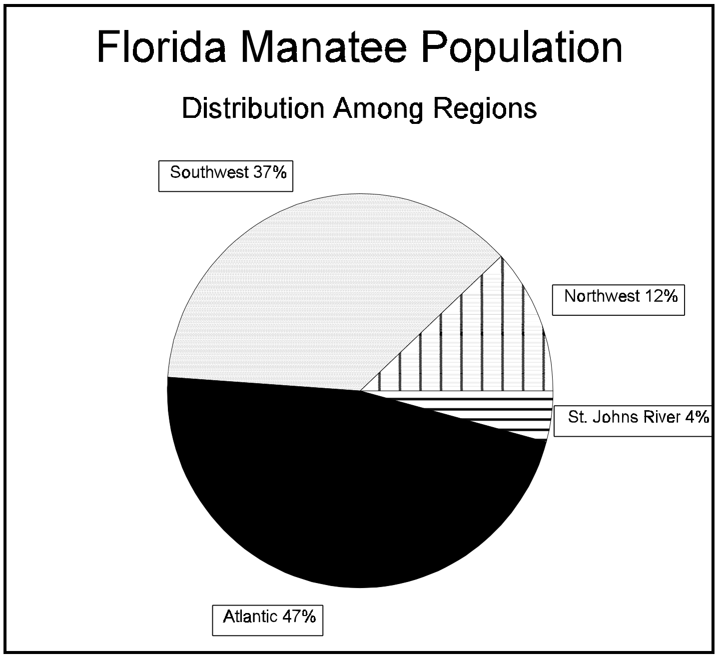

Figure 6. Florida manatee population distribution among regions. Percentage estimates are based upon highest minimum winter counts for each region between 1996 and 2000 (FWC, unpublished data).

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% of the females and 87% 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 **Northwest Region** (Fig. 1). 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 **Southwest Region** (Fig. 1).

Determination of manatee population status is based upon research described in Objective 2 and Appendix B. Table 2 provides regional status summaries and includes an overview of current status, habitat concerns, carcass recovery and cause of death data, and reproduction, survival, and population growth estimates for each region, if available. Cause of death data are summarized for each region in Appendix C to provide an overview on causes of death for: (1) all age classes; and (2) for adults only. Modeling has shown that manatee population trends are most sensitive to changes in adult survival rates (Eberhardt and O'Shea 1995; Marmontel *et al.* 1997; Langtimm *et al.* 1998).

Table 2. Florida manatee population status summaries by region. Data from the Northwest, Upper St. Johns River and Atlantic Regions were based upon survival rates from Langtimm et al. (1998) and population growth estimates from Eberhardt and O'Shea (1995).

		Northwest Primarily NW peninsular FL	**Southwest** Tampa Bay to Whitewater Bay	**Upper St. Johns** Upstream, South of Palatka	**Atlantic** GA - Miami & lower St. Johns
Photo-identification-based estimates	Adult Survival (% per year)	96.5 (95.1-97.5)	Survival, reproductive and population growth rate estimates based on resightings of known individuals are not currently available.	96.1 (90.0-98.5)	90.7 (88.7-92.6)
	Population Growth Rate (% per year)	7.4		5.7 (3-8)	1.0
	Reproduction: Percent adult females with calf	43% ± 9%		41%	42%
	Percent adult females with 1st year calf	36% ± 6%		30%	39%
	Mean interbirth interval	2.5 ± 0.77		2.6 ± 0.81 winter seasons	2.6 ± 0.64 winter seasons
	Mean calf dependency period	1.2 ± 0.42		1.3 ± 0.48 winter seasons	1.2 ± 0.42 winter seasons
	Mean age females at first reproduction	5.1 ± 1.21 years		5.4 ± 0.98 years	- - -
Causes of death based on carcass recovery	1980 - 1999 Overview	• Total of 153 carcasses • All causes, increasing 5.5% per year • Watercraft-related, increasing 10.8% per year	• Total of 1,358 carcasses • All causes increasing 4.8% per year • Watercraft-related, increasing 7.1% per year	• Total of 79 carcasses • All causes, increasing 2.6% per year • Watercraft-related, increasing 1.6% per year	• Total of 1,659 carcasses • All causes, increasing 6.9% per year • Watercraft-related, increasing 5.5% per year
	1989 - 1999 More recent trends	• Average of 8.9 per year (range = 6-12) • Human related cause of death 30% (adults 40%)	• Average of 85.5 per year (range = 57-134) • 281 in 1996 (including 145 red tide related deaths) • Human related cause of death 30% (adults 48%)	• Average of 4.5 per year (range = 2-7) • Human related cause of death 43% (adults 62%)	• Average of 107 per year (range = 70-135) • 206 in 1990 (46 cold-related) • Human related cause of death 34% (adults 57%)
Habitat Related Concerns		• Spring flow rates • Water quality and SAV • Storm-related salinity fluctuations, resulting in vegetation declines • Storm-related impacts on adult survival • Human disturbance at warm-water springs • Potential conflict between weed control and manatee food supply • Papilloma virus implications unknown	• Manatee dependence on power plants as thermal refuges • Increasing boat traffic • Periodic red tide-related deaths • Moderate level of water control structure deaths • Water quality and SAV • Salinity fluctuations, resulting in vegetation declines • Storm-related impacts on adult survival • Human disturbance	• Spring flow rates • Increasing boat traffic • Water quality and SAV • Low to moderate level of water control structure deaths • Potential conflict between weed control and manatee food supply	• Manatee dependence on power plants as thermal refuges • Increasing boat traffic • ICW shared manatee-human travel corridor • High level of water control structure deaths, especially in SE • Water quality and SAV • Salinity fluctuations, resulting in vegetation declines • Storm-related impacts on adult survival • Human disturbance
Current Status		• Exceeds survival, reproduction, and population growth criteria • Although overall deaths are relatively low, watercraft-related deaths are increasing rapidly	• Estimates of survival and population growth not yet available; reproduction criterion has been exceeded for group that summers in Sarasota Bay • Overall deaths are high, watercraft-related deaths are increasing rapidly	• Meets or exceeds survival, reproduction, and population growth criteria • Overall deaths are moderate, watercraft-related deaths increasing slowly	• Meets reproduction criterion; may meet survival and population growth criteria • Overall deaths are high, watercraft-related deaths increasing moderately

CURRENT STATUS Two goals of the MPSWG are to assess the status of the Florida manatee population and provide interpretation of available information on manatee population biology to managers. The MPSWG developed a status statement (Appendix D) for these purposes, and through Recovery Task 2.1 will update this statement annually.

The **Northwest** and **Upper St. Johns River Regions** have survival and reproduction rates that are adequate to sustain population growth (Eberhardt and O'Shea 1995). The adult survival rates are estimated at 96.5% and 96.1% respectively (Table 2). These two regions represent only 16% of the manatees documented in the last three years (Fig. 6). Collection of comparable life history data for the **Southwest Region** only began in 1995 and was not adequate for these survival estimates. This region represents 37% of the population. The health of the population in the **Atlantic Region**, which represents almost one-half of the entire population, is less certain, and the confidence interval surrounding a 90.7% adult survival rate suggests a cause for concern as it drops below 90.0% (Langtimm *et al*. 1998). These statements about the regions are based on data collected from 1977 to 1993 and thus may not reflect the current status of the population. Additionally, the recent increase in the percentage of watercraft-related deaths as a proportion of the total mortality and the effects this will have on adult survival rates is uncertain. Regional demographic estimates are currently being updated for the Manatee Population Ecology and Management Workshop in April 2002.

The near and long term threats from human-related activities are the reasons for which the Florida manatee currently necessitates protection under the ESA. The focus of recovery is not on how many manatees exist, but instead the focus is on implementing, monitoring and addressing the effectiveness of conservation measures to reduce or remove threats which will lead to a healthy and self-sustaining population. The Florida manatee could be considered for reclassification from endangered to threatened provided that threats can be reduced or removed, and that the population trend is stable or increasing for a sufficient time period.

D. DISTRIBUTION AND HABITAT USE PATTERNS

Based on telemetry, aerial surveys, photo identification sighting records, and other studies over the past 20 years, manatee distribution in the southeastern United States is now well known (Marine Mammal Commission 1984, 1986; Beeler and O'Shea 1988; O'Shea 1988; Lefebvre *et al.* 2001). In general, the data show that 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 (Fig. 7, 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 (Fig. 7). 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 feed in adjacent Lake Worth and in Jupiter and Hobe Sounds, 19 to 24 km (12 to 15 mi) to the north (Packard 1981); animals using the Port Everglades power plant feed in grass beds in Biscayne Bay 24 to 32 km (15 to 20 mi) to the south (Marine Mammal Commission 1988); animals in Kings Bay feed on submerged aquatic vegetation along the mouth of the Crystal River (Rathbun *et al.* 1990); animals at Blue Spring leave the spring run to feed on freshwater aquatic plants along the St. Johns River and associated waters near the spring (Bengtson 1981; Marine Mammal Commission 1986).

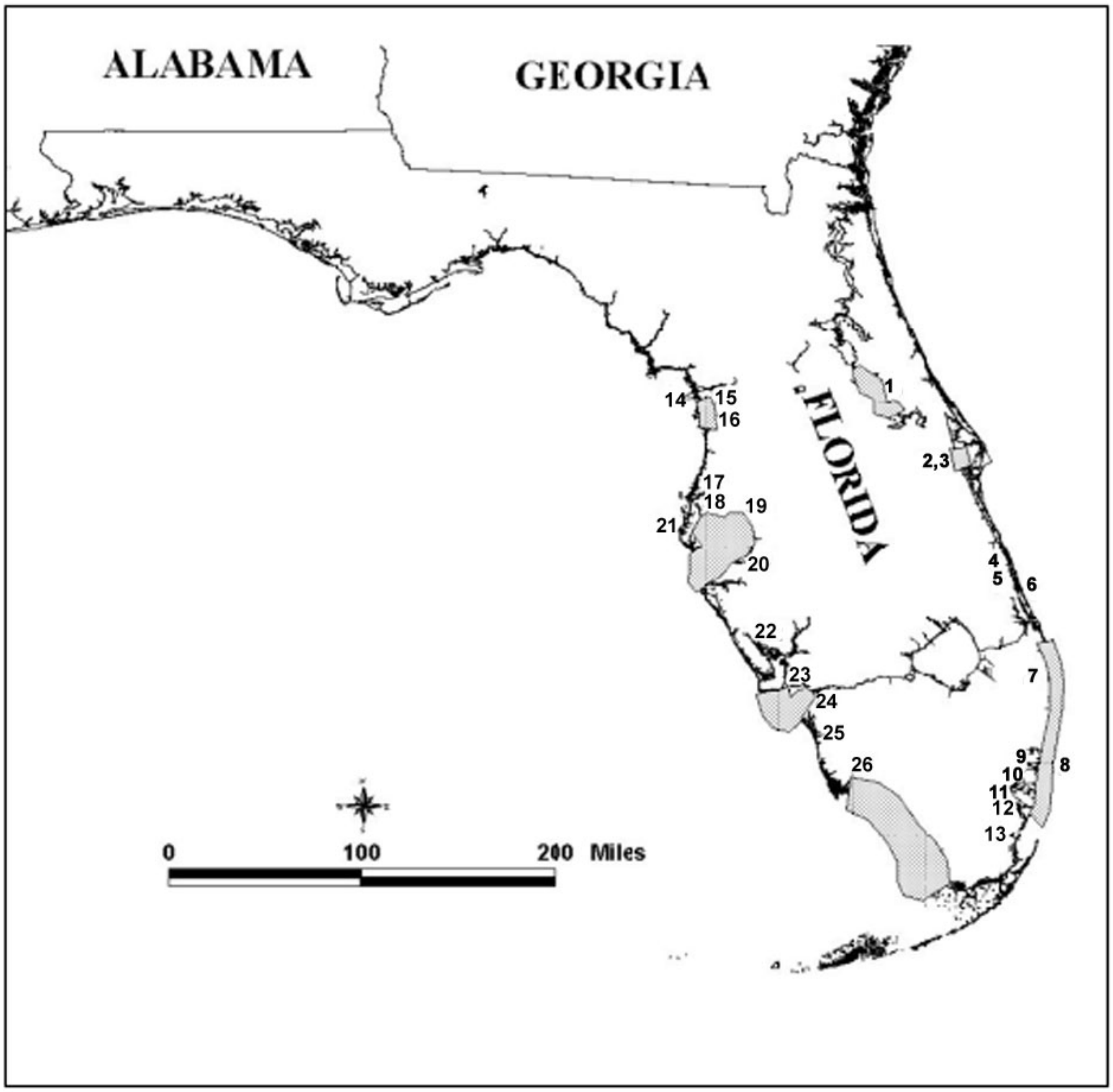

Figure 7. General winter distribution and warm-water manatee aggregation sites in the southeastern United States. Key with name of location and status of refuge is on the following page.

Key to Figure 7. Winter Aggregation Sites (based on Table 1, FWS 1996)

	❶ =	commonly have aggregations of 100 or more manatees
	❷ =	commonly have aggregations of 25 to 100 manatees
	❸ =	aggregations of less than 25 manatees
EAST COAST	(1)	❶Blue Spring (Volusia County, FL)
	(2)	❶Reliant Energy Power Plant (Brevard County, FL)
	(3)	❶FPL Canaveral Power Plant (Brevard County, FL)
	(4)	❷Sebastian River (Brevard County, FL)
	(5)	❷Vero Beach Power Plant (Indian River County, FL)
	(6)	❷Henry D. King Electric Station (St. Lucie County, FL)
	(7)	❶FPL Riviera Beach Power Plant (Palm Beach County, FL)
	(8)	❶FPL Port Everglades Power Plant (Broward County, FL)
	(9)	❶FPL Fort Lauderdale Power Plant (Broward County, FL)
	(10)	❷Little River (Dade County, FL)
	(11)	❷Coral Gables Waterway (Dade County, FL)
	(12)	❷ Palmer Lake (Dade County, FL)
	(13)	❸Black Creek Canal (Dade County, FL)
WEST COAST	(14)	❷FPC Crystal River Power Plant (Citrus County, FL)
	(15)	❶Crystal River (Citrus County, FL)
	(16)	❶Homosassa River (Citrus County, FL)
	(17)	❸Weeki Watchee/Mud/Jenkins Creek Springs (Hernando County, FL)
	(18)	❸FPC Anclote Plant (Pasco County, FL)
	(19)	❷TECO Port Sutton Plant (Hillsborough County, FL)
	(20)	❶TECO Big Bend Power Plant (Hillsborough County, FL)
	(21)	❷FPC Bartow Power Plant (Pinellas County, FL)
	(22)	❷Warm Mineral Springs (Sarasota County, FL)
	(23)	❷Matlacha Isles (Lee County, FL)
	(24)	❶FPL Fort Myers Power Plant (Lee County, FL)
	(25)	❷Ten Mile Canal Borrow Pit (Lee County, FL)
	(26)	❶Port of the Islands (Collier County, FL)
Abbreviations:	FPC	Florida Power Corporation
	FPL	Florida Power & Light Company
	TECO	Tampa Electric Company

As water temperatures rise manatees disperse from winter aggregation areas. While some remain near their winter refuges, others undertake extensive travels along the coast and far up rivers and canals. On the east coast, summer sightings drop off rapidly north of Georgia (Lefebvre *et al.* 2001) and are rare north of Cape Hatteras (Rathbun *et al.* 1982; Schwartz 1995); the northernmost sighting is from Rhode Island (Reid 1996). On the west coast, sightings drop off sharply west of the Suwannee River in Florida (Marine Mammal Commission 1986), although a small number of animals, about 12 to 15 manatees, are seen each summer in the Wakulla River at the base of the Florida Panhandle. Rare sightings also have been made in the Dry Tortugas (Reynolds and Ferguson 1984) and the Bahamas (Lefebvre *et al*. 2001; Odell *et al.* 1978).

In recent years, the most important spring habitat along the east coast of Florida has been the northern Banana River and Indian River Lagoon and their associated waters in Brevard County; more than 300 to 500 manatees have been counted in this area shortly before dispersing in late spring (Provancha and Provancha 1988; FWC, unpublished data). A comparable spring aggregation area does not appear to exist on the west coast, although Charlotte Harbor was visited in the spring by almost half of the 35 manatees radio-tagged at the Fort Myers power plant in Lee County (Lefebvre and Frohlich 1986). During summer, manatees may be commonly found almost anywhere in Florida where water depths and access channels are greater than 1 to 2 m (3.3 to 6.6 ft) (O'Shea 1988). Manatees can be found in very shallow water. Hartman (1979) observed manatees utilizing waters as shallow as 0.4 m with their backs out of the water. In warm seasons they usually occur alone or in pairs, although interacting groups of five to ten animals are not unusual.

Shallow grass beds with ready access to deep channels are preferred feeding areas in coastal and riverine 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).

E. BEHAVIOR AND PHYSIOLOGY

The first comprehensive study of manatee behavior was conducted in the late 1960s at Crystal River by Hartman (1979). This study attempted, among other things, to develop an ethogram for the species, and despite a number of additional studies that have been done since, Hartman's work stands today as the best source of information on certain aspects of manatee behavior, such as locomotion, breathing, resting, and socializing.

Other aspects of manatee behavioral ecology have been clarified during the last 20 years of manatee research. Migration corridors and responses by individual animals have been elaborated by long-term telemetry studies initiated by scientists at U.S. Geological Survey, Sirenia Lab (USGS-Sirenia) and the Florida Fish and Wildlife Conservation Commission (FWC) Florida Marine Research Institute (FMRI). Scientists have demonstrated site-fidelity in manatees, but have also noted that individual animals adjust their behaviors to take advantage of protected areas or changes in availability of resources. For example, Buckingham *et al.* (1999) confirmed increased manatee use of selected sanctuary areas during times when surrounding disturbance by boats was high. Reynolds and Wilcox (1994) continued to document the extent that manatees seek warm water at power plant discharges in winter (Fig. 8), taking advantage of the tendency by the manatees to aggregate around warm-water refuges in winter. Packard (1981, 1984), Lefebvre and Powell (1990), Rathbun *et al.* (1990) and Zoodsma (1991) described feeding and feeding ecology of manatees aggregated at natural or artificial warm-water refuges in winter, and additional studies further elaborated aspects of feeding behavior and ecological consequences thereof. Studies of foraging ecology were complemented by analyses of gut contents (e.g., Ledder 1986) and assessments of the functional morphology of the gastrointestinal tract (Reynolds and Rommel 1996).

Figure 8. Manatee aggregation at power plant warm-water outfall in Titusville, Florida. (*Photograph by T. O'Shea*)

Descriptions of behaviors have been followed or paralleled by studies that address how and why questions. Perhaps the most obvious questions center around why manatees need to seek warm-water refuges in winter. Gallivan and Best (1980) and Irvine (1983) documented the surprisingly low metabolism of manatees, and scientists suggested that water temperatures below 19° C triggered manatee behavioral changes, such as movements to warm-water sources. Recent research suggests that the temperature eliciting metabolic and behavioral changes in manatees is closer to 17° C, but upper and lower critical temperatures for manatees (the points at which they become metabolically stressed) remain unclear (Worthy *et al.* 1999). It is also unclear, but vital to understand, how manatees would react physiologically and behaviorally to reductions, cessations, or other changes in availability of warm water in winter.

Scientists have noted that manatees seek freshwater sources to drink. Hill and Reynolds (1989) suggested that the structure of the manatee kidney should permit the animals to survive well without regular access to freshwater. In other words, fresh water may be an attractant, without being required for survival, by manatees. Although manatees can tolerate a wide range of salinities (Ortiz *et al.* 1998), they prefer habitats where osmotic stress is minimal or where fresh water is periodically available (O'Shea and Kochman 1990). Ortiz *et al*. (1998) report that "manatees may be susceptible to dehydration after an extended period if freshwater is not available."

A number of research projects have considered manatee sensory capabilities, in part to attempt to comprehend how manatees perceive their environment, including aspects of the environment that are harmful to manatees, such as high-speed watercraft. Behavioral observation studies (e.g., Hartman 1979; Wells *et al*. 1999), and anatomical studies (e.g., Ketten *et al*. 1992) and psychoacoustic research that produced an audiogram for the manatee (Gerstein *et al.* 1999) have all addressed manatee hearing capabilities and the watercraft/manatee issue. These studies have not produced a complete understanding of manatee acoustics.

Other studies that have assessed other sensory capabilities, neuroanatomy, or fine motor coordination include: (1) Cohen *et al.* 1982 (photo receptors and retinal function); (2) Griebel and Schmid 1996 (color vision); (3) Griebel and Schmid 1997 (brightness discrimination); (4) Marshall *et al.*1998a (use of perioral bristles in feeding); (5) Marshall *et al.* 1998b (presence of a muscular hydrostat to facilitate bristle use); (6) Marshall and Reep 1995 (structure of the cerebral cortex); (7) Mass *et al.* 1997 (ganglion layer topography and retinal resolution); (8) O'Shea and Reep 1990 (extent of encephalization); (9) Reep *et al.* 1998 (distribution and innervation of facial bristles and hairs)and (10) Bowles *et al.* 2001(studies of response to novelty). Questions still remain regarding chemosensory ability of manatees, and clarification is needed regarding acoustics and the functional morphology of non-cerebral cortex regions of the brain.

The outcome of research into behavior, general physiology and sensory biology is that these aspects of manatee biology are better understood than is the case for most marine mammals. Due to long-term and diverse research efforts, scientists understand a great deal and continue to learn more about manatee habitat utilization, general behavior patterns, and life history attributes. Science and management would benefit from a carefully structured approach to answering, or providing higher resolution answers to questions associated with thermoregulation and thermal requirements of manatees and aspects of psychoacoustics and perceptual psychology (e.g., what they hear and how they respond to high levels of anthropogenic noise).

A comprehensive description of manatee behavior appears in Wells *et al.* (1999). This chapter provides synopses of the following topics: diving behavior, predation, foraging, thermoregulation and thermally-induced movements, resource aggregations, mating, rearing patterns, communication, and social organization. Sensory and general physiology of manatees are reviewed by Wartzok and Ketten (1999) and Elsner (1999), respectively. Reynolds and Powell (in press) provide a brief overview of manatee biology and conservation, including synopses of behavioral and physiological attributes.

F. FEEDING ECOLOGY

Manatees are herbivores that feed opportunistically on a wide variety of submerged, floating, and emergent vegetation. Because of their broad distribution and migratory patterns, Florida manatees utilize a wider diversity of food items and are possibly less specialized in their feeding strategies than manatees in tropical regions (Lefebvre *et al.* 2000).

Feeding rates and food preferences depend, in part, on the season and available plant species. Bengtson (1981, 1983) reported that the time manatees spent feeding in the upper St. Johns River was greatest (6 to 7 hrs/day) before winter (August to November), least (3 to 4 hrs/day) in spring and summer (April to July), and intermediate (about 5 hrs/day) in winter (January to March). He estimated annual mean consumption rates at 33.2 kg/day/manatee or about 4 to 9% of their body weight per day depending on season (Bengtson 1983). At Crystal River, Etheridge *et al.* (1985) reported cumulative daily winter feeding times from 0 to 6 hrs. 10 min. based on observations of three radio-tagged animals over seven 24-hour periods. The estimated daily consumption rates by adults, juveniles, and calves eating hydrilla (*Hydrilla verticillata*) were 7.1, 9.6, and 15.7% of body weight per day, respectively.

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).

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).

G. REPRODUCTION

Breeding takes place when one or more males (ranging from 5 to 22) are attracted to an estrous female to form an ephemeral mating herd (Rathbun *et al*. 1995). Mating herds can last up to 4 weeks, with different males joining and leaving the herd daily (Hartman 1979; Bengtson 1981; Rathbun *et al*. 1995. Cited in Rathbun 1999). Permanent bonds between males and females do not form. During peak activity, the males in mating herds compete intensely for access to the female (Fig. 9; Hartman 1979). Successive copulations involving different males have been reported. Some observations suggest that larger, presumably older, males dominate access to females early in the formation of mating herds and are responsible for most pregnancies (Rathbun *et al.* 1995), but males as young as three years old are spermatogenic (Hernandez *et al.* 1995). Although breeding has been reported in all seasons, Hernandez *et al.* (1995) reported that histological studies of reproductive organs from carcasses of males found evidence of sperm production in 94% of adult males recovered from March through November. Only 20% of adult males recovered from December through February showed similar production.

Figure 9. Mating herd in Plummers Cove, St. Johns River, Jacksonville, Florida. (*Photograph by B. Brooks*)

Females appear to reach sexual maturity by about age five but have given birth as early as four (Marmontel 1995; Odell *et al.* 1995; O'Shea and Hartley 1995; Rathbun *et al.* 1995), and males may reach sexual maturity at 3 to 4 years of age (Hernandez *et al.* 1995). Manatees may live in excess of 50 years (Marmontel 1995), and evidence for reproductive senescence is unclear (Marmontel 1995; Rathbun *et al.* 1995). Catalogued Florida manatee CR 28, a wild manatee that overwinters in Crystal River, was last documented with a calf in 1998, at which time she was estimated to be at least 34 years of age (USGS-Sirenia, unpublished data). A captive animal, MSTm-5801, gave birth to a calf in 1990, at which time she was estimated to be 43 to 48 years of age (FWS, unpublished data). The length of the gestation period is uncertain but is thought to be between 11 and 14 months (Odell *et al.* 1995; Rathbun *et al.* 1995; Reid *et al.* 1995). The normal litter size is one, with twins reported rarely (Marmontel 1995; Odell *et al.* 1995; O'Shea and Hartley 1995; Rathbun *et al.* 1995).

Calf dependency usually lasts one to two years after birth (Hartman 1979; O'Shea and Hartley 1995; Rathbun *et al.* 1995; Reid *et al.* 1995). Calving intervals vary greatly among individuals. They are probably often less than 2 to 2.5 years, but may be considerably longer depending on age and perhaps other factors (Marmontel 1995; Odell *et al.* 1995; Rathbun *et al.* 1995; Reid *et al.* 1995). Females that abort or lose a calf due to perinatal death may become pregnant again within a few months (Odell *et al.* 1995), or even weeks (Hartman 1979).

H. THREATS TO THE SPECIES

The most significant problem presently faced by manatees in Florida is death or serious injury from boat strikes. 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. Consequences of an increasing human population and intensive coastal development are long-term threats to the Florida manatee. Their survival will depend on maintaining the integrity of ecosystems and habitat sufficient to support a viable manatee population.

CAUSES OF DEATH (A summary of Cause of Death by region can be found in Appendix C). Data on manatee deaths in the southeastern United States have been collected since 1974 (O'Shea *et al.* 1985; Ackerman *et al.* 1995; FWC, unpublished data). Data since 1976 were used in the following summary (Table 3), as carcass collection efforts were more consistent following that year. They indicate a clear increase in manatee deaths over the last 25 years (Fig. 10, 6.0 % per year exponential regression between 1976 and 2000; Ackerman *et al.* 1995; FWC, unpublished data). Most of the increase can be attributed to increases in watercraft-related and perinatal deaths (Marine Mammal Commission 1993). However, it is unclear whether this represents a proportional increase relative to the overall population of manatees.

Natural causes of death include disease, parasitism, reproductive complications, and other non-human-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% of all deaths between 1976 and 2000 (FWC, unpublished data). Perinatal deaths accounted for 21% of all deaths in the same period. Human-related causes of death include watercraft collisions, manatees crushed in water control structures and navigational locks, and a variety of less-common causes. Human-related causes of death accounted for at least 31% of deaths between 1976 and 2000. Cause of death of some carcasses could not be determined, because they were too decomposed, the cause was medically difficult to determine, or the carcass was verified but not recovered. The cause of death for these carcasses was classified as undetermined (30% of deaths between 1976 and 2000).

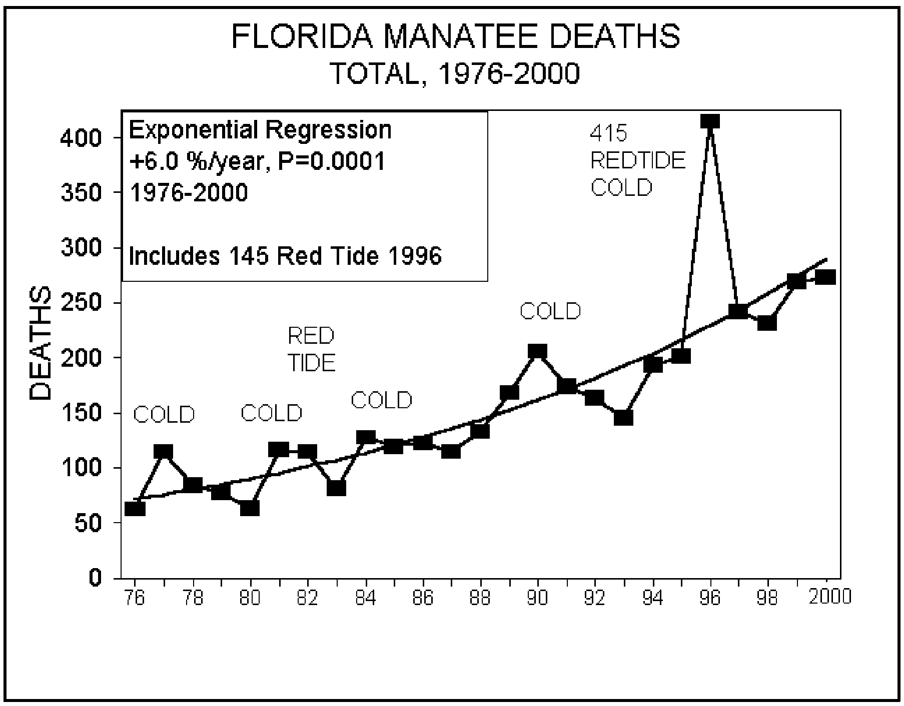

Figure 10. Florida manatee deaths from 1976 to 2000 with an exponential regression of +6.0% per year (FWC, unpublished data).

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, 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 (Fig. 11; 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.

Figure 11. Several of the 145 manatees that died during the red tide mortality event, Southwest Florida, 1996. (*Photographs by T. Pitchford*)

Perinatal deaths are carcasses of very small manatees (≤150 cm in length, O'Shea *et al.* 1995). Some are aborted fetuses; others are stillborn or die of natural causes within a few days of birth. Some may die from disease, reproductive complications, and/or congenital abnormalities. The cause of many perinatal deaths is difficult to determine, because these carcasses are generally in an advanced state of decomposition at the time they are retrieved. Most perinatal deaths appear to be due to natural causes; however, watercraft-related injuries or disturbance, or other human-related factors affecting pregnant and nursing mothers also may be responsible for a significant number of perinatal deaths. It has also been suggested that some may die from harassment by adult males (O'Shea and Hartley 1995). Between 1976 and 1999, perinatal deaths increased at an average of 8.8 % per year, increasing from 14% of all deaths between 1976 and 1980 to 22% between 1992 and 2000 (Ackerman *et al.* 1995; FWC, unpublished data).

The largest known cause of manatee deaths is collisions with the hulls and/or propellers of boats and ships. Between 1976 and 2000, watercraft-related deaths accounted for 24% of the total mortality and increased at an average of 7.2% per year: increasing from 21% of all deaths between 1976 and 1980; to 29% between 1986 and 1991; and 24% between 1992 and 2000 (Ackerman *et al.* 1995; FWC, unpublished data). Watercraft-related deaths were much lower in 1992 and 1993, but increased thereafter. From 1996 to 2000, the watercraft-related deaths have been the highest on record.

The next largest human-related cause of manatee deaths is entrapment or crushing in water control structures and navigational locks and accounts for 4% 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. 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 South Florida Water Management District (WMD), U.S. Army Corps of Engineers (COE), FWS, Miami-Dade Department of Environmental Research Management (DERM), FWC and Florida Department of Environmental Protection (FDEP). 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.

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% 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% between 1976 and 1980, 3% between 1981 and 1985, 2% between 1986 and 1991, and 2% 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 (7 in Florida, 4 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.

These data on causes of manatee deaths, and particularly the increasing number of watercraft-related deaths, should be viewed in the context of Florida's growing human population, which increased by 130% since 1970, 6.8 to 15.7 million (Florida Office of Economic and Demographic Research, 2001). The rise in manatee deaths during this period is attributable, in part, to the increasing number of people and boats sharing the same waterways. It should be noted that the increasing number of deaths could, in part, also be due to increasing numbers of manatees.

Table 3. Known manatee mortality in the southeastern United States reported through the manatee salvage and necropsy program, 1976 to 2000 (FWC, unpublished data).

Age Class	Adult/Subadult					Perinatal (≤150 cm)				Total
Cause / Year	Water-craft	Lock Gate	Other Human	Natural	Undeter-mined	Water-craft	Lock Gate	Other Human	Natural/ Undeter-mined	
1976	10	3	0	1	32	0	1	0	15	62
1977	13	6	5	1	79	0	0	1	10	115
1978	21	9	1	3	40	0	0	0	10	84
1979	22	8	8	4	24	2	0	1	9	78
1980	15	8	2	6	19	1	0	0	14	65
1981	23	2	4	9	65	1	0	0	13	117
1982	19	3	2	40	37	1	0	0	15	117
1983	15	7	5	6	30	0	0	0	18	81
1984	33	3	1	24	41	1	0	0	27	130
1985	35	3	3	20	39	0	0	0	23	123
1986	31	3	1	13	47	2	0	0	28	125
1987	37	5	3	15	23	2	0	1	31	117
1988	43	7	3	22	25	0	0	1	33	134
1989	50	3	4	32	45	1	0	1	40	176
1990	49	3	4	71	41	0	0	0	46	214
1991	52	9	6	15	39	1	0	0	53	175
1992	38	5	6	21	49	0	0	0	48	167
1993	35	5	7	24	36	1	0	0	39	147
1994	50	16	5	37	40	0	0	0	46	194
1995	43	8	5	35	55	0	0	0	57	203
1996	59	10	1	118	164	1	0	0	63	416
1997	52	8	8	46	67	3	0	1	61	246
1998	66	9	6	23	85	1	0	0	53	243
1999	83	15	7	43	69	0	0	1	56	274
2000	79	8	8	51	75	0	0	0	58	279
Total	973	166	105	680	1,266	18	1	7	866	4,082

THREATS TO HABITAT

WARM WATER One of the greatest threats to the continued existence of the Florida manatee is the stability and longevity of warm-water refuges. Historically, the sub-tropical 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. 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. 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).

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. During periods of extreme cold, some plants are unable to provide water warm enough 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 plants are less cost-effective to operate, and market economics will increasingly play a more significant role in the plants' operating schedules (FWS 2000).

In addition, natural wintering sites also have been affected by human activities (FWS 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.

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.

OTHER HABITAT As discussed earlier in this document, Florida manatees are found in fresh, brackish, and marine environments in the southeastern United States. These areas include many habitat types (including vegetated freshwater bottoms, salt marshes, sea grass meadows, and many others) where manatees ably exploit the many resources found in these areas. As herbivores, manatees feed on the wide range of forage that these habitats provide. In addition, manatees utilize many other resources found in these areas, including: (1) springs and deep water areas for warmth; (2) springs and freshwater runoff sites for drinking water; (3) quiet, secluded tributaries and feeder creeks for resting, calving, and nurturing their young, (4) open waterways and channels as travel corridors, etc.

These habitats are affected by human activities. Dredge and fill activities, polluted runoff, propeller scarring, and other actions have resulted in the loss of vegetated areas and springs. 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 areas are now used as wintering sites, stormwater pipes and freshwater discharges in marinas provide manatees with drinking water, and the imported exotic plant, hydrilla (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. The loss of industrial warm-water discharges can result in the deaths of individuals using these sites. Dozens of manatees die each year due to collisions with watercraft. Other activities may also affect manatees, albeit on a much more subtle level. Harassment by boats and swimmers may drive animals away from preferred sites; the loss of vegetation in certain areas (e.g., as seen in winter foraging areas) requires manatees to travel greater distances to feed. Adequate feeding habitat associated with warm-water refuge sites is important to the overall recovery of the Florida manatee, however, it does not appear that warm season foraging habitat is limiting.

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 effect of human activities on manatees and their habitat (e.g., Clean Water Act, Rivers and Harbors Act, ESA, Fish and Wildlife Coordination Act, Coastal Zone Management Act, etc.), and significant efforts are being made to improve this environment and to maintain those resources that are vital to the manatee. Also refer to the discussion in section I, **HABITAT PROTECTION**.

CONTAMINANTS AND POLLUTION EFFECTS The reliance of manatees on inshore habitats and their attraction to industrial and municipal outfalls have the potential to expose them to relatively high levels of contaminants. Despite this relationship, there have been few studies of contaminant levels and their effects on manatees. Available information suggests that direct effects are not significant at a population level. O'Shea *et al.* (1984) investigated levels of pesticides, polychlorinated biphenyls, mercury, lead, cadmium, copper, iron, and selenium in manatee tissues collected in the late 1970s and early 1980s. Of these, only copper levels in the liver were found to be notably high. The highest copper levels (1,200 ppm dry weight) were found in animals from areas of high herbicidal copper usage and exceeded all previously reported concentrations in livers of wild mammals. Despite these findings, there were no field reports of copper poisoning and no evidence of deleterious effects to individual animals. Ames and Van Vleet (1996) analyzed a small number of tissue samples for chlorinated hydrocarbons and petroleum hydrocarbons. None of the latter were found; however, pesticides (o,p-DDT, o,p-DDD, hexachlorobenzene, and lindane) were found in some of the liver, kidney, and blubber samples, but at very low concentrations and at a lower frequency of occurrence than in earlier studies. Contaminants, siltation and modified deliveries of fresh water to the estuary can indirectly impact manatees by causing a decline in submerged aquatic vegetation on which manatees depend.

Manatees ingest various debris incidental to feeding. Beck and Barros (1991) found monofilament fishing line, plastic bags, string, rope, fish hooks, wire, rubber bands, and other debris in the stomachs of 14.4% of 439 manatees recovered between 1978 and 1986. Monofilament line was the most common item found. In most cases, ingested items do not appear to affect animals. However, ingested monofilament line has resulted in death due to blockage of the digestive system (Forrester *et al.* 1975; Buergelt *et al.* 1984). A few deaths were caused by ingesting wire, which perforated the stomach lining, and plastic sheeting, which blocked the digestive tract (Laist 1987). Discarded monofilament line and rope were found wrapped around flippers, sometimes leading to serious injury or death (Beck and Barros 1991). Records of scarred or mutilated flippers on free-ranging manatees known from the photo-ID catalog and rescue events suggest that female manatees are more vulnerable than males to entanglement in fishing gear (Beck and Lefebvre 1995).

I. PAST AND ONGOING CONSERVATION EFFORTS

Under the guidance of previous manatee recovery plans, federal agencies, state agencies, local agencies and private organizations have initiated cooperative actions to address the important conservation needs, which this plan builds upon. Some of the major initiatives are reviewed below.

EFFORTS TO REDUCE WATERCRAFT-RELATED INJURIES AND DEATHS The largest identified cause of manatee death is collisions with watercraft. Many living manatees also bear scars or wounds from vessel strikes. An analysis of injuries to 406 manatees killed by watercraft and recovered between 1979 and 1991 found that 55% were killed by impact, 39% were killed by propeller cuts, 4% had both types of injuries, either of which could have been fatal, and 2% with unidentified specifics (Wright *et al.* 1995). Between 1976 and 2000, the total number of carcasses (i.e., deaths due to all causes) collected has increased at a rate of 6.0 percent per year, while deaths caused by watercraft strikes increased by 7.2 percent per year (Fig. 12). Because watercraft operators cannot reliably detect and avoid hitting manatees, federal and state managers have sought to limit watercraft speed in areas where manatees are most likely to occur to afford both manatees and boaters time to avoid collisions.

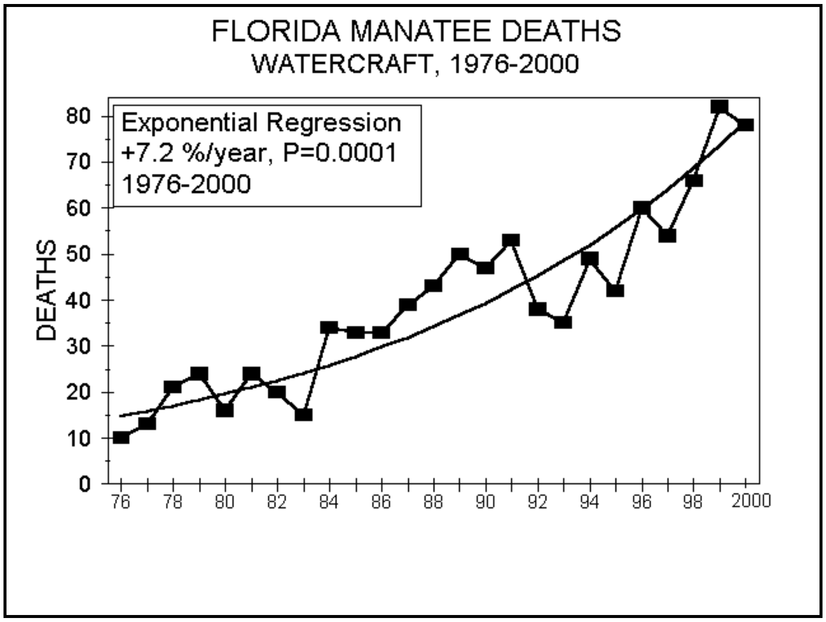

Figure 12. Florida manatee watercraft deaths from 1976 to 2000 with an exponential regression increase of 7.2% per year (FWC, unpublished data).

In 1989, the Florida Governor and Cabinet approved a series of recommendations by the former FDNR to improve protection of manatees in 13 key counties. For the next ten years, state and local governments cooperated in the creation and implementation of four county Manatee Protection Plans and 12 county-wide manatee protection speed zone rules. In 1999, Florida's manatee research and management programs were transferred to the newly created FWC. FWC approved comprehensive manatee protection rules in Lee County, completing the speed zone component of the initiative started in 1989. As the State of Florida's initiative to establish manatee protection zones in the 13 key counties is completed, attention is now focused on the development and approval of key county manatee protection plans.

Two types of manatee protection areas also have been developed by FWS: (1) manatee sanctuaries; and (2) manatee refuges. Manatee sanctuaries are areas in which all waterborne activities are prohibited, and manatee refuges are areas where certain waterborne activities are restricted or prohibited (designation of refuges or sanctuaries, however, will not eliminate waterway property owner access rights). To date, FWS has established seven winter sanctuaries to protect manatees in association with the Crystal River National Wildlife Refuge (NWR). The most recent was a one-quarter-acre sanctuary established in 1997 at Three Sisters Spring run (Fig. 13).

Figure 13. Three Sisters Spring Manatee Sanctuary, Crystal River, Florida. Manatees within the sanctuary and tour boats (left) and snorklers (right) along the outer sanctuary boundary edge. (*Photographs by J. Kleen and C. Shaw*)

FWS and FWC continue to evaluate needs for additional protection areas that may be necessary to achieve recovery. The goal is to consider the needs of the manatee at an ecosystem level and to establish regulations to ensure that adequate protected areas are available throughout Florida to satisfy habitat requirements of the Florida manatee population with a view toward recovery. In addition, through the NWR System Administration Act, access rules for boats have been established by FWS to protect manatees within Merritt Island NWR.

In recent years, both the FWS and FWC have been using targeted enforcement strategies in an attempt to increase boater compliance with speed zones and ultimately reduce manatee injuries and death. FWS strategy has been to allocate significant enforcement manpower to specific areas on designated weekends. These enforcement teams travel to various locations around the state, with particular emphasis given to those zones within counties where there is a history of high watercraft-caused manatee deaths. FWC has increased its emphasis on enforcement and compliance with manatee speed zones by adding new officers, conducting law enforcement task force initiatives, increasing overtime, and increasing the proportion of law enforcement time devoted to manatee conservation.

In addition to manatee protection plans, manatee protection areas, and other efforts, managers, researchers, and the boating industry have investigated the use of various devices to aid in the reduction of watercraft-related manatee deaths. For example, the State of Florida funded an evaluation of propeller guards (Milligan and Tennant 1998). The state's evaluation concluded that these devices would reduce cutting damage associated with propellers when boats were operating at low speeds. However, when boats (including boats equipped with propeller guards) operate at high speeds, guards would be of little benefit because animals would continue to be killed by blunt trauma associated with impacts from boat hulls, lower units, and other gear. The U.S. Coast Guard (USCG) identified additional concerns, stating that propeller guards on small recreational vessels "may create more problems than they solve" and does not support their use on recreational vessels at this time (Carmichael 2001). There are propeller guard applications, however, that appear to work for certain large, commercial vessels; for example, the use of guards on C-tractor tugs has eliminated this specific source of manatee mortality at the Kings Bay Naval Submarine Base in St. Marys, Georgia. To prevent injuries to manatees, propeller guards are used on some rental and sight-seeing boats at Blue Spring and Crystal River.

Researchers have also begun to investigate the manatees' acoustic environment to better evaluate the animal's response to vessel traffic. This line of research needs to be thoroughly assessed for its potential as another management tool to minimize collisions between manatees and boats. Results from Gerstein (1999) indicate that manatees hear in the range from 500 Hz to 38 kHz and that inadequate hearing sensitivity at low frequencies may be a contributing factor to the manatees' ability to effectively detect boat noise to avoid collisions. One technology often discussed is an acoustic deterrence device mounted on a boat. Conceptually, this technological approach may sound like an answer to the manatee/watercraft issue. A number of problems have been defined with the use of acoustic deterrents. No alarm/warning device has yet been demonstrated to adequately protect wildlife or marine mammals. Additionally, concern has also been stated regarding the increase in background noise that these deterrents would add to an already noisy marine environment. It has not been determined what negative impacts this device would have on marine life and what effects it would have on animals that use acoustic cues for a variety of purposes. For these reasons, this technology needs to be thoroughly researched and assessed and managers need to evaluate the MMPA and ESA "take" issues related to implementing such technology.

Current research into the sensory capabilities of manatees is being supported at both the state and federal levels. The FWC contracted Mote Marine Laboratory to further test manatee sensory capabilities. One contract assessed the effects of boat noise in a more controlled environment. This study recorded the physical and acoustic reaction of a manatee to a pre-determined acoustical level. This study design will allow the development of a relationship between acoustic dosage and behavioral responses (vocal and visual displays; movements). Another contract study looked at acoustical propagation over various types of marine topography. In cooperation with Mote Marine Laboratory and the Woods Hole Oceanographic Institution, the FWC is also examining manatee behavioral response to watercraft using new technology, the DTAG, a digital acoustic tag which records acoustic attributes of the environment and detailed manatee movement simultaneously. A FWS contracted study to assess manatee behaviors in the presence of fishing gear and their response to novelty and the potential for reducing gear interactions has an acoustic component. The FWC also received funding to support the development and implementation of technological solutions for reducing the risks that watercraft pose to manatees. They recently issued a Request for Proposals (RFP) to specifically address manatee avoidance technology.

Currently, priority actions in manatee conservation and protection include boater education, enforcement, maintenance of signs and buoys, compliance assessment, and periodic re-evaluation of the effectiveness of the rules. Such work requires close cooperation between FWC Bureau of Protected Species Management (BPSM), FWC's Division of Law Enforcement (DLE), county officials, the Inland Navigation Districts, FWS, USCG, and, of course, boaters.

Efforts to Reduce Flood Gate and Navigation Lock Deaths Entrapment in water-control structures and navigational locks is the second largest cause of human-related manatee deaths. In some cases, manatees appear to have been crushed in closing gates; in others, they may have been drowned after being pinned against narrow gate openings by water currents rushing through openings. Water-control structures implicated in manatee deaths in Dade and Broward counties are operated by the South Florida WMD. From 1976 through 2000, 166 manatees have been killed in water control structures in Dade County alone, accounting for 33% of all manatee deaths in this county.

The COE operates five water-control structures in conjunction with navigational locks along the Okeechobee Waterway and also operates the Port Canaveral Lock, located in Brevard County. FDEP operates locks and water-control structures associated with the Cross Florida Greenway.

In the early 1980s, steps were taken to modify gate-opening procedures to ensure openings were wide enough to allow a manatee to pass through unharmed. Steps were also initiated to fence off openings and cavities in gate structures where manatees might become trapped. Manatee deaths subsequently declined and remained low for much of the 1980s (Table 2). Since the 1996 Recovery Plan, much progress has been made toward identifying, testing, and installing manatee protection devices at water control structures. The COE Section 1135 Study, "Project Modification on Manatee Protection at Select Navigation and Water Control Structures, Part I," has been completed and the technology developed and successfully tested. Consequently, since 1996, pressure sensor devices have been installed at the five water control structures. Three recent deaths at two of the modified South Florida Water Management District water control structures suggests that these type of protective measures will continue to need on-going maintenance, review and refinement. The COE has also installed removable barriers on the upstream side of the Ortona and St. Lucie Lock spillway structures. The large difference in the up and downstream water levels at these structures compromises the effectiveness and use of pressure sensor devices. Such barriers will be considered for other structures where appropriate. A task force, established in 1991, comprised of representatives from the South Florida WMD, COE, FWC, FDEP, DERM, and FWS, continues to monitor, examine and make recommendations to protect manatees at water control structures and navigational locks.

The COE completed the "Section 1135 Project Modification Report on Manatee Protection at Select Navigation and Water Control Structures, Part II," which investigated several alternatives to protect manatees at locks. The COE contracted with the Harbor Branch Oceanographic Institute (HBOI) to develop and install a prototype acoustic array for manatee protection at lock gates. HBOI completed system design, and during 1999 the St. Lucie Lock was equipped with this manatee protection system (Fig. 14). This system consists of a device that is installed on the lock gates and detects the presence of manatees through acoustic signals. When a manatee is detected near the gate during the last 52 inches of closure, an alarm sounds; the gate stops closing and is then re-opened back to 52 inches. An upgraded version of this same type of system also has been installed at Port Canaveral Lock. Future plans are to install protective systems at the following locks: Moore Haven, Ortona, and Port Mayaca.

Figure 14. Water control structure retrofitted with pressure sensitive technology (left). Retrofitting of St. Lucie Lock with acoustic sensors (right) to protect manatees from being crushed as the gates close. (*Photographs by FWS and B. Brooks*)

FDEP currently is designing and preparing to install barriers at the Kirkpatrick Dam (Putnam County), and on the tainter valve culvert pipes at Buckman Lock (Putnam County) and downstream side of Inglis Lock (Levy County); work is anticipated to be completed during 2001. FDEP also has contracted with HBOI to install an acoustic array system at Buckman Lock, similar to arrays installed at the COE's Port Canaveral and St. Lucie Locks. Upon completion of the manatee protection systems at the Rodman Reservoir (Putnam County), FDEP plans to reopen Buckman Lock for operation. Currently the FDEP's Inglis Lock at Lake Rouseau/Withlacoochee River is not operating; long-term plans are to replace Inglis Lock with a smaller one with a manatee protection system installed.

HABITAT PROTECTION Intensive coastal development throughout Florida poses a long-term threat to the Florida manatee. There are three major approaches to address this problem. First, FWS, FWC, Georgia Department of Natural Resources (GDNR), and other recovery partners review and comment on applications for federal and state permits for construction projects in manatee habitat areas and to minimize their impacts. Under section 7 of the ESA, FWS annually reviews hundreds of permit applications to the COE for construction projects in waters and wetlands that include or are adjacent to important manatee habitat. FWC and GDNR provide similar reviews to their respective state's environmental permitting programs.

A second approach is the development of county manatee protection plans. The provisions of these plans are anticipated to be implemented through amendments to local growth management plans under the Florida's Local Government Comprehensive Planning and Land Development Regulation Act of 1985. In addition to boat speed rules, manatee protection plans are to include boat facility siting policies and other measures to protect manatees and their habitat. To date, five counties (Citrus, Collier, Dade, Duval, and Indian River counties) have completed manatee protection plans, which the State of Florida has approved, and other counties' plans are in varying stages of development. Of the five completed plans, FWS has approved only two, those of Citrus and Dade.

A third approach to habitat protection is land acquisition. Both FWS and the State of Florida have taken steps to acquire and add new areas containing important manatee habitat to federal and state protected area systems. The State of Florida has acquired important areas through several programs, most notably the Florida Forever Program (formerly the Conservation and Recreational Lands Program). In Florida, the Governor and Cabinet have included special consideration for purchase of lands that can be of benefit to manatees and their habitat. Over $500 million has been spent to acquire 250,000 acres, whose importance included, but was by no means limited to, protection of manatee habitat. Particularly important purchases have been made along and near the Crystal River, at Rookery Bay, the Sebastian River, and near Blue Spring. FWS has also acquired and now manages thousands of acres of land important to manatees and many other species in the NWR System. In addition to these efforts, FWS's initiative to propose new manatee refuges and sanctuaries factors into habitat protection. Both the State of Florida and FWS are continuing cooperative efforts with a view towards establishing a network of important manatee habitats throughout Florida.

MANATEE RESCUE, REHABILITATION AND RELEASE Thousands of reports of distressed manatees purportedly in need of assistance have been made to the state wildlife enforcement offices and other resource protection agencies by a concerned public. While most of the manatees do not require assistance, dozens of manatees are rescued and treated each year. A network of state and local agencies and private organizations (Fig. 15), coordinated by FWS, has been rescuing and treating these animals for well over twenty years.

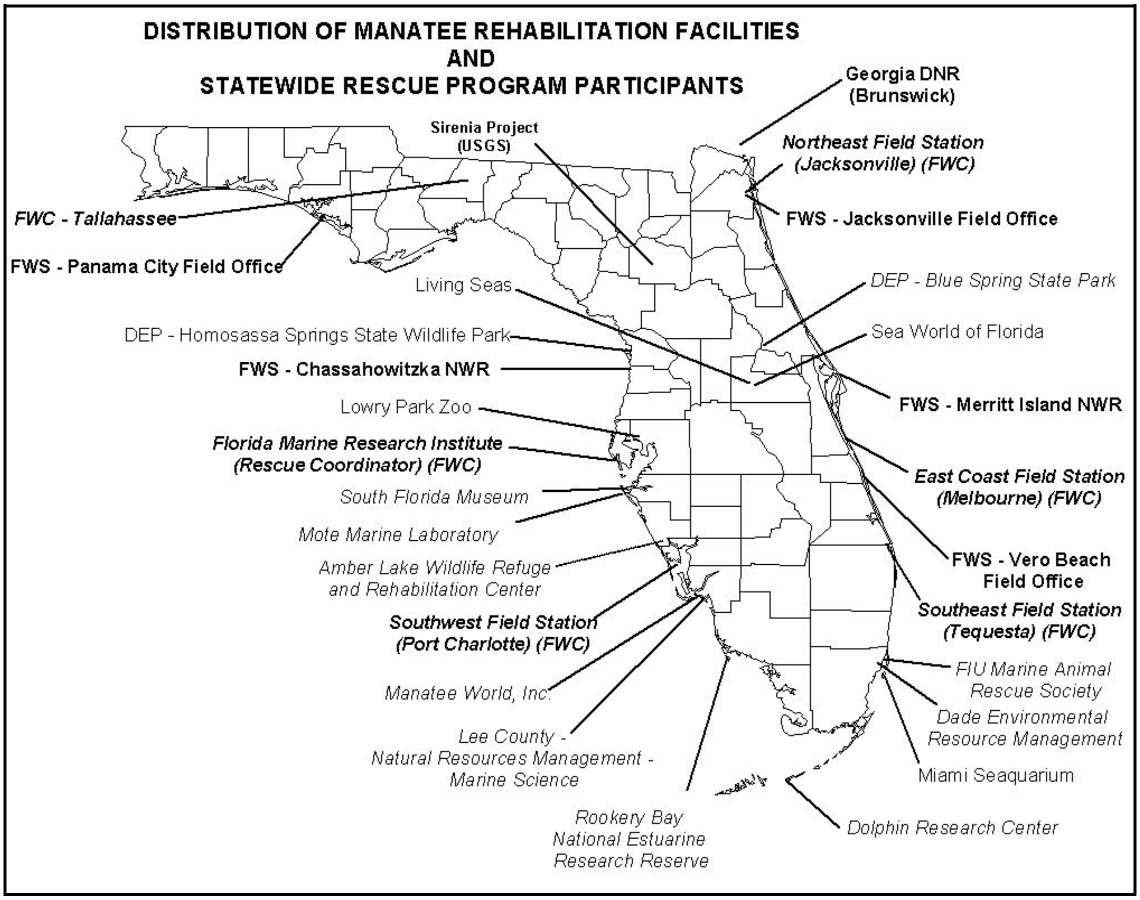

Figure 15. Locations of participants in the manatee rescue, rehabilitation, and release program.

Manatees are brought into captivity when stressed by cold weather, when struck and injured by watercraft, when injured because of entanglements in crab traps and monofilament fishing line, when orphaned, and when compromised by other natural and man-made factors. Program veterinarians and staff have developed treatments and protocols for these animals and have been remarkably successful in their efforts to rehabilitate compromised individuals (Fig. 16). Since 1973, over 180 manatees have been treated and returned to the wild (FWS unpublished data).

Treatments and protocols developed for these distressed animals have provided notable insights into the physiology and behavior of manatees. In certain settings, captive manatees are used in research; captive studies have provided a wealth of information on sensory capacities, digestion, reproduction, etc. Information obtained through treatments and research, in addition to the number of animals released back into the wild each year, contributes significantly to efforts to reduce mortality and further the recovery of the species.

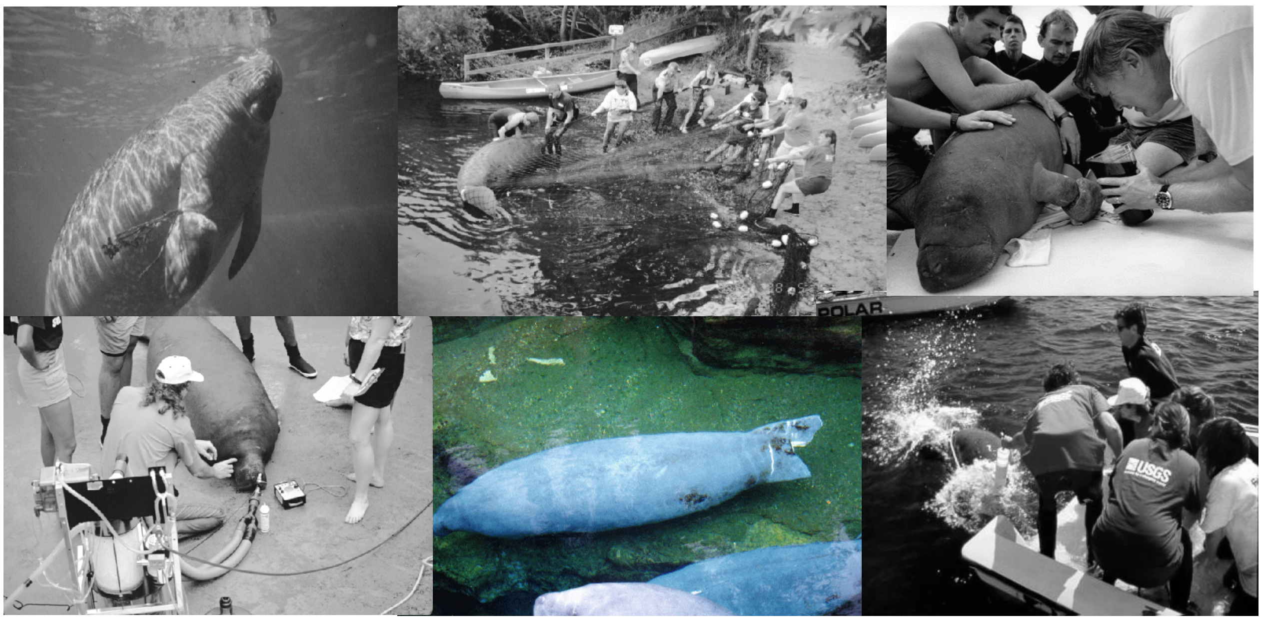

Figure 16. Manatee rescue, rehabilitation, and release program. (*Photographs by G. Rathbun, C. Shaw, J. Reid, Miami Seaquarium, J. Pennington, and J. Reid*)

Media coverage of manatee rescues, treatments, and releases helps to educate millions of people about manatees, the life-threatening problems that they face, and actions that can be taken to minimize the effect of anthropogenic activities on this species. In addition, more than eighteen million visitors a year see manatees at rehabilitation facilities and participate in manatee education programs sponsored by several parks. The publicity and outreach inherent in this program provide significant support to efforts to recover the manatee.

PUBLIC EDUCATION, AWARENESS, AND SUPPORT Government agencies, industries, oceanaria and environmental groups have all contributed to manatee public awareness and education efforts that were initiated in the 1970s. These efforts have expanded in scope and increased in quantity since that time. Some key counties in Florida also have started the education component of their manatee protection plans.

These public awareness and education efforts encourage informed public participation in regulatory and other management decision-making processes and provide constructive avenues for private funding of state manatee recovery programs, research, and land acquisition efforts through programs such as the specialty automobile license tag for manatees. This particular funding source has resulted in substantial savings in federal and state tax revenues and has permitted important work to proceed which likely would not have been possible in their absence.

The public has been made aware of new information on the biology and status of manatees, urgent conservation issues, and the regulations and measures required to assure their protection through the production of brochures, posters, films and videos, press releases, public service announcements and advertisements, and other media-oriented materials. Outdoor signs have been produced that provide general manatee information and highlight the problems associated with feeding manatees.

Manatee viewing opportunities have also been made available to the public. In addition, volunteers from several organizations annually give presentations to schools and other groups and distribute educational materials at festivals and events. Such efforts are essential for obtaining public compliance with conservation measures to protect manatees and their habitats.

Many public awareness materials have been developed specifically focusing on boater education. Public awareness waterway signs are produced and distributed alerting boaters to the presence of manatees. Brochures, boat decals, boater's guides, and other materials with manatee protection tips and boating safety information have been produced and are distributed by law enforcement groups, through marinas, and boating safety classes. Educational kiosks have been designed and installed at marinas, boat ramps, and other waterfront locations. Fishing line collection sites and cleanup efforts are being established. In addition, the Manatee Awareness Coalition of Tampa Bay and Crystal River NWR have initiated programs for on-water manatee public awareness.

Several agencies and organizations provide educator's guides, posters, and coloring and activity books to teachers in Florida and across the United States. In addition, Save The Manatee Club (SMC) and FWC Advisory Council on Environmental Education have produced a video for distribution to schools throughout Florida and the United States. SMC and FWC also provide free manatee education packets to students and staff interviews for students. Agencies and organizations help to educate law enforcement personnel about manatees and inform them about available outreach materials that can be distributed to user groups.

Public interest in manatee conservation also has grown internationally. Manatee education and public awareness materials are distributed in Central and South America and the wider Caribbean, as well as to numerous other countries around the world.