AERIAL SURVEYS FOR MANATEES AND DOLPHINS IN WESTERN PENINSULAR FLORIDA

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ABSTRACT

Low altitude aerial surveys were conducted to count West Indian manatees, *Trichechus manatus*, and bottlenose dolphins, *Tursiops truncatus*, in western peninsular Florida. A total of 554 manatees was observed in 297 groups. Most of the manatees (58.5%) were sighted in the Collier-Monroe Counties in shallow, brackish inshore areas. A total of 1,383 bottlenose dolphins was observed in 431 herds, including 700 (in 146 herds) in the Gulf of Mexico, 491 (in 185 herds) in bays, and 192 (in 100 herds) in marsh-river habitats.

West Indian manatees, *Trichechus manatus*, and bottlenose dolphins, *Tursiops truncatus*, occur in rivers, estuaries, and coastal areas in Florida (Moore 1953; Layne 1965; Hartman 1974[3]; Irvine and Campbell 1978). Manatees are dispersed throughout Florida waters during the summer, but concentrate around warmwater sources in winter (Hartman footnote 3; Irvine and Campbell 1978). Aerial surveys indicate that bottlenose dolphins are also well dispersed in coastal waters of Florida (Odell 1976, 1979; Leatherwood 1979; Odell and Reynolds 1980[4]). However, localized distribution patterns and seasonal changes in distribution and abundance have only been documented in a few areas for manatees (Odell 1976, 1979; Irvine et al. 1978[5]; Shane 1980[6]) or dolphins (Odell 1976, 1979; Shane and Schmidly 1978[7]; Irvine et al. 1979[8]). The distribution of manatees and dolphins in various habitat types and salinities in Florida also is unclear.

More information is needed to serve as a basis for sound conservation and management decisions because manatees and dolphins are protected by the Marine Mammal Protection Act of 1972; manatees are also protected by the Endangered Species Act of 1973. Southwestern Florida, encompassing Everglades National Park (ENP; Monroe County) and the Ten Thousand Islands (Collier-Monroe Counties), is of particular interest because this area has been relatively unaffected by human development. Abundance, habitat use, and herd size information is therefore of interest for comparison with more developed areas.

We conducted a series of aerial surveys from July to December 1979 to examine the distribution and relative abundance of manatees and dolphins from Bayport, Hernando County (lat. 28°32'N, long. 82°39'W), Fla., south to Flamingo Ranger Station (ENP), Monroe County (lat. 25°08'N, long. 81°02'W), Fla.

METHODS

Surveys were conducted during five periods: 24 through 29 July, 6 through 11 and the 17th of

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[3]Hartman, D. S. 1974. Distribution, status, and conservation of the manatee in the United States. Report to U.S. Fish and Wildlife Service, National Fish and Wildlife Laboratory, Wash., D.C. National Technical Information Service PB 81 140725.

[4]Odell, D. K., and J. R. Reynolds III. 1980. Distribution and abundance of the bottlenose dolphin, *Tursiops truncatus*, on the west coast of Florida. Report to the U.S. Marine Mammal Commission, Wash., D. C. National Technical Information Service PB 80-197650.

[5]Irvine, A. B., M. D. Scott, and S. H. Shane. 1978. A study of the West Indian manatee, *Trichechus manatus*, in the Banana River and associated waters, Brevard County, Florida. U.S. Fish and Wildlife Service, National Fish and Wildlife Laboratory, Final Draft Contract Report to John F. Kennedy Space Center, NASA, Kennedy Space Center, FL 33899. Contract No. CC 63426A, KSC-DF-112.

[6]Shane, S. H. 1980. Manatees (*Trichechus manatus*) in Brevard County, Florida: Abundance, distribution and use of power plant effluents. Report to Florida Power and Light Co., P.O. Box 13100, Miami, FL 33101. Contract No. 61552-86540.

[7]Shane, S. H., and D. J. Schmidly. 1978. The population biology of the Atlantic bottlenosed dolphin, *Tursiops truncatus*, in the Aransas Pass area of Texas. Report to U.S. Marine Mammal Commission, Wash., D.C. National Technical Information Service PB 283-393.

[8]Irvine, A. B., M. D. Scott, R. S. Wells, J. H. Kaufmann, and W. E. Evans. 1979. A study of the movements and activities of the Atlantic bottlenosed dolphin, *Tursiops truncatus*, in-

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September, 2 through 8 October, 2 through 8 November, and 3 through 9 December 1979. Weather permitting, surveys were conducted on consecutive days in a chartered Cessna[9] 172 aircraft at an airspeed of about 160 km/h and an altitude of about 150 m. The final day of the September survey was postponed until 17 September because of adverse weather caused by Hurricane Frederic. The flight on 6 December was shortened, and flights scheduled for 7 and 8 December were cancelled due to inclement weather. The cancellation of those flights prevented December coverage of Charlotte Harbor and associated rivers, all of the Caloosahatchee and Orange Rivers, and the area from Estero Bay (Lee County) south to the Broad River (Monroe County) in ENP. The Whitewater Bay area of ENP was surveyed on 9 December 1979. After the July surveys, an extra survey day was added to the schedule, and daily coverage was redistributed to shorten flights in south Florida. Daily surveys lasted from 2 h 25 min to 6 h 21 min ($\bar{x}$ = 3 h 52 min).

Flights usually began between 0730 and 0800 h. The right door of the aircraft was removed to increase visibility on the 7 September flight and on all flights in subsequent months. One observer was seated in the right front and another in the left rear. Sighting locations of all manatees and dolphins were noted on charts of each earea by the forward observer. Comments were dictated into a cassette tape recorder, or noted directly on the chart. Calves were defined as small manatees or dolphins closely associating with larger animals of approximately twice their size (after Irvine and Campbell 1978). Dolphins or manatees within an arbitrary distance of about 100 m of conspecifics were counted as being in the same "herd" or group. Use of the term "herd" to describe social aggregations of dolphins is well established in the literature by Norris and Dohl (1980), but "herds" of manatees are not known to occur (Hartman 1979; Reynolds 1981).

Flight routes were marked on maps of the entire western Florida study area to facilitate consistent coverage on successive surveys. The routes were selected to cover probable manatee habitat (Hartman footnote 3; Irvine and Campbell 1978). Survey routes generally followed the 2 m bottom contour. The deepwater shipping channel was also surveyed in Tampa Bay. Pilots used the route maps to navigate, leaving the observers free to scan for animals. The plane deviated from the route only to investigate sightings and to count or photograph animals.

Areas surveyed included 1) bays and estuaries; 2) the Caloosahatchee River to the Ortona Lock in July and to Moore Haven on other surveys; 3) canals, bayous, rivers, and creeks (>1 m deep) up to 25 km inland; 4) the Intracoastal Waterway (ICW); 5) coastal areas to 0.5 km offshore, or to depths of about 2 m where shoals extended well offshore (Pasco and Hernando Counties).

Sighting locations on the flight record charts were categorized into three habitat types: 1) offshore: the Gulf of Mexico, 2) bay-estuary: bays, estuaries, and large rivers with direct access to the Gulf of Mexico, and 3) marsh-river: complex marsh habitats (Leatherwood and Platter[10]), inland bays (Monroe County), and narrow rivers. Using criteria from Remane and Schlieper (1971), salinity at each sighting location was subsequently classified as fresh (<0.5‰ salt), brackish (0.5 to 30‰ salt), or marine (>30‰ salt) based on available reports (E.P.A.[11]; Wang and Raney 1979[12]; U.S. Department of Commerce 1973; Weinstein et al. 1977; Schmidt and Davis 1978[13]). Offshore habitats were always categorized as marine, even though salinities in some areas might have been influenced by tide and freshwater runoff from recent storms. Relative survey effort was estimated as the percentage of total flight time in each habitat and salinity type.

Patterns of relative abundance and mean herd or group size were evaluated using chi-square and analysis of variance (ANOVA) procedures (Sokal and Rohlf 1969). Multiple comparisons among means were analyzed with Duncan's

cluding an evaluation of tagging techniques. Report to U.S. Marine Mammal Commission, Wash., D.C. National Technical Information Service PB 298 042.

[9]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

[10]Leatherwood, S., and M. F. Platter. 1979. Aerial assessment of bottlenose dolphins off Alabama, Mississippi and Louisiana. *In* D. K. Odell, D. B. Siniff, and G. H. Waring (editors), *Tursiops truncatus* assessment workshop, p. 49-86. Report to U.S. Marine Mammal Commission, Wash., D.C. National Technical Information Service PD 291 161.

[11]E.P.A. Water Quality Information Storage System (STQRET), 401 M. Street, SW., Wash., DC 20460.

[12]Wang, J. C. S., and E. C. Raney. 1971. Distribution and fluctuations in the fish fauna of the Charlotte Harbor Estuary, Florida. Charlotte Harbor Estuarine Studies. Mote Marine Laboratory, 1600 City Island Park, Sarasota, FL 33577.

[13]Schmidt, T. W., and G. E. Davis. 1978. A summary of estuarine and marine water quality information collected in Everglades National Park, Biscayne National Monument and adjacent estuaries from 1879 to 1977. U.S. National Park Service, South Florida Research Center, P.O. Box 279, Homestead, FL 33030. Report T-519.

Multiple Range Test (Steel and Torrie 1960). A square root transformation ($\sqrt{\text{herdsize} + 0.5}$) was applied to the counts to make them suitable for parametric analysis (Steel and Torrie 1960). Computations were performed with programs of the Statistical Analysis System (Helwig and Council 1979) at the University of Florida, Gainesville, Fla.

RESULTS

Manatees

Two hundred and ninety-seven groups of manatees, totaling 554 individuals, were observed during 121.8 survey hours (Fig. 1). Numbers sighted (Table 1) and average number of individuals per groups (Table 2) varied by county and month. Total numbers of manatees sighted increased from September to November, but the total per county consistently increased only in Monroe County. Total counts were not statistically compared among counties because habitat type, weather, and amount of survey area were not equivalent.

Ninety-four percent of the groups sighted consisted of one to four animals (Fig. 2). Group sizes were not observed with equal frequency, and more than half of the 297 sightings were of single animals ($P<0.005$; chi-square). However, 367 (66.2%) of the 554 manatees sighted were in groups. Pooled samples of all counties indicated that group size-frequency distributions did not vary significantly between months ($P>0.80$; chi-square).

Mean group size for the pooled sample of all sightings was 1.9 (SE = 0.12). A subset of data, including only those counties with sightings in each month (Monroe, Lee, and Sarasota Counties), was analyzed as a two-way ANOVA. This analysis provided no evidence of a month by county interaction ($P>0.85$), indicating that any pattern of monthly variation in group size was comparable for those three counties. Monthly variation in average group size, analyzed as a separate one-way ANOVA for each county, was significant ($P<0.05$) only in Hillsborough County, due to high December counts at warmwater effluents.

Numbers of manatees sighted were not proportional to the amount of survey time in each habitat type or salinity ($P<0.005$; chi-square). Pooled samples from all counties indicated that numbers of manatees sighted per month varied significantly by salinity and habitat ($P<0.0005$; chi-square). Except in December, substantially more manatees were sighted in marsh-river habitats than in other habitat types, and most were in brackish water (Table 3).

From 51 to 100 manatees, representing 54.3 to 75.7% of those sighted on July to November surveys and 58.5% overall, were observed in Monroe and Collier Counties (Table 1). Manatees were consistently sighted in Whitewater Bay, Chevalier Bay, and in the Lopez River (ENP, Monroe County), but the largest concentrations were found in Collier County from Marco Island to Chokoloskee. Manatees may have been overlooked if they were not near the surface or creating surface wakes or mud trails because of water turbidity (estimated visibility 0-0.5 m).

A maximum of two manatees per survey was sighted in Charlotte Harbor (Charlotte County; Fig. 1) and small numbers of manatees were consistently sighted in Pine Island Sound, Matlacha Pass, San Carlos Bay, in the lower reaches of the

TABLE 1.—Numbers of manatees and bottlenose dolphins observed, by county, during aerial surveys in western peninsular Florida from July to December 1979. C = calves.

	Manatees					Bottlenose dolphins				
County	July	Sept.	Oct.	Nov.	Dec.	July	Sept.	Oct.	Nov.	Dec.
Charlotte	4	5	6	0	[1]1	13+1C	22+1C	11+1C	1	[1]12+2C
Collier	41	49+2C	63+1C	49	([2])	9	20	11	29+1C	([2])
De Soto	0	0	0	0	([2])	0	0	0	0	([2])
Glades	0	0	0	1	([2])	0	0	0	0	([2])
Hendry	0	0	0	2+2C	([2])	0	0	0	0	([2])
Hernando	0	0	0	0	0	4	0	7	8	0
Hillsborough	16	3	0	0	47+3C	30+2C	17+2C	17	0	3
Lee	15	17+1C	7	26+1C	[1]12	34	37+1C	100+1C	32	[1]62+3C
Manatee	6	0	3	4	0	8+2C	6	44+3C	13	44+1C
Monroe	9+1C	10	20	48+3C	[1]28	15	35+2C	26+1C	66	[1]28+4C
Pasco	0	0	0	0	1	2	17+1C	27	119+3C	59+3C
Pinellas	0	0	0	0	7	56+1C	36+3C	39	73+2C	33+1C
Sarasota	2	6	11	14+1C	6	12+1C	60+4C	23+1C	6	9
Total	93+1C	90+3C	110+1C	144+7C	102+3C	183+7C	250+14C	305+7C	347+6C	250+14C

[1]Incomplete survey
[2]Not surveyed

FIGURE 1.—Locations and numbers of manatees sighted during 1979 aerial surveys in western peninsular Florida. Symbols: triangle = July, open square = September, open circle = October, solid circle = November, solid square = December, c = calf. Multiple sightings in localized areas are summarized.

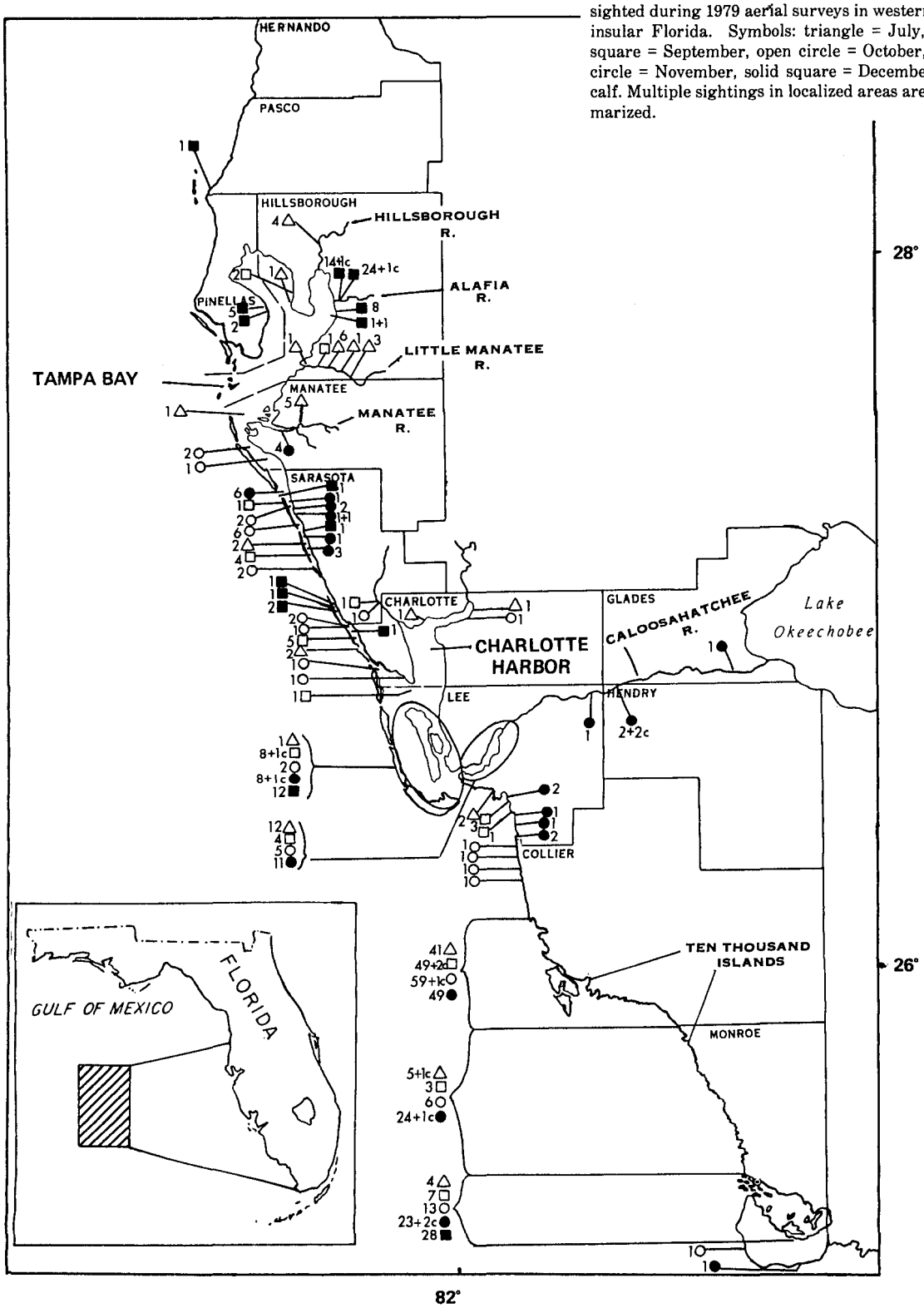

TABLE 2.—Average group or herd size of manatees and bottlenose dolphins sighted, by county, during aerial surveys of western peninsular Florida from July to December 1979.

	Manatees						Bottlenose dolphins					
County	July	Sept.	Oct.	Nov.	Dec.	Composite average	July	Sept.	Oct.	Nov.	Dec.	Composite average
Charlotte	1.3 (0.33;3)	5.0 (--;1)	1.2 (0.20;5)	—[2]	1.0 (--;1)	1.6 (0.4;10)	2.8 (0.86;5)	1.9 (0.40;12)	1.7 (0.57;7)	1.0 (--;1)	3.5 (1.50;4)	2.2 (0.33;29)
Collier	1.7 (0.27;24)	2.0 (0.38;25)	1.5 (0.16;42)	1.5 (0.15;33)	[3]	1.7 (0.11;12)	2.3 (0.63;4)	1.5 (0.33;13)	1.4 (0.26;8)	2.7 (0.84;11)	[3]	1.9 (0.30;36)
De Soto	—	—	—	—	[3]		—	—	—	—	[3]	—
Glades	—	—	—	1.0 (--;1)	[3]	1.0 (--;1)	—	—	—	—	[3]	—
Hendry	—	—	—	4.0 (--;1)	[3]	4.0 (--;1)	—	—	—	—	[3]	—
Hernando	—	—	—	—	—	—	4.0 (--;1)	—	7.0 (--;1)	1.3 (0.21;6)	—	2.4 (0.75;8)
Hillsborough	2.7 (0.84;6)	1.5 (0.50;2)	—	—	12.5 (4.94;4)	5.8 (2.11;12)	4.0 (0.57;8)	2.7 (1.13;7)	3.4 (2.40;5)	—	1.5 (0.50;2)	3.2 (0.66;22)
Lee	1.9 (0.30;8)	1.6 (0.24;11)	2.3 (0.88;3)	1.9 (0.32;14)	1.5 (0.19;8)	1.8 (0.14;44)	3.1 (0.68;11)	1.7 (0.24;22)	2.5 (0.36;41)	1.9 (0.41;17)	5.4 (1.45;12)	2.6 (0.27;103)
Manatee	3.0 (2.00;2)	—	1.5 (0.50;2)	4.0 (--;1)		2.6 (0.81;5)	3.3 (1.45;3)	1.5 (0.29;4)	4.7 (1.74;10)	2.6 (0.98;5)	15.0 (8.14;3)	4.8 (1.34;25)
Monroe	1.3 (0.16;8)	1.1 (0.11;9)	1.7 (0.36;12)	1.7 (0.26;31)	1.6 (0.34;18)	1.5 (0.14;78)	1.7 (0.33;9)	2.0 (0.58;19)	1.5 (0.15;18)	1.9 (0.22;35)	2.1 (0.65;15)	1.9 (0.18;96)
Pasco	—	—	—	—	1.0 (--;1)	1.0 (--;1)	2.0 (--;1)	4.5 (3.50;4)	27.0 (--;1)	20.3 (10.72;6)	10.3 (6.74;6)	12.8 (4.40;18)
Pinellas	—	—	—	—	3.5 (1.50;2)	3.5 (1.5;2)	2.7 (0.49;21)	4.3 (1.24;9)	3.9 (1.29;10)	5.0 (1.76;15)	4.3 (1.56;8)	3.9 (0.55;63)
Sarasota	2.0 (--;1)	2.0 (1.00;3)	2.8 (1.11;4)	2.5 (0.76;6)	1.2 (0.20;5)	2.1 (0.37;19)	2.2 (0.31;6)	5.8 (2.40;11)	4.8 (2.33;5)	1.2 (0.20;5)	2.3 (0.63;4)	3.7 (0.96;31)

[1]Standard error of the mean and *n* (sightings) in parentheses; -- = no value.
[2]No sightings.
[3]Not surveyed.

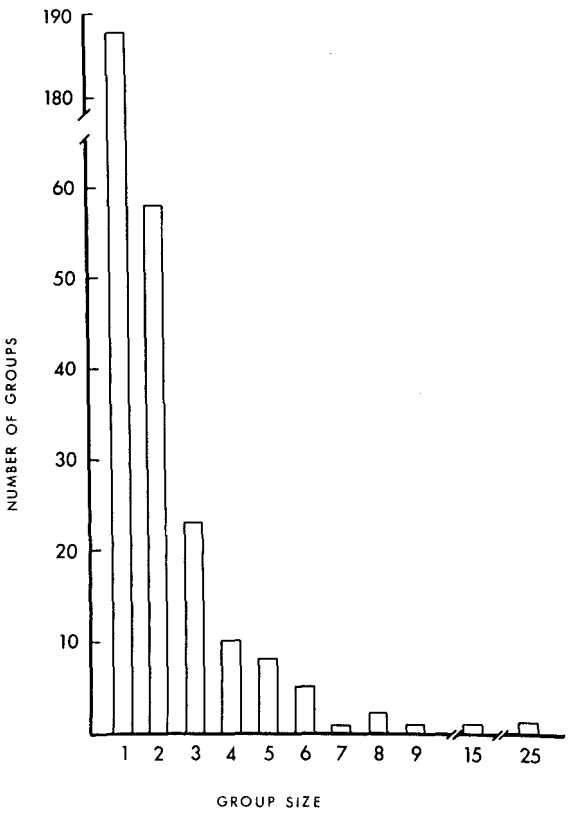

FIGURE 2.—Group size-frequency distribution of manatees sighted during aerial surveys from July through December 1979.

Caloosahatchee River, and in Estero Bay (Lee County). Manatees were sighted in the Upper Caloosahatchee River (Glades and Hendry Counties) only in November. Manatees were not sighted near the warmwater refuge in the Orange River, Lee County (Hartman footnote 3), but the area was not surveyed in December when ambient air and water temperatures were coldest.

A few manatees were consistently sighted between Charlotte Harbor and Tampa Bay. The animals were sighted in Lemon Bay, Roberts Bay, and Little Sarasota Bay, and were often near the channel of the ICW.

North of Sarasota County, manatees were primarily sighted in rivers emptying into Tampa Bay, including the Hillsborough, Alafia, Manatee, and Little Manatee Rivers. Our observations in Hillsborough and Manatee Counties may have been hampered in September by cloud cover and in October by turbid waters resulting from recent flooding.

Manatees were observed near warmwater refuges described by Hartman (footnote 3) only during the December flights. A total of 40 manatees was sighted at the two warm effluents of the Gibsonton Phosphate Plant in the Alfia River (Hillsborough County). Eight manatees were sighted in the Big Bend Power Plant effluent (Hillsborough County), and a cow and calf were observed just offshore of the effluent. Five manatees were observed at the P. L. Bartow Plant effluent (Pinellas County), and two manatees were observed near the intake canal. A single manatee was sighted in the intake canal of the Anclote Power Plant (Pasco County).

A maximum of three calves per county was sighted on any survey. Total percentage of calves sighted ranged from 0.9 to 4.9% on different surveys.

Bottlenose Dolphins

Four hundred and thirty-one herds, totaling 1,383 bottlenose dolphins, were observed. The total number of dolphins sighted increased from July to November, but fluctuated in most counties with no obvious trends (Table 1). Sightings were common in interior bays and rivers in ENP

TABLE 3.—Manatee and bottlenose dolphin sightings in different habitat-types and estimated salinities.

	Manatees						Bottlenose dolphins					
	Habitat-type			Salinity			Habitat-type			Salinity		
	Off-shore	Bay-estuary	Marsh-river	Fresh (<0.5‰)	Brackish (0.5-30‰)	Salt (>30‰)	Off-shore	Bay-estuary	Marsh-river	Fresh (<0.5‰)	Brackish (0.5-30‰)	Salt (>30‰)
Mean group or herd size (±SE)	1.29 (0.13)	2.38 (0.34)	1.69 (0.10)	1.93 (0.35)	1.85 (0.14)	1.93 (0.21)	4.79 (0.70)	2.65 (0.19)	1.92 (0.19)	0	2.19 (0.14)	3.97 (0.44)
No. of groups or herds	14	85	198	14	240	43	146	185	100	0	184	247
No. of animals (percent)	18 (3.2)	202 (36.5)	334 (60.3)	27 (4.9)	444 (80.1)	83 (15.0)	700 (50.7)	491 (35.5)	192 (13.9)	0	403 (29.1)	980 (70.9)
Percent of survey time	17.7	44.3	38.0	8.9	50.1	41.0	17.7	44.3	38.0	8.9	50.1	41.0

and well into Tampa Bay. In the Charlotte-Lee Counties area, dolphins were common in the Gulf of Mexico, around Pine Island, and occasionally in the lower Caloosahatchee River. Most coastal sightings were within 0.5 km of the beach.

Dolphin herd sizes were not sighted with equal frequency (Fig. 3); most sightings (56%) consisted of two or more animals ($P<0.005$; chi-square). Mean herd size for the pooled sample of all sightings was 3.2 dolphins/herd (SE = ±0.26). Effects of county and month on average herd size in counties with sightings in each month (Table 2) were analyzed as a two-way ANOVA. The county by month interaction was significant ($P<0.0005$), indicating that monthly variations in dolphin herd sizes were not comparable among counties. A separate one-way ANOVA for each county indicated that monthly variation in herd size was significant ($P<0.05$) only in Lee County, due to a high December mean. Pooled sightings from all counties indicated that herd size-frequency distributions varied significantly between months ($P<0.001$; chi-square), with fewer single dolphins and more large groups (>4) sighted in July and December.

Numbers of dolphins observed were not proportional to the amount of survey time in different habitats and salinities ($P<0.005$; chi-square). More animals were observed off the beach and in saltwater (Table 3), but monthly trends were not apparent. Dolphins were not sighted in freshwater. Pooled samples from all counties where sightings occurred indicated that numbers of dolphins sighted per month varied significantly by habitat and salinity ($P<0.001$). Most dolphins were sighted offshore in Pinellas and Sarasota Counties; more animals were in bay-estuary than in other habitats in Lee County; and most were in marsh-river habitats in Collier and Monroe Counties.

A maximum of 5.3% calves was observed during both the September and December surveys. A high of 12.5% calves was sighted in Monroe County in December, but this total may not be representative because relatively few dolphins were sighted in the area during the abbreviated surveys (Table 1).

DISCUSSION

Manatees are usually sighted in small groups when away from warmwater refuges. Eighty-six percent of the sightings during aerial surveys by Odell (1979) and 89% of the sightings by Hartman (1979) were of one to four manatees. Our results and those from other surveys (Hartman 1979; Odell 1979; Reynolds 1981) indicate that the greater percentage of manatees sighted are found in groups, but one is the most common group size. Although Hartman (1979) suggested that manatees are "essentially solitary," solitary manatees are nevertheless a minority of the total numbers sighted.

Odell (1979) sighted from 0 to 71 manatees

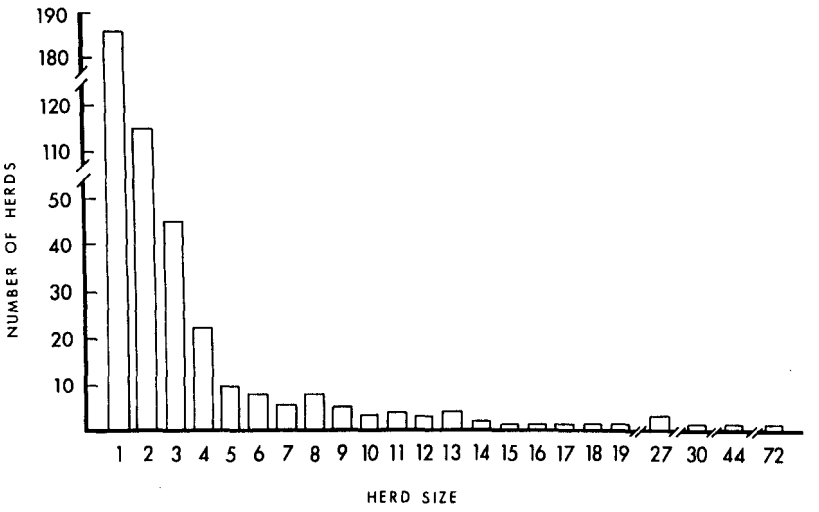

FIGURE 3.—Herd size-frequency distribution of bottlenose dolphins sighted during aerial surveys from July through December 1979.

during transect surveys conducted from July to December 1973 through 1976 in Monroe and Collier Counties. Hartman (footnote 3) sighted 45 manatees in Monroe and Collier Counties during a summer survey; Irvine and Campbell (1978) reported observing 163 manatees during a 1976 winter survey of the same area. Although abundance reports by different authors are not completely comparable because of variability among survey methodologies, results of our study clearly support previous reports that southwestern Florida is a center of manatee abundance (Moore 1951; Hartman footnote 3; Irvine and Campbell 1978).

Southerly shifts in the distribution of manatees in Florida during the fall were predicted by Moore (1951) and Hartman (footnote 3). Although total counts in Monroe and Collier Counties generally increased during fall surveys, the significance of this trend is unclear. Increased sightings may correlate with changes in manatee abundance, but could also indicate that the animals are for some reason more easily observed in that season. In any event, a southerly autumn shift in distribution cannot be conclusively shown based on our data.

The preponderance of manatee sightings in brackish water and marsh-river habitats occurred in the areas of Collier and Monroe Counties, which are characterized by that combination of habitat and salinity. Inland bays in ENP and Ten Thousand Islands area of Collier County were classified as "marsh-river" habitat because access to the Gulf of Mexico is restricted by relatively narrow or shallow channels. Although the survey results may be general indicators of habitat use, they should be viewed with some caution because all habitat types were not surveyed equally, and local salinities may have varied seasonally due to runoff from rainfall. Irvine and Campbell (1978) reported the relative frequencies of manatee sightings in fresh, brackish, and salt water as 19.1, 42.5, and 38.3%, respectively, during winter surveys, and 35.2, 34.9, and 29.6% during a summer survey of the entire state. In contrast, 80% of the manatees sighted in our surveys were in brackish water (Table 3).

The few sightings in Charlotte Harbor are noteworthy because manatees are often sighted by residents in this area (Moore 1951; Hartman footnote 3), and 36 manatees were counted in Charlotte Harbor during a summer aerial survey by Hartman (footnote 3). Manatee use of the Bartow and Anclote power plants has not been specifically reported, but two sightings mapped by Irvine and Campbell (1978) were at these plants.

We sighted few manatee calves (4.9% maximum per survey) compared with other surveys. Calves made up 5.2% of the animals sighted by Odell (1979) in Collier and Monroe Counties in 1973 through 1976, but during a 1976 winter survey of the same area, 10.4% of the manatees sighted were calves (Irvine and Campbell 1978). Leatherwood (1979) counted 9.9% calves in the Indian and Banana Rivers in eastern Florida, and Irvine and Campbell (1978) reported overall calf percentages of 9.6% in winter and 13.4% in summer from surveys of the entire state. Odell (1979) suggested that the tendency of calves to stay close to their mothers might result in fewer calf sightings in turbid waters, but this hypothesis has not been verified. Too few calves were sighted in our study to indicate seasonal reproductive trends.

The dolphin sightings are of particular interest due to the paucity of information on *T. truncatus* in nearshore areas of western peninsular Florida. The sightings were not analyzed for abundance and density estimates (see discussion by Leatherwood et al. 1978), because flight routes were designed to optimize manatee sightings and were not flown as straight lines. Our observations can, however, provide information on dolphin herd size and habitat use.

Average herd size (3.2 dolphins/herd) was considerably smaller than herd sizes reported from other aerial surveys in nearshore areas. In coastal waters of Alabama, Mississippi, and Louisiana, herd sizes averaged 25.2 dolphins with herd size in marshlands averaging 16.7 (Leatherwood and Platter footnote 10). Subgroups contained a mean of 5 dolphins in sounds and 3.8 dolphins in marshes (Leatherwood and Platter footnote 10). Barham et al. (1980) reported that herd sizes averaged 6.95 dolphins in Texas, and Leatherwood (1979) reported herds averaging 8.20 dolphins in eastern Florida. In primarily estuarine areas of western Florida, group size (equivalent to herd size as used here) was 4.8 dolphins/group (Irvine et al. 1981). Differences between observed herd sizes have been attributed to the influence of geography and habitat on dolphin groups structure (Leatherwood and Platter footnote 10), with largest groups found offshore (Wells et al. 1980). However, criteria for defining "herds" or "subgroups" are rarely reported, and could influence differ-

ences in reported results. During our surveys we often encountered several herds within a few kilometers of each other, after not seeing dolphins for distances of 20 km or more. Although such assemblages may have been dispersed subgroups of a larger herd, they did not meet our arbitrary criteria for defining a "herd." Our spatial definition of herd may be unsatisfactory if bottlenose dolphins, like some other cetaceans, maintain acoustic contact over many kilometers (Payne and Webb 1971). Acoustic contact among free ranging groups of *T. truncatus*, however, has not been demonstrated, and we know of no more appropriate basis for defining herds from aerial sightings.

The proportion of dolphin calves noted during our surveys (5.3%) is low when compared with other reports. Leatherwood (1979) observed 8.1-10.1% calves during aerial surveys in eastern Florida in August, while Irvine et al. (footnote 8) reported a maximum of 11% from May to July during surface surveys near Sarasota, Fla. Shane and Schmidly (footnote 7) noted that calves constituted 7.6% of all dolphin sightings during surface surveys near Port Aransas, Tex., and Barham et al. (1980) sighted 9.3% calves from the air in the same area. Leatherwood[14] observed 7.7% calves in 1974 and 7.9% calves in 1975 near the mouth of the Mississippi River. Our calf counts may be lower because we only counted very small animals; calves may grow to 2 m long within the first year (Leatherwood footnote 14) and therefore large calves may not have been distinguished as such.

SUMMARY AND CONCLUSIONS

Most of the manatees (58.5%) were located in the Everglades National Park (Monroe County) and Ten Thousand Islands (Collier County) areas, and most (80.1%) were in brackish water. Because these areas are relatively undisturbed by human development, they have great value as locations to protect and study the endangered manatee.

Dolphins were well dispersed in the survey area. Fifty-one percent were sighted in the Gulf of Mexico, 49% were in brackish water, and none were located in freshwater.

Seasonal movement patterns and reproductive trends based on calf sightings of both dolphins and manatees are unclear. While the survey results are valuable as indicators of relative abundance, they are not useful to estimate total abundance because the percentage of animals not observed is unknown.

[14]Leatherwood, S. 1977. Some preliminary impressions on the numbers and social behavior of free swimming bottlenosed dolphin calves (*Tursiops truncatus*) in the northern Gulf of Mexico. *In* S. H. Ridgway and K. W. Benirshke (editors), Breeding dolphins: Present status, suggestions for the future, p. 143-167. National Technical Information Service PB 273 673.

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