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http://www.fws.gov/r9endspp/i/a/saa0c.html

U.S. FISH AND WILDLIFE SERVICE
DIVISION OF ENDANGERED SPECIES

SPECIES ACCOUNTS

Source: Endangered and Threatened Species of the Southeastern United States (The Red Book) FWS Region 4 -- As of 8/93

WEST INDIAN MANATEE
Trichechus manatus
FAMILY: Trichechidae
STATUS: Endangered, Federal Register, March 11, 1967, June 2, 1970

DESCRIPTION: The West Indian Manatee is a large gray or brown aquatic mammal. Adults average about 10 feet long and weigh 1,000 pounds. They have no hindlimbs, and their forelimbs are modified as flippers. Manatee tails are flattened horizontally and rounded. Their body is covered with sparse hairs and their muzzles with stiff whiskers. Sexes are distinguished by the position of the genital openings and presence or absence of mammary glands. Manatees will consume any aquatic vegetation available to them and sometimes even shoreline vegetation. Although primarily herbivorous, they will occasionally feed on fish. Manatees may spend about 5 hours a day feeding, and may consume 4 to 9 percent of their body weight a day.

REPRODUCTION AND DEVELOPMENT: Observations of mating herds indicate that females mate with a number of males during their 2- to 4-week estrus period, and then they go through a pregnancy estimated to last 12 to 14 months (O'Shea 1992). Births occur during all months of the year with a slight drop during winter months. Manatee cows usually bear a single calf, but 1.5 percent of births are twins. Calves reach sexual maturity at 3 to 6 years of age. Mature females may give birth every 2 to 5 years. The only long-term, stable bond between manatees is that between a cow and her calf. Weaning generally occurs between 9 and 24 months of age, although a cow and calf may continue to associate with each other for several more years. There is little information on the life-time reproductive output of females, although they may live over 50 years.

RANGE AND POPULATION LEVEL: During the winter months, the United States' manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia. Manatees also winter in the St. Johns River near Blue Spring State Park. During summer months, they may migrate as far north as coastal Virginia on the east coast and the Louisiana coast on the Gulf of Mexico.

Manatee populations also exist outside the continental United States in coastal areas of the Caribbean and Central and South America. In Puerto Rico, manatees apparently occur around the southern and eastern end of the island and around nearby Vieques Island. Except for rare sightings, manatees seem to be absent from the Virgin Islands at present, but fossils have been found in middens on St. Croix. The population of manatees in Florida has been estimated to be at least 1,865 individuals. There are an estimated 60 to 100 manatees in Puerto Rico. In the last decade, yearly mortality in Florida has averaged nearly 150 animals a year, double that of the preceding decade. The average proportion of first-year calves in the population is 10 percent with a range of 5 to 15 percent.

HABITAT: Manatees inhabit both salt and fresh water of sufficient depth (1.5 meters to usually less than 6 meters) throughout their range. They may be encountered in canals, rivers, estuarine habitats, saltwater bays, and on occasion have been observed as much as 3.7 miles off the Florida Gulf coast. Between October and April, Florida manatees concentrate in areas of warmer water. When water temperatures drop below about 21 to 22 degrees Centigrade, they migrate to south Florida or form large aggregations in natural springs and industrial outfalls. Severe cold fronts have been known to kill manatees when the animals did not have access to warmwater refuges. During warmer months they appear to choose areas based on an adequate food supply, water depth, and proximity to fresh water. Manatees may not need fresh water but they are frequently observed drinking fresh water from hoses, sewage outfalls, and culverts. There is no evidence of any periodicity in manatee habitat use in Puerto Rico.

CRITICAL HABITAT: The following areas in Florida (exclusive of those existing manmade structures or settlements which are not necessary to the normal needs or survival of the species) are critical habitat for the manatee: Crystal River and its headwaters known as King's Bay, Citrus County; the Little Manatee River downstream from the U.S. Highway 301 bridge, Hillsborough County, the Little Manatee River downstream from the Lake Manatee Dam, Manatee County; the Myakka River downstream from Myakka River State Park, Sarasota and Charlotte Counties; the Peace River downstream from the Florida State Highway 760 bridge, DeSoto and Charlotte Counties; and Charlotte Harbor north of the Charlotte-Lee County line, Charlotte County; Caloosahatchee River downstream from the Florida State Highway 31 bridge, Lee County; all United States territorial waters adjoining the coast and islands of Lee County; all United States territorial waters adjoining the coast and islands and all connected bays, estuaries, and rivers from Gordon's Pass near Naples, Collier County, southward to and including Whitewater Bay, Monroe County; all waters of Card, Barnes, Blackwater, Little Blackwater, Manatee, and Buttonwood Sounds between Key Largo, Monroe County; and the mainland of Dade County; Biscayne Bay, and all adjoining and connected lakes, rivers, canals, waterways from the southern tip of Key Biscayne northward to and including Maule Lake, Dade County; all of Lake Worth, from its northernmost point immediately south of the intersection of U.S. Highway 1 and Florida State Highway A1A southward to its southernmost point immediately north of the town of Boynton Beach, Palm Beach County; the Loxahatchee River and its headwaters, Martin and West Palm Beach Counties; that section of the intracoastal waterway from the town of Sewalls Point, Martin County, to Jupiter Inlet, Palm Beach County; the entire section of water known as the Indian River, from its northernmost point immediately south of the intersection of U.S. Highway 1, and Florida State Highway 3, Volusia County,

southward to its southernmost point near the town of Sewalls Point, Martin County; the entire inland section of water known as the Banana river and all waterways between the Indian and Banana rivers, Brevard County; the St. Johns River including Lake George, and including Blue Springs and Silver Glen Springs from their points of origin to their confluences with the St. Johns River; that section of the Intracoastal Waterway from its confluence with the St. Marys River on the Georgia-Florida border to the florida State Highway A1A bridge south of Coastal City, Nassau and Duval Counties.

REASONS FOR CURRENT STATUS: The manatee population was probably more abundant in the 18th or 19th century than today. Initial population decreases probably resulted from overharvesting for meat, oil, and leather. Today, hunting is prohibited and is not considered a problem, although there is an occasional incidence of poaching. Heavy mortality does occur, however, from accidental collisions with boats and barges, and from canal lock operations.

Manatee population trends are poorly known, but deaths have increased steadily (6.1 percent a year, exponential regression, 1976 to 1991). Mortalities from collisions with watercraft are up 10.3 percent a year from 21 percent of all deaths in 1976 to 1980 to 29 percent in 1986 to 1991. Deaths of dependent calves are up 12 percent a year from 14 to 24 percent of all deaths. The combination of high mortality rates and low reproductive rates have led to serious doubts about the species' ability to survive in the United States.

Another closely related factor in the decline has been the loss of suitable habitat through incompatible coastal development, particularly destruction of seagrass beds by boating facilities. In Puerto Rico, the primary cause of manatee mortality seems to be from entanglement in gill nets. Collisions with boats and illegal killing of manatees for food may also be affecting the Puerto Rican population to some extent, but supporting data are limited.

MANAGEMENT AND PROTECTION: Based on revised recovery plan (1989) recommendations, the primary objective in the recovery of the Florida population of the West Indian manatee is to reestablish and maintain optimum sustainable populations in natural habitats throughout the manatee's historic range. To accomplish this primary objective there are several sub-objectives. They are:

1. Minimize human-caused injuries and mortalities to manatees. Rescue and rehabilitate sick, injured, or orphaned manatees. Minimize mortality from boat and barge collisions, water control structures, and poaching. Evaluate effectiveness of current and future regulations and enforcement efforts. Conduct programs to inform and educate the public and develop bilateral and multilateral agreements with other countries for manatee conservation and research.

2. Minimize alteration, degradation, and destruction of habitat used by manatees and monitor its status. (Adverse habitat alteration may result from human use of water resources and industrial and residential .development.) Evaluate potential hazards such as coastal zone development, outer continental shelf oil and gas development, toxicants, dredging, siltation, and power plant failures. Identify, protect, and monitor areas of special significance to manatees and enhance habitats used by manatees.

3. Minimize harassment of manatees from boat and barge traffic, fishing, diving, and swimming.

4. Determine and monitor status of manatee population and determine aspects of life history and ecology.

5. Coordinate implementation of recovery activities, monitor and evaluate progress, and periodically update and revise recovery plan.

A recovery plan developed specifically for the manatee population in Puerto Rico indicates three primary objectives for recovery. The first objective is to identify, assess, and reduce human-related mortality, especially that related to gill net entanglement. The second objective is to identify and minimize alteration, degradation, and destruction of habitats important to the survival and recovery of the Puerto Rico manatee population. The third objective is to develop the criteria and biological information necessary to determine whether and/or when to delist or downlist (reclassify to threatened) the Puerto Rican population of manatees.

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http://bluegoose.arw.r9.fws.gov/NWRSFiles/WildlifeMgmt/SpeciesAccounts/Mammals/FLManatee/FLManateeTableOfContents.html

West Indian Manatee, Florida Population

The information provided in this document is from the Draft Florida Manatee Recovery Plan, second revision, prepared by the Florida Manatee Recovery Team. U.S. Fish and Wildlife Service, Atlanta, GA. 1993. 176 pp. Copies of the complete recovery plan may be purchased from:
U.S. Fish and Wildlife
Reference Service,
5430 Grosvenor Lane, Suite 110,
Bethesda, Maryland 20814,
(301) 492-6403
or 1-800-582-3421.

Table of Contents

Additional Information

Brochure of Manatee Questions and Answers.

http://refuges.fws.gov/NWRSFiles/WildlifeMgmt/SpeciesAccounts/Mammals/FLManatee/FLManateeTableOfContents.html -- Revised: 18 December 1996

http://bluegoose.arw.r9.fws.gov/NWRSFiles/WildlifeMgmt/SpeciesAccounts/Mammals/FLManatee/FLManateeIntroduction.html

Manatee Recovery Plan Introduction, Taxonomy and Description

Introduction

The West Indian manatee (*Trichechus manatus*) is one of the most endangered marine mammals in coastal waters of the United States. In the southeastern U.S., manatees are limited primarily to Florida and Georgia. This group constitutes a separate subspecies called the Florida manatee that appear to be divided into at least two virtually separate populations -- one centered along the Atlantic Coast and the other on the Gulf of Mexico coast of Florida. Despite concerted research, it has not been possible to develop a reliable estimate of manatee abundance in Florida. The highest single-day count of manatees from an aerial survey is 1,856 animals in January 1992 (Ackerman et al. 1992).

Historical accounts and archeological evidence of manatees prior to the first half of the 20th century are poor and often contradictory (O'Shea 1988). It does indicate that manatees probably are as geographically widespread today as they were historically. They were hunted by pre-Columbian indians, 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. Genetic studies, however, indicate that the reduction did not cause a "genetic bottleneck" (McClenaghan and O'Shea 1988).

The long-term survival of manatees in Florida, however, is uncertain. Known mortality, which averaged over 170 animals per year between 1988 and 1992, is more than twice what it was in the late 1970s.

Given what is known about the present population size and the species' ability to produce only a single calf every 2.5-5 years per mature female, mortality may be exceeding the populations' ability to produce new animals. The major threats to Florida manatees are collisions with watercraft, which account for about 25 percent of known manatee deaths in Florida annually, and destruction and degradation of habitat caused by widespread development throughout much of the species' Florida range.

Based on the known minimum size of the southeastern U.S. manatee populations, 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 and Tobago. In these areas, remaining populations are believed to be much smaller than the U.S. population and are subject to poaching for food, incidental take in gillnets, and habitat loss. Manatee protection programs in other countries are not well organized or supported and, in this context, protection of the Florida population takes on international significance.

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 under the U.S. Endangered Species Act. 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 an 8 m (26 ft) long toothless sirenian that fed on kelp (Reynolds and Odell 1991).

Two subspecies of West Indian manatee are now recognized: the Florida manatee, *T. manatus latirostris*, which occurs in the southeastern U.S., 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 later researchers (Moore 1951 and 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 ranges of the two subspecies may overlap on the coast of Texas; however, there is no confirming evidence. Swift currents and open water in the Florida

Strait appear to be effective barriers preventing the movement of manatees between the Greater Antilles and Florida (Domning and Hayek 1986).

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. Their bones are massive and heavy with no marrow cavities in the ribs or long bones of the forearms (Odell 1982). Adults average about 3.5 m (11.5 ft) in length and 1000 kg (2,200 lbs) in weight, but may reach lengths of up to 4.6 m (15 ft.) (Gunter 1941) and 1,650 kg (3,630 lbs) (Rathbun et al. 1990). Newborns average 1.2 to 1.4 m (4-4.5 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 (Hartman 1969 and Husar 1977). 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. 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 low frequency 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). Manatees have two axillary mammae, one at the base of each forelimb.

http://bluegoose.arw.r9.fws.gov/NWRSFiles/WildlifeMgmt/SpeciesAccounts/Mammals/FLManatee/FLManateePopBiology.html

Manatee Recovery Plan Population Biology, Structure and Size

Population Biology

Recent information on manatee[1] population biology was reviewed during a technical workshop sponsored by the Fish and Wildlife Service and the former Florida Department of Natural Resources[2] and held on 4-6 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 constructing new population models.

There has been a tremendous increase in reproductive and mortality data since the last such workshop in 1978. There have been recent breakthroughs in age determination and survival rate estimation, which were reported at the workshop. The value of maintaining a long-term individual animal photoidentification database was emphasized. This database not only provides information on manatee reproductive traits and movements, it provides capture-recapture histories that can be used in a variety of statistical models to determine aspects of manatee population dynamics. It was concluded that sufficient data now exist to allow development of new population models. The Population Model Working Group emphasized that there will not be one final and conclusive model; rather modelling will be an ongoing process that evolves as databases and modelling tools are improved.

Population Structure

Three principal lines of research have been particularly helpful in identifying population structure of manatees in Florida. These are analyses of the manatee photoidentification scar catalogue, telemetry, and genetic studies. Information from these sources suggests that there is little routine intermixing of individual manatees living on the east and west coasts of Florida, but that, genetically, they constitute a single population.

As of the end of 1991, the manatee scar catalogue maintained by the Fish and Wildlife Service since 1981 included over 913 distinctively scarred manatees represented by 9,796 sightings or resightings from throughout the Southeastern U.S. (Beck and Reid 1992). Within this extensive data set, no individuals have been documented from both the Atlantic and Gulf of Mexico coasts. (One animal has been documented occurring on the Atlantic coast and on the west side of Lake Okeechobee.) In addition, radio-tracking studies of over 100 manatees by the Service and the former Florida Department of Natural Resources have found no movement of animals between Florida's east and west coasts. Notwithstanding these findings, there appears to be at least some genetic exchange around or across the peninsula based on genetic research. A study of tissues from 59 manatees collected from throughout Florida found little genic variability among geographic regions (McClenaghan and O'Shea 1988). It seems likely, therefore, that there is occasional movement of some animals between the two coasts that has yet to be documented, that some interbreeding occurs at the southern tip of Florida or in Lake Okeechobee, or that these events occurred very recently.

Within both the east and west coast manatee populations, documented movements suggest that at least some loosely formed subpopulations or groups exist which may constitute useful management units. These groups tend to return to the same warm-water refuge(s) each winter and have similar non-winter distribution patterns. For example, on the east coast, a core group of more than 70 manatees use the Blue Spring warm water refuge on the upper St. Johns River. Radio-tracking studies (Bengtson 1981) and other information (Beeler and O'Shea 1988 and Marine Mammal Commission 1988) suggest that most "Blue Spring manatees" tend to remain in the upper St. Johns River. On the west coast, Rathbun et al. (1990) report that of 100 recognizable manatees identified at the Kings Bay and Homosassa River warm water refuges in northwest Florida in the early 1980s, 92 % of the females and 84 % of the males returned to the same refuge each year. Radio-tracking work suggests that many animals wintering at Crystal River dispersed north in warm seasons to rivers along the Big Bend Coast, particularly the Suwannee River, and some move south to Tampa Bay and beyond.

The existence of more or less distinct subgroups in the southern half of Florida (i.e., south of Cape Canaveral on the east

coast and Tampa Bay on the west coast) 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, possible sampling biases in studies to date, the proximity of these areas to one another, and the distribution of manatees throughout this stretch of coast, such distinctions are highly speculative at this time.

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 populations in the southeast United States (O'Shea 1988 and O'Shea et al. 1992). Even though many manatees aggregate at warm water refuges in winter and most if not all such refuges are known, direct counting methods (i.e., by aerial and ground surveys) have been unable to account for uncertainty in the number of animals that may be away from these refuges at any given time, the number of animals which are not seen because of turbid water, and other factors. The use of mark-resighting techniques to estimate manatee population size based on known animals in the manatee photoidentification database also has been impractical because of the difficulty in estimating the proportion of known animals in the population. Sampling protocols to estimate population size using these techniques would require major changes in the data collection methods and survey effort far beyond those possible based on available resources.

The only credible data on population size have been minimum point estimates based on maximum counts of animals at all 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) interpretation of analyses for temporal trends is difficult (Packard and Mulholland 1983 and Garrott et al. 1992). Aerial survey methods useful for monitoring trends in manatee abundance have yet to be developed.

Beginning in 1991, the former Florida Department of Natural Resources initiated a synoptic aerial survey program to count manatees in potential winter habitat during periods of severe cold weather (Ackerman 1992). During a survey in January 1991, 1,268 manatees were counted (697 east coast and 589 west coast). In February 1991, 1,465 manatees were counted (813 east coast, 652 west coast). In 1992, one survey was done in January yielding a count of 1,856 animals (907 east coast, 949 west coast. No synoptic surveys were done during the winter of 1992-93 because of the lack of severe mid-winter cold fronts. It remains unknown what proportions of the manatee populations were counted in these surveys. The counts do not provide a basis for assessing population trends. Based on the surveys, the sizes of the east and west coast populations appear to be approximately equal and the total number of Florida manatees is at least 1,856 animals.

On a more limited basis, it has been possible to estimate and 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 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 animals used the spring (Beeler and O'Shea 1988), and in the winter of 1992-1993, the number increased to 73 animals (Wayne Hartley, personal communication).

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 1967-1968 Hartman (1979) counted 38 animals. By 1981-1982, the maximum winter count had increased to 114 animals (Powell and Rathbun 1984) and in 1992, the maximum count was 292 animals (U.S. Fish and Wildlife Service, unpublished data). Both births and immigration of animals from other areas have contributed to the increases at Crystal River and Blue Spring.

The trends at Blue Spring and Crystal River are not believed to be reflective of manatee population trends elsewhere in Florida (O'Shea and Langtimm 1992). In part, this is because the observed increases at these sites are due to immigration of animals, because mortality differs in different parts of Florida, and because maximum aerial survey counts at other winter refuges in Florida from 1977 and 1992 (Reynolds 1992) show no comparable increases. Based on preliminary analyses of survivorship, population growth at Blue Spring and Crystal River appears reasonable, while increases along the Atlantic coast do not seem likely (O'Shea and Langtimm 1992).

Footnotes

1 The unmodified word "manatees" hereafter refers to Florida manatees, Trichechus manatus latirostris.

2 In July 1993 most offices and functions of Florida's Department of Natural Resources were combined with the offices and functions of the State's Department of Environmental Regulation to create the Department of Environmental Protection.

http://bluegoose.arw.r9.fws.gov/NWRSFiles/WildlifeMgmt/SpeciesAccounts/Mammals/FLManatee/FLManateePopDemography.html

Manatee Recovery Plan Population Demography and Distribution

Population Demography

The east and west coast populations are believed to be approximately equal in

size. The sex ratio of adults and calves at Crystal River is 1:1 (Rathbun et al. 1992) and is considered reflective of the populations' overall sex ratio.

An evaluation of manatee reproduction based on carcasses recovered from both coasts of Florida between 1976 and 1992 found that manatees may mature as early as 3-4 years of age; 46 % of the females were sexually mature; and 33 % of the mature females were pregnant (Marmontel 1993). The annual pregnancy rate was estimated to be about 21 % and the gross annual recruitment rate was estimated to be 7% (Marmontel 1992). These reproductive rates and survivorship data derived from ages-at-death indicate a stable or slightly increasing population with high probability of persistence over the long term provided present conditions remain constant. Sensitivity analyses show that high adult survival is critical for population maintenance, whereas calf mortality has little effect on population growth rate and persistence probability (Marmontel 1992).

Preliminary analyses of survival rates based on resighting data in the manatee scar catalogue suggest that mean annual adult survival differs on the east and west coasts. Survival rates were highest at Crystal River, slightly lower at Blue Spring, and lowest on the Atlantic coast. Based on available population models, these rates may be high enough to permit population growth at Crystal River and Blue Spring, but are too low for growth on the Atlantic coast given apparent rates of reproduction and mortality and survival rates in immature age classes. Further refinements to the database and analytic techniques are needed, however, to more accurately estimate and compare survival rates in these three areas.

Some information on the proportion of calves in the population is available from counts of cow-calf pairs during aerial surveys. From winter surveys of major refuges at power plant outfalls between 1977 and 1992, annual percentages of calves observed range from 12.8-6.6 %, with maximum one-day calf counts in those years ranging from 23 to 73 animals (Reynolds 1992). The overall percent and maximum number of calves sighted in this data set show a decline in recent years suggesting a decline in recruitment of calves into older age classes. While this trend, combined with information on increasing perinatal mortality (see mortality below), is a cause for concern, some problems exist in interpreting aerial calf counts (Rathbun 1990). Estimated calf percentages from recent state-wide surveys are 8.6 % in January 1991, 8.8 % in February 1991 survey, and 8.6 % in January 1992 (Ackerman 1992 and Ackerman personal communication). The actual numbers of calves counted in the February 1991 and January 1992 surveys were 129 and 139 calves, respectively (Ackerman personal communication). The latter count, however, excludes calves in 13 percent of the count (248 of 1865 animals) where observers did not distinguish calves from adults due to sighting conditions.

Distribution and Habitat Use Patterns

Due to telemetry, aerial surveys, photoidentification sighting records, and other studies over the past 15 years, manatee distribution in the Southeastern U.S. is now well known (Beeler and O'Shea 1988, O'Shea 1988, Marine Mammal Commission 1988, and Lefebvre et al. 1989). In general, the data show that manatees exhibit both opportunism and independence 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 degrees C (68 degrees F) in autumn and winter, manatees aggregate within the confines of natural or artificial warm water refuges (Lefebvre et al. 1989) or move to the southern tip of Florida (Snow 1991). Most artificial refuges are created by warm water outfalls from power plants or paper mills. The largest winter aggregations (50 or more animals) are at refuges in central and southern Florida (**Table 1**), although three or four smaller aggregations (about 15 or fewer animals) use warm water outfalls in northern Florida and southern Georgia on the east coast (Marine Mammal Commission 1988). The northernmost refuge used regularly on the west coast is at Crystal River. 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 and 1985, Rathbun et al. 1990, and Reid et al. 1991). There are also many lesser known, minor aggregation sites used as temporary thermal refuges. Most of these are

Manatee Recovery Plan/Table 1 Aggregation Sites

List of major aggregation sites for Florida Manatees (* = major sites with 25 or more manatees in aggregations).

East Coast:

1.Georgia Pacific (Glynn County, GA)
2.Gilman Paper Company (Camden County, GA)
3.Container Corporation of America (Nassau County, FL)
4.Jefferson Smurfit Corporation (Duval County, FL)
5.JEA Kennedy Generating Station (Duval County, FL)
6.JEA Southside Generating Station (Duval County, FL)
7.Blue Springs (Volusia County, FL)*
8.OUC Indian River Power Plant (Brevard County, FL)*
9.FPL Canaveral Power Plant (Brevard County, FL)*
10.Vero Beach Power Plant (Indian River County, FL)
11.Henry D. King Electric Station (St. Lucie County, FL)
12.FPL Riviera Beach Power Plant (Palm Beach County, FL)*
13.FPL Port Everglades Power Plant (Broward County, FL)*
14.FPL Fort Lauderdale Power Plant (Broward County, FL)*
15.Sebastian River (Brevard County, FL)*

West Coast:

1.FPC Crystal River Power Plant (Citrus County)
2.Crystal River (Citrus County)*
3.Homosassa River (Citrus County)*
4.TECO Port Sutton Power Plant (Hillsborough County)
5.TECO Big Bend Power Plant (Hillsborough County)*
6.FPC Bartow Power Plant (Pinellas County)*
7.FPL Fort Myers Power Plant (Lee County)*
8.Port of the Islands (Collier County)*
9.Myakka River (Sarasota County)*

Abbreviations:
FPC Florida Power Corporation
FPL Florida Power and Light Company
JEA Jacksonville Electric Authority
OUC Orlando Utilities Commission
TECO Tampa Electric Company

canals or boat basins where warmer water temperatures persist as temperatures in adjacent bays and rivers decline.

During mild winter periods, manatees move to nearby grassbeds to feed. For example, manatees using the Riviera Power Plant feed in adjacent Lake Worth and in Jupiter and Hobe sounds 12-15 miles to the north (Packard 1981); animals using the Port Everglades power plant feed in grass beds in Biscayne Bay 15-20 miles to the south (Marine Mammal Commission 1988); animals in Kings Bay feed on submerged vegetation near 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 (Bengston 1981); and animals using outfalls from a paper plant in southern Georgia and a container manufacturing plant on Amelia Island in northern Florida fed in creeks within one to two miles of those refuges (Zoodsma 1991).

As water temperatures rise in spring, 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. 1988) and are rare north of Cape Hatteras (Rathbun et al. 1982); the northernmost sighting is from the Potomac River, Maryland. On the west coast, sightings drop off sharply north of the Suwannee River in Florida (Marine Mammal Commission 1986), although a small number of animals -- about 12-15 manatees -- are seen each summer in the Wakulla River at the base of the Florida panhandle. Louisiana is considered the western limit of the Florida manatee's range (Powell and Rathbun 1984 and Lefebvre et al. 1989); manatees in Texas are believed to be migrants from Mexico though this has not been confirmed (Domning and Hayek, 1986). Rare sightings also have been made in the Dry Tortugas (Reynolds and Ferguson 1984) and the Bahamas (Odell et al. 1978).

In recent years, the most important spring habitat for the east coast population has been the northern Banana River in Brevard County; more than 300 manatees have been counted in this area shortly before dispersing in late spring (Provancha and Provancha 1988). 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 found almost anywhere in Florida where water depths are greater than 1-2 m (O'Shea 1988). 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. 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 and 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).

http://bluegoose.arw.r9.fws.gov/NWRSFiles/WildlifeMgmt/SpecieAccounts/Mammals/FLManatee/FLManateeTrophic.html

Manatee Recovery Plan Trophic Relationships and Reproduction

Trophic Relationships

Manatees are herbivores that feed opportunistically on a wide variety of submerged, floating, and emergent vegetation (see **Table 2**). They include submerged rooted seagrasses, emergent vascular plants, benthic algae, and floating plants. Manatees also forage opportunistically on detritus as illustrated by their use of acorns in the upper St. Johns River (Bengtson 1981 and O'Shea 1986).

Feeding rates and food preferences depend, in part, on the season and available plant species. Bengtson (1981 and 1983) reports that time manatees spent feeding in the upper St. Johns River was greatest (6-7 hrs/day) immediately before winter (August-November), least (3-4 hrs per day) in spring and summer (April-July), and intermediate (about 5 hrs/day) in winter (January-March). He estimates annual mean consumption rates at 33.2 kg/day/manatee or about 4-9% of their body weight per day depending on season (Bengtson 1983). At Crystal River, Etheridge et al. (1985) report 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 are 7.1, 9.6, and 15.7 percent of body weight per day, respectively.

Packard (1984) notes two feeding methods in coastal seagrass beds: rooting, where virtually the entire plant is consumed, and grazing, where exposed grass blades are eaten without disturbing the roots or sediment. In the winter of

Manatee Recovery Plan/Table 2 - Foods

Plants species commonly eaten by manatees (
man 1979, Bengtson 1981, Packard 1981, Lef
and Powell 1990, and Zoodsma 1991).

Submerged Seagrasses -- Estuarine and Marin

Shoalgrass - Halodule wrightii
Manatee grass - Syringodium filiforme
Turtle grass - Thalassia testudinum
Widgeongrass - Ruppia maritima
Star grass - Halophila spp.

Submerged Plants -- Fresh Water Areas

Hydrilla - Hydrilla verticillata
Wildcelery/eelgrass - Vallisneria americana
Southern naiad - Najas quadalupensis
Coontail - Ceratophyllum demersum
Para grass - Panicum purpurascens
Parrot's feather - Myriophyllum sp.
Sago pondweed - Potamogeton pectinatus

Benthic Macroalgae -- Estuarine and Marine

sea lettuce - Ulva sp.
red algae - Gracilaria sp.
caulerpa - Caulerpa prolifera

Floating Plants -- Fresh Water Areas

Water hyacinth - Eichhornia crassipes
Pickerelweed - Pontederia lanceolata
Water lettuce - Pistia stratiotes

1980-1981 in Lake Worth and Jupiter Sound on Florida's east coast, Packard (1981) reports that rooting was the predominant feeding mode with feeding scars left in beds of manatee grass having only 4-7 % of the biomass found in adjacent undisturbed areas. She estimates 40 % of the grass beds near the Riviera Power Plant warm water refuge were disturbed that winter and suggests that the creation of bare patches favors the growth of manatee grass and shoalgrass which recolonize disturbed areas more rapidly than turtle grass (Packard 1984). During the milder winter of 1988-89, Lefebvre and Powell (1990) found that manatees in Hobe Sound appeared to prefer shoalgrass, that 46-67 % of the root biomass was removed in feeding scars, and that the area disturbed by manatees was much less than during the winter of 1980-81.

In the upper Banana River, Provancha and Hall (1991) found spring concentrations of manatees grazing in grass beds dominated by manatee grass. They also reported an apparent preference for manatee grass and shoalgrass over the macroalga Caulerpa spp. Along the Florida-Georgia border, Zoodsma (1991) found that manatees fed in salt marshes on smooth cordgrass by timing feeding with periods of high tide.

Reproduction

Breeding takes place when one or more males (groups of up to 17 have been reported) are attracted to an estrus female to form an ephemeral mating herd (Marmontel et al. 1992). Such herds may remain together from a few hours to a few weeks. Permanent bonds between males and females do not form. During peak activity, the males in mating herds compete intensely for access to the female (Hartman 1979). Successive copulations involving different males are common. 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. 1992). Females remain in estrus for about two weeks (Lynn Lefebvre, personal communication). Although breeding has been reported in all seasons, Hernandez et al. (1992) report that histological studies of reproductive organs from salvaged males found evidence of sperm production in 94 % of adult males recovered from March through November, but only 20 % of adult males recovered from December through February.

Females appear to reach sexual maturity at about age five (Marmontel 1992, Odell et al. 1992, Rathbun et al. 1992) and males may reach sexual maturity at three to four years of age (Hernandez et al. 1992). Manatees may live in excess of 50 years (Marmontel 1992) and may not undergo reproductive senescence (Marmontel et al. 1992); a captive animal named Juliet gave birth to a calf in 1990 at which time she was estimated to be 43 to 48 years of age (Bossart, personal communication). The length of the gestation period is uncertain but is thought to be between 12 and 14 months (Odell et al. 1992, Rathbun et al. 1992, and Reid et al. 1992). The normal litter size is one, with twins reported rarely (Odell et al. 1992 and Rathbun et al. 1992).

Calf dependency usually lasts one to two years after birth (Hartman 1979, Rathbun et al. 1992, and Reid et al. 1992). Calving intervals vary greatly among individuals. They are probably not often less than about 2 to 2.5 years, but may be considerably longer depending on age and perhaps other factors (Marmontel 1992, Odell et al. 1992, Rathbun et al. 1992, and Reid et al. 1992). Females that abort or lose a calf due to perinatal death may become pregnant again within a few months (Odell et al. 1992), or even weeks (Hartman 1979).

http://bluegoose.arw.r9.fws.gov/NWRSFiles/WildlifeMgmt/SpeciesAccounts/Mammals/FLManatee/FLManateeMortality.html

Manatee Recovery Plan Mortality, Contaminants and Pollution

Mortality

Data on manatee mortality in the Southeastern U.S. have been collected since 1974 (Table 3, see recovery plan). It indicates a clear increase in manatee deaths over the last 15 years (6.1 %/year exponential regression between 1976 and 1991; Ackerman et al. 1992). Although both natural and human-related causes are significant components of manatee mortality, most of the increase in mortality can be attributed to increases in watercraft-related deaths and perinatal deaths (Marine Mammal Commission 1993).

A prominent cause of natural mortality in some years is cold stress. For example, following a severe winter cold spell at the end of 1989, 46 manatee carcasses whose death was attributed to cold stress were recovered. Exposure to cold also is believed to have caused many deaths in the winters of 1977, 1981, and 1984 (O'Shea et al. 1985). In 1982, a large number of manatees also died coincident with a red tide outbreak between February and March in Lee County, Florida (O'Shea et al. 1991). At least 37 manatees appear to have died due to ingestion of filter-feeding tunicates which had accumulated the neurotoxin-producing dinoflagellates responsible for causing the red tide. Other natural causes of death are disease, parasitism, and non-human related injuries (O'Shea et al. 1985 and Ackerman et al. 1992). Some, and perhaps many perinatal deaths are certainly due to natural causes; however, pollution, watercraft injuries or disturbance, or other human-related factors affecting pregnant and nursing mothers also may be responsible for a significant number of perinatal deaths.

The largest known human-related cause of manatee mortality is collisions with hulls and/or propellers of boats and ships. Between 1976 and 1991, watercraft-related deaths increased at an average of 10.3 % per year, increasing from 21 % of all deaths between 1976-1980 to 29 % between 1986-1991 (Ackerman et al. 1992). In 1992, the number of watercraft-related deaths declined by the largest amount in over 10 years (from 53 in 1991 to 38 in 1992) although, given a decline in total deaths in 1992, it still represented 23 % of the total 1992 mortality. The next largest human-related cause of manatee mortality is entrapment in flood gates and navigation locks. Such deaths declined from an average of 8 animals per year between 1978 and 1980 to an average of 4 animals per year between 1989 and 1990. In 1991 and 1992, however, they increased to 9 and 5, respectively.

Other known causes of human-related manatee mortality include poaching and vandalism, entrapment in shrimp nets and other fishing gear, entrapment in water pipes, and ingestion of marine debris. Together, deaths attributable to these causes have remained constant and have been a low percentage of total known mortality, i.e., about 5 % between 1976-1980, 3 % between 1981-1985, and 2 % between 1986 and 1991. In recent years, entrapment in shrimp nets has been the largest component of this catch-all category accounting for possibly 8 of 26 deaths between 1986 and 1991.

Contaminants and Pollution Effects

The reliance of manatees on inshore habitats and their attraction to industrial and municipal outfalls expose them to relatively high levels of contaminants. Despite this relationship, there have been few studies of contaminant levels and effects on manatees. What information is available 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. 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.

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. A few deaths, however, have been caused by ingesting wire, which perforated the stomach lining, and plastic sheeting, which blocked the digestive tract (Laist 1987). Discarded monofilament line and rope also have been found wrapped around flippers, some-times leading to serious injury or death (Beck and Barros 1991).

http://bluegoose.arw.r9.fws.gov/NWRSFiles/WildlifeMgmt/SpeciesAccounts/Mammals/FLManatee/FLManateeAccomplishments.html

Manatee Recovery Plan Accomplishments

Under the guidance of previous Manatee Recovery Plans, Federal agencies, State agencies, and private organizations have initiated cooperative actions to address important conservation needs upon which this plan builds. Some of the major initiatives are reviewed below.

Watercraft Injuries and Deaths

The largest source of human-related manatee mortality is collisions with watercraft. Many, if not most, living manatees also bear scars or wounds from vessel strikes. A recent analysis of injuries to 406 manatees killed by watercraft and recovered between 1979 and 1991 found that 39 % were killed by propeller cuts, 55 % were killed by impact, and 4 % had both types of injuries, either of which could have been fatal (Wright et al. 1992). Analyses of wounds suggest that most lethal propeller wounds were caused by medium-sized or larger vessels, but that impact injuries appear to be caused by fast-moving small- to medium-sized boats (Wright et al. 1992). Most propeller wounds are on the backs and sides rather than the heads of animals, suggesting that they were diving to avoid collision when hit. 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 manatees time to avoid oncoming boats.

In 1989, the Florida Governor and Cabinet approved a series of recommendations by the former Florida Department of Natural Resources to improve protection of manatees in 13 key manatee counties (Brevard, Duval, Broward, Dade, Indian River, Martin, Palm Beach, St. Lucie, and Volusia Counties on the east coast and Lee, Citrus, Collier, and Sarasota on the west coast). Initial work has been devoted to developing waterway speed and access (i.e., no entry) rules in these counties. At this time, the Florida Governor and Cabinet have approved county rules for eleven key counties. Efforts are underway to finalize rules for the remaining two counties. Speed and access rules for boats also have been developed by the Fish and Wildlife Service to protect manatees in certain National Wildlife Refuges.

As initial work in the 13 key counties is completed, attention is shifting to development and approval of county manatee protection plans, and similar protection of important manatee habitat in counties not listed among the 13 key counties will need to be considered. Ongoing needs include boater education, maintenance of signs and buoys, enforcement, compliance assessment, and periodic reevaluation of the effectiveness of the rules. Such work requires close cooperation between the Office of Protected Species Management in the new Florida Department of Environmental Protection, county officials, the Florida Marine Patrol, the Florida Governor and Cabinet, the Fish and Wildlife Service, and, of course, boaters.

Flood Gate and Navigation Lock Deaths

Entrapment in flood gates and navigation locks is the second largest cause of human-related manatee deaths. In some cases, manatees appear to have been crushed in closing doors; in others, they may have been pinned against narrow door openings by water currents rushing through openings and drowned. Most flood gates implicated in manatee deaths are in Dade and Broward counties and are operated by the South Florida Water Management District. Most navigation locks implicated in manatee deaths have been along waterway access routes to Lake Okeechobee and are operated by the Corps of Engineers. In the late 1970s, one quarter of all manatee deaths in Dade County were attributed to flood control structures.

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 in which manatees might become trapped. Manatee deaths subsequently declined and remained low for much of the 1980s (see Table 3 in recovery plan). However, a recent increase in deaths at modified gates suggests that the measure may only partially address the problem. A task force with representatives of the South Florida Water Management District, the Corps of Engineers, the new Florida Department of Environmental Protection, the Dade County Environmental Resource Management office, and the Fish and Wildlife Service has been formed to examine further actions. Options being considered include further modifications to gate opening and closing sequences, sonar devices to detect the presence of manatees near structure doors, and automatic reversal mechanisms similar to those on elevator doors. The latter option is now being tested cooperatively by the South Florida Water Management District and the Corps. If successful, a strategy and schedule to install such devices will need to be developed and implemented.

Habitat Protection

Intensive coastal development throughout Florida is degrading important manatee habitat and poses perhaps the greatest long-term threat to the Florida manatee. Three major approaches have been initiated to address this problem. First, the Fish and Wildlife Service and the former Florida Department of Natural Resources initiated extensive efforts to review and comment on applications for Federal and State permits for construction projects in manatee habitat areas. For example, pursuant to Section 7 of the Endangered Species Act, the Service now annually reviews hundreds of permit applications to the Corps of Engineers for construction projects in waters and wetlands that include or are adjacent to important manatee habitat.

The new Florida Department of Environmental Protection has a similar program for reviewing Environmental Resources Permits and applications for leasing state owned submerged lands. In 1989, the Florida Governor and Cabinet also established an interim boating facility siting policy for the thirteen key counties that limits construction of new or expanded multi-slip docking facilities to one power boat slip per 100 feet of shoreline owned or controlled by a permit applicant.

A second major approach is developing county manatee protection plans for the 13 key manatee counties. The provisions of these plans are anticipated to be implemented as amendments to local growth management plans prepared pursuant to the State's Local Government Comprehensive Planning and Land Development Regulation Act of 1985. In addition to boat speed rules, manatee protection plans are to include marina siting policies and other measures to protect manatees and their habitat. To date, one County has completed its manatee protection plan and plans for the other 12 counties are in varying stages of development.

A third approach to habitat protection is land acquisition. Both the Fish and Wildlife Service 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. At the State level, several programs, most notably the Conservation and Recreational Lands (CARL) Program, have acquired important areas. At the direction of the Florida Governor and Cabinet, special attention is given by the CARL Program to manatee habitat. Five percent of the CARL program budget is currently devoted to manatee-related purchases. Approximately $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, and near Blue Spring.

The Fish and Wildlife Service also has acquired thousands of acres of land important to manatees for inclusion in the National Wildlife Refuge System. Particularly important recent acquisitions over the past 10 years have been for National Wildlife Refuges along the Crystal River, the Homosassa River, and the Suwannee River. Both the State and the Service are continuing cooperative efforts with a view towards establishing a network of core manatee habitats throughout Florida.

Three new Sanctuaries and one of the three existing Sanctuaries were established by the Fish and Wildlife Service in Kings Bay within or near the Crystal River National Wildlife Refuge under authority of the Endangered Species Act. In addition, a 15 square mile motorboat-prohibited area was established in the Banana River within the Merritt Island National Wildlife Refuge and the Kennedy Space Center.

Research

The foundation of the manatee recovery program is detailed information on manatee ecology and life history. These data have been gathered cooperatively by the Fish and Wildlife Service, the former Florida Department of Natural Resources, academic institutions, and marine zoological parks. Key elements of the manatee research program are: the salvage and necropsy program to monitor manatee mortality; radio-tagging and tracking studies using VHF and satellite-linked telemetry to define manatee movements and habitat use patterns; a scar catalogue to photographically identify individual animals and thereby determine basic life history parameters such as calving intervals, age of first reproduction, and survivorship; age determination studies to develop age-specific population parameters; studies of manatee food preferences and feeding ecology; aerial surveys to identify distribution and relative abundance; and a geographic information system to store, integrate, and retrieve site-specific information for myriad research and management tasks.

Many of the above elements were pioneered by staff of the Sirenia Project of the Fish and Wildlife Service's National Ecology Research Center. The Florida Marine Research Institute, now in the Florida Department of Environmental Protection, developed the geographic information system for manatee data, and has assumed responsibility for, or become directly involved in, many of the above activities. The Federal and State agencies work closely with one another as well as with cooperating researchers at various institutions. The Florida Department of Environmental Protection now has a modern, well-equipped Marine Mammal Pathobiology Laboratory in St.

Petersburg, Florida that was partially funded by the Fish and Wildlife Service through Section 6 grant-in-aid funds. To providemanagers with basic, up-to-date information for making informed management decisions, continued work in all of the above areas is essential.

Rescue, Rehabilitation and Release

Over the past five years, distressed manatees have been rescued at a rate of about 25 animals per year in the Southeast United States. Most rescues involve animals seriously injured by collisions with boats, animals entangled in rope or line, orphaned calves judged unlikely to survive on their own, or animals trapped in water conduits, such as power plants intake canals or drainage pipes. Voluntary support by marine zoological parks and other groups is a cornerstone of the manatee rescue and rehabilitation network and involves close cooperation among those groups and Federal agencies, State agencies, and law enforcement officials.

Initially, rescue work was authorized under a Fish and Wildlife Service research permit. However, as methods for capturing, transporting, treating, and maintaining animals were refined and the potential to successfully treat and release animals has increased, this work has become more of a management function. In addition, space and resources for maintaining and treating injured manatees have become a concern because some animals judged unreleasable have necessitated costly, long-term care and maintenance. Animals judged unreleasable have included those whose injuries make survival in the wild unlikely and calves born in captivity or brought in as orphans which have not learned necessary survival skills. A soft release facility was developed at Merritt Island National Wildlife Refuge was built in 1994 to provide a staged release alternative for long-term captives and orphans. As of mid-1993, nearly 50 animals were in captivity at five captive maintenance facilities in Florida.

To guide rescue/rehabilitation work, the Fish and Wildlife Service recently shifted responsibility for this aspect of the recovery program from its former research arm to its management staff. The Service also established an Interagency/Oceanaria working group to coordinate captive manatee management and rehabilitation, and obtained an enhancement permit under the Marine Mammal Protection Act to authorize related activities. The Service also developed a system authorizing three levels of involvement by cooperating organizations: report verification teams to corroborate reports of distressed animals and to remain with animals pending arrival of further help; rescue/transport teams to undertake hands-on rescue operations and to transport live animals; and approved rehabilitation facilities to maintain and treat animals.

To operate the rescue/rehabilitation network, the Service has issued letters of authorization under its enhancement permit outlining responsibilities of cooperating groups at each of these three levels of involvement. The Service also has developed criteria to guide and schedule release of rehabilitated animals and convened meetings of the Interagency/Oceanaria working group to review and coordinate network activities. The Florida Department of Environmental Protection, through the salvage and necropsy program staff at its Florida Marine Research Institute, has agreed to coordinate rescue responses by receiving reports of distressed animals and arranging for the appropriate authorized participants to respond.

http://bluegoose.arw.r9.fws.gov/NWRSFiles/WildlifeMgmt/SpeciesAccounts/Mammals/FLManatee/FLManateeLiterature.html

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Manatee Questions and Answers

Call 1-800-DIAL-FMP (1-800-342-5367) or *FMP on your cellular phone if you see an injured, dead, tagged, or orphaned manatee, or if you see a manatee being harassed. And Keep Our Precious Marine Mammals Safe

What's wrong with feeding manatees or - giving them water?

Feeding manatees or giving them water - can result in behavior modification. Because they have approached humans expecting food or water, some manatees - have been harassed or fed dangerous or non-food items. Manatees' natural feeding
patterns may be altered by encouraging them to "hang around," waiting for food or water. When hand-fed lettuce or water from a hose is no longer available, manatees may not know where to find or identify natural, reliable sources of food. Feeding and watering may also adversely affect manatee juveniles who learn feeding, avoidance, migration and other behaviors from their mothers.

But I wouldn't harm a manatee.

Of course you wouldn't. But not everyone loves manatees, and feeding manatees or giving them water could encourage them to swim up to people who might be cruel to them. Manatees have been ridden, shot at with guns and bows, had rakes embedded in their backs, and initials carved into their skin. They have been purposely hooked by fisherme

I need to feed the manatees. They look hungry, and I've heard there may not be enough natural seagrass for them.

Although seagrass beds are declining from pollution in many areas, there is more than enough vegetation to sustain a healthy manatee population in the wild in Florida. Manatees not only eat seagrass, they eat other submerged, floating, and emergent plants.

Don't Take Lettuce Or Water From Strangers
If only we could teach manatees that rule. But we can't so it's up to us to do what's right for manatees.

Mind Your Manatee Manners

• Practice "passive observation" and observe manatees from a distance.

• Resist the urge to feed manatees or give them water.

• When swimming or diving, "look, but don't touch."

• "Stash your trash." Discard monofilament line, hooks, and other trash properly.

West Indian manatees are endangered animals. At present, it is estimated there are only about 2,000 of these unique animals left in the United States. Since 1989, there bas been an average of 174 manatee deaths per year. Fully one third of those deaths have been attributed to human-related factors. Because human-related manatee deaths are preventable, this area is the most logical place to begin in order to reduce mortalities.

I see manatees when I'm out in the boat, and they are so cute. I want to pet them. Besides, they act like they like it.

If manatees swim up to boats, it is likely they have been fedbefore and are expecting the same from you. But think about it-watercraft collisions are the number one cause of human-related manatee mortalities. Encouraging manatees to approach boats makes them prone to encounters with propellers and entanglement in fishing gear. Also, manatees sometimes like to feed on the vegetation that gets wrapped around the boat's propeller. Before starting up, always check around your boat for manatees, especially around the motor area.

I always put out a hose for manatees at the marina because they look thirsty. Since they are in salt water, I assume they need it.

Manatees can be found in fresh, brackish, or salt water Often, people will leave hoses running from their docks because it is known that manatees are attracted to fresh water. But manatees in salt water can go for long periods without actively drinking fresh water. It is still not known what their fresh water requirements are, but there are many natural sources of freshwater to which they have access.

What should I do when I'm swimming or diving and I see a manatee?

"Look, but don't touch" is the best policy. You actually have the most to gain by remaining at a distance. If you approach manatees, they will most likely swim away. By quietly observing manatees, you win get a rare opportunity to see the natural behavior of this unique animal (any other actions might be considered harassment). When diving, switch to your snorkel gear and float on the surface of the water, as the sound of bubbles from scuba gear may cause manatees to leave the area. When swimming, slowly enter the water in the presence of manatees, avoiding excessive noise and splashing. Please don't ride, chase or harass manatees in any way.

I don't understand how throwing a few things in the water can harm a great, big animal like a manatee.

Debris in waterways, such as discarded plastic bags, six-pack holders, fishing hooks, or monofilament line is dangerous to manatees and other forms of wildlife. Litter, especially plastic litter that does not degrade, can get tangled in plants that manatees eat, and the manatee can become entangled or accidentally ingest these plastics. When a manatee swallows a plastic bag or a wad of fishing line, it can choke them or block their intestines. Fish hooks can puncture their esophagus, stomach or intestinal lining and leads to infection which, in turn, can lead to illness or death.

My Normal Behavior

Hi, I'm your average manatee. I weigh about 1,000 pounds and am 10 feet long. I can live in fresh, brackish, or salt water. I can get sick and die if I stay too long in waters with a temperature of less than 68 degrees, so in the winter, I find a warm water source. In the summer, I roam throughout many of Florida's (and southern Georgia's) waterways. What I need is a clean water home, lots of naturally occurring plants to eat, space to travel, and safe, protected areas. Can you help me?

Get Involved!

For more information on manatees, contact:

Fish & Wildlife Service,
6620 Southpoint Dr., So.,
Suite 310, Jacksonville, FL 32216,
(904) 232-Z580

Save the Manatee Club,
500 N. Maitland Ave.,
Maitland, FL 32751,
1-800-432-J0IN (5646)

Give To The Emergency Rescue Fund

If you would like to contribute to Save the Manatee Club's Emergency Rescue Fund, call 1-800-432-JOIN (5646) for more details. These funds will only be spent on manatee rescue and rehabilitation efforts.

It's The Law

Manatees are protected under federal law by the Marine MammalProtection Act of 1972 and the Endangered Species Act of 1973, which make it illegal to harass, hunt, capture or kill any marine mammal. Manatees are also protected by the Florida Manatee Sanctuary Act of 1978. Anyone convicted of violating this state law faces a possible maximum fine of $500 and/or imprisonment for up to 60 days. Conviction on the federal level is punishable by a fine up of to $100,000 and/or one year in prison. Feeding manatees, giving them water, or otherwise altering their behavior can be considered harassment.

It is a second degree misdemeanor to intentionally discard any monofilament fishing line or monofilament netting into or onto the waters of the state of Florida.

The West Indian Manatee in Florida

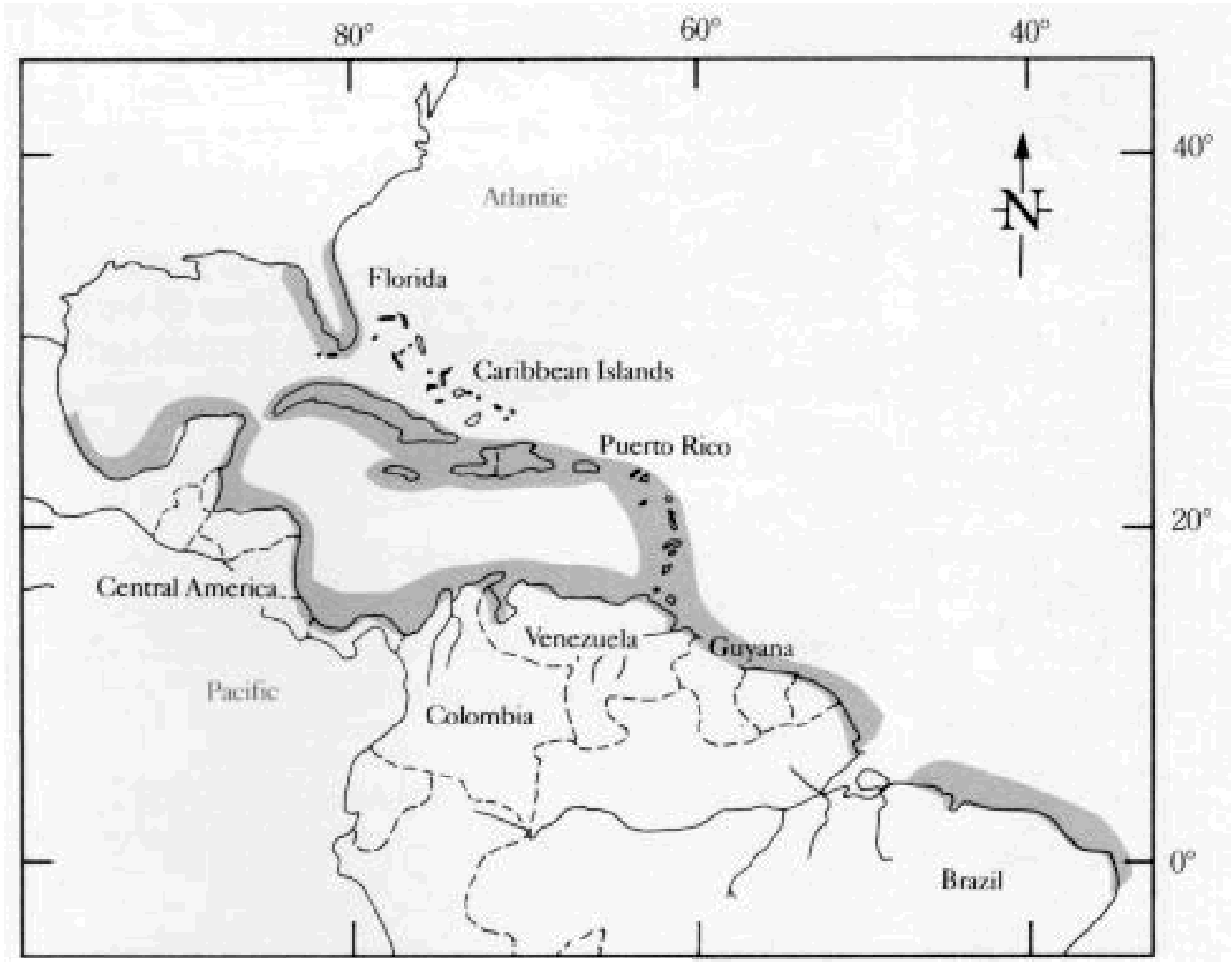
Written for Florida Power & Light Company Miami, Florida
By Victoria Brook Van Meter
Illustrated by Laura Sartucci Wiegert

It is Florida Power & Light Company's responsibility to meet our customers' energy needs, and at the same time minimize impacts on the environment to help protect Florida's natural resources, wildlife and scenic beauty.

FPL maintains an active environmental awareness program to demonstrate to the public and regulators that utility power plants and other facilities can be built and operated compatibly with the environment.

We also want to help you understand that industry and the environment can share resources in a manner beneficial to both. Plus we ask you to act responsibly to preserve and protect the environment and its plants and animals.

That's why FPL produces a series of educational publications on aspects of the environment that we affect through our operations, including this one on the West Indian Manatee in Florida. FPL operates 13 power plants across its service territory. Manatees - an endangered species - congregate in the warm-water outflow from five of these plants during the winter months. We have the obligation to help protect these manatees for at least two reasons. One: they are a precious and increasingly rare resource. And two: we need to prove we can build and operate the facilities necessary to bring you the power you demand, and protect the animals with which we coexist.



Blue indicates general distribution of the West Indian manatee in the Caribbean.

Introduction

The West Indian manatee or sea cow (*Trichechus manatus*) is a large, plant-eating aquatic mammal that can be found in the shallow coastal waters, rivers, and springs of Florida. These gentle creatures are endangered throughout their range. High mortality, primarily associated with human activity, as well as a low reproductive rate and loss of habitat continue to keep the number of manatees low and threaten the species' future.

In response to an increased awareness of the plight of the manatee, governmental agencies, universities, private conservation groups and concerned corporations have joined together to promote research and identify the actions needed to encourage the recovery of manatee populations. This work has increased our knowledge of this species as well as raised many questions that remain unanswered. The following presents a review of the current knowledge concerning the biology, life history and status of the manatee in Florida.

Description

Manatees are large somewhat seal shaped mammals with flat, rounded tails. Adults range in color from gray to brown, while calves are darker at birth, changing to a grayish color by about one month.1 Adults can reach a length of 3.9 meters (12.7 feet)2 and can weigh up to 1,500 kilograms (3,500 pounds). These maximum figures are unusually high. The average length of a manatee is about 3 meters (9.8 feet) and the average weight is about 360-540 kilograms (793-1,190 pounds).3 Female manatees may tend to reach greater lengths and weights than males.4

The Skin of the manatee is finely wrinkled and the surface layer is continually sloughing off, possibly to reduce the build-up of surface algae and other growths. A layer of blubber occurs under the skin and fat deposits are found among muscle tissue and around the intestines. Hair is distributed sparsely over the body and stiff whiskers grow around the face. The manatee has no hind limbs and its forelimbs or flippers are paddle-shaped. The bones are massive and heavy and lack marrow cavities in the ribs and long bones of the forelimbs.4 The West Indian manatee has three or sometimes four nails at the tip of each flipper.

The face of a manatee is bulbous; the small, wide-set eyes give the animal a placid expression. The nostrils, located on the upper surface of the snout, are tightly closed by valves when underwater, and the eyes have inner membranes that can be drawn across the eyeballs for protection. The ear openings, located just behind the eyes, are small and lack external lobes. The brain of the manatee is small for a mammal of its size.5

About five hours a day are spent feeding on seagrasses, freshwater plants and even plants growing along the shoreline. Manatees have a flexible upper lip that is used to manipulate food into the mouth. The teeth of manatees are unique because they are continually replaced. Grinding molars form at the back of the jaw, wear down as they move forward, and eventually fall out. Tooth replacement is an adaption to the manatee's diet of abrasive plants that often are mixed with sand. The wrinkles in the surface enamel of the molars also may help reduce wear.6 The extreme wear of the front teeth noted in Florida's manatees appears to be unusual and may be caused by the quartz-sand substrates of the Atlantic and Gulf coasts.7

The digestive system of the manatee is similar to that of plant eaters such as horses, with bacterial digestion of cellulose occurring primarily in the hind part of the gut. This digestive system is adapted to processing large amounts of high- fiber low-protein food. The intestines of adults can measure up to 40 meters (130 feet) in length. A large glandular structure called the cardiac or digestive gland protrudes form the curvature of the stomach. This structure produces mucus which coats swallowed food and protects the lining of the digestive system from abrasion.8 Digestion is accompanied by the formation of large amounts of gas.9

The lungs of the manatee may exceed 1 meter (3 feet) in length in adults and contain large amounts of muscle tissue. Manatees and other aquatic mammals exchange lung air very rapidly as compared with similarly sized land mammals.10 Both the lungs and diaphragm extend the length of the body cavity and so are oriented in the same horizontal plane as a manatee. This arrangement is important for buoyancy control.

The main external difference between male and female manatees is the location of the urinary and reproductive opening. In the female, this opening is located just in front of the anus; in the male, it is located further forward, just behind the navel. Females also have a prominent teat

located against the body under each flipper.

Evolution

Manatees belong to the order Sirenia, which also includes the manatee's relative in the Pacific, the dugong. Sirenians evolved from four-footed land mammals more than 60 million years ago.11 The presence of undeveloped pelvic bones in manatees is evidence of their terrestrial ancestry.12 The closest modern relatives of the Sirenia are the elephants and small Asian and African mammals known as hyraxes.13,14 More than a dozen sirenian genera are known from the fossil record, so this order was once much more diverse and widespread than it is today.15,7

The fossil record shows that both manatees and dugongs were once found in the new world, but that manatees eventually replaced the dugongs. Manatees may have prevailed because they evolved more wear-resistant teeth and so were better able to exploit developing areas of freshwater vegetation as a food source.7

Forty-five million-year-old sirenian fossils have been found in Florida.16 Fossil dugong ribs have been discovered in shallow-water marine and estuarine sedimentary deposits throughout the state,11 and manatee bones have been found in pre-Columbian Indian refuse mounds in southeastern Florida.17

Related Species

The West Indian manatee is one of only four living species in the order Sirenia. A fifth species, Steller's seacow (Hydrodamalis gigas), which grew to almost 10 meters (33 feet) in length and weighed several tons, was hunted to extinction within 27 years of its discovery in the Bering Sea in 1741. Besides its extraordinary size, this species was unique because it inhabited cold water and fed exclusively on marine algae.18

The living sirenians are tropical and subtropical in distribution and consist of one species of dugong and three species of manatees. The dugong (Dugong dugon) was once widely distributed but is now restricted to certain regions of the coastal waters of the Indian and Pacific oceans. The largest surviving populations are found in northern Australian waters.19

Manatees are found along the tropical coasts of both the eastern and western Atlantic. The West African manatee (Trichechus senegalensis) is found in the coastal waters and rivers of western Africa. Very little is known about this species, and its numbers have been greatly reduced by hunting and netting. The Amazonian manatee (Trichechus inunguis) is restricted to the fresh waters of the Amazon basin. Decimated by hunting over the past few centuries, the Amazonian manatee is now protected by law. However, enforcement is ineffective and the remaining populations are subject to illegal hunting.20

Florida's manatees belong to the third species of manatee (Trichechus manatus), which is found from the southern United States to the northeast coast of Brazil. Recent studies of skull characteristics have verified that manatees in the southeastern United States are a subspecies distinguishable from manatees found in the West Indies, the Caribbean and northeastern South America. The cool winter of the northern Gulf coast and the deep water and strong currents of the Straits of Florida appear to keep the population in the United States genetically isolated.6 The preferred common name for the species is the West Indian manatee, but the subspecies found in Florida also can correctly be called the Florida manatee.

Habitat

The West Indian manatee lives in freshwater, brackish and marine habitats and can move freely between salinity extremes. It can be found in both clear and muddy water. Water depths of at least 1 to 2 meters (3-7 feet) are preferred and flats and shallows are avoided unless adjacent to deeper water. Along the coast manatees tend to travel in water that is 3 to 5 meters (10-16 feet) deep and are rarely seen in areas over 6 meters (20 feet) deep.

High tides are used to reach thoroughfares or feeding grounds that are inaccessible at low tide. Currents of over 5 kilometers (3 miles) per hour usually are avoided. If the water is deep enough and the currents are not too strong, these animals will travel great distances up coastal rivers. Manatees living in the upper St. Johns River are more than 200 kilometers (124 miles) from the ocean. Along the west coast of Florida, the principal summer habitats are the estuaries and grassbeds of rivers. Manatees rarely are seen in the Gulf of Mexico further than 1 kilometer (0.6 miles) from the mouth of a river.21

Distribution

The West Indian manatee currently is distributed from the southern United States through the Caribbean Islands, eastern Central America, Colombia, Venezuela and south to Brazil's northeast coast.

Manatees can be found in freshwater, brackish and marine habitats throughout Florida A maximum of 62 manatees have been counted in Puerto Rico.22 Eight manatees were sighted on the coast of Haiti and it is estimated that perhaps 32 liver there.23 The complete distribution of the species is not known because many regions within the range have not been surveyed in detail.

Records from the sixteenth and seventeenth century show that the West Indian manatee was once found as far south as latitude 20oS, a few degrees north of Rio de Janeiro. This historical range corresponds with the limits of the 24oC (75.2oF) mean annual isotherm.24

Florida is essentially the northern end of the West Indian manatee's range. During the winter, cold temperatures keep the population concentrated in peninsular Florida. In the summer, however, manatees occasionally are reported from as far north as Virginia and the Carolinas. More commonly, manatees are seen around industrial warm-water effluents in Georgia during the spring.25

Manatees have been sighted as far west as Texas. These individuals are probably visitors from Mexico and not part of the Florida population.6 In Texas manatee sightings have become less frequent as the Mexican manatee population declines, but the numbers in Louisiana and Mississippi have increased as the manatee population of the Big Bend coast re-

gion of Florida has become more widespread.21

During the summer months, manatees range throughout the coastal waters, estuaries, bays, and rivers of both coasts of Florida and are usually found in small groups. Studies of known individuals show that many manatees return to preferred summer and winter grounds. Manatees can travel great distances as evidenced by voyages of more than 850 kilometers (528 miles) between Blue Spring on the St. Johns River and Coral Gables. Another manatee is known to have traveled more than 230 kilometers (143 miles) from the Indian River to southern Georgia in only four days.26 Most travel occurs seasonally as manatees move between summer dispersal areas and winter gathering sites but manatees may also shift wintering locations during a season.

Manatees inhabit the St. Johns River basin throughout the year, concentrating at Blue Spring during cold winter weather.27,28 The number of manatees gathering at Blue Spring has increased dramatically over the past 10 years due largely to reproduction and some immigration.26 Some manatees that spend the summer in the river migrate south in the winter or congregate at warm-water outfalls around Jacksonville.

As many as 245 manatees have been counted in the Indian and Banana river area of Brevard County during the spring and 100 to 150 during the summer months.29 Manatees may prefer the Banana River because boat access is restricted as part of security for the Kennedy Space Center complex and, therefore, the manatees are free of the harassment and danger associated with boat traffic.26 Many individuals from this region migrate to south Florida through the Indian River and Intracoastal Waterway for the winter.30 A small number of manatees are reported year-round in the Hobe Sound and Jupiter Inlet area.31

Along the eastern coast of Florida, manatees are found mostly in the Intracoastal Waterway and lagoons but they are also occasionally sighted offshore in coastal waters. About 50 manatees were landlocked by salinity barriers in Blue Lagoon Lake near Miami International Airport until the construction of a flood-control dam allowed escape.32 Manatees are observed throughout southern Florida in the summer, particularly in Monroe and Collier counties.33 Farther north on the west coast, manatees range up to Taylor and Wakulla counties in the Panhandle area in the summer,34 although the Suwannee River generally is considered to be the northern limit of the range.

Manatees that roam beyond Florida in the summer and fail to return by winter rarely survive.26 As winter approaches, these tropical mammals must move toward sources of warm water. During extreme drops in temperature, they remain as close to a warm-water source as possible and, during breaks in the weather, travel to nearby feeding areas.

It is believed that the historical winter range of the manatee was once centered in southern Florida, with small groups spending the winter at a few natural springs in northern Florida.35,33 Over the past 30 years, the construction of power plants and other industrial sites that discharge warm water, coupled with the loss of natural habitats, has caused a shift in manatee winter distribution.

Winter aggregations now center around about 24 warm-water sources, six of which are natural springs.36 As a result, manatees now winter as far north as Duval County. In the relatively mild winter of 1979-1980, up to 100 manatees used two power plants on the Indian River near Titusville as winter refuges.29 However, during the extremely cold winter of 1980-1981, only 36 manatees were counted at the two plants. This decrease at the northern refuges was offset by an increase in the winter populations at power plants farther south on the Intracoastal Waterway, including plants at Riviera Beach and Port Everglades.30

On the west coast, manatees may move south to Collier and Monroe counties in the winter. During aerial surveys of western peninsular Florida conducted from July through November 1979, 50 to 75 percent of the manatees sighted were in these two counties.33 Manatees use several man-made warm- water sources on the west coast; the primary one is Florida Power & Light Company's (FPL) Ft. Myers plant near the junction of the Orange and Caloosahatchee rivers. More than 300 manatees have been counted at this site during a cold spell. The dependence of so many manatees on this site prompted FPL to dig artesian wells that provide an alternative warm-water source in case of a plant shutdown during cold spells.37

Several natural springs are used on the west coast during the winter, the most important of which are at the headwaters of the Crystal and Homosassa rivers in Citrus County. There are no reports of large numbers of manatees in the headwaters of these rivers before the early 1960s, but the number of manatees using these springs has doubled in less than a decade, More than 200 manatees now use the Crystal and Homosassa river area as winter aggregation sites. As with the Blue Spring population on the St. Johns River, this increase is mostly the result of reproduction and some immigration.26

Manatees form temporary "mating herds" consisting of a female in heat pursued by several males. These springs are managed for manatee protection and areas are set aside where manatees are free of danger and harassment. This protection, plus the currently unlimited food supply of exotic vegetation, has contributed to the increased number of manatees.26 About 90 percent of the same individuals return to the headwaters of the Crystal and Homosassa rivers each winter and six manatees have returned to Crystal River for at least 14 years.21

Manatees on Florida's east coast tend to travel farther than those on the west coast.38 The Gulf coast lacks continuous sheltered areas for travel and the natural springs on the west coast provide large, reliable natural sources of warmth and abundant food.21 Manatees do not seem to move from one coast of Florida to the other. Travel across Florida through the Okeechobee Waterway has not been documented nor do manatees appear to cross Florida Bay. However, no regional genetic differences have been detected and so some gene flow must occur across the peninsular.39 The number of manatees on the Atlantic and Gulf coasts is

about equal.26

Population Estimates

There is no evidence that manatees were once much more abundant in Florida than they are now or that they ever nearly became extinct. Manatee bones are relatively scarce in pre-Colombian Indian refuse heaps indicating that manatees were probably not abundant.36 Genetic studies also show that manatees have relatively high genetic variability as compared with species whose numbers have been greatly reduced.39 During the past 30 years manatees have become more widespread, and, possibly even more numerous, in Florida as a result of protection, the increase in winter refuges and the introduction of exotic vegetation.26

No one knows the exact number of Florida manatees but intensive winter aerial surveys at warm-water refuges in 1992 counted a minimum of 1,856. This number is higher than previous estimates because of improved survey methods coupled with favorable weather conditions during the survey. Manatees are difficult to count because they are often found in areas of poor visibility and they tend to cluster together at warm-water sources. As a result, the size of the total population is difficult to determine. Manatees are so longlived and reproduce so slowly that it may take many years before trends become evident. Locally, however, the manatees at a few natural springs have been studied for several years and generalizations as to population trends can be made.

In northeast Florida, the number of manatees may be declining as a result of the chronic loss of adult manatees to boat and barge collisions coupled with low reproductive rates.40 However, on the west coast of Florida, particularly around the Big Bend region, the population appears to have increased. Mortality is low compared to other parts of the state, there is a relatively large percentage of calves, and some manatees are emigrating from the south. The introduction of exotic freshwater plants such as hydrilla also has increased the amount of food available. This hopeful news must be tempered by the reports of some researchers that the growth of recent decades has slowed in the past few years.41 With the exception of the Everglades, the Big Bend area is the least developed part of Florida's coastline, making it critical to the long-term outlook for the manatee in Florida.21

The percentage of calves in Florida's manatee population is relatively low. Surveys in southwest Florida, a center of manatee abundance, found that only 4.9 percent of the manatees were calves. This figure was lower than that found in earlier counts.33 In a survey of northeast Florida, 7 percent of the manatees were calves.40 Aerial survey counts of manatees at warm-water refuges during cold winter weather show that from about 9 to 13 percent of the animals are calves.30,42 These figures may reflect a tendency for females with calves to seek out warm-water refuges more than other adults. It is not known if the birth rate is high enough to offset the 120 or so dead manatees recovered annually in Florida in recent years.

Economic Importance

Past

The manatee has been hunted for thousands of years for meat, bone, hides and fat. Manatees were well-known among prehistoric Indians as evidenced by the use of ceremonial pipes in the form of manatees.43 Hides were made into leather shields, cords and shoes, and the ivory-like bones were believed to be of medicinal value.44 Florida Indians hunted manatees as a supplement to their diet and may have sold excess meat to the Spanish.45

In the seventeenth century, shiploads of dried manatee meat were shipped from the Guianas to feed sugar plantation laborers in the Caribbean.46 Pioneers arriving in the nineteenth century shot manatees for meat, oil and hides, and poaching was common in parts of Florida during the Depression and World War II. Cowpens Key in the Florida Keys is thought to be so named because manatees were once penned in a small cove there as a food supply.

Despite many centuries of hunting by prehistoric Indians and, later, by Europeans, manatees in Florida were never subjected to the intense commercial exploitation experienced by South American manatee populations.7,26 This hunting, which continues today in many countries, eliminated manatees from many parts of their former range. About the only hope for manatees in many poor countries is that, as hunting expertise disappears with the older generation, these populations can grow.23

Present

It has been suggested that manatees could be raised commercially for their meat, but their endangered status and low reproductive rate make this unlikely. Another proposal was that manatees could be of value in controlling aquatic weeds that are a problem in many parts of the world, including Florida.47,48 However, recent studies have shown that manatees do not eat enough to be effective plant control agents.49 It has been calculated that about 3,000 manatees would be needed just to maintain a constant amount of hydrilla in the 165 hectares (408 acres) of the headwaters of Crystal River.50

We now realize that the value of the manatee goes beyond its use for meat production or weed control. The manatee has been an integral part of Florida's ecology for millions of years and has the right to survive. The sight of one of these animals in its natural habitat is a memorable experience, whether for the Florida resident or the visitor enjoying one of Florida's many waterways. It is difficult to put a dollar figure on ecological value or aesthetic appeal, but, clearly, manatees are an important asset and an attraction unique to Florida.

Physiology

Little is known about the physiology of manatees and current studies are restricted because of the risk of working with endangered animals. The manatee's metabolic rate is unusually low compared with other mammals, which in part may account for its susceptibility to cold51 and slow healing rate.52 A low metabolic rate is adaptive for a large tropical animal

that must keep cool and that lives on a relatively poor quality diet. However, this adaption can be a liability for populations at the northern edge of the species' range where metabolic heat is needed to maintain body temperature. The manatee's body temperature is reported to be 36.4oC (97.5oF) but this may vary seasonally or with water temperature.

Manatees ar rest have a relatively low heart rate of 50 to 60 beats per minute. During a prolonged dive, the rate may decrease to about 30 beats per minute.53 Dives of up to 24 minutes in duration have been reported,32 although the length of time between breaths usually ranges from about four minutes while resting to half a minute during strenuous activity.54 The interval between breaths is prolonged by replacing a large percentage of the air in the lungs with each breath.

It is known that manatees are long-lived but no adequate method of determining age has been developed. One manatee has been maintained in captivity for almost 40 years.

Reproduction

Female manatees may reproduce as early as 4 to 5 years of age but at such an early age may be unsuccessful at raising calves. Most females breed successfully by 7 to 9 years of age.2 The smallest female known to have given birth was 2.6 meters long (8.5 feet).4

Manatee calves nurse underwater and may remain with their mothers for more than two years. The gestation period of the manatee is about 13 months and females usually produce one calf with each pregnancy. Twins occur occasionally and females may care for orphaned calves.54 The interval between births is probably 3 to 5 years, although a female losing her calf soon after birth could have another calf within two years. Calving occurs throughout the year.34 Newborn calves range in length from 1.2 to 1.4 meters (4 to 4.5 feet) and weigh about 30 kilograms (66 pounds).4

Calves remain dependent on their mothers for up to two years. The young nurse underwater for about three minutes at a time from teats located at the junction of the forelimbs and the body. Manatee milk contains more fats, proteins and salt than cow's milk and does not contain lactose.55 Manatees are born with premolars and molars, and as a calf begins to eat plants, the mechanical stimulation of chewing causes the teeth to move forward about 1 millimeter (.03 inches) a month. The front teeth wear down and eventually fall out to be replaced by the teeth moving forward.56 Calves begin nibbling on plants within a few weeks of birth.

Research suggests that mothers and their young recognize each other beyond weaning and the some offspring spend at least their subadult lives within the range of their mother. This may enhance survival by enabling manatees to learn migration routes and the location of winter refuges and feeding grounds.57

Behavior

The behavior of manatees may appear simple, but it is well suited to the needs of these animals. Manatees evolved in regions with plentiful food supplies and fairly constant temperatures and so have never needed to develop complex behaviors to obtain food or protect themselves from the elements. Furthermore, because manatees have no natural enemies their only defense is to swim away. The lack of major environmental stress also is reflected in social behavior. Since manatees do not need to work together to obtain food or deter predators they have a relatively unstructured social life.54

Activity Cycles

Manatees do not have any set daily routines and will feed, rest and perform other activities throughout the day and night. However, during winter cold spells, activities such as feeding trips may be regulated by diurnal temperature cycles. Extensive studies at Blue Spring revealed that manatees would leave the constant- temperature spring run in late afternoon to feed in the St. John River and return in the early morning, thus conserving energy by leaving the spring run when the river was at its warmest. This routine ceased with warm spring weather.27 Manatees also have been reported to time their activities to avoid harassment by boats or divers.32,58

Locomotion

Manatees move forward by undulating their tails and steering with their tails and flippers. They are neutrally buoyant in the water and can move vertically in the water, apparently by changing the volume of air in the lungs by muscular contraction or relaxation.59

Manatees are surprisingly agile underwater and can perform maneuvers such as somersaults, barrel rolls, head and tail stands and upside-down gliding. Although clocked at speed of up to 25 kilometers (15 miles) per hour for short bursts, manatees generally cruise at speeds of 4 to 10 kilometers (2-6 miles) per hour.54

Feeding

Manatees spend about five hours a day feeding and in that time consume about 4 to 9 percent of their body weight in wet vegetation.69,49 Vegetation is grasped and torn by the lips, which are strengthened with lateral, horny pads, and then passed back to the grinding molars. Stomach content analyses show that food is well-chewed.61 Manatees feeding in a seagrass bed either crop the seagrass leaves or dig into the sediment with their flippers to eat the rhizomes or roots as well as the leaves.31 Much of the biomass and carbohydrates in seagrasses is concentrated in the below-ground portion of the plant. In areas where manatees are concentrated, such as near warm-water refuge, digging up rhizomes can result in the temporary disruption of seagrass beds. However, there is no evidence to suggest that manatees have a damaging effect on grassbeds.

Manatees are often seen feeding at the edge of seagrass beds, possibly because nearby deeper areas offer an escape route if disturbed. Protection from wind and currents is preferred, so manatees will often chose feeding sites behind barrier islands.62 Birds, such as little blue herons, sometimes feed on the fish and invertebrates flushed out of vegetation by browsing manatees.63 Just before winter, manatees living in the St. Johns River and Blue Spring increase the amount of time spent feeding. Manatees need large

amounts of food in winter because more energy is required to maintain body temperature in cooler water and winter forage may have a lower caloric value.60 Manatees may also fast, especially during cold weather. Several manatees observed in Blue Spring during a cold spell did not feed for over a week.27

Manatees are opportunistic feeders and many kinds of plants are eaten in the wild and in captivity. Some researchers have suggested that manatees will eat any plant soft enough to be torn by the muscular upper lip, and a varied diet is probably necessary to meet nutritional requirements. However, some plants such as spatterdock are clearly avoided, possibly because they taste bitter.27 Submerged, emergent and floating vegetation, in that order, appear to be the preferred food of manatees. The orientation of the manatee's mouth is particularly adapted to feeding on bottom vegetation.64

Manatees can crawl partway onto a bank to reach shoreline vegetation and, at Blue Spring run, manatees have been observed feeding on acorns that fall to the river bottom from overhanging live oak trees. Acorns can be a nutritious source of food in early winter when aquatic vegetation is sparse.65 Manatees also incidentally eat invertebrates, which may supply needed protein. In captivity, manatees will readily accept fish; in Jamaica they have been observed eating fish captured in fill nets.66

Manatees may or may not need freshwater to survive, but they frequently are reported drinking freshwater from hoses, sewage outfalls and culverts in saline areas.29

Resting and Maintenance Behavior

Manatees rest from 2 to 12 hours a day either suspended near the surface or lying on the bottom, usually for several hours at a time. If resting on the bottom, they surface to breathe in an almost hypnotic state. On cold days when surface waters are warmer, manatees tend to rest at the surface. Manatees usually spend less than five minutes at a time underwater,62 but bottom resting for almost 12 minutes has been reported.54

Manatees often clean their mouths with their flippers and root in sand or mud bottoms. They also rub themselves against logs, rocks, ropes and even the hulls of boats. Females tend to rub more than males and the parts of the body rubbed often are places where glandular secretions may be produced such as the genitals, around the eyes, armpits and chin. This scratching may just be to relieve itching, but it has been speculated that it might serve to leave a scent message as to the presence and reproductive condition of resident females. Males traveling over large areas could check traditional rubbing posts to assess the receptivity of local females. This would assure that females would have a wide selection of mates.67

Manatees rest at the surface or on the bottom for many hours each day, surfacing only to breathe. While resting on the bottom, some manatees lie on their backs.

Communication

Manatees communicate through sound, sight and probably taste, touch and smell. Despite the absence of external ears and the small size of the auditory passage, manatees hear very well, including a certain degree of ultrasonic reception.68 Manatee cows will respond to the squeals of their calves from more than 60 meters (almost 200 feet) away, and adult manatees have been reported to home in on sounds from 50 meters (160 feet) away.54

Manatees emit a range of sounds underwater that are within human auditory range. These sounds are believed to be used for communication and not for echolocation or navigation.69 Indeed, manatees may bump into objects in murky water.70 Manatees make sounds when they are frightened, sexually aroused or playing, and vocalization plays a role in maintaining contact between adults and between cow and calf. A cow and her calf separated by a flood gate vocalized constantly for three hours until the dam was opened.32 Calls are used to maintain contact while feeding and traveling, particularly in turbid water. Rapid calling has been noted when a group is startled and flees an area and manatees appear to greet new arrivals with rapid vocalizations.71 Information can be conveyed by varying the pitch, loudness and duration of calls.67

Manatees will investigate objects visually, although depth perception seems poor at close range. In very clear water, manatees respond to visual cues from distances of 35 meters (115 feet).54 The presence of two types of cone cells in the retina suggests that manatees can see in color.72

Touch, taste and smell also may be forms of communication as manatees frequently make body contact and mouth each other.54 Manatees also seem able to discriminate preferred foods through taste.27

Social Behavior

The manatee has been described as "a mildly social, essentially solitary animal.54" Except for the relationship between a cow and her calf, most associations appear temporary. However, continuing research is revealing that social interactions may be more complex than previously thought.

Manatees are not territorial or aggressive and individuals within a group do not dominate others. Groups seem to form casually without regard to sex or age, with the exception of cow-calf pairs and groups of juvenile males that form temporary bachelor herds as a result of their exclusion from reproduction.32

"Kissing" may be a form of communication between manatees.

Although individuals within a group do not exhibit dominance, an individual may initiate an activity that others will follow. Manatees in Blue Lagoon Lake were seen bodysurfing together in flumes created by a salinity intrusion barrier. Four adults, following the lead of a fifth manatee, bodysurfed for over an hour, with frequent vocalizations and nuzzling between rides.32

Other forms of social interaction include "kissing," mouthing, bumping and chasing. Juvenile males sometimes instigate play with juvenile or adult females that

suggests sexual activity. Manatees may play for hours but generally only after they have fed and are not harassed.

Sexual Behavior

While female manatees do not form permanent associations with males, during estrus or heat, a cow will be pursued by courting bulls. This "mating herd" may remain together from a week to a month. Juvenile males may join and leave the herd but a nucleus of mature, persistent bulls will remain.54 The males may establish a dominance order for mating rights. Females have a long estrous period that allows time for many males to gather and increases the number of potential mates.67 During most of the cycle, however, females attempt to flee and avoid the persistent bulls. When the female is receptive, she will copulate with one or more males in succession. Copulation is brief and occurs in an abdomen-to- abdomen position with the male below; in shallow water, a side-to-side position may be used.

In studies of the summer movements of manatees in the St. Johns River system, radio transmitters were used to track individual manatees.27 Adult males were found to systematically patrol and search sections of the river system in "circuits" lasting several days. Adult females, however, unless in estrus, stayed within relatively small home ranges along well-traveled routes. These contrasting travel patterns may serve a reproductive function. The behavior of the males allows them to maintain contact with many females and increases the chances of locating a female in estrus. Likewise, the female's behavior increases the likelihood of contact with males. As the female in estrus travels with males in pursuit, additional males are attracted for mating.

Cold-Related Aggregations

Between November and March each year, large numbers of manatees in Florida converge on sources of warm water. Individuals may come and go or move to other refuges throughout the winter. Warm-water refuges may be essential to manatee survival, particularly in north Florida. However, in winter not all of Florida's manatees can be accounted for at warm-water refuges. Some manatees may take refuge in coastal waters or protected bays where temperature fluctuations are minimal; groups of manatees have been reported in the Everglades National Park during cold snaps.73

The air and water temperatures associated with the arrival of manatees at warm-water refuges seem to vary with the location of the refuge and possibly the time of year. Air temperatures below 10oC (50oF) and water temperatures below 21-22oC (70-72oF) are correlated with the arrival of manatees at Crystal River and Blue Spring.54,27,28 At a power plant on the east coast, water temperatures of 15oC (59oF) were associated with large manatee aggregations.31

Irregular feeding of manatees is noted at 18-19OC (64-66OF)

Manatees may acclimate to cold temperatures as the season progresses. Research has shown that air temperatures of 10oC (50oF) prompted aggregations at Crystal River in November, but temperatures near 5oC (41oF) were needed before manatees sought warm water in March.54 A similar seasonal pattern also has been noted in studies at power-plant effluents. However, the decrease in the temperature associated with aggregations near warm water may reflect an increased need for feeding trips rather than acclimation.74 Manatees may be able to feed in cold water if they can move to warmer water for digestion.75 Energy stores appear to decrease over the winter as evidenced by the thinning of the fat layer.51

The threshold of cold tolerance has not been well established, but the 20- 23oC (68-73oF) temperatures found at the winter refuges is near the lower thermal neutral limit proposed for manatees.75 Work with captive manatees has shown that activity decreases with lower water temperatures. Irregular feeding is noted at 18-19oC (64-66oF) and feeding may cease completely as temperatures approach 10oC (50oF). The minimum temperature suitable for manatees generally is believed to be 19oC (66oF). However, manatees have been observed in water as cold as 13.5oC (53oF) with no ill effects.54 Undoubtedly, cold tolerance varies with age, health, vigor, activity and reproductive state of the individual.

Mortality

Over the past centuries, the principal sources of manatee mortality have been opportunistic hunting by man and deaths associated with unusually cold winters. Today poaching is rare, but high mortality rates from human-related sources threaten the future of the species.

A primary focus of research and conservation efforts has been to identify and quantify manatee mortality. Since the program began in 1974, more than 1,000 dead manatees have been recovered through the Manatee Salvage Program. Additional manatee deaths were verified but carcasses were not recovered and, presumably, other dead manatees were never found or reported. These statistics support the belief that reducing mortality is the fastest and most direct method of stabilizing or increasing manatee populations.76

Man-Related Causes

Information gathered through the Manatee Salvage Program has led to the identification of some of the causes of manatee mortality. Over 30 percent of the deaths for which a cause was determined were attributed to human activities. These are discussed in decreasing level of importance.

Boats and Barges

The largest single mortality factor is collision with boats and barges. The primary culprit is large boats over 7.3 meters (24 feet) long with inboard motors and propellers over 38 centimeters (15 inches) in diameter.77 However, small, fast-moving boats also kill manatees. Barges moving through shallow water or docking often crush manatees that have no room to escape. Most manatees in Florida bear scars or deformities from being run over by boats. These scars are so common and distinctive that they are used in research for long-term recognition of individuals. Over 900 individual manatees have been catalogued by distinctive scars.78.2

About half of the manatees killed by boats do not have fresh propeller marks, indicating that they were killed by impact

rather than propeller cuts. Manatees cannot escape fast boats, and there may not be enough clearance to get out of the way even when a boat is moving slowly.77 Some researchers have noted that manatees do not necessarily avoid areas with heavy boat traffic and may even become habituated to the sound of boats.31,32 Eighty percent of all deaths from boat/barge collisions occur in eastern Florida, particularly Brevard County and the St. Johns River.40,79

A massive effort by the state of Florida, the U.S. Fish and Wildlife Service (USFWS) and private organizations is underway to educate the boating public. Regulation of boat speeds and boat exclusionary areas are being enforced to reduce boat-related injuries and harassment. However many waterways used by manatees are not protected. Manatees regularly travel through the Intracoastal Waterway and the St. Johns River, including the main channels, as they migrate and so must contend with heavy boat and barge traffic. The effect of boats on manatee populations is particularly critical because it is mostly adults that are killed. Manatees need to maintain a high adult survival rate because they reproduce so slowly.79 The use of propeller guards may reduce injuries and deaths but since so many deaths are caused by impact with large boats, it has been calculated that no more than nine deaths a year would be prevented.79

Boat-related mortality is probably the greatest single threat to the manatee. Efforts by the USFWS, the Florida Department of Natural Resources and the Army Corps of Engineers to limit dredge and fill permits and control the size and location of marinas are directed toward this problem.

Flood-Control Structures

Manatees also are killed in flood gates and canal locks. This problem was particularly acute in Dade County, where automatic flood-control dams were killing more manatees than was boat traffic.80 Investigations of how manatees were killed in these structures led to the implementation of modified operating procedures. These inexpensive modifications have reduced this cause of mortality.79

Boat and barge collisions are responsible for many manatee deaths each year. Almost all manatees in Florida bear scars or deformities from being hit by boats.

Fishing Gear

Another cause of death is entanglement in or ingestion of fishing gear.81,82 Manatees often are seen with fishing hooks and lures imbedded in their lips and, occasionally, crabtrap lines may knot so tightly around their flippers that severe infections, amputation or death may result. Hoop nets formerly used by commercial fishermen in the St. Johns River would sometimes drown calves but the use of a simple excluder device appears to have solved this problem.

Poaching and Vandalism

Poaching and vandalism account for a few manatee deaths a year. However, with continued public awareness and law enforcement, the number of these deaths should be further reduced.

Loss of Habitat

Loss of habitat is one of the most serious threats to the manatee, as it is for all of Florida's wildlife. Many freshwater and marine grassbeds have been reduced or eliminated by water pollution, herbicides, dredge and fill projects and surface runoff. Formerly productive areas, including north Biscayne Bay and parts of Tampa Bay, have been extensively modified by human activity and many natural warm-water areas have been affected by loss or reduction of artesian flows.

Explosives used to widen the Miami River in 1943 killed at least 100 manatees,35 although the effects of development are usually less dramatic. Unprecedented human population growth and associated boat traffic along Florida's coasts and waterways have degraded and eliminated manatee habitat. There are now few places where the manatee is free from the danger and harassment posed by boats and other human activities.

Pollution

Pesticides, herbicides and industrial chemicals from ingested water and vegetation can accumulate in manatee tissue. Some studies have shown that pesticide residues in manatee tissue are below the levels of pathologic significance and that manatees are relatively uncontaminated by organochlorines, lead or mercury.83,81

Other analyses, however, have revealed that some manatees have high concentrations of copper in their tissue, probably - as a result of feeding on vegetation treated with copper-based herbicides.83 The level of copper in the diet of manatees normally is very low so there may be no physiological regulating mechanism to prevent the accumulation of copper in the liver. Copper-based herbicides were once widely used in areas where manatees gather. In one year alone, six tons of elemental copper were applied to the Crystal River system.83 Herbicide spraying is now restricted during times when manatees gather and the use of alternative control measures such as mechanical harvesting is encouraged.

Ingestion of pollutants may cause a range of sublethal effects that can reduce manatee viability. This is of particular concern in view of the potential for oil exploration on the outer continental shelf of both coasts of Florida. Many important coastal manatee habitats would be vulnerable to an offshore oil spill.

Harassment

Manatees frequently are disturbed by shin divers, boaters and fishermen. The noise pollution associated with boats disrupts vocal communication among manatees and boat traffic can interrupt mating activity.67 Although some manatees will seek the attention of divers, most will avoid humans. Harassment, particularly in warm-water refuges, forces manatees to use less-preferred or marginal habitat and subjects them to the possibility of cold-related illness.

Manatees cannot escape fast boats, and there may not be enough clearance to get out of the way even when a boat is moving slowly. Regulation of boat speeds and boat exclusionary areas are being enforced to reduce boat-related injuries and harassment.

Natural Factors

Cold Weather

Reports of manatee deaths often follow unusually cold weather, as occurred in the winters of 1977, 1981 and 1984.79 The presence of man-made warm-water sources in central and northern Florida may cause some manatees to winter in areas that during severe winters are too cold for their needs. However, winter deaths are geographically widespread throughout Florida and not concentrated around plants or other winter refuges.79

The reasons for cold-associated deaths still are not clear. It was once thought that cold made manatees more susceptible to diseases such as pneumonia, but recent studies suggest that most cold-related deaths are not due to disease. Instead, during severe winters, affected individuals cannot produce enough metabolic heat to make up for heat loss to the environment. These animals have reduced fat reserves and show general physical wasting as from malnutrition.84,79 At water temperatures below 16oC (60.8oF), captive manatees become lethargic and stop eating.85

Young in their first year of independence account for many winter deaths. The susceptibility of the young may be due to their smaller size which causes them to lose more body heat than larger animals. Because of their inexperience with traditional migration routes, they also may become stranded in cold water, become lethargic and stop eating.79

Red Tide

During the spring of 1982, at least 37 manatees died in Lee County in the lower Calooosahatchee River and San Carlos Bay in association with an outbreak of red-tide. Many of the dead manatees had ingested large numbers of small marine animals, known as ascidians or sea squirts, that may have accumulated toxins from the red-tide organisms. The sea squirts were probably ingested incidentally as the manatees fed in seagrass beds.84 These manatees also may have been exposed to airborn toxins from red tide as they breathed at the water's surface.

Legal Protection and Conservation Efforts

Florida was established as a manatee sanctuary by the English as early as the eighteenth century. In 1893, a Florida law was established to protect manatees, and since 1907 there has been a fine of $500 for a person who kills or molests one. In July 1978, protection was increased significantly when the "Florida Manatee Sanctuary Act" was passed by the state. This act established the entire state of Florida as a "refuge and sanctuary for the manatees" and allowed for enforcement of boat speed regulations in designated areas. State responsibility for manatee protection is vested with the Florida Department of Natural Resources (DNR) and the Florida Game and Fresh Water Fish Commission.

Manatees are protected at the federal level by the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973, as amended. The Endangered Species Act makes it a violation to "harass, harm, pursue, hunt, shoot, wound, kill, capture, or collect endangered species." Violations can result in fines of up to $20,000 and/or up to one year in prison. The law also prohibits the importation or exportation of endangered species or their parts or products. Federal legislation is administered by the U.S. Fish and Wildlife Service (USFWS) in cooperation with state agencies. Many state law-enforcement officers have been federally deputized so that they can enforce the federal as well as state laws.

Many federal, state and private groups have joined in the effort to protect the manatee. The USFWS (through the National Ecology Center) is directing its efforts toward research. In 1974, this agency began the Sirenia Project to plan and conduct the basic research needed to protect the species. The Manatee Salvage Program, begun as part of this project, provides a network for reporting and recovering injured or dead manatees. Treatment for injured animals is provided by private oceanaria and dead manatees are salvaged for necropsy. This program, which is now under the direction of DNR, has provided valuable information on manatee mortality as well as specimens for research. The USFWS is also responsible for establishing manatee refuges and sanctuaries; these efforts are performed under the authority of the Endangered Species Act and the Florida Manatee Sanctuary Act.

Twenty-two manatee wintering sites are now manatee protection zones including Kings Bay at the headwaters of Crystal River and Blue Spring on the St. Johns River. Boat speeds are curtailed in manatee protection zones; in areas designated as refuges, no boats, swimmers or divers are permitted.

To determine how to meet the goals of recent legislation, the USFWS led a group of state and private agencies in developing the "West Indian Manatee Recovery Plan" to identify the actions needed to "prevent further decline and to encourage recovery of manatee populations in U.S. waters.76" This plan sets priorities for research and management and presents a schedule for implementing the objectives of the plan.

Manatee protection must be addressed at the regional, county and local levels. The DNR, in concert with the USFWS, works closely with regional planning councils, county planners and city officials to include manatee protection in log-term planning. Marine industry representatives and boating interests have also been enlisted in determining how to balance the needs of boaters with manatee safety.

In 1978-1979, radio-tracking was used to study manatees in the St. Johns River system.27 Later, techniques were developed to monitor the movements of manatees in saltwater areas. This method uses a VHF or satellite-monitored transmitter attached to a 2-meter long (6.5 foot) tether that is belted around the tail of a manatee. The long tether allows the transmitter to float at the surface, thus avoiding the problems of attenuation of signals in saltwater. The belt buckle around the manatee is designed to eventually corrode and fall off and the tether will pop off if a manatee becomes entangled. The location of the manatee, activity information, and water temperature are plotted from satellite information and verified by boat or shore observation.

Satellite radios are expensive but the te-

chnology is improving and much valuable information is being gathered on manatee movements. VHF radios are not expensive but require extensive man power to track the animals. One problem encountered in tracking studies is that many tags are being removed by bystanders unaware of the telemetry research. The equipment is not dangerous or stressful to the animals.86

The best plans are ineffective if the public is not sufficiently informed to support conservation efforts. In response to this, the DNR and conservation organizations conduct a variety of public-awareness programs on manatee conservation. The DNR operates a Resource Alert number to receive reports of manatee injuries, deaths, tag sightings or harassment. The number, for the stat of Florida only, is 1-800-DIAL-FMP (342-5367).

Private organizations contribute greatly to conservative efforts. The Save the Manatee Club is located at 500 N. Maitland Ave., Maitland, FL 32751, (407-539-0990). With over 27,000 members, this growing organization focuses on promoting public awareness of the manatee and funding research and conservation projects. Private oceanaria in Florida have spent millions of dollars in rescuing and rehabilitating manatees. This work has led to an improvement in manatee husbandry methods and yielded important information on life history.

Florida Power & Light Company (FPL) is an important contributor to manatee research and conservation efforts. Funded by FPL, the Florida Audubon Society, and, more recently, Eckerd College have conducted aerial surveys to monitor manatee populations and identify important habitats. A USFWS investigation of the manatees' winter use of two power plant effluents on the Indian River in Brevard County was also funded by FPL. The ongoing projects of cataloging distinctively scarred manatees and radio-tracking animals are also supported. In addition, FPL sponsors public-awareness and educational programs, distributes booklets and films, and supplies bumper stickers that declare "I Slow for Manatees."

Many manatees take refuge during cold weather in the warm-water discharges of power plants.

Outlook for the Future

The extinction of all sirenians is a distinct possibility. The tragedy of this is that the conservation of the manatee, particularly in Florida, poses such an ideal challenge. The manatee in the United States does not present the international conflicts such as posed by whaling, does not conflict with fishing interests, is not used by indigenous people for subsistence, is not dangerous, and in fact, is a tourist attraction.87 Manatees are adaptable animals that eat a wide range of plants and move readily between fresh and saltwater habitats. They do not require large wilderness areas and, when not hunted, lose their fear of man and can even live in heavily developed urban environments.26 The primary conflict appears to be with boating-related activities.

As one of the most affluent and conservation-minded nations in the world, we should be able to coexist with this docile mammal.87 If we cannot save the manatee in the United States, it sets a poor example for Third World countries under pressure to preserve habitat and wildlife where the issues can be much more complex.

Wildlife management is really people management. In Florida the problem is one of preserving habitat and travelways in the face of an ever increasing number of people, marinas, boats, divers and waterfront developments.88 Research and conservation efforts by many cooperating public and private groups raise hopes that a way may be found to ensure the survival of the manatee. The establishment of refuges and sanctuaries, enforcement of boat speed limits, public education campaigns, and the reduction of mortality from specific causes such as flood-control structures and hoop nets are all positive steps. However, the loss of at least 37 manatees in the spring of 1982 from red tide show how tenuous any progress can be.

In the near future, many of the man-made sources of warm water that manatees have come to depend on will be approaching the end of their operating life span. Decisions will have to be made as to how to compensate or cope with these losses.26 The struggle to protect the manatee will have to continue for many years.

As the human population of Florida continues to grow, the competition between man and manatee for the use of aquatic habitats will increase. If manatees are to survive, ways must be found to minimize this conflict and sufficient waterfront property must be left undeveloped. At some point we must realize that if the human population of the state is allowed to grow indefinitely, there will be very little wildlife and few wild places left.

Non-legislative solutions are very important. These include public education, environmental and conservation organizations, corporate funding, and land-use planning that considers the needs of manatees.89 Attention also must be directed at cooperative efforts with other nations to develop research and conservation plans for manatee populations outside of the United States. Much still needs to be done if future generations are to know these unique animals.

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Florida Power & Light Company (FPL), in its concern for the environment, has funded a series of educational booklets, including this one, as well as many other educational and research projects. Dr J. Ross Wilcox, chief ecologist with the environmental affairs department at FPL, is responsible for developing and coordinating these projects.

Additional Information Available from FPL

Publications

Florida's Sea Turtles
Florida's Wood Storks
Florida's Alligators and

Crocodiles
The Florida Panther

16-mm Films

Silent Sirens: Manatees in Peril (a 25-minute film about manatees in Florida) Seasons in the Swamp (a 28-minute film about wildlife and seasonal cycles of a south Florida cypress swamp) These materials may be obtained by writing to: Florida Power & Light Company Corporate Communications P.O. Box 029100 Miami, Florida 33102-9100

Manatee Protection Zones in Florida

The numbers refer to counties that are targeted by the Department of Natural Resources for protection zones. Areas in the following counties have boating speed limits already in effect or planned:

1.Citrus County 2.Sarasota County 3.Lee County 4.Collier County 5.Dade County 6.Broward County 7.Palm Beach County 8.Martin County 9.St. Lucie County 10.. Indian River County 11.. Brevard County 12.. Volusia County 13.. Duval County

For site-specific details, consult the local marine patrol in the appropriate county.

Blue indicates general distribution of the West Indian manatee in the Caribbean.

Boating Speed Zones

To alert the boater and protect the manatee, the law provides a number of cautionary and regulatory speed zones. Following are some illustrations and a brief explanation of the various signs:

Safe Operation Zone A sign indicating that you may resume safe boating speed; visible as you leave a protected area.

Caution Zone A zone frequently inhabited by manatees, requiring caution on the part of boaters to avoid disturbing or injuring the animals.

Slow Speed Zone A no-wake or minimum-wake zone where boats must not be on a plane and must be level in the water; generally these signs are posted on the fringe of protected areas to warn you that you are approaching an area frequented by manatees; in some areas the channel is exempt.

Idle Speed Zone A zone in which boats are not permitted to go any faster than necessary to be steered; generally these signs appear near the center of a protected manatee zone.

No Entry Zone A protected zone that prohibits boating, swimming and diving for the protection of manatees. For information on obtaining "Caution, Manatee Area" and display signs for your area and boat ramps, please contact the Bureau of Protected Species Management at 904-922-4330.

Help Save the Manatee

You can help save the manatee. You can make a donation of $1 or more to the Department of Natural Resources to help protect the manatee. When filing your boat registration, simply note the amount you would like to contribute in the box marked "manatee donation."

When renewing or purchasing new auto tags, request a "manatee tag." The additional fee you'll pay will fund manatee research and conservation activities at the state and federal levels, in addition to environmental education in Florida schools. Call your local auto tag agency for additional information.

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