BULLETIN OF MARINE SCIENCE, 33(1): 1–9, 1983

ABUNDANCE, DISTRIBUTION, AND MOVEMENTS OF MANATEES (*TRICHECHUS MANATUS*) IN BREVARD COUNTY, FLORIDA

Susan H. Shane

ABSTRACT

Data on the relative abundance, distribution, and movements of manatees (*Trichechus manatus*) in Brevard County, Florida, were collected from January 1978 through February 1980. Aerial and land surveys showed seasonal changes in manatee abundance and distribution. Highest aerial counts were recorded in March of each year: 148 in 1978 and 245 in 1979. During the warm months, most manatees counted during aerial surveys were in the Banana River and in the Indian River between Titusville and Rockledge. Few animals were counted in the Indian River north of Titusville or in Mosquito Lagoon, suggesting that these areas are not suitable manatee habitat. During the winter, most manatees in the study area aggregated in the warm water effluents of two power plants on the Indian River. Aggregations of up to 72 manatees were also observed during the warm season in marinas and dredged coves. Forty-eight individuals, identifiable by scars, were each sighted two or more times during the study, and 29 of these were resighted only at their initial sighting locations. Some manatees, resident in Brevard County in the summer, were observed during the winter at a power plant effluent in Riviera Beach 210 km south of the study area. Eight manatees showed some fidelity to summer ranges by returning to the same or nearby locations following winter absences.

Manatees (*Trichechus manatus*) have been reported in Brevard County on the east coast of Florida (Fig. 1) since the late 1800's (True, 1884; Bangs, 1895). Hartman (1974) suggested that Brevard County might contain the largest concentration of manatees in Florida, but he provided no abundance data. The only abundance figure for this area was an aerial count of 75 manatees recorded in January 1976 (Irvine and Campbell, 1978).

Manatees are dispersed throughout Brevard County during the warm months of the year, but during the winter they aggregate in the warm water effluents of two power plants on the Indian River: the Florida Power and Light Company Canaveral Plant (FPL) and the Orlando Utilities Commission Indian River Plant (OUC) (Hartman, 1974; Shane, 1981). Before the construction of these power plants (OUC in 1959 and FPL in 1965), manatees were reported to leave Brevard County and migrate south for the winter (Nelson, 1918; Moore, 1951b; 1956). Their winter range on the east coast was believed to extend northward only to the Sebastian River, 75 km south of the FPL and OUC plants (Moore, 1951b).

The present study sought to establish baseline information on the seasonal abundance, distribution, and movements of manatees in Brevard County from January 1978 through February 1980.

METHODS

The study area included three saltwater lagoons, two of which are misleadingly called rivers: the Indian River, the Banana River, and Mosquito Lagoon (Fig. 1). The study area was divided into six sections for summarizing manatee counts made during aerial surveys: the Banana River (55 surveys conducted); the Indian River from Titusville to Rockledge (53 surveys); the power plant basin of the Indian River from the State Road 528 Causeway to the NASA Causeway (38 Intensive Surveys); Mosquito Lagoon excluding the Intracoastal Waterway (ICW; 24 surveys); the northern Indian River (north of Titusville) excluding the ICW (12 surveys); and the ICW in Mosquito Lagoon and the northern Indian River (32 surveys).

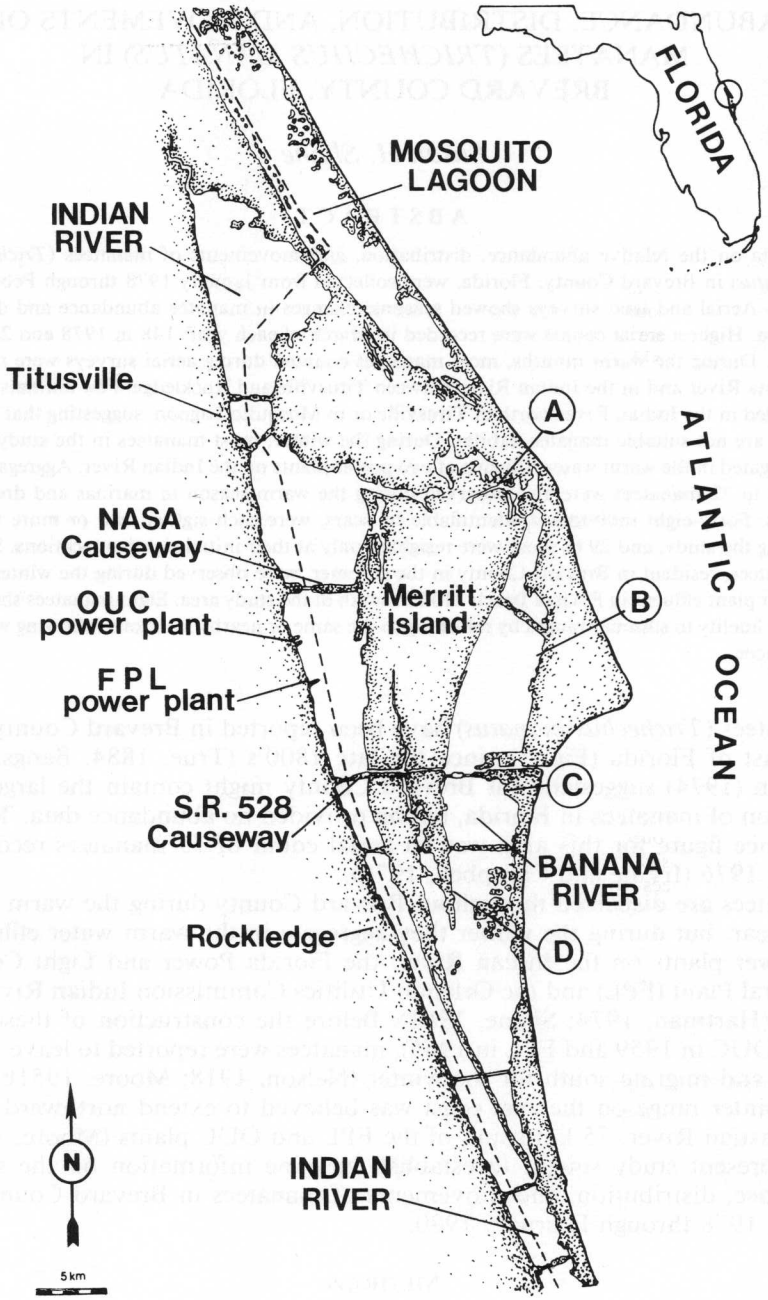

Figure 1. The study area in Brevard County, Florida. Sites A, Mobile Service Structure; B, Hangar AF; C, Cape Canaveral Sewage; D, Banana River Marine Service Marina locations where land surveys were conducted in the Banana River. Dashed line shows the Intracoastal Waterway (ICW).

Aerial surveys of likely manatee habitat were flown to estimate abundance and determine distribution. Surveys were conducted in a Cessna 172[1] at altitudes of 150 to 185 m and speeds of 130 to 140 km/h. Two observers usually participated in each flight. Typically, the right side observer scanned the area between the shoreline and water of about 1½- to 2-m depth while the left side observer scanned deeper, open water. Areas where manatees were known to congregate were circled clockwise. The only exception to this survey pattern occurred on Intensive Surveys: total coverage of the area within about 5 km of the FPL and OUC plants was attempted by flying about 15 east-west transects across the river and circling the plants (Fig. 1). Manatee visibility was affected by wind, water turbidity, cloud cover, and glare. Each flight was rated as excellent, good, fair, or poor, based on a subjective evaluation of these conditions.

Surveys covering the Banana River, the Indian River, and Mosquito Lagoon usually were flown biweekly. Intensive Surveys were flown daily to biweekly from October 1978 through April 1979 and from November 1979 through February 1980.

Maximum aerial counts in each of the six sections each month were used in the data analysis. Monthly maxima were used because they usually occurred on the days with the best observation conditions and probably were the best indication of the actual number of animals present. The maximum number of manatees per month in the entire study area was calculated by adding the highest counts recorded in five of the six survey sections on 3 consecutive days. Since the Indian River survey and the Intensive Survey covered much of the same area, the higher of these two counts occurring in the designated 3-day period was used. A 3-day period was chosen to reduce the possibility of recounting individuals that moved from one section to another.

Observations and counts of manatees were made from land at four sites on the Banana River and at the warm water effluents of the power plants (Fig. 1). These sites were chosen because manatees were frequently seen there from the air or because people reported observing manatees there regularly. Observations at each site continued for at least 10 minutes or until all manatees present were counted. Land counts at the power plant effluents were made only at FPL from January through mid-October 1978, and at both FPL and OUC after that time. One to five surveys were conducted each month at the effluents, and two to five surveys were conducted monthly at the Banana River sites.

The mean number of manatees per land survey per month was used to describe seasonal distribution. Means were used instead of maximum counts, because visibility conditions did not affect the accuracy of land counts as much as they did aerial counts.

Aerial and land counts were analyzed to determine the proportion of calves sighted. Calves were defined as animals one-half or less the size of an adult (>275 cm) or animals two-thirds or less the size of an adult which they accompanied closely. Only calf sightings made during Banana River, Indian River, and Intensive Survey flights flown under good to excellent conditions were used, because these flights provided the bulk of the aerial data and calves could be overlooked easily under poor or fair conditions. All calf sightings made from land were used.

Individual manatees were identified by unique scar patterns, and each recognizable individual was given a code number, starting with *Tm* 1. One 319-cm male, captured and tagged during a previous study (Irvine and Scott[2]), was identified as Freeze Brand No. 10. Opportunistic sightings of individuals made after February 1980 were included. Distances between sighting locations were measured as the most direct route by water.

RESULTS

Manatee abundance varied seasonally (Fig. 2). Manatee counts in the study area peaked in March each year: 148 in 1978 and 245 in 1979. Summer counts of 75 to 150 were typical, and early fall counts of 50 to 100 rose to about 140 each November. The highest winter aerial count of manatees in the power plant effluents was 106 in January 1979. Aerial counts were considerably higher in 1979 than in 1978. Extremely low counts in the northern Indian River and Mosquito Lagoon contrasted sharply with counts in the Banana River and Indian River (Table 1). Animals in the northern Indian River and Mosquito Lagoon usually were seen in the ICW or along the shores of spoil islands bordering the ICW.

---

[1] Use of trade names does not imply endorsement by the U.S. Fish and Wildlife Service.

[2] Irvine, A. B. and M. D. Scott. MS. Development and use of marking techniques to study manatees in Florida.

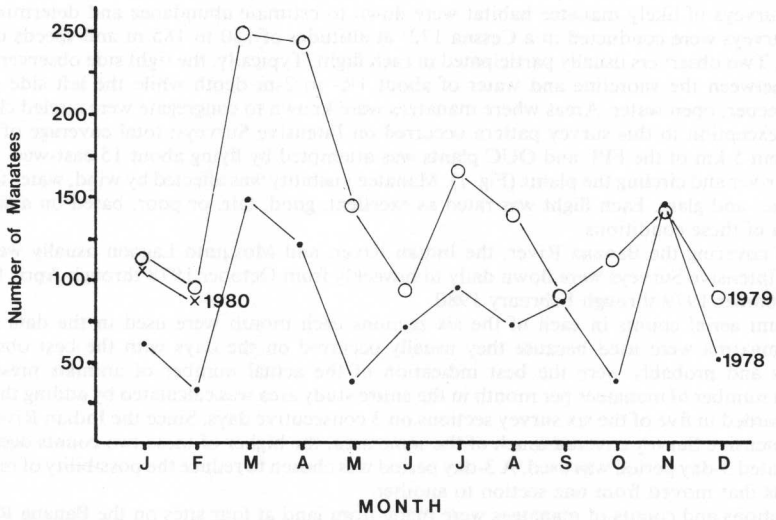

Figure 2. Seasonal variation in manatee abundance in Brevard County, Florida during 1978, 1979 and January–February 1980. Totals represent the highest counts recorded in the study area during aerial surveys on 3 consecutive days each month.

Calves made up 8.8% (326 of 3,686) of manatees sighted from the air, and 8.9% (157 of 1,770) of those seen from land.

Aerial surveys showed that manatees were distributed throughout the Indian and Banana Rivers from March through December, but in January and February the majority of animals observed was found in the power plant effluents (Intensive Survey in Table 1). Observations from land sites showed the same seasonal shift in distribution from the Banana River to the effluents (Fig. 3).

Aggregations of manatees were observed repeatedly at several sites during the warm season. Counts made during regular land surveys at the four Banana River sites ranged from zero to 37. Maximum counts were recorded between mid-March and December, whereas no manatees were seen on 72 of 78 surveys in January and February. During the warm months, manatees were present during 182 of 301 visits to the four sites.

The largest warm season aggregations (up to 72 manatees on 27 March 1979) occurred in a small marina off the Banana River in March and April 1979 (site D in Fig. 1). An average of 41 $\pm$ SD 21 manatees (N = 18) was counted in the marina in March and 13 $\pm$ SD 4 (N = 8) in April. Large aggregations of up to 70 manatees were counted at this marina again in March 1981. Observations at the marina were infrequent in March and April 1978 and 1980, but marina residents reported increases in manatee abundance at these times as well.

Forty-eight individuals were resighted at least once during the study. Twenty-nine of these were resighted only where they were initially identified. Nineteen manatees were resighted at locations from 2 to 210 km away from their original sighting locations. One adult male manatee, *Tm* 9, was seen repeatedly at the same sites in the Banana River for four consecutive warm periods (April–September 1978, April–October 1979, April–September 1980, and April–August 1981). Freeze Brand No. 10 was observed during three warm seasons (1978, 1979, and 1981) at a site in the Banana River. Three adults (*Tm* 45, *Tm* 46♀, *Tm* 49) and one subadult (*Tm* 68) returned to the same warm season locations following winter

Table 1. Maximum aerial counts of manatees each month in six survey sections in Brevard County, Florida. The Intensive Survey covered the power plants and the area within 5 km of them. The ICW (Intracoastal Waterway) section includes sightings in the ICW in Mosquito Lagoon and the northern Indian River. Dashes indicate no surveys were flown

	Survey Section					
Month	Banana R.	Indian R.	Intensive Survey	ICW	Mosquito Lagoon Outside ICW	Northern Indian R. Outside ICW
1978						
Jan	6	48	—	—	—	—
Feb	0	29	—	—	—	—
Mar	130	63	—	—	—	—
Apr	106	15	—	—	—	—
May	37	6	—	—	—	—
Jun	48	34	—	—	—	—
Jul	68	32	—	—	—	—
Aug	52	23	—	—	—	—
Sep	87	15	—	—	—	—
Oct	36	11	5	—	—	—
Nov	135	10	7	3	0	—
Dec	52	14	30	5	1	—
1979						
Jan	1	89	106	1	0	—
Feb	60	53	95	0	0	—
Mar	177	68	77	1	0	—
Apr	165	71	25	7	0	—
May	114	35	—	5	0	—
Jun	93	28	—	3	0	—
Jul	146	18	—	1	0	—
Aug	115	34	—	8	0	—
Sep	58	43	—	5	0	2
Oct	70	35	—	0	0	4
Nov	101	38	26	4	—	0
Dec	20	27	89	0	—	0
1980						
Jan	8	47	105	0	—	0
Feb	4	48	87	0	—	0

absences. Two adult manatees (*Tm* 12♀ and *Tm* 32) returned to locations within 4 km of their pre-winter locations following winter absences. Of the eight manatees that were resighted at warm season sites, only three were ever seen at a winter refuge. *Tm* 9 was identified in aerial photographs taken by P. Rose (Florida Audubon Society, Maitland, Florida) at the Florida Power and Light Riviera Plant in Riviera Beach (Palm Beach County) on 1 February 1979, and I observed him at the Riviera Plant on 2 February 1980. He was not seen in Brevard County from 20 September 1978 to 20 April 1979, nor from 17 October 1979 to 8 April 1980. During the winter of 1980–81, J. Packard (Univ. of Minnesota, Minneapolis, Minnesota) observed and photographed *Tm* 9 at the Riviera Plant on 6 days from 28 December 1980 through 4 February 1981. Packard also sighted and photographed *Tm* 68 (in December 1980 and January 1981) and Freeze Brand No. 10 (in December 1980 and January–February 1981) at the Riviera Plant. The Riviera Plant is 210 km south of the summer ranges of these individuals.

Two other manatees, originally identified in Brevard County, were sighted by Packard at the Riviera Plant. *Tm* 156, an adult, was seen in the Banana River in August, September, and November 1979 and was observed at Riviera Beach in

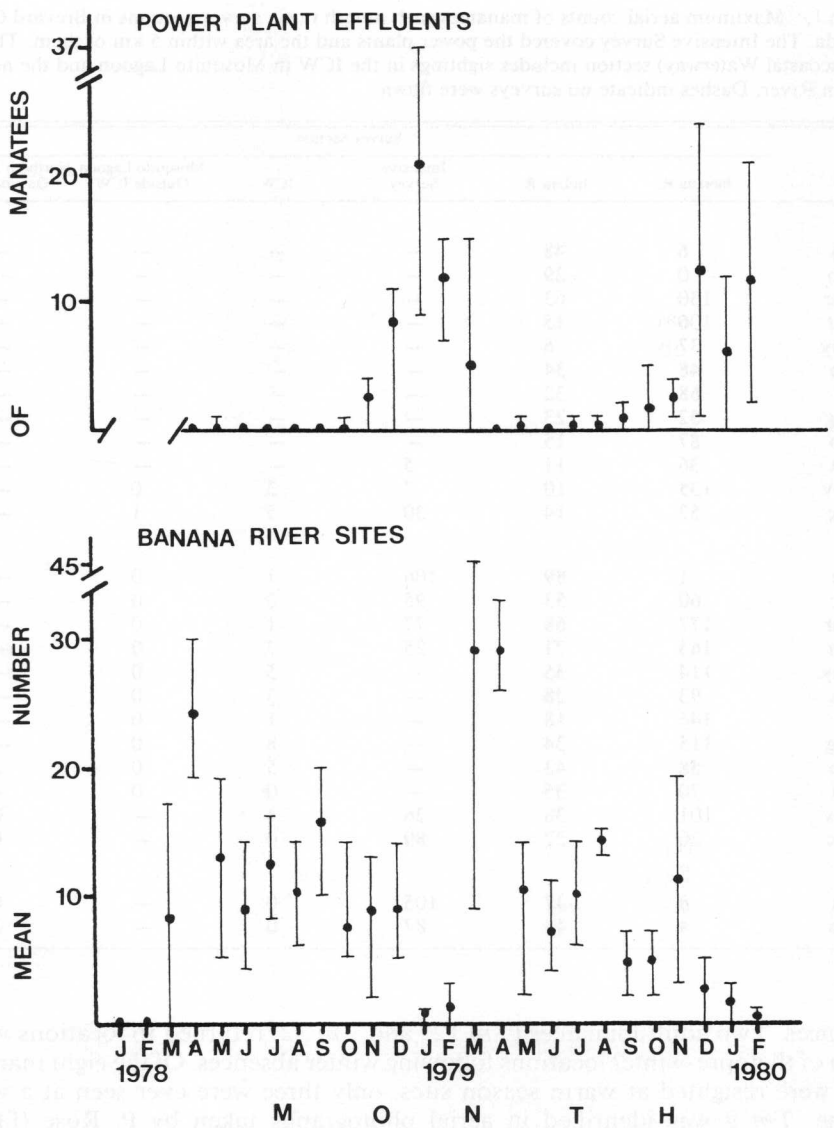

Figure 3. Seasonal variation in manatee distribution in Brevard County, Florida as shown by mean (and range) manatee counts per month at four sites (A–D on Fig. 1) on the Banana River and at the FPL and OUC power plant effluents. Data were collected during land surveys.

December 1980 and January–February 1981. *Tm* 78, an adult female, was observed during two winters (1978–79 and 1979–80) at the FPL and OUC effluents in Brevard County and was seen at the Riviera Plant on 5 days in January and February 1981. The presence of *Tm* 78 at the Riviera Plant represents a change in wintering location for this individual.

Only three manatees sighted at the FPL and OUC effluents in the winter were observed elsewhere in the warm season. All three were seen in the FPL and OUC intake canals during the warm season, and one of these was also seen 32 km north

of the power plants in the northern Indian River. No manatees identified in the Banana River during the warm season were ever sighted at the FPL and OUC effluents during the winter.

Discussion

The Florida population of *T. manatus* is estimated to be at least 1,000 animals (Campbell and Powell, 1976). Our count of 245 manatees in March 1979 indicates that a significant proportion of the estimated total population resides in Brevard County, at least during some parts of the year. The discrepancy between the 1978 and 1979 aerial counts may have resulted from having the same two experienced observers participate in most flights in 1979, whereas occasionally different and less experienced observers participated in 1978 (see Caughley et al., 1976 for a discussion of observer effects on aerial survey results).

Manatee counts in the open waters of Mosquito Lagoon and the northern Indian River were notably lower than counts in the rest of the Indian River and the Banana River. True (1884) stated that manatees were never seen in Mosquito Lagoon. Although Mosquito Lagoon and the northern Indian River contain abundant vegetation, they lack the many dredged areas and freshwater sources found in the Indian River south of Titusville and the Banana River. Moore (1951b) suggested that manatees may avoid the lower Florida Keys because of a lack of fresh water, and Hartman (1979) stated that manatees may require fresh water. The few manatees in Mosquito Lagoon and the northern Indian River may be restricted to the ICW and to spoil islands bordering the ICW for two reasons. First, manatees may travel through these sections via the ICW. Second, the spoil areas with shallow waters sloping to deep waters may be the only suitable parts of the habitat for manatees. Moore (1951a) also observed that in open bay areas manatees often are found near islands or points of land.

The proportion of calves seen from the air (8.8%) and from land (8.9%) is consistent with reports by Irvine and Campbell (1978) who found 9.6% calves on their winter flights over Florida, and Leatherwood (1979) who found 9.9% calves on flights over the Indian and Banana Rivers. Others have reported somewhat higher calf percentages: 15% of 65 known individuals in Miami (Moore, 1956); 14.4% of manatees counted on summer flights over Florida (Irvine and Campbell, 1978); and 12% and 23% of the Crystal River manatee population during two consecutive winters (Hartman, 1979).

Manatee distribution in Brevard County varies seasonally (Table 1 and Fig. 3). During the warm months of the year manatees are dispersed widely, but in January and February they usually are restricted to the FPL and OUC warm effluents as suggested by Hartman (1974). While at least a few Brevard County summer residents take refuge at the FPL and OUC Indian River power plants, others travel 210 km south to the Riviera Plant for the winter. Manatees in the St. Johns River have been shown by Bengtson (1981) to use areas over 200 km apart during the course of a year. The winter location of most Brevard County summer residents is undetermined. The summer range of most manatees that winter at FPL and OUC is, likewise, unknown.

The sighting of *Tm* 78 at the Riviera Plant in January–February 1981, after it had apparently spent the previous two winters at FPL and OUC in Brevard County, demonstrates that a manatee can travel a long distance to switch wintering locations from year to year. According to weather data recorded at Daytona Beach, 85 km north of Titusville, air temperatures averaged 2.3°C below normal in December 1980 through February 1981 (temperatures in January were 5.3°C

below normal, NOAA, 1980, 1981). The unusually cold winter may have contributed to *Tm* 78's move to Riviera Beach. Although manatees usually have been reported to return to the same wintering site each year (Moore, 1956; Powell and Waldron, in press; Hartman, 1979), Hartman (1979) mentioned that one manatee was seen in Homosassa Springs one winter and in Crystal River, 45 km away, the following winter. Powell and Waldon (in press) noted that adult manatees never seen before at Blue Spring Run, a wintering site for manatees on the St. Johns River, joined the permanent winter residents there each winter. These new individuals presumably left other wintering sites in favor of Blue Spring Run.

I believe that the seasonal movements observed in Brevard County indicate a complex pattern of seasonal movements along Florida's entire east coast. There probably is a general southward movement of manatees along the east coast each fall and a northward movement each spring. The abundance peaks in Brevard County each November and each spring (Fig. 2) indicate a temporary influx of animals during these periods. Factors that may affect winter distribution of manatees on the east coast probably include: (1) a traditional movement southward (Nelson, 1918; Moore, 1951b; 1956); (2) the availability of artificial warm water sources in northern and central Florida (Hartman, 1974; Campbell and Irvine, in press); (3) the severity of the winter; and (4) the operating status of the units producing the warm effluents. Other factors, such as age, sex and food availability also may influence seasonal movements.

Although the aggregation of manatees at warm water sources during the winter is well-documented (Moore, 1951a; 1951b; 1956; Hartman, 1974; Irvine and Campbell, 1978; Hartman, 1979), the regular occurrence of manatee aggregations at specific sites during the warm season is less well-known. Warm season aggregations at the four sites on the Banana River were common and fairly predictable during the present study. The large aggregations in the marina on the Banana River in March–April 1979 and March 1981 were comparable in size, duration, and predictability to aggregations at many winter refuges. Eight manatees returned to the same warm season sites following winter absences, and one of them (*Tm* 9) was observed at the same sites during four consecutive warm seasons. These observations differ from Hartman (1979) who "doubt[ed] that manatees return to the same summer range year after year or that movements of each individual follow a repetitive pattern." In fact, manatees may be nearly as faithful to summer ranges as they are to wintering sites. Just as all winter refuges provide warmer than ambient water temperatures, there are some characteristics shared by most of the warm season aggregation sites: (1) deep, dredged coves set off from the main waterway, possibly providing shelter from boats and wind; (2) nearby shallow grass flats; (3) availability of fresh water; and (4) occasional entrapment of uprooted, floating seagrasses. These characteristics may play a role in motivating manatees to form warm season aggregations as may social bonds between individuals.

Acknowledgments

This research was supported primarily by the Florida Power and Light Co. (Contract No. 61552-86540). Assistance during the project was received from: the Merritt Island National Wildlife Refuge staff; the staff of Applied Biology, Inc.; R. Wilcox, J. Robinson and other employees of the FPL and OUC power plants. S. Chestnut served as the second observer on most aerial surveys. T. O'Shea, B. Irvine, G. Rathbun, C. Beck, and P. Larson made helpful comments and suggestions regarding the manuscript. L. Whitehead typed the paper.

LITERATURE CITED

Bangs, O. 1895. The present standing of the Florida manatee, *Trichechus latirostris* (Harlan), in the Indian River waters. Amer. Nat. 29: 783–787.

Bengtson, J. L. 1981. Ecology of manatees (*Trichechus manatus*) in the St. Johns River, Florida. Ph.D. Thesis. Univ. of Minnesota. 126 pp.

Campbell, H. W. and A. B. Irvine. (in press). Manatee mortality during the unusually cold winter of 1976–1977. The West Indian Manatee in Florida. Proceedings of a Workshop held in Orlando, Florida, 27–29 March 1978. R. L. Brownell, Jr. and K. Ralls, eds. Florida Dept. of Natural Resources.

——— and J. A. Powell. 1976. Endangered species: the manatee. Florida Nat. 49: 15–20.

Caughley, G., R. Sinclair and D. Scott-Kemmis. 1976. Experiments in aerial survey. J. Wildl. Manage. 40: 290–300.

Hartman, D. S. 1974. Distribution, status and conservation of the manatee in the United States. U.S. Fish and Wildlife Service, Natl. Fish and Wildl. Lab Rep., Contract No. 14-16-0008-748, NTIS Pub. No. PB 81-140725. 246 pp.

———. 1979. Ecology and behavior of the manatee (*Trichechus manatus*) in Florida. Amer. Soc. Mammal., Spec. Publ. No. 5. 153 pp.

Irvine, A. B. and H. W. Campbell. 1978. Aerial census of the West Indian manatee, *Trichechus manatus,* in the southeastern United States. J. Mammal. 59: 613–617.

Leatherwood, S. 1979. Aerial survey of the bottlenosed dolphin, *Tursiops truncatus,* in the Indian and Banana Rivers, Florida. Fish. Bull. U.S. 77: 47–59.

Moore, J. C. 1951a. The status of the manatee in the Everglades National Park, with notes on its natural history. J. Mammal. 32: 22–36.

———. 1951b. The range of the Florida manatee. Quart. J. Florida Acad. Sci. 14: 1–19.

———. 1956. Observations of manatees in aggregations. Amer. Mus. Novit. 1811: 1–24.

Nelson, E. W. 1918. Florida manati (*Trichechus latirostris*). Pages 465–468 *in* Wild animals of North America. Natl. Geog. Society, Wash., D.C.

NOAA. 1980. Climatological data: Florida 84 (12). Environmental Data and Information Service, National Climatic Center, Asheville, N.C.

———. 1981. Climatological data: Florida 85 (1 and 2). Environmental Data and Information Service, National Climatic Center, Asheville, N.C.

Powell, J. A. and J. C. Waldron. (in press). The manatee population in Blue Spring, Volusia County, Florida. The West Indian Manatee in Florida. Proceedings of a Workshop held in Orlando, Florida, 27–29 March 1978. R. L. Brownell, Jr. and K. Ralls, eds. Florida Dept. of Natural Resources.

Shane, S. H. 1981. Abundance, distribution and use of power plant effluents by manatees (*Trichechus manatus*) in Brevard County, Florida. U.S. Fish and Wildlife Service, Natl. Fish and Wildl. Lab Contract Rep. No. 61552-86540 to Florida Power and Light Co., NTIS Publ. No. PB 81-147019. 244 pp.

True, F. W. 1884. The sirenians or sea-cows. Bull. of Fisheries and Fisheries Industr. of the U.S. Pages 114–136 *in* Natural history of useful aquatic animals. Sec. 1, Art. C, 00-885.

DATE ACCEPTED: February 8, 1982.

ADDRESS: *Denver Wildlife Research Center, 412 N.E. 16th Ave., Gainesville, Florida 32601.* PRESENT ADDRESS: *Univ. of California, Biology-Applied Sciences Bldg., Santa Cruz, California 95064.*