

# The Past, Present, and Future of Manatees In The Southeastern United States: Realities, Misunderstandings, and Enigmas

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## Abstract

A review of the historical and recent (1970s-1980s) literature on the distribution, abundance, and mortality of West Indian manatees (*Trichechus manatus*) in the southeastern United States is presented. Recent unpublished data on mortality, Florida boat registrations, sizes of certain manatee wintering populations, and records outside of Florida are also given. Manatees never regularly occurred outside of Florida, except during the summer in Georgia. Current distribution is also limited largely to Florida and coastal Georgia in summer, with extralimital records in other southeastern states. In winter the range contracts and is centered around warm water sources in Florida. The historical record on past abundance is inconclusive, but does not provide any compelling evidence to claim that manatees ever nearly became extinct. There are no satisfactory means to estimate manatee population size. However, within Florida, manatees have become more widespread and possibly more abundant during the past 30 years due to protection, greater availability of warm water in winter, and in some areas, increased exotic vegetation. Deliberate killing for food was long a historical pressure on manatee populations in Florida, but is now almost non-existent. Nevertheless, recent increasing trends in accidental mortality caused by boats, coupled with an understanding of manatee population dynamics, suggests that the future for manatees is not secure. Ample justification exists for continued manatee conservation efforts.

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## Introduction

Many of our endangered mammals can be characterized by 1 or more of the following 3 attributes: (1) a major reduction in range in comparison with past distribution; (2) a marked decrease in abundance from historical times; and (3) a narrow range of habitat requirements. However, these attributes are sometimes inappropriately generalized to all endangered mammals. Misunderstandings can arise and become perpetuated through such generalizations, and this has sometimes occurred in the case of the West Indian manatee. The first objective of this report, therefore, is to critically review the literature on the past distribution, abundance, and mortality of the West Indian manatee in the southeastern United States. The second objective is to summarize recent information on these topics from the 1970s and 1980s to better understand the species' present status. Past and present comparisons are made, and common misunderstandings and enigmas arising from the above generalizations are identified. Finally, the need for actions for future manatee conservation and the bases for their justification are examined.

Colleagues at the Sirenia Project, National Ecology Center, provided numerous discussions on this topic over the past several years. Problems faced by biologists concerned with manatee conservation issues at the U.S. Fish and Wildlife Service Endangered Species Office in Jacksonville, Florida also helped provide impetus for this review. P. Rose and co-workers at the Florida Department of Natural Resources shared information, including unpublished data on boat registrations and on manatee mortality totals for 1986 and the latter part of 1985. Prior mortality data were acquired by colleagues at the Sirenia Project and the University of Miami, particularly C. Beck,

R. Bonde, K. Frohlich, and D. Odell. C. Beck and B. Beeler helped maintain and tabulate extralimital records. Recent manatee counts at Crystal River and Blue Spring were provided by G. Carowan and W. Hartley, respectively. D. Wesley, E. Possardt, P. Rose, J. Vorhees, and anonymous reviewers provided comments on the manuscript. Preparation of early drafts of the manuscript was assisted by the Florida Cooperative Fish and Wildlife Research Unit. A. Brand typed the later drafts.

## Methods

This paper is largely a literature review. Much of the historical literature is difficult to acquire, and therefore key points and quotations are tabulated in chronological sequence for easy reference (Table 1). The original statements of the authors are important to see for what they contain and do not contain. Recent, previously unpublished data are presented in addition to a treatment of the literature on present status (1970s and 1980s). Previously unpublished sightings are included, and these are subject to the same potential biases cautioned by Rathbun et al. (1982) in their presentation of similar accounts through June 1981.

## The Past

**Distribution**—Misunderstandings continue to exist that suggest that manatees were once more widespread in the southeastern United States and that their current distribution represents a reduction in range. This is clearly not true based on the archaeological evidence and the written record (Table 1). The basis for supposing

a more widespread former distribution probably lies in the statement made by Stearns to True (1884), quoted in Table 1. I found no historical references prior to this remark that suggested that manatees regularly occurred outside of Florida along the Gulf or Atlantic coasts, but the suggestion appears several times subsequently (Table 1). Although some authors have perpetuated this misunderstanding (Table 1), Gunter (1941) was skeptical of Stearns' remarks, and Moore (1951a: p.11) wrote that Stearns' statements "are not regarded as based upon fact."

Moore (1951a) presented the first detailed accounts that showed that up until the time of his writing manatees did not regularly occur outside of Florida. He noted that the winter range was constricted by southern migration, but that in summer manatees ranged farther north. Moore (1951a) concluded that manatee distribution records in southeastern states other than Georgia represented exceptional seasonal wanderers. This view on records outside of Florida has been substantiated by more recent reviews and distribution records compiled by Hartman (1974), Husar (1977), Rathbun et al. (1982), and Powell and Rathbun (1984). It is also upheld by our current knowledge of the physiological limits of temperature tolerance for this species (Irvine 1983). Manatees are tropical mammals subsisting on a low-energy food base. A very low rate of basal metabolism, a limited capacity for thermogenesis, and a high thermal conductance allow them to exist on this food base in warm areas, but these physiological traits also dictate the limit of their winter range (Irvine 1983). Manatees that do not return to Florida following summer wanderings (except perhaps for a few finding artificial warm water sources in Georgia) die from cold exposure (O'Shea et al. 1985, and recent accounts given below). The northern Gulf of Mexico, for example, is considered to be a strong enough climatic barrier to have contributed to the currently recognized subspecific differentiation of manatees in Florida (Domning and Hayek 1986).

The distribution of manatees within Florida had apparently changed on the Gulf Coast by the first half of the 20th century, but not on the Atlantic Coast. Records assembled by Moore (1951a) for this period indicated that in winter manatees did not occur north of the Sebastian River on the Atlantic Coast, but in summer were more widespread. However, on the Gulf Coast, Charlotte Harbor was considered by Moore (1951a) to be the northern limit in both winter and summer. Manatees were not regularly seen in the Tampa Bay area, or at the Suwannee, Crystal, or Homosassa rivers at any time of year. This is a reduction in range since prior times. Manatee rib fragments are known from a pre-Columbian Indian midden at Crystal River (Cumbaà 1980), a specimen was collected in the Homosassa River in 1879 (Powell and Rathbun 1984), Bartram (1791) reported sightings at Manatee Springs on the Suwannee River in the late 1700s, and Maynard (1872) noted that manatees were common from Tampa Bay south in the 1800s.

**Abundance**—References on the historical abundance of manatees have been vague and contradictory (Table 1), and as a result the true levels of past manatee populations will always remain enigmatic. Nevertheless, these early accounts have been cited as evidence of drastic reductions in manatee population size. This misunderstanding is not unequivocally supported by the historical record. Hartman (1974) was the first recent writer to examine the literature on this point, and considered several of the references noted in Table 1. The following 4 statements made in Hartman's (1974) comprehensive report are particularly critical for reexamination: (1) "In the United States the manatee is believed to have been close to extinction at the end of the last century." (p. ii), (2) "The scarcity of such remains [manatee bones in pre-Columbian Indian middens] suggests that manatees were a supplemental rather than a staple element of the native diet and probably not abundant." (p.202), (3) "Based on the meager evidence in the literature it seems fair to assume there were several thousand in the United States before the advent of the white man. From the time of the Spanish Occupation in the 16th century until the first decade of the 20th century, it appears the number of manatees was gradually reduced to status below their current level of abundance. Although poorly documented, it is generally agreed that manatee stocks suffered their severest depletion around the turn of the last century..." (p. 202), (4) "Reports in the early literature... are conflicting and episodic but infer that manatees were relatively common in historic times, at least until the middle of the 19th century." (p. 202).

Reports in the early literature are indeed "conflicting and episodic" (Table 1). They are also lacking in data and build upon one another over the years. Archaeological findings (Table 1) suggest that manatees were not very numerous in pre-Columbian times. Although manatee bones may sometimes have been left at kill sites and not transported to middens, these findings agree with Hartman's statement that manatees were supplemental Indian dietary items and probably not abundant. However, they do not provide any basis to assume the existence of several thousand manatees in pre-Columbian times. Early Indians were more numerous prior to European colonization, with culture and economies tied to hunting and fishing (Williams 1837, Goggin and Sturtevant 1964), and undoubtedly exerted some degree of hunting pressure on manatees. Direct comments on subsequent abundance begin to appear in the early 1800s, some 300 years after the "advent of the white man," and these indicate that manatees were not uncommon at the time (Table 1). By the mid-1800s some authors continued to state that manatees were "found in large numbers," were "remarkably abundant" (Maynard 1872), "considered common" (LeBaron 1880), and "cannot yet be

considered as threatened with extinction" (True 1884); others stated "They are nearly extinct" (Brinton 1869), or were "fast becoming an extinct animal" (Canova 1885). These conflicting remarks are not firm evidence for declining populations. The disparities may be rooted in the amount of first-hand knowledge of manatees possessed by the writers. Perhaps Stearns' comments on abundance were closer to the mark than those on distribution when he noted a possibly greater abundance of manatees than generally recognized because of the species' shyness (Table 1). In areas where they are hunted, manatees become elusive and secretive (Barrett 1935), even to the extent of shifting activity patterns to become nocturnal (Rathbun et al. 1983). Manatees were hunted throughout all but the most recent history of human occupation in Florida (see *Mortality* below).

The only evidence for the conclusion of a near-extinction of manatees at the close of the 19th century appears to be the anecdotal account by Bangs (1895), whose opinion cannot be corroborated. Bangs (1895) may have been unduly influenced by the finding of 5 dead manatees killed by extremely cold weather, and the report of a local resident who had not seen manatees for several years (Table 1). However, a less frequently quoted account by Cory (1896) claims that manatees were abundant during the same era (Table 1). Subsequent references throughout the 20th century curiously note that manatees were not particularly rare and that populations therefore must have increased since the supposed decline noted by Bangs in the 1890s. This evidence for "severe depletion" or near extinction in the late 19th century is far from compelling, and should be considered more of a misunderstanding than an enigma. To the contrary, data from modern genetic studies indicate that Florida manatee populations were never severely reduced to the point of creating long-lasting genetic "bottlenecks," and a relatively high genetic variability characterizes the present population (McClenaghan and O'Shea, in press).

**Mortality**—A number of accounts record the deaths of manatees following unusually cold winter weather (Bangs 1895, Cahn 1940, Hamilton 1941, Moore 1956). No historical records exist for natural predation on Florida manatees or for other major die-offs. Past accounts indicate instead that centuries of opportunistic exploitation by man for food was the principal source of mortality for manatees in Florida. Manatee bones, although not numerous, are known from pre-Columbian middens (Cumbaa 1980), and mound pipes in the form of manatees were widely used for ceremonial smoking (Barber 1882), indicating that knowledge of the species was widespread among prehistoric Indian groups. Bartram (1791) noted the hunting of the "big beaver" by Indians, as did Harlan (1824). No detailed descriptions of manatee hunting by Indians are known from the early Spanish colonists, in contrast to several Spanish accounts from the 1500s on native whale hunts along Florida's east coast (Goggin and Sturtevant 1964, Larson

1970). (Swanton [1922, 1946] suggested these accounts were descriptions of manatee hunts, but subsequent authors disagree.) However, the Spanish were familiar with manatee hunting elsewhere at the time, having devised a crossbow technique for this use in South America in the 1500s (Baughman 1946), and one 19th century author stated (without documentation) that Florida Indians sold manatee meat to the Spanish (Canova 1885). Other secondary sources also refer to manatee hunting by early Florida Indians (Elliott 1943). It is likely that Indian hunting pressure on manatees existed long before the advent of the European, and early Spanish explorers found much greater populations of indigenous people in Florida to exert such pressure than endured through the following centuries (Williams 1837, Goggin and Sturtevant 1964). The Europeans added firearms to the hunt, however, apparently first noted by Williams (1837) (Table 1). Audubon (in Proby 1974) described his pilot in the Keys in 1832 as having killed "hundreds" for sale in Cuban markets, but it is unclear if the manatees were killed in Florida or elsewhere. Some of the accounts from the mid-1800s on refer to netting and shooting of manatees in Florida (Table 1), much of which may have been incidental to fisheries and turtle-netting activities. However, LeBaron (1880) and Canova (1885) also give excellent descriptions of deliberate manatee netting episodes. Cory (1896) described the manatee harpooning and shooting activities of a small number of Seminoles centered around the New River, and noted that surplus meat was sold to white settlers.

The true extent of hunting pressure on manatees in Florida will never be known because of an absence of detailed records, but it is clear that manatees in Florida were never subjected to the level of *commercial* exploitation they experienced in South America (Domning 1982). The English declared Florida a manatee sanctuary in the 1700s (Campbell and Powell 1976) and the State of Florida provided protective legislation in 1893, with provisions for fines and prison sentences for manatee killing enacted in 1907 (Hartman 1974). Clandestine killing for meat, however, continued into the twentieth century despite legal protection (Allen 1942; Elliott 1943; Barbour 1944; Moore 1951a,b; Lyons 1969). Reports suggest that manatee poaching was common in parts of Florida during the 1930s and 1940s (Moore 1951a,b; Hartman 1974), when meat was in greater local demand due to the hardships of the Great Depression and World War II. Reports of illegal taking for meat during the late 1950s and early 1960s are rare, and are replaced by reports of deaths in collisions with boats as the primary source of human-related mortality (Layne 1965). The earliest notation of manatee deaths due to boat strikes may be that of Elliott (1943).

## The Present

**Distribution**—Much of our understanding of the present distribution of manatees in the southeastern

United States is based upon the detailed report by Hartman (1974). He solicited sighting records, conducted numerous interviews, and flew aerial surveys searching for manatees, all between November 1972 and January 1974. Hartman noted that records outside of Florida and the coastal sounds and rivers of Georgia were rare, that major seasonal migratory movements probably occurred, and that the locations of constant temperature springs and warm industrial effluents were critical areas of winter manatee concentrations in Florida. More recent summaries on distribution records in the southeastern United States outside of Florida were reported by Powell and Rathbun (1984), and Rathbun et al. (1982, in press). The following section reviews these records, provides additional recent unpublished data to update information on this topic, and describes the present distribution of manatees in Florida.

Rathbun et al. (1982) compiled 160 records of both live and dead manatees on the Atlantic coast north of Florida from 1676 through June 1981. Reports occurred with decreasing frequency northward, and most observations were in warm seasons. Relatively few manatees were reported north of Cape Hatteras, where the influence of cooler currents becomes strong, and the northernmost record was from the Potomac River. Manatee sightings and mortality reports compiled from June 1981 to 1986 (Table 2) repeat the pattern described from the earlier data. Forty-seven of the 63 sighting records were in Georgia, with only 5 during months from December through March (Fig. 1). Eleven deaths were also documented (Table 3), including the first 2 manatees reported to be killed by boats outside of Florida, and the first death in a shrimp trawl in Georgia. In contrast to these 11 recent deaths, Rathbun et al. (1982) noted 4 deaths during the 5-year period ending in 1981 and a total of just 15 since 1676. The number of dead manatees reported north of Florida appears to be increasing. The total number of records (sightings plus deaths) reported for the period 1981-1986 (74), however, is comparable to that reported by Rathbun et al. (1982) for the period 1975-1980 (73), despite the discontinuance of an active live sighting solicitation program around 1979.

Certain recent reports of manatees north of South Carolina may be multiple sightings of the same individuals. Two of these cases are of interest because they also show that failure to return south to Florida in winter may result in death. Six of the 9 sighting records reported from North Carolina (Table 2) were in 1983, and these shifted southward in autumn. Sightings ceased after the recovery of a manatee dead from cold stress in the Pamlico River in January 1984. A second series of sightings in Virginia in August and September 1985 was followed by a late September sighting in the York River in North Carolina, and the recovery of a carcass near Wilmington in March 1986.

In comparison with Atlantic coast states, manatee records in Gulf coast states outside of Florida are less numerous. However, the number of records in these

states appears to have increased in the 1970s and 1980s. Prior to 1970 there were no manatee records known from Mississippi or Alabama, 1 from Louisiana, 1 from the Louisiana-Texas border, and at least 9 from Texas (Powell and Rathbun 1984). The latter included at least 7 captured in the Rio Grande and Laguna Madre in the early 1900s thought to be drawn from Mexico rather than from Florida populations (Gunter 1942, Powell and Rathbun 1984). Powell and Rathbun (1984) reviewed 8 additional records from 1970 through 1981. These included multiple reports in Mississippi from 1978 to 1981; 1 sighting near Corpus Christi, Texas in 1979; and 3 reports of single manatees in Louisiana in 1975, 1976, and 1979. One of the Mississippi records was a subadult-sized female found dead from probable cold stress in January 1980 (Powell and Rathbun 1984).

Since 1982 there have been 2 separate sightings in Alabama (the first on record), a series of sightings of a single manatee in spring 1985 in Louisiana, and the first dead manatee recovered in Texas in nearly 50 years (Gunter 1942) (Table 4). The latter case was a badly decomposed carcass recovered in winter by S. Fernandez and S. Jones of Texas A&M University at Galveston. The skull was subsequently examined to determine if the specimen could be grouped with the Florida subspecies (*T. manatus latirostris*) or the Antillean subspecies (*T. manatus manatus*) found in Mexico. Unfortunately it could not be conclusively placed in either grouping (D. Domning, pers. commun.).

The distribution of manatees in Florida varies seasonally. In warm months (April-November) manatees may range nearly anywhere in Florida (Fig. 2) where depth exceeds 1-2 m, with the exception of isolated bodies of water or regions far from deep channels. They prefer estuarine or freshwater habitats over saltwater and do not regularly range offshore. They either require or prefer periodic access to freshwater (Hartman 1974, 1979). On the northern Gulf coast they are relatively infrequently seen west of the Suwannee River, but the lower Suwannee and its estuary are well used (Powell and Rathbun 1984). Manatees also frequent the lower Withlacoochee River, the lower Barge Canal, Crystal River, Homosassa River, and the mouth of the Chassahowitzka River, but are not seen in abundance along the coast between these sites; most of the manatees which occupy these summer-use areas winter in Crystal River and Homosassa Springs (Powell and Rathbun 1984, Rathbun et al. in press). South of the Chassahowitzka the Gulf of Mexico coast is not regularly used by manatees until suitable habitat is encountered in the Tampa Bay area. In this region manatees are reported to be most common in the vicinity of Manatee River and Little Manatee River (Hartman 1974). Manatees are not common on the coast south of Tampa Bay, but "sizeable" numbers occur in Charlotte Harbor, including the lower Peace and Myakka rivers (Hartman 1974). The passes between Charlotte Harbor and Estero Bay are frequented by manatees, as well as the lower

Caloosahatchee River; manatees are also relatively abundant southward through the Ten Thousand Islands and coastal Everglades, but not in Florida Bay or the Florida Keys (Hartman 1974, Irvine et al. 1982). On the Atlantic coast, manatees are reported from Biscayne Bay and the canals and rivers of southeastern Florida (including the Miami River, New River, and Little River), and the Intracoastal Waterway north to St. Lucie Inlet, although this region seems most heavily used in winter (Hartman 1974, Rose and McCutcheon 1980). Manatees are frequently sighted in summer in the Indian River lagoon north to Titusville, including the lower reaches of the St. Lucie and Sebastian rivers, and Crane and Turkey creeks (Shane 1983, Leatherwood 1979, Tiedemann 1983, Hartman 1974). The Banana River is well used by manatees but the northern Indian River and Mosquito Lagoon are not (Shane 1983). The Banana River's heavy use in non-winter months may be related to its restricted access to boats as part of security for the Kennedy Space Center complex. The Intracoastal Waterway north of Mosquito Lagoon is infrequently used by manatees except as a travel corridor, with most summer sightings occurring near inlets or in the Halifax or Tomoka rivers (Hartman 1974, Kinnaird 1985). The lower St. Johns River and associated creeks are well used by manatees in the warm seasons (Hartman 1974, Kinnaird 1985). The upper St. Johns system is used year-round as far south as upper Lake Monroe, particularly by manatees which winter at Blue Spring near DeLand (Hartman 1974, Bengtson 1981).

In winter, manatee distribution in Florida shifts to more southerly locations and to the vicinity of warm water sources (Fig. 3). Manatees leave the Suwannee and other waters of the southern Big Bend coast to winter at Crystal River and Homosassa Springs (Powell and Rathbun 1984). In the Tampa Bay region the animals collect near 2 industrial effluents (Reynolds and Wilcox 1985). In southwestern Florida the Fort Myers region becomes the focus of over 300 manatees drawn to the effluent of a single power plant (Reynolds and Wilcox 1986). Manatees are seen in winter around Whitewater Bay and other inshore sites in the Everglades (Irvine et al. 1982). Power plants on the Intracoastal Waterway in the Fort Lauderdale and Riviera Beach area are also the sites for aggregations of hundreds of manatees (Reynolds and Wilcox 1986), and significant numbers winter at 2 effluents on the Indian River near Titusville (Shane 1984), north of the historic winter range limits defined by Moore (1951a). Winter sightings north of the Indian River are unusual, except for small numbers of manatees typically seen in early or late winter at Jacksonville industrial effluents on the lower St. Johns (Kinnaird 1985). Manatees use the upper St. Johns near Blue Spring throughout the winter period (Bengtson 1981).

The use of warm water effluents is triggered by drops in ambient water temperature below about 20°C (Hartman 1979, Powell and Waldron 1981), and manatees

may move considerable distances to reach these sources. Individuals recognizable on the basis of scar patterns seen in the upper St. Johns in late fall have been resighted at southeastern Florida aggregation sites 850 km away later in the winter (U.S. Fish and Wildlife Service, unpublished data). Manatees along the Atlantic coast waterways (where travel corridors are continuous) seem to move these long distances readily. Individuals may shift wintering locations at Atlantic coast sites both within and between winters, and radiotagged manatees have been documented to move north between the Indian River and southern Georgia, covering over 230 km in as little as 4 days (U.S. Fish and Wildlife Service, unpublished data).

Travel between wintering sites on the Gulf Coast from Charlotte Harbor north may be more restricted because of less suitable habitat between well-used areas. About 90% of the same individuals return to the headwaters of the Crystal and Homosassa rivers each winter, but movement of one individual as far south as Sanibel Island has been reported (Powell and Rathbun 1984). Manatees do not use Lake Okeechobee heavily, and movements from the Gulf Coast to the Atlantic Coast through the Okeechobee waterway have not been documented. Little movement is suspected across Florida Bay. However, the high vagility of manatees on both coasts is sufficient enough to prevent any detectable regional genetic differentiation (McClenaghan and O'Shea, in press). Aerial surveys suggest that about equal numbers of manatees inhabit the Gulf and Atlantic coasts (Hartman 1974, Irvine and Campbell 1978).

**Abundance**—Perhaps the most troublesome enigma surrounding manatees in Florida is the problem of population size. Crude estimates of population size or minimum population size have been released in the past, and significant effort has gone into attempts to make more refined judgments on manatee numbers and population trends. Nevertheless manatee numbers presently cannot be estimated with any degree of sophistication, and this is frequently misunderstood. In the section below, the history of the present state of knowledge on this topic is reviewed and clarified.

The first numbers based on aerial survey data were crude estimates provided by Hartman (1974), who spent 151 hours searching for manatees by air over both Florida coasts, the Florida Keys, and the St. Johns River in summer 1973. The number of manatees seen (255) was corrected by calculations that sightings were 10, 50, or 90 percent underestimates in each of 3 water clarity categories assigned to the different areas surveyed. Hartman (1974) then stated "the total number of manatees in the United States is estimated between 750 and 850 with 1000 the conceivable maximum and 600 the conceivable minimum." Such an estimate has no statistical level of confidence associated with it, and estimates in subsequent years are not comparable because they are based on winter counts without correction.

The second attempt to count manatees occurred in 1976, and took advantage of winter cold fronts to survey from the air at aggregation sites (Irvine and Campbell 1978). Including observations from land at certain places, a total of 738 were counted. A workshop was convened in 1978 which reported that these data and a few subsequent counts "suggest a Florida population of at least 800 to 1000" (Brownell et al. 1981), thus revising Hartman's (1974) crude estimate upward. This was a simple *minimum* estimate, but use of *at least* has subsequently been misunderstood and transformed to *only* or *about* in numerous quarters; a conservative minimum estimate with no measure of accuracy or precision has been misunderstood to be an accurate, precise census.

This minimum estimate was revised to 1200 by the Florida Department of Natural Resources and the U.S. Fish and Wildlife Service in 1985. The revised minimum was based on high total counts (866) from aerial surveys at power plants made under unusually cold and favorable counting conditions in January 1985 (Reynolds and Wilcox 1986), unpublished totals at Tampa Bay sites, counts of 136 at Crystal River and 37 at Blue Spring, and estimated numbers in southern Florida not likely to have utilized areas subject to counting. The revised estimate was misunderstood in some quarters as evidence for a population increase. There is no evidence for or against a manatee population increase based on these 3 different estimates. In reality the most recent revision of the minimum number reflects unusually good conditions for counting (including exceptionally cold weather), the lack of a statistically firm basis for estimating population size, and the continued misunderstanding that the previous estimate was something other than *at least* 800 to 1000.

The major problems in trying to estimate manatee population size in Florida based on aerial counts are the high number of variables affecting both visibility and density (Packard 1985a). These problems do not allow precise or accurate population estimates and consequently also preclude detection of *changes* in population size. Counts have focused on warm water aggregation sites in winter, where a substantial data base on numbers seen has been developed over the past 10 years (see, for example, Rose and McCutcheon 1980, Shane 1984, Powell and Rathbun 1984, Reynolds and Wilcox 1986). Maximum counts for each site are employed as indices of abundance, but have no measure of variation to allow significance testing of changes seen among years. Counts at these warm water sites are negatively correlated with environmental temperature, but are also affected by water turbidity, surface chop and glare, prior weather patterns, manatee activity, and other variables (Packard 1985a). Conditions at some sites vary from shallow water of high clarity, to deep, dark water with foam-covered surfaces; manatees typically rest below the surface and may rise to breathe at irregular intervals from less than 1 to 20 minutes or more (Hartman 1979, Reynolds 1981). A significant amount of research has gone into efforts to control for some of these

variables or develop alternative means of estimating population size, but useful results have not yet been employed on a successful basis. Mean adjusted counts based on covariance models have promise (Packard and Mulholland 1983) but the technique requires considerably more development. Correction factors for visibility bias can also be obtained for different habitats (Packard et al. 1985), but these require independent development for multiple sites and survey conditions. A unit-recount technique has been recommended and employed on a trial basis at one site (Packard et al. 1986), but this also requires extensive effort and independent development for multiple sites, as well as further conceptual testing and verification. Mark-recapture techniques seem attractive, thereby avoiding the variability in winter aerial counts, but the number that would require capture and marking and the length of time required to recover data currently renders the development of such techniques impractical (Packard and Nichols 1983). The use of scar patterns inflicted by boats may have potential in mark-recapture estimates, but require the development of appropriate models (Packard and Nichols 1983). Unfortunately this has not been undertaken. However, an extensive photographic catalog of individual manatees recognizable on the basis of scar patterns has been developed which has over 900 entries and continues to grow (U.S. Fish and Wildlife Service, unpublished data). Considering the number of uncatalogued, scarred manatees and unblemished manatees not suitable for cataloguing, this total hints at greater numbers of manatees in Florida than previously believed.

Two manatee wintering areas have exceptionally clear water and are well-isolated from other such areas, as well as from each other: Blue Spring and the Crystal-Homosassa rivers. These are the only 2 areas where counts can be considered relatively accurate. Individual recognition of all manatees by scars at Blue Spring and aerial counts at the Crystal and Homosassa rivers show that these populations have been increasing remarkably. Counts have more than doubled in less than a decade and together all sites harbor some 250 manatees (Table 5). Data prior to the mid-1970s were not gathered consistently at these sites every winter. However, Hartman (1979) noted maximum winter counts ranging from 38 to 44 at Crystal River between 1967-68 and 1973-74, from 7 to 17 at Homosassa River between 1968-69 and 1973-74, and 11 and 18 at Blue Spring in winters 1970-71 and 1971-72, respectively. The maximum for all areas combined during these years is 79. Totals for winters 1986-87 at these sites (Table 5) represent a 300% increase over these earlier records. This population growth has been a result of strong internal recruitment as well as immigration. At Blue Spring, where all individuals can be recognized, about 70% of the increase in the past 10 years has been the result of reproduction (U.S. Fish and Wildlife Service, unpubl. data). The increase at Crystal River is also thought to be due largely to reproduction, with some additional

growth through immigration (Powell and Rathbun 1984). Since the mid-1970s both of these sites have also been intensively managed for manatee protection. Sanctuaries have been set aside where manatees can avoid intrusion by swimmers and boaters, and boat speeds and aquatic weed control are regulated in the surrounding areas. Inadvertently introduced exotic vegetation has flourished in Crystal River over the past 20 or more years, creating an as yet unlimited winter food supply (Etheridge et al. 1985) that together with low boat-caused mortality has probably also played a major role in the growth of the manatee population in this area (Powell and Rathbun 1984).

**Mortality**—Manatee deaths in other states have been described above. Mortality is by far greatest in Florida and is the subject of this account. A well-organized manatee carcass recovery program has been in existence in Florida since 1974. Standardized procedures are employed (Bonde et al. 1983), and records are periodically analyzed and reported (Odell and Reynolds 1979, Irvine et al. 1981, O'Shea et al. 1985). About 35% of the deaths from 1976-1981 were classified as human-related, principally due to collisions with boats; in regions of high boat-related mortality a disproportionate number of adults were killed (O'Shea et al. 1985). A common misunderstanding exists that propeller lacerations alone are responsible for these manatee deaths. Salvage records show that nearly half of all the boat-killed manatees are the victims of impact trauma with no involvement of propellers (Beck et al. 1982). The second leading cause of human-related mortality was entrapment in flood gates and canal locks (Odell and Reynolds 1979), which has been substantially reduced at certain structures as a result of operational modifications (O'Shea et al. 1985).

Although human-related mortality is of greatest concern, manatees were also found to be vulnerable to natural catastrophes. Larger numbers of deaths were reported in 1977, 1981, and 1984 in association with record cold weather, and at least 42 manatees died in 1982 coincident with a red tide outbreak in southwestern Florida (Buergelt et al. 1984, O'Shea et al. 1985). Winter kills chiefly involved subadults away from the vicinity of warm water sources. These deaths were not a result of pneumonia or other disease agents, as commonly misunderstood, but were thought to be a direct result of cold exposure (O'Shea et al. 1985).

Increasing numbers of manatees killed by boats and tremendous increases in boat traffic are the most important problems presently faced by manatees in Florida. A detailed analysis of the most recent mortality data is beyond the scope of this report. However, a simple listing of the number of dead manatees recovered in Florida during the past 10 years, including the number killed by boats, is illustrative of the most important present trend (Table 6). The number known to be killed by boats has ranged from 33 to 35 over the past 3 years, whereas the number of boat-kills averaged half this

amount over the previous 7 years (mean= $16 \pm 7.0$ , range=13-24). The number of boats registered in Florida counties within the range of manatees has also shown a steady and large increase during the past decade (Fig. 4). An increase in the responsible agents coupled with higher numbers of boat-caused deaths clearly leads to the prudent conclusion that the problem is growing seriously.

### **Past and Present: Comparisons and Conclusions**

There are no data to support the assumption that the present manatee population in the southeastern United States is reduced in range or numbers in comparison with the past. Manatees cannot survive winter water temperatures outside of Florida, but they can easily move into those areas in summer where suitable travel corridors exist. Re-examination of the historical record on abundance reveals that record to be rather inconclusive, yet suggests that manatees were never extremely rare. There are no records for the occurrence of manatees outside of Florida at archaeological sites, and manatee remains are not abundant at Florida Indian middens. Colonization of Florida by Europeans could conceivably have resulted in a reduced take by Indians because of a related reduction in Indian numbers, but settlers and pioneers killed manatees throughout recorded history. This long history of hunting pressure probably always suppressed manatee populations, never allowing them to become extremely abundant in the past, but there is no compelling evidence that it led to a near extinction at the turn of the century.

Manatees may have become more widespread and numerous since the 1950s due to protection, greater availability of warm water in winter, and increases in exotic vegetation. This comparison cannot be quantified because of the inadequacy of the historical record and our inability to accurately estimate current population size. However, manatees are now found at locations such as Tampa Bay and rivers of Florida's southern Big Bend coast, where records indicate rarity for many years. Wintering aggregations occur in the Indian River near Titusville north of historic winter range limits. Numbers have grown substantially at Crystal River on the southern Big Bend coast due to recent inadvertent introductions of exotic vegetation, natural warm water sources, and protection. Extralimital incursions of manatees into other southeastern states appear to be on the increase and may have been facilitated by these recent increases in populations at the northern extremes of the Florida winter range.

These northern limits represent areas where manatees exist on an energetic fringe imposed by their metabolic physiology. The proliferation of aquatic vegetation at Crystal River and the advent of warm water discharges from currently used power plants elsewhere in Florida (most of which were activated 30 years ago

(Rose and McCutcheon 1980)), may have helped tip the energetic balance to the positive side for manatees, possibly also contributing to an increase in population size. Killing as a food resource, long a historical pressure, also abated substantially about 30 years ago. This pressure has recently been replaced, however, by deaths due to collisions with boats and other forms of human-related mortality that are on the increase.

### The Future

The prospects for the future for manatees in the southeastern United States will lie in actions taken within Florida. Although manatees may have made a resurgence through the 1970s and early 1980s, it is likely that this trend may be over, and greater efforts will be required to maintain present numbers or to prevent a serious decline. The greatest misunderstanding that could arise from this evaluation of the past and present status of this species would be that current levels of abundance and distribution alleviate the need for further action. To the contrary, the unprecedented human population growth in Florida (Fernald et al. 1981) and the demands this growth imposes on the environment shared with manatees makes the future far from secure. Specific research and management actions will be necessary to better understand and mitigate the impact of the rapidly increasing number of boats on manatee mortality in Florida. Increased application of boat speed restriction zones and careful regulations affecting the locations and size of new boating facilities will be required. Most current speed regulation zones for manatee protection are in the immediate vicinity of seasonal aggregation areas, but boat-kills are widespread and take place in all seasons (O'Shea et al. 1985). Consideration will also need to be given to establishing larger reserves and determining criteria for such sanctuaries. Difficult decisions will be required of industry and conservation agencies as power plants approach the end of their operating lifespan in the near future, potentially cutting short the relatively recent energetic windfall created for manatees in Florida. Other problems will also require future deliberations, including conflicts between control of aquatic weeds and assurance of quality food supplies, preparedness for reducing manatee vulnerability to catastrophic losses, and attempts to foresee and avert new challenges to the continued existence of manatees and the habitat that supports them.

The management and research activities necessary for this effort will be involved, long-term, and costly. Cooperative participation of several levels of government, private conservation organizations, and industry will be required. The task of securing a future for manatees in Florida is no small one, and therefore requires justification. I conclude this paper with a discussion of the biological, legal, and humanistic justifications that obligate this responsibility.

**Biological Justification**—Two aspects of the biology of manatees justify actions required to secure their

future. Population dynamics indicate that recent increases in mortality could well result in declining trends; the behavioral and ecological plasticity of the species indicate that manatee populations will respond to actions taken in their behalf.

Packard (1985b) made the first efforts at modeling manatee population growth based on our current knowledge of life history traits, including a minimum age at first reproduction of 5 or more years, a minimum interbirth interval of 2 years, and litter size of 1 (U.S. Fish and Wildlife Service, unpubl. data). Various simulations involving a range of estimates for survival rates and variable reproductive traits revealed a maximum potential rate of increase of 2-7%. This low estimate is comparable to projections made for other marine mammal species (Eberhardt and Siniff 1977). The resulting model population is most sensitive to changes in adult survivorship followed by subadult survival (Packard 1985b). The disproportionate number of adults killed by boats and the susceptibility of subadults to cold winter weather previously revealed among manatee mortality patterns in Florida (O'Shea et al. 1985) appear ominous in light of the modeling results. Given the low potential rate of increase and the uncertainties in existing population data, Packard (1985b) could not rule out the possibility that a population decline may now be underway. Additionally, because of the statistical level of error involved with suggested indices of manatee population size (Packard et al. 1986), and the lack of other firm population estimation techniques, declining trends could continue for decades before such trends would be clearly recognizable in a statistical sense (Packard 1985b). Decades from now would be too late, particularly when the slow recovery rate from potential catastrophes revealed by the model are also considered (Packard 1985b). These population characteristics make it prudent to continue to develop safeguards for the manatee's future. Although we lack a solid means of estimating manatee numbers at present, quibbling over numbers or waiting until such techniques are developed before continuing management actions would be a serious mistake.

Manatees are unique in being the only large herbivorous aquatic mammal in our national fauna. Within this lifestyle, however, they are not narrowly specialized and they readily adapt to changing conditions. They are known to eat a wide range of food plants (Hartman 1979, Best 1981). Individual animals easily switch from floating freshwater aquatics to submerged saltwater seagrasses (Rathburn et al., in press), or will divide time between winter sites where seagrass predominates to summering areas where the only food available is marsh grass at high tide (U.S. Fish and Wildlife Service, unpubl. data). They will move freely between freshwater and saltwater, and quickly learn the locations of freshwater sources and warm water effluents (Hartman 1979). Areas set aside as sanctuaries are readily used by manatees (Table 5), on both a small scale (Rathburn et al., in press) as well as on a larger scale (Shane 1983). Manatees survive

numerous accidental encounters with boats and bear multiple scar patterns from these wounds, yet continue to reproduce (Hartman 1979, Beck et al. 1982, Powell and Rathbun 1984). They become shy and elusive when hunted, but where protected they may lose their fear of man and approach swimmers for rubbing and play (Hartman 1979, Powell and Rathbun 1984). Manatees do not require extensive wilderness, and can be observed in waters surrounded by urban environments as extreme as Miami, Tampa, or Jacksonville (Hartman 1974). The basic social organization of manatees, involving wide-ranging movements and the continual mixing, breaking up, and reforming into groups (Hartman 1979, Bengtson 1981) facilitates the quick transfer of information on the locations of key resources and also plays a role in their flexibility. Perhaps the greatest testimony of all to the ability of manatees to respond to a changing environment is their ability to persist at all in present-day coastal Florida. The numbers that exist in this environment today can provide a base for future populations without requiring extreme interventions such as captive breeding programs, provided that boat-related mortality and habitat deterioration can be held in check.

**Legal Justification**—Management agencies are legally obligated to secure the species' future and the continued existence of its habitat. The U.S. Marine Mammal Protection Act of 1972 (MMPA) requires management of marine mammals "to maintain the health and stability of the marine ecosystem" at "optimum sustainable populations" (see Eberhardt 1977a,b). The U.S. Endangered Species Act of 1973 (ESA) and its amendments have a number of important provisions that all apply to manatees, including Section 7 of ESA, which forbids Federal agencies from taking action that jeopardizes the continued existence of listed species. The U.S. Fish and Wildlife Service has issued more jeopardy opinions regarding manatees than for any other species, primarily due to mushrooming development of boating facilities in Florida. The State of Florida passed the Manatee Sanctuary Act of 1978, which declared the entire State a manatee sanctuary and allowed for the designation of boat speed regulation zones in critical areas. More recently, Florida's Growth Management Act of 1985 has resulted in many local government entities beginning the process of incorporating manatee conservation elements in their required plans for future development and growth.

**Humanistic Justification**—Our nation's attitude toward its own conservation responsibilities is undergoing a period of rapid change. Public values embrace a wide array of species beyond those with a traditional dollar or recreational value. Federal legislation such as the MMPA and ESA, new laws of the various states, institution of nongame programs, and growing membership in broad-based conservation groups all signal a widening respect and concern for the diversity of life as a reflection of the quality of life. Permitting the extinction of any species is an irrevocable desecration of this

emerging view of the quality of life. Nevertheless, some species are cast more to the forefront of the public eye than others, and in Florida the manatee ranks among them. In some sense perhaps this rank among taxa of concern is not disproportionate. If the future is lost for manatees we lose the only representative of an entire mammalian order in our country, and the only example we have of the marvelous adaptations represented by this level of evolutionary distinctiveness. We will lose our self-respect by eliminating a benign species with no direct conflict with man for resources, a species tough enough and flexible enough to have endured centuries of pressure and environmental change. Florida is undergoing prodigious development, yet remnants of its fauna manage to persist in a remarkable, highly visible interface between wildlife and man. Maintenance of that interface with continued development is a great experiment in how far our society can go while still upholding principles of respect for the diversity of life. Manatees currently have the biological chance and the legal justification to persist, but if the species is lost to future generations it will be a bellwether, a signal that through lack of commitment we can lose the battle to maintain the compatibility of civilization and living diversity.

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Table 1. Selected historical references on manatee distribution, abundance, and mortality in the southeastern United States.

Period	References	Relevant Information
Pre-Columbian	Larson (1970), Cumbaa (1980)	Manatee remains found only in Florida among archaeological sites in the southeastern United States, and not in great abundance.
late 1700s	Bartram (1791)	Observed a skeleton at Manatee Springs on the Suwannee River killed by Indians in winter. Noted a second-hand sighting of three at these springs at some time in the past.
early 1800s	Audubon (1832-39) <i>in</i> Proby (1974)	"For years his (pilot Egan's) employment had been to hunt those singular animals called Sea Cows or Marratees, and he had conquered hundreds of them, 'merely,' as he said, because the flesh and hide bring 'a fair price' at Havannah." (p. 328-329).
early 1800s	Burrows ( <i>in</i> Harlan 1824), Harlan (1825)	"They are found in considerable numbers about the mouths of rivers, near the capes of East Florida, lat 25° The Indians kill them with the harpoon, during the summer months. One Indian has been enabled to capture ten or twelve during a season" (1824: 392).
early 1800s	Williams (1837)	"This is a shy fish and is mostly confined to the grassy bays and particularly to the deep springs on the coast. . . They are usually shot while feeding near shore." (p. 100).
1850s-1860s	Canova (1885)	"These animals were once quite abundant, in many parts of the extreme South, but I think I can, with propriety, assert that the St. Lucie river is the only place the manatee can be looked for with any degree of certainty" (p. 71). "In days long gone by, the Seminoles living in Whitewater Bay, near Cape Sable, killed the manatee, jerked the flesh, and sold it to the Spaniards at a good price, and ten years ago the meat could be bought at fifty cents a pound. . . There is no doubt that the manatee is fast becoming an extinct animal" (p. 74).
mid 1800s	Brinton (1869)	"once abounded in Florida. When Audubon visited the peninsula, his guide boasted of having killed "hundreds" of them, and their bones are often found as far north as the Suwannee River. The Manatee spring and Manatee River bear record in their names to their former abundance. Now, I think, they are nearly extinct." (p. 51).
mid 1800s	Maynard (1872) <i>in</i> True (1884)	"found in large numbers about the inlets of Indian River. . . remarkably abundant upon the western coast in the various rivers and creeks which abound between Tampa Bay and Cape Sable." (p. 115).
mid-1800s	Stearns, <i>in</i> True (1884)	"It is generally supposed. . . that there are very few manatees in existence in this country. . . ten, fifteen, or twenty years ago manatees were occasionally seen in nearly all the inland waters from Key West westward to civilization at Pensacola, Mobile, and New Orleans. It is evident that they have been abundant along the entire Gulf Coast, and probably on the Atlantic as far north as the Carolinas, for their bones can be found along the shore nearly everywhere that civilization has not reached. . . As they are so shy, there may be many more existing in the State than we are aware of." (p. 114)
1870s	LeBaron (1880)	"considered common by naturalists on the southern Florida Peninsula, both east and west sides." (p. 1005)
1870s	Rambler (1876)	"From Jupiter, parties can organize for a manatee hunt." (p. 85)
1870s-1880s	True (1884)	"It is probable, as Mr. Stearns surmises, that the existing species ranged farther north in former days" (p. 116) "the Florida manatee cannot yet be considered as threatened with extinction" (p.123).

Period	References	Relevant Information
1880s-1890s	Bangs (1895)	"It is now eight years since Mr. Ulrich saw a living Manatee, but when he first came to the (Indian) river fifteen years ago they were still common and he often saw them from the door of his little house." (p. 786) "they are protected by law, and the netting has been stopped; it should slowly come up again to something like its old numbers." (p. 787).
1880s	Henshall (1884)	Notes capture techniques and abundance in St. Lucie River.
1890s	Cory (1896)	"They are abundant in the bays and rivers all along the west and east coasts of southern Florida. . . Many of these animals are killed by the Indians every year." (p. 24)
c.1900	Dimock (1908), Dimock and Dimock (1909)	"A few years ago the manatee was thought to be near extinction; now it is often seen, and is increasing. I am personally acquainted with about fifty specimens, a fair proportion of which are calves. Their shyness protects them from the rifle of the tourist." (1908:848).
1910s	Nelson (1916)	"The Florida manati regularly frequents that coast from eastern Florida to Mexico. . . in summer it sometimes strays as far north as the coast of Virginia. . . Manatis were formerly plentiful in the Indian River and elsewhere along the Florida coast, but were shot and netted to the verge of extermination. As a result of (passage of protective laws), manatis have increased rapidly. A correspondent writing on June 20, 1916, from Ponce Park on the Indian River, says that at this season scarcely an hour in the day passes but that from one to half a dozen may be seen in front of his house." (p. 465).
1910s	Safford (1919)	"it is not uncommon in the Miami and other streams close by" (p. 424).
early 1900s	Anthony (1928)	"Fisherman occasionally catch the manatee in their nets. . . Found along the east coast of Florida as far north as Daytona, and sporadically along the Gulf coast." (p. 555).
1930s	Allen (1942)	"common in the Indian River. . . and south along the coast and around the tip of the peninsula for a short distance on the west side. Formerly they were commoner than now and apparently more generally distributed." (p. 544). "About 1890 the manatee had become rather scarce in many parts of Florida." (p. 546). "As a result of protection, the numbers have slowly increased. . . It is believed to be now quite safe." (p. 547)
1930s-1940s	Barbour (1944)	"manatees now are closely protected, but they are so delicious to eat that most crackers find it hard to refrain from taking one into camp when the opportunity offers. . . an officer of one of the blimps on the coastal patrol. . . reported that from high in the air he had seen some thirty manatees in a day while flying over the shallow waters of Bay Biscayne." (p. 98-99).
1940s	Gunter (1941, 1942)	"The manatee also occurs sporadically, and possibly was more abundant in former years, along the Gulf Coast of the United States" (1941:60). "In former years manatees were more numerous in their present recognized haunts than today" (1941:63). "For years it has been a matter of common knowledge with conservationists and mammalogists that manatees are very uncommon in the United States." (1942:89).
1940s	Trumbull (1949)	"In areas of protection, like Miami, the animals are making a comeback." (p. 337).
1940s-1950s	Moore (1951a)	Reviews distribution in detail, noting seasonal changes and rarity of occurrence outside Florida. Recounts several cases of poaching and illegal killing during this period.

Period	References	Relevant Information
1940s-1950s	Moore (1951b)	Indicates that poaching was a problem in southwestern Florida. Suggests that "ruthless hunting" caused manatee scarcity in Florida Bay, noted the species abundance in Miami.
1950s-1960s	Layne (1965)	Noted numerous reports and observations of manatees throughout Florida.
1960s	McClung (1969)	"Today the Florida manatee is found in only the southern part of that state, and its total population can be numbered in the hundreds." "At one time the Florida subspecies ranged coastal lagoons and brackish rivers from North Carolina to the Texas Gulf Coast. . . Indians, explorers, and settlers all killed it so enthusiastically for its meat and oil that by the early years of the twentieth century it had disappeared over much of its range and was rare nearly everywhere" (p. 166).

Table 2. Manatee sighting records from the Atlantic coast north of Florida, June 1981-December 1986.

Date	Location	County	No.
GEORGIA			
06 JUN 81	St. Marys River, 5 mi. upstream from St. Marys	Camden	3
03 JUL 81	Buttermilk Sound (30°17'15"N, 81°23'45"W)	McIntosh	3
10 JUL 81	DNR Building Dock, Brunswick	Glynn	1
10 JUL 81	Two-Way Fish Camp, Hwy. 17, Altamaha River	Glynn	1
12 JUL 81	Burnside River, So. of Skidaway Island	Chatham	1
12 JUL 81	Brunswick City Dock, East River	Glynn	1+
14 JUL 81	Jekyll Marina, Jekyll Island	Glynn	2
20 JUL 81	Hickory Bluff	Chatham	1
02 AUG 81	MacKay River, N. side St. Simons Causeway Bridge	Glynn	1
05 AUG 81	Crooked River, Harriet Bluff, W. of Cumberland Island	Camden	5-6
26 AUG 81	NE side Jekyll Island Bridge	Glynn	1
02 SEP 81	Jekyll Creek, S. of Jekyll Island Causeway Bridge	Glynn	1
13 SEP 81	Back River, near SSI Causeway, Brunswick	Glynn	2
12 DEC 81	Dungeness Dock, Cumberland Island	Camden	1
24 FEB 82	Hercules Dock, Terry Creek, Brunswick	Glynn	1
15 MAR 82	Hercules Dock, Terry Creek, Brunswick	Glynn	1
06 APR 82	Hercules Dock, Terry Creek, Brunswick	Glynn	6
07 APR 82	Hercules Dock, Terry Creek, Brunswick	Glynn	4-5
12 APR 82	Hercules Dock, Terry Creek, Brunswick	Glynn	2
16 APR 82	North River, S. of Kings Bay Naval Base	Camden	5-6
12 MAY 82	Hercules Dock, Terry Creek, Brunswick	Glynn	2
13 MAY 82	Torras Causeway, Brunswick	Glynn	several
15 MAY 82	Dubignon, Jekyll Island	Glynn	2
14 JUN 82	Floyd Creek, near Union Carbide Plant	Glynn	1
17 JUN 82	Hercules Dock, Terry Creek, Brunswick	Glynn	3
15 JUL 82	Satilla River, marker A-19	Camden	1
SEP 82	Dungeness Dock, SW Cumberland Island	Camden	6
02 SEP 82	E. side Brunswick River	Glynn	1
12 SEP 82	End of 11th St., Sea Island	Glynn	2
16 SEP 82	Clubbs Creek, U.S. 17 ditch	Glynn	1
01 NOV 82	Hercules Dock, Terry Creek, Brunswick	Glynn	1
01 NOV 82	Terry Creek, Brunswick	Glynn	1

Date	Location	County	No.
30 DEC 82	Terry Creek, behind Dixie O'Brien Point	Glynn	1
30 DEC 82	Terry Creek, N. of Hercules Dock	Glynn	1
21 APR 83	Brunswick Pulp Mill Outfall, Turtle River	Glynn	4-5
30 APR 83	Coastal Resources Division Dock, Brunswick	Glynn	1
05 MAY 83	Confluence, Back River and Terry Creek	Glynn	1
05 MAY 83	Marker 64, E. bank, Cumberland River	Camden	1
06 MAY 83	Euclid Lewis' Dock, Terry Creek	Glynn	1
07 MAY 83	1/4 mi. S. of MacKay River Bridge	Glynn	2
09 MAY 83	Foot of "K" St., East River	Glynn	2-3
26 MAY 83	Two-Way Fish Camp, Altamaha River (Hwy. 17)	Glynn	1
24 JUN 83	S. end Public Dock, East River, Brunswick	Glynn	1
03 JUL 83	Salters Dock, Cedar Creek	McIntosh	1
03 JUL 83	ICW, between St. Catherines and Wahoo Islands	Liberty	1
21 SEP 83	Kings Bay Naval Base, St. Marys	Camden	1
10 AUG 83	South end of Cumberland Island	Camden	6
SOUTH CAROLINA			
05 OCT 81	Hunting Island	Beaufort	1
15 JUL 81	Under U.S. Highway 17 Bridge, Charleston Harbor	Charleston	1
30 MAY 83	Dock, South End Daufuskie Island, Mungen Creek	Beaufort	1
Summer 85	Calabash River, at ICW	Horry	1
NORTH CAROLINA			
04 AUG 81	Peletier Creek, off Bogue Sound	Carteret	1
29 JUN 82	Kill Devil Hills, Avalon Pier	Dare	1
24 JUN 83	A small harbor, Ocracoke Island	Hyde	1
SEP 83	5-8 mi. N. of Roanoke Island, Kill Devil Hills	Dare	1
SEP 83	Pamlico Sound, Rodanthe, Hatteras Island	Dare	1
30 SEP 83	Southeast Side, Wanchese Seafood Harbor	Dare	1
23 OCT 83	Stumpy Point Bay	Dare	1
02 NOV 83	Greenville	Pitt	1
20 SEP 85	0.5 mi. west of Washington, Tar River	Pitt	1
VIRGINIA			
AUG 85	Between Hampton and Norfolk, Hampton Rds.	York	1
04 SEP 85	Newport News, in Hampton Creek	York	1
10 SEP 85	Off Clay Bank, in York River	York	1

Table 3. Manatee mortality records from the Atlantic coast north of Florida, June 1981-December 1986.

Date	Location	Remarks
GEORGIA		
21 JUN 82	Ossabaw Island, Chatham Co.	Adult male, cause of death undetermined.
17 AUG 82	St. Simons Sound, Glynn Co.	Adult female, drowned in shrimp trawl.
18 SEP 82	St. Andrews Sound, Camden Co.	Adult male, cause of death undetermined.
14 SEP 84	St. Catherines Sound, Liberty Co.	Perinatal
21 MAY 85	Brunswick River, Glynn Co.	Adult male, boat-kill
21 JUN 85	ICW N. of Jekyll Is., Glynn Co.	Adult female, boat-kill
28 NOV 85	Cumberland Is., Camden Co.	Female, advanced decomposition, cause of death undetermined
09 JUN 86	Satilla River, Camden Co.	Adult female, cause of death undetermined
SOUTH CAROLINA		
27 FEB 85	Stono River, Charleston Co.	Immature male, winter-kill
NORTH CAROLINA		
06 JAN 84	Pamlico River, Beaufort Co.	Adult male, winter-kill
17 MAR 86	Wilmington, Brunswick Co.	Advanced decomposition, cause of death undetermined.

Table 4. Recent (1982-1986) records of manatees on the Gulf Coast of the United States outside of Florida. See Powell and Rathbun (1984) for a summary of records prior to December 1981.

Date	Location	County/Parish	Occurrence	No.
ALABAMA				
13 June 1985	Tensaw River, 25 mi. S. of Jackson	Baldwin	Sighting	1
21 October 1986	Bon Secour Bay, 0.5 mi. E. of Highway 57 Bridge	Baldwin	Sighting	1
LOUISIANA				
22 April 1985	Amite River, 0.5 mi. N. of confluence with Bayou Manchac	East Baton Rouge	Sighting	1
29 April 1985	Blind River, I-10 Highway Bridge	St. James	Sighting	1
11 & 21 May 1985	Pass Manchac, 1 and 3 mi. W. of Lake Pontchartrain	Tangipahoa	Sighting	1
TEXAS				
07 February 1986	Caplan, 1 mi. W. of Bolivar Peninsula	Galveston	Dead	1

Table 5. Maximum counts of manatees at winter aggregation sites at Blue Spring, Crystal River, and Homosassa River, 1977-1987. Data for Crystal and Homosassa rivers for winters 1985-86 and 1986-87 courtesy of Chassahowitzka National Wildlife Refuge; previous winter counts at these sites from Powell and Rathbun (1984) and Rathbun et al. (In press). Blue Spring data for winter 1977-78 are from Powell and Waldron (1981).

Winter	Blue Spring	Crystal River	Homosassa River
1986-87	50	157	47
1985-86	57	115	51
1984-85	37	116	24
1983-84	43	124	43
1982-83	42	123	24
1981-82	36	114	21
1980-81	35	99	24
1979-80	26	87	16
1978-79	23	80	29
1977-78	21	78	11

Table 6. Annual manatee mortality totals in Florida, 1977-1986. Totals do not include reports of carcasses that were not recovered.

Year	Carcasses Recovered	Killed by Boats
1986	122	33
1985	113	33
1984	127	35
1983	78	14
1982	111	21
1981	111	23
1980	59	16
1979	72	24
1978	78	21
1977	98	13

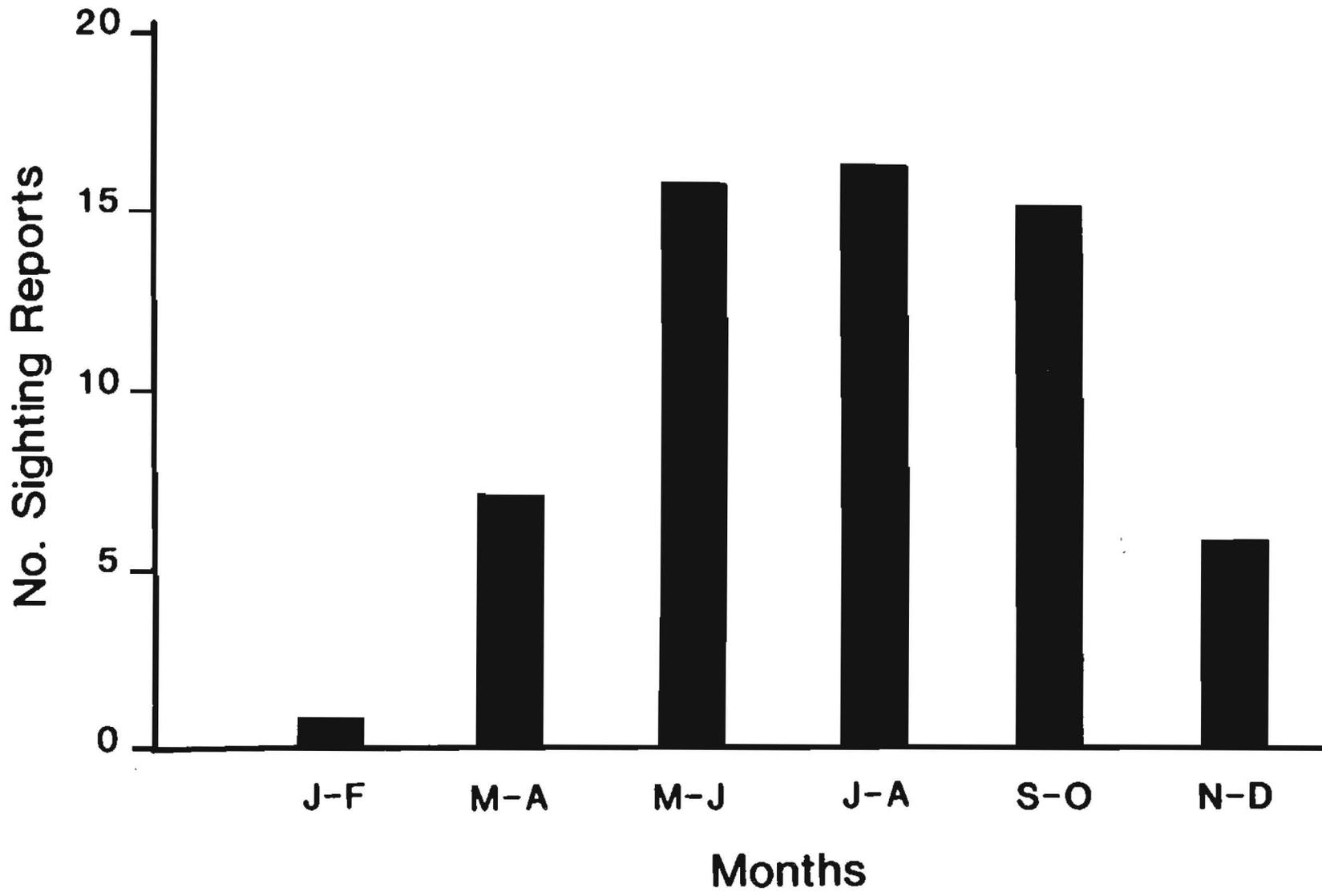


Fig. 1. Seasonal distribution of manatee live sighting reports on the Atlantic coast north of Florida, July 1981-December 1986.

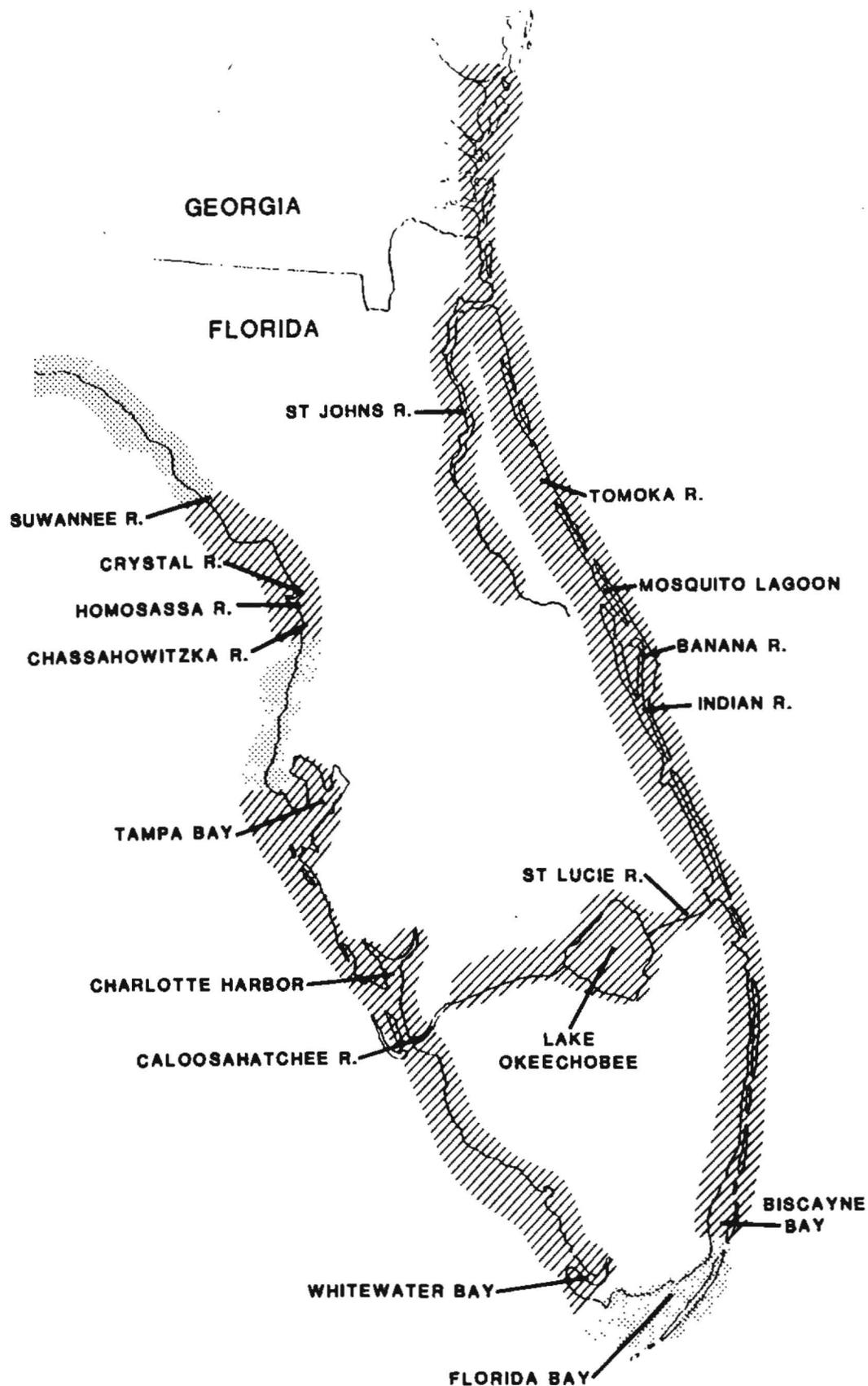


Fig. 2 General warm season distribution of manatees in the southeastern United States. Areas where sightings are relatively rare are indicated with stippling. Sightings in states north of Georgia and west of Florida are uncommon (see Tables 2-4 and text.)

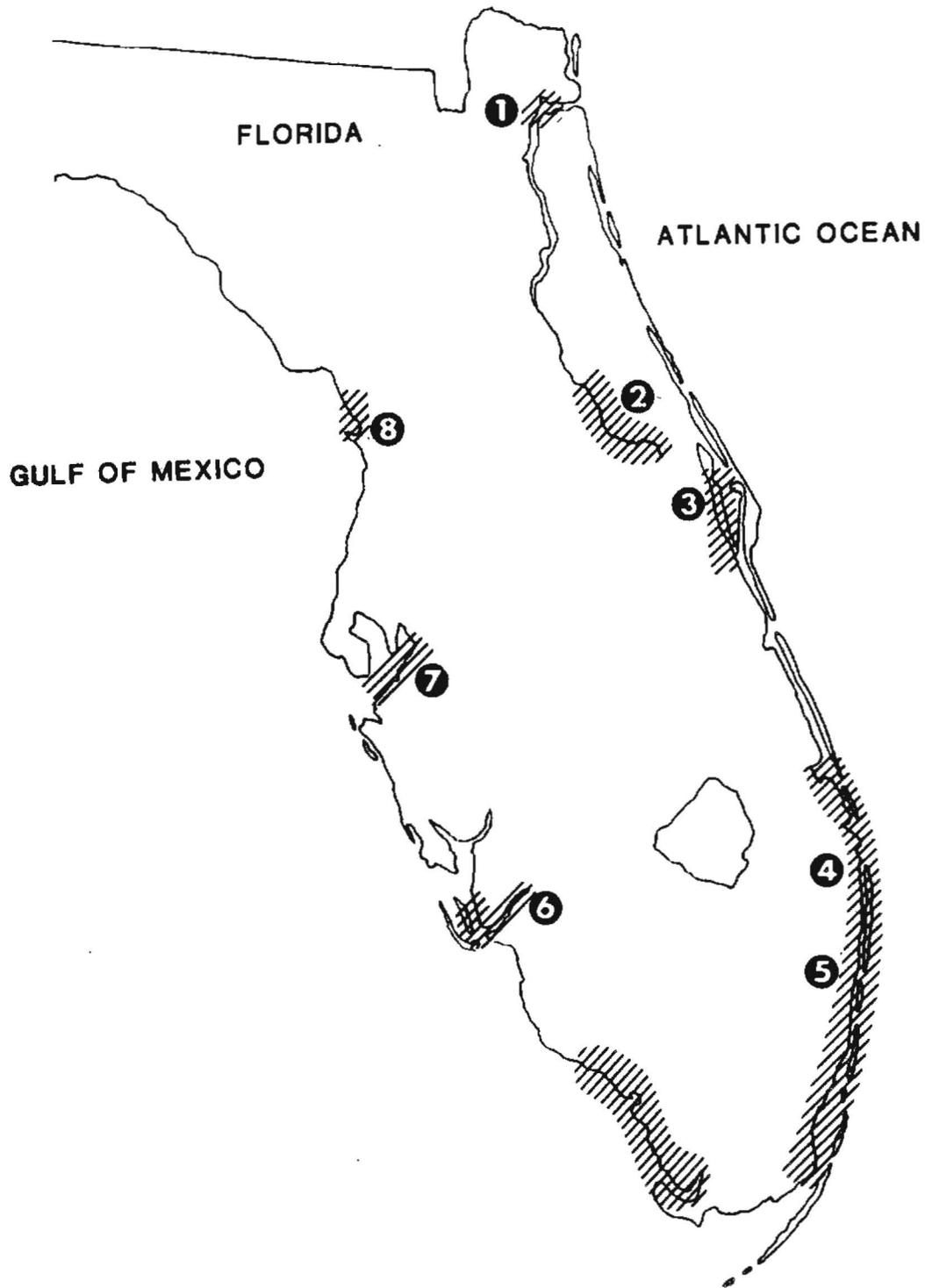


Fig. 3 Mid-winter range (cross-hatching) of manatees in the southeastern United States. Circles indicate locations of important warm water aggregation sites numbered as follows: (1) Jacksonville; (2) Blue Spring; (3) Titusville (two sites, at Delespine and Frontenac); (4) Riviera Beach; (5) Port Everglades; (6) Fort Myers; (7) Tampa; (8) Crystal and Homosassa rivers.

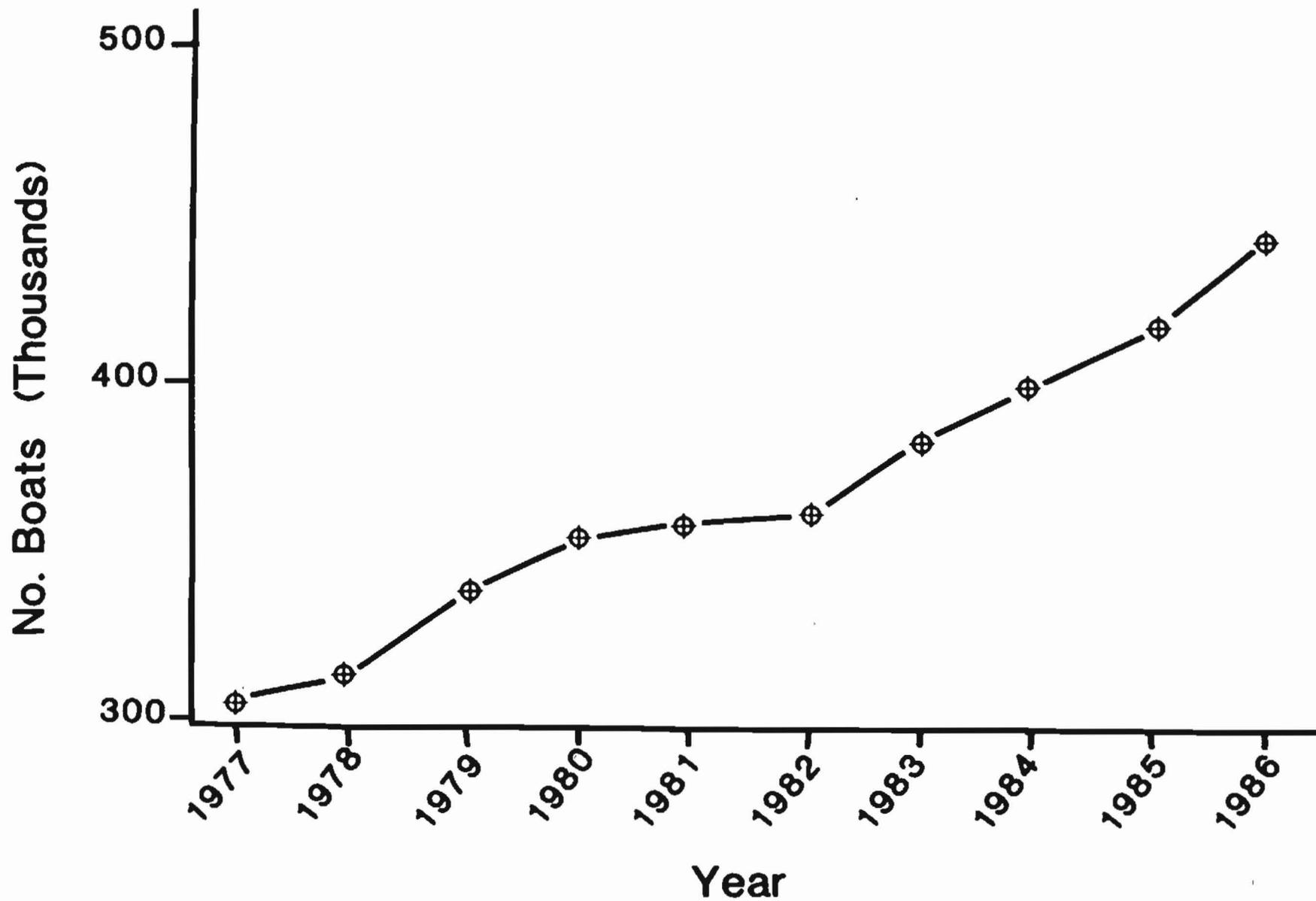


Fig. 4 Annual boat registration totals in all counties of Florida inhabited by manatees. Data provided courtesy of the Florida Department of Natural Resources.

