Biological Services Program

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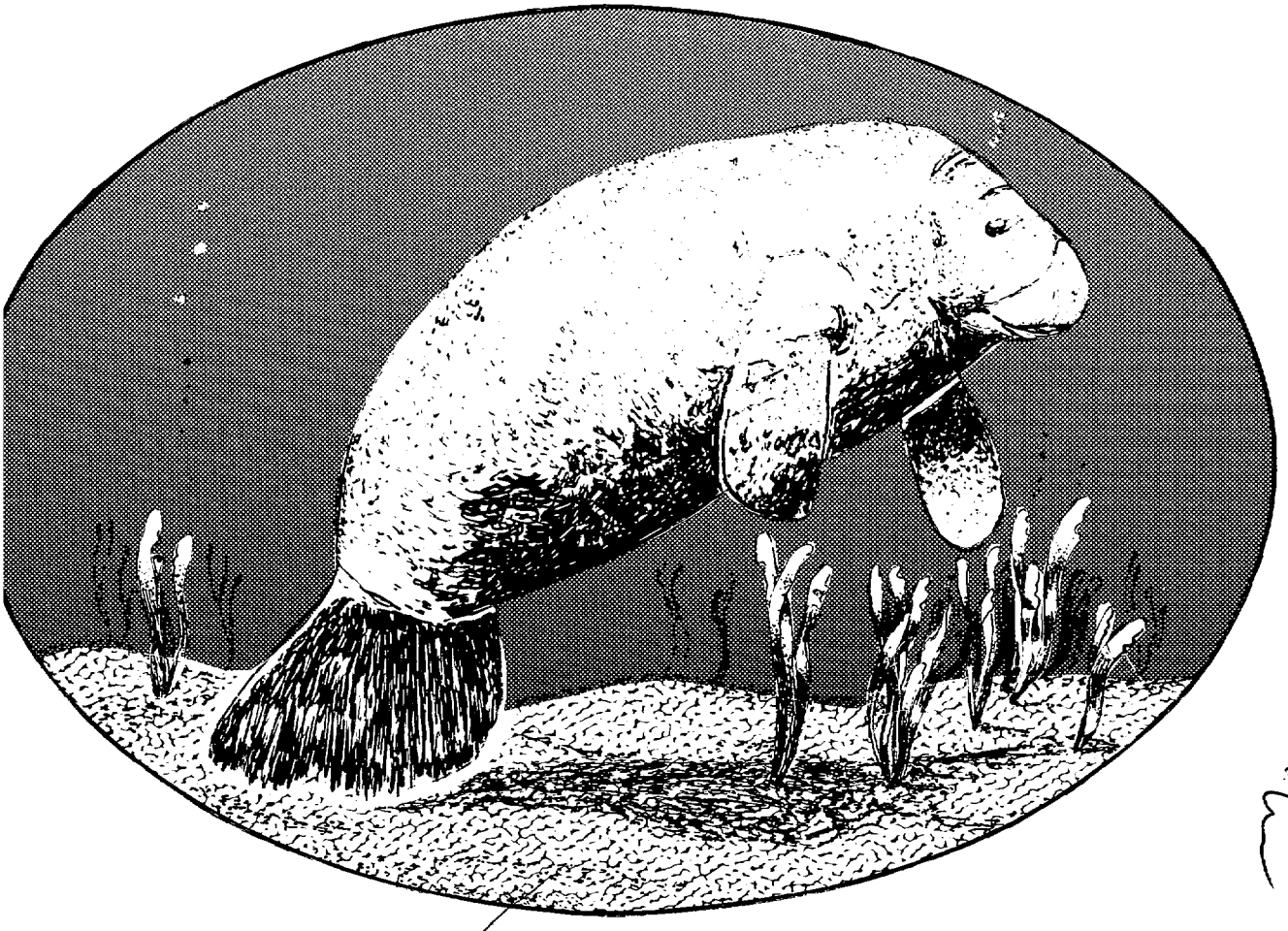
April 1981

Aerial Surveys for Manatees and Dolphins in Western Peninsular Florida



Bureau of Land Management

Fish and Wildlife Service

U.S. Department of the Interior

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- To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

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April 1981

AERIAL SURVEYS FOR MANATEES AND DOLPHINS IN WESTERN PENINSULAR FLORIDA

(With Notes on Sightings of Sea Turtles and Crocodiles)

by

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PREFACE

This report is one of several resulting from a 1979 pilot study on the distribution and abundance of marine mammals, birds, and turtles, and the endangered manatee of the South Atlantic and Gulf of Mexico. The report summarizes observations made during aerial surveys of manatees and dolphins along Florida's western peninsular coast. Sightings of sea turtles and one crocodile are also noted. The abundance of manatee and dolphin sightings are analyzed by month by county and by habitat type. Group sizes of the animals observed are also discussed.

SUMMARY

Low altitude aerial surveys were conducted at approximately monthly intervals from July to December 1979 to count West Indian manatees (*Trichechus manatus*) and bottlenose dolphins (*Tursiops truncatus*) in western peninsular Florida. Sightings of sea turtles, turtle tracks, and a crocodile were also noted. A total of 554 manatees was observed in 297 groups. Fifty-eight percent of the manatees were sighted in the Collier-Monroe Counties area 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. Fifty-eight sea turtles (including 45 loggerheads, *Caretta caretta*) and 30 sets of turtle tracks were counted. One crocodile, probably *Crocodiles acutus*, was sighted in the Everglades National Park.

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ACKNOWLEDGEMENTS

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INTRODUCTION

West Indian manatees (Trichechus manatus) and bottlenose dolphins (Tursiops truncatus) occur in rivers, estuaries, and coastal areas in Florida (Moore 1953a, Layne 1965, Hartman 1974, Irvine and Campbell 1978). Manatees are dispersed during the summer, but concentrate around win-m-water sources or in southw-estern Florida in winter (Hartman 1974, Irvine and Campbell 1978). Bottlenose dolphins are usually sighted in coastal and estuarine waters of Florida (Moore 1953a, Layne 1965, Odell 1976, 1979, Leatherwood 1979), and may remain in some areas throughout the year (Irvine et al. 1979). Seasonal changes in local distribution and abundance have only been documented in a few areas for manatees (Odell 1976, 1979, Irvine et al. 1978, Shane 1981) or dolphins (Odell 1976, 1979, Shane and Schmidly 1978, Irvine et al. 1979). The distribution of manatees and dolphins in various habitat types and salinities in Florida also is unclear.

Manatees and dolphins are protected by the Marine Mammal Protection Act of 1972 and manatees are also protected by the Endangered Species Act of 1973. Areas with high densities of these animals, which would potentially be im patted by Outer Continental Shelf (OCS) development, must therefore be identified. Southwestern Florida, encompassing Everglades National Park (EN P, Monroe County) and the Ten Thousand Islands (Collier-Monroe Counties), is of particular interest because this area has relatively large numbers of manatees (Moore 1951a, Hartman 1974, 1979, Irvine and Campbell 1978) and only minimal human development. Abundance, habitat use, and herd-size data will provide baseline inform ation for comparison with more developed areas.

Especially over large areas, aerial surveys are the only cost-effective m cans to census marine mammals. Statewide census flights in probable manatee habitat have been conducted by Hartman (1974) and Irvine and Campbell (1978), and the population in Florida may number as few as 1,000 manatees (Brownell et al. 1978). Comparable surveys for bottlenose dolphins have not been conducted, although results of transect surveys have been reported by Leatherwood (1979) for the Indian and Banana Rivers in eastern Florida, and by Odell and Reynolds (1980) who censused dolphins up to 48 km offshore of western Florida. Counts from any aerial surveys for marine mammals must be viewed with caution, because the number of animals undetected during a survey is never known, and ground truthing techniques are not available (Hartm an 1974, Irvine and Campbell 1978). The results of nearshore aerial surveys for manatees and dolphins may therefore be only an index of minimum abundance at the time of the survey, but these counts are also useful to show distribution and habitat use.

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 Count y , Florida ($28^{o}32'N, 82^{o}39'W$), south to Flamingo Ranger Station (EN P), Monroe

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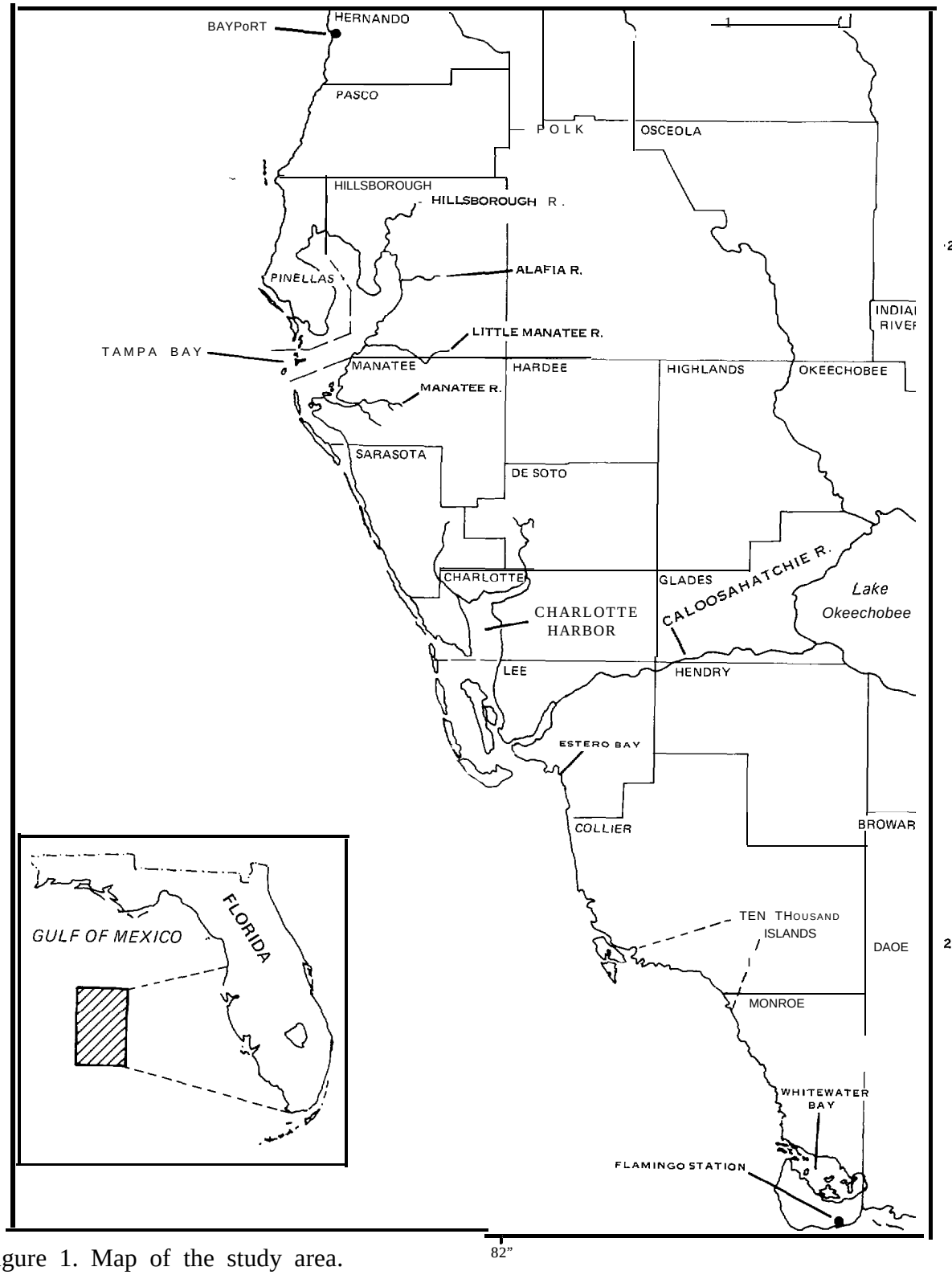

Figure 1. Map of the study area.

METHODS

Surveys were conducted during five periods: 24 through 29 July, 6 through 11 and the 17th of 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 172 aircraft at an air speed of approximately 160 km/h and an altitude of approximately 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 rein).

Flights usually began between 0730 and 0800 hours. 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, dolphins, sea turtles, sea turtle tracks, and crocodiles were noted on charts of each area by the forward observer. Corn ments 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 approximately 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 (see review by Norris and Dohl 1980), but "herds" of manatees are not known to occur (Hartman 1979, Reynolds In press).

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 1974, Irvine and Campbell 1978). Survey routes generally followed the 2 m bottom contour. The deep water 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; (5) coastal

areas to 0.5 km offshore, or to depths of approximately 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 (see Leatherwood and Platter 1979), 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°/00 salt), brackish (0.5 to 30°/00 salt), or marine (> 30°/oo salt) based on available reports (E. P. A., Wang and Raney 1971, U.S. Dept. of Commerce 1973, Weinstein et al. 1977, Schmidt and Davis 1978). Offshore habitats were always categorized as marine, even though salinities in some areas might have been influenced by tide and fresh water 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 (A NOVA) procedures (Sokal and Rohlf 1969). Multiple comparisons among means were analyzed with Duncan's Multiple Range Test (Steel and Torrie 1960). A square root transformation ($\sqrt{herdsize + 0.5}$) 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, Florida.

RESULTS AND DISCUSSION

iMANATEES

Abundance and Distribution

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

From 51 to 100 manatees, representing 54.3 to 75.7% of those sighted on July to November surveys, respectively, and 58.5% overall, were observed in Monroe and Collier Counties (Table 1). Manatees were consistent ly sighted in White water 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. Due to water turbidity (estimated visibility 0-0.5 m) and the complexity of marsh-river habitats, we believe that many manatees were overlooked because they were not near the surface or creating obvious surface wakes or mud trails.

Odell (1979) sighted from O to 71 manatees during transect-surveys conducted from July to December, 1973 through 1976, in Monroe and Collier Counties. Hartman (1974) 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 y among surveys, results of our study clearly support previous reports (Moore 1951a, 1951b, Hartman 1974, Irvine and Campbell 1978) that southwestern Florida is an important center of manatee abundance. Relative abundance of manatees away from warm-water refuges (see below) has been documented in the Banana River, Brevard County, where over 100 manatees were counted during biweekly surveys (Irvine et al. 1978, Shane 1981), but few other warm season counts are available.

Southerly shifts in the distribution of manatees in Florida during the fall were predicted by Moore (1951b) and Hartman (1974). 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.

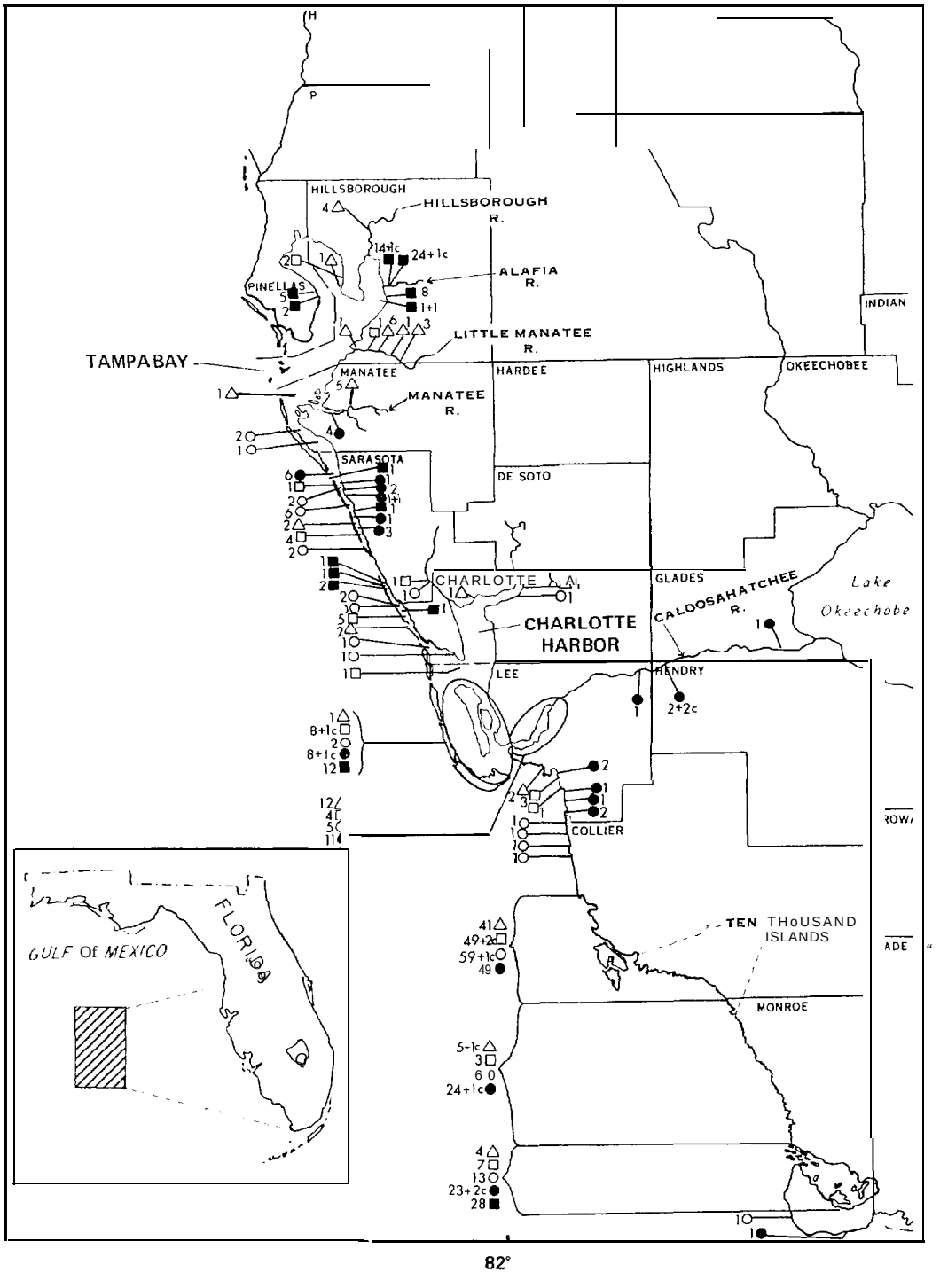

Figure 2. Location and numbers of manatees sighted during 1979 aerial surveys in western peninsular Florida. Symbols: △ July, O September, ○ October, ● November, and ● December; c = calf. Multiple sightings in localized areas are summarized.

Table 1. Numbers of manatees, bottlenose dolphins, and turtles observed, by county, during aerial surveys in western peninsular Florida from July to December 1979.

COUNTY	MANATEES					BOTTLE NOSE DOLPHINS					TURTLES				
	July	Sept,	Ott.	Nov.	Dec.	July	Sept.	Oct.	Nov	Dec.	July	Sept.	Oct.	Nov.	Dec.
Charlotte	4	5	6	0	1*	13+1C	22+1C	11+1C	1	12+2C*	1?	o	0	1 logg	1 logg*
Collier	41	49+2C[a]	63+1C	4 9	x	9	20	11	29+1	x	0	2 logg[b] 1 green[c]	2 logg	1 logg	x
De Soto	0	0	0	0	x	o	0	0	0	x	0	0	0	0	x
Glades	0	0	0	1	x	o	0	0	0	x	0	0	0	0	x
Hendry	0	0	0	2+2C	x	o	0	0	0	x	0	0	0	0	x
Hernando	0	0	0	0	0	4	0	7	8	0	0	0	0	1 logg	0
Hillsborough	16	3	0	0	47+3C	30+2C	17+2C	17	0	3	1 1? logg	o	0	0	0
Lee	15	17+1C	7	26+1C	12*	34	37+1C	100+1C	32	62+3C*	0	0	2 logg	o	0*
Manatee	6	o	3	4	0	8+2C	6	44+3C	13	44+1C	2?	1 logg	2 logg	1 logg	0
Monroe	9+1C	10	20	48+3C	28'	15	35+2C	26+1C	66	28+4C*	1 logg	4 logg 3?	1 logg 1?	3 logg	6 logg*
Pasco	o	0	0	0	1	2	17+1C	2 7	119+3C	59+3C	1?	o	0	5 logg	o
Pinellas	0	0	0	0	7	56+1C	36+3C	39	73+2C	33+1C	0	2 logg	2 logg	1 leather[d]	1 ride
Sarasota	2	6	11	14+1C	6	12+1C	60+4C	23+1C	6	9	1?	2 logg	o	0	4 logg
TOTAL	93*IC	90+3C	110+1C	144+7C	102+3C	183+7C				250+14C	2 logg 6?	11 logg 1 green 3?	9 logg 1?	12 logg 1 leather	11 logg 1 rid

KEY

a) +C . plus calves
b) logg . loggerhead turtle
c) green . green turtle
d) rid . ridley turtle
e) leather . leatherback turtle
? = unidentified turtle
* = incomplete survey
x . not surveyed

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.

COUNTY	MANATEES						BOTTLE NOSE DOLPHINS					
	JULY	SEPT.	OCT.	NOV.	DEC.	COMPOSITE AVERAGE	JULY	SEPT.	OCT.	NOV.	DEC.	COMPOSITE AVERAGE
Charlotte	1.3 (0.33;3)	5.0 (--;1)	(0.20,5)		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)	x	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)	x	1.9 (0.30; 36)
De Soto					x						x	
Glades				1.0 (--;1)	x	1.0 (--;1)					x	
Hendry				4.0 (--;1)	x	4.0 (--;1)					x	
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 (.15; 18)	1.9 (0,22; 35)	2.1 (0.65; 15)	1.9 (0.1 8;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)

● Standard Error of the mean and n (sightings) in parenthesis
= no sightings
-- = no value
X = not surveyed

A maximum of 2 manatees per survey was sighted in Charlotte Harbor (Charlotte County; Figure 1) and small numbers of manatees were consistently sighted in Pine Island Sound, Matlacha Pass, San Carlos Bay, in the lower reaches of the Caloosahatchee River, and in Estero Bay (Lee County). The few sightings in Charlotte Harbor are noteworthy because manatees are often sighted by residents in this area (Moore 1951b, Hartman 1974), and 36 manatees were counted in Charlotte Harbor during a summer aerial survey by Hartman (1974). Manatees were sighted in the Upper Caloosahatchee River (Glades and Hendry Counties) only in November. Manatees were not sighted near the warm-water refuge in the Orange River, Lee County (Hartman 1974), 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 Intercostal Waterway.

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.

Winter Concentrations

Manatees were observed near warm-water refuges (Hartman 1974) only during the December flights. A total of 40 manatees was sighted at the two warm effluents of the Gibsonton Phosphate Plant in the Alafia 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 Power 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). Use of the Bartow and Anclote power plants has not been specifically reported, but manatees were sighted previously at these locations (A. B. Irvine, personal observation) and were mapped by Irvine and Campbell (1978).

Information is not available to determine if the manatees sighted at the heated effluents were residents of the Tampa Bay area or were migrants. In either case, manatees arrived at the Gibsonton effluents through a ship channel and have been sighted previously in and adjacent to ship channels of Tampa Bay (Hartman 1974, A. B. Irvine, personal observation), making them potentially vulnerable to increased shipping caused by OCS development. Large concentrations of wintering manatees in western Florida have also been identified at the artesian springs of Crystal River, Citrus County (Powell 1978, Hartman 1979), which is north of our study area, and at a heated effuent in the Orange River, Lee County (Hartman 1974), which was not surveyed during the December flights. Manatees usually arrive at these warm-water refuges during the fall as surrounding waters cool and leave as water temperatures warm in the early spring, but warm season movements are unknown.

Group Size

Mean group size for the pooled sample of all sightings was 1.9 (SE ± O .12). A two-way ANOVA of group size by month and county would have included missing cells (i.e., specific combinations of month and county for which no data were available). Consequently, 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 warm-water effluents.

Ninety-four percent of the groups sighted consisted of one to four animals (Figure 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 frequent y distributions did not vary significantly between months ($P > 0.80$; chi-square).

Manatees are usually sighted in small groups when away from warm-water 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 In press) indicate that the, greater percentage of manatees sighted are found in groups, but one is the most common group size. Although Hartman (1979) suggests that manatees are "essentially solitary", solitary manatees are nevertheless a minority of the total num hers sighted.

Habitat Use

Substantially more manatees were sighted in marsh-river habitats than in other habitat types, and most were in brackish water (Table 3). 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 relative numbers of manatees sighted per month varied significantly by salinity and habitat ($P < 0.0005$; chi-square).

The preponderance of manatee sightings in brackish water and marsh-river habitats occurred in the Collier and Monroe Counties areas, which are characterized by that combination of habitat and salinity. Inland bays in ENP and the 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 these survey results may be general indicators of habitat use, they should be viewed with some caution. All habitat types were not surveyed equally, and local salinities may have varied seasonally due to runoff from rainfall. Irvine and Campbell (197 8) 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).

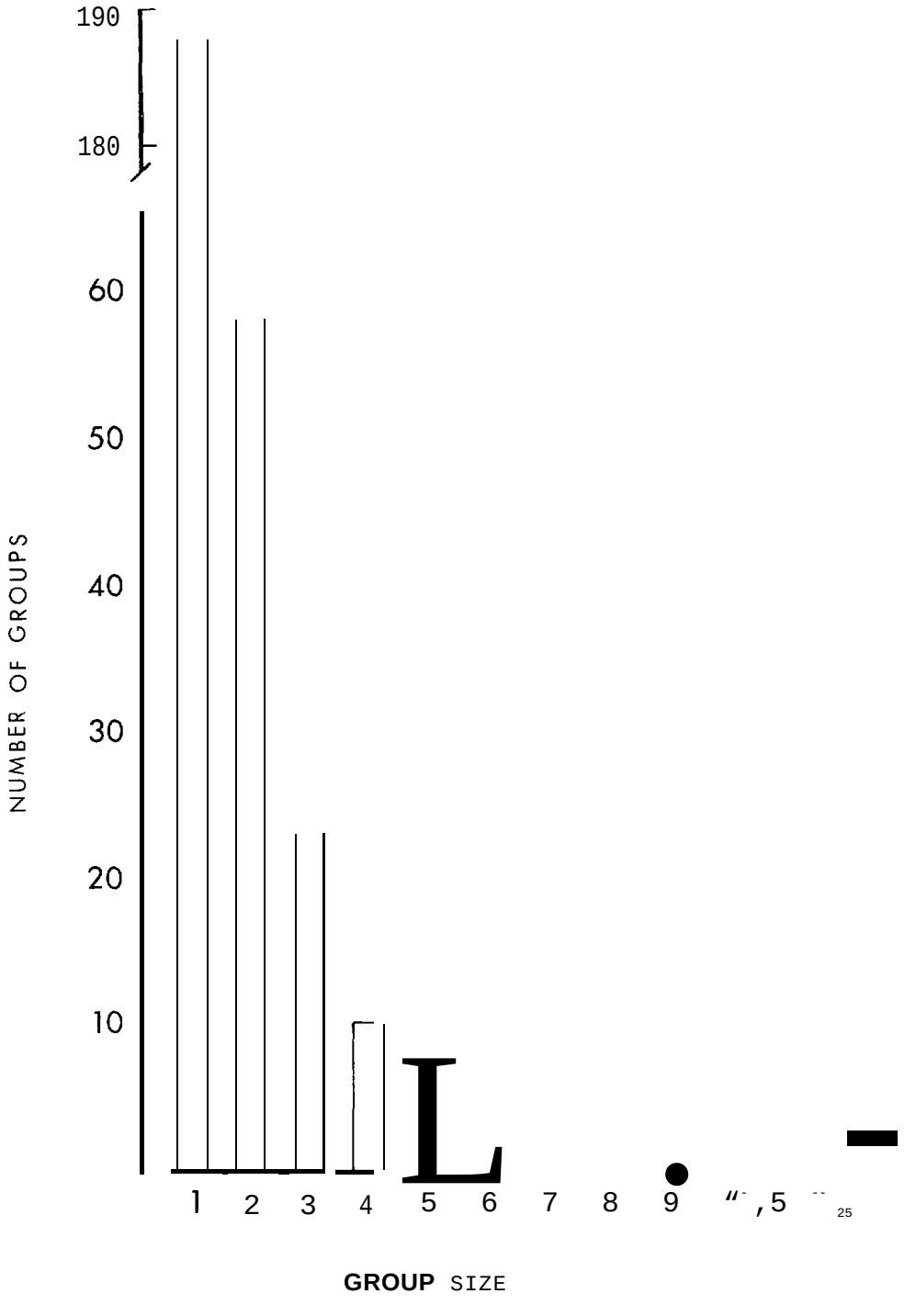

Figure 3. Group-size frequency distribution of manatees sighted during aerial surveys from July through December 1979. n = 297 groups.

Table 3. Manatee and dolphin sightings in different habitat-types and estimated salinities.

	MANATEES						DOLPHINS					
	Habitat-type			Salinity			Habitat-type			Salinity		
	off shore	Bay-Estuary	Marsh-River	Fresh < 0.5 o/oo	Brackish 0,5-300/00	Salt >30 o/oo	off Shore	Bay-Estuary	Marsh-River	Fresh < 0.5 o/oo	Brackish 05-300/00	Salt > 30 o/oo
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

Calf Sightings

A maximum of 3 calves per county was sighted on any survey. Total percentage of calves sighted ranged from 0.9% to 4.9% in different months, which is low compared to surveys by other investigators. 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 his hypothesis has not been verified. Too few calves were sighted in our study to indicate seasonal reproductive trends.

BOTTLENOSE DOLPHINS

Abundance and Distribution

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 most common off the beaches, but were also frequent in interior bays and rivers in ENP 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.

The dolphin sightings are of particular interest due to the paucity of information on Tursiops 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.

Herd Size

Dolphin herd sizes were not sighted with equal frequency (Figure 3), and most sightings (56%) consisted of 2 or more animals ($P < 0.005$; chi-square). Mean herd size for the pooled sample of all sightings was 3.2 dolphins per herd [SE $\pm$ 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 variaton 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 relatively fewer single dolphins and more large groups (>4) sighted in July and December.

Average herd size was considerably smaller than herd sizes reported from other aerial surveys in nearshore areas. In coastal waters of Alabama, Mississippi, and

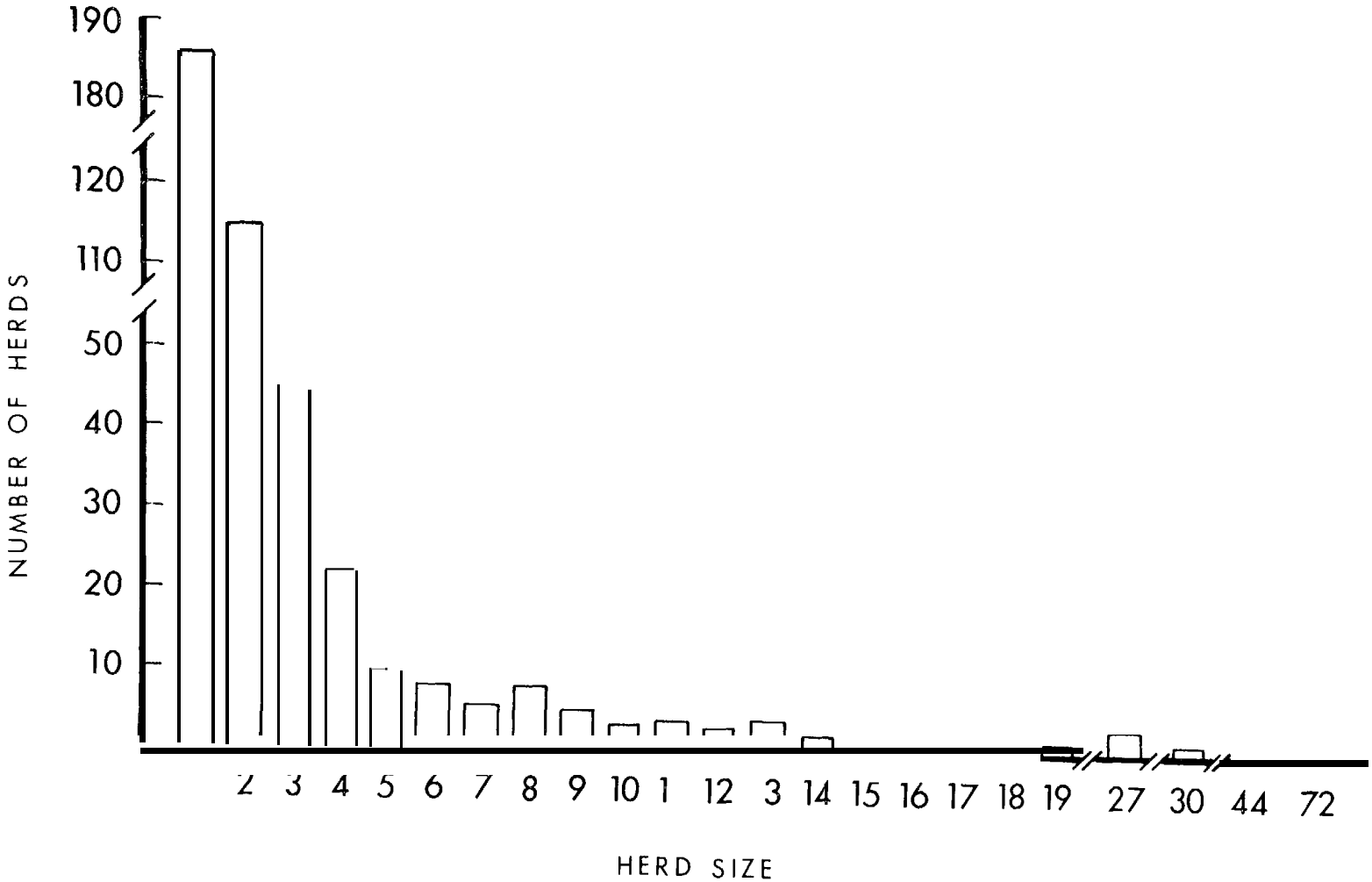

Figure 4. Herd-size frequency distribution of bottlenose dolphins sighted during aerial surveys from July through December 1979. n = 431 herds.

Louisiana, herd sizes averaged 25.2 dolphins with herd size in marshlands averaging 16.7 (Leatherwood and platter 1979). Subgroups contained a mean of 5 dolphins in sounds and 3.8 dolphins in marshes (Leatherwood and Platter 1979). 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. Differences between observed herd sizes have been attributed to the influence of geography and habitat on dolphin groups structure (Leatherwood and platter 1979), with largest groups found offshore (Wells et al. 1980). However, criteria for defining "herds" or "subgroups" are rarely reported, and could influence differences in reported results. During our surveys we often encountered several herds within a few km 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" (see methods section). 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.

Habitat Use

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 offshore and in salt water (Table 3), but monthly trends were not apparent. Dolphins were not sighted in fresh water. Pooled samples from all counties where sightings occurred indicated that numbers of dolphins sighted per month varied significantly by habitat and salinity ($P < 0.001$; chi-square). Most dolphins were sighted offshore in Hernando, PineHas, 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.

Calf Sightings

A maximum of 5.3% of all animals sighted were calves 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).

The proportion of dolphin calves noted during our surveys is low when compared with other reports. Leatherwood (1979) observed 8.1 to 10% calves during aerial surveYs in eastern Florida, while Irvine et al.(1979) reported a maximum of 11% from May to July during boat surveys near Sarasota, Florida Shane and Schmidly (1978) noted that calves constituted 7.6% of all dolphin sightings during surface surveys near Port Aransas, Texas, and Barham et al. (1980) sighted 9.3% calves from the air in the same area. Leatherwood (1977) 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 1977), and therefore we may not have distinguished large calves from adults.

TURTLES

Eight to fourteen turtles were sighted per survey (Table 1). Sightings included 45 (78%) loggerheads (*Caretta caretta*), 10 (17%) unidentified species, and single sightings of a green turtle (*Chelonia mydas*), a leatherback (*Dermochelys coriacea*), and an Atlantic ridley (*Lepidochelys kempi*). Sightings were most frequent near freshwater sources in Collier County (Fakahatchee Pass) and Monroe County (Shark River-Whitewater Bay outlet). A total of 30 sets of probable turtle tracks were sighted on coastal beaches during the July survey. The majority of the tracks were in Charlotte (13), Sarasota (8), and Hillsborough (5) Counties. All were in sparsely populated areas. Turtle tracks were not sighted during other surveys. The significance of the turtle sightings is difficult to assess, but indicates that oil spills and increased boat traffic associated with OCS development could impact endangered and threatened sea turtles in nearshore areas. The decrease in unidentified turtles on late surveys (Table 1) suggests that identification efficiency increased as observers became more experienced.

CROCODILES

A single crocodile (*Crocodiles* sp.), an estimated 2.5 to 3 m long, was observed on a bank of the Broad River in ENP on 8 November 1979. The animal was later confirmed to be a crocodile (not *Alligator mississippiensis*) from photographs, although the species could not be determined. The American crocodile (*C. acutus*) occurs in the southeastern ENP, but the range in southwestern Florida is unclear (Moore 1953b, Ogden 1978).

SUMMARY AND CONCLUSIONS

Three hundred and twenty-four manatees (58.5%) were sighted in the Monroe-Collier County area of southwestern Florida and others were probably not observed due to the complexity of the habitat and turbidity of the water. The 100 manatees counted in Monroe and Collier Counties in November represent IO% of the total Florida population of 1,000 animals estimated by Brownell et al. (1978). Southwestern Florida thus has an important concentration of manatees that would be potentially vulnerable in the event of an oil or chemical spill. Concentrations of manatees wintering near warm-water effluents in Tampa Bay were identified, but a Lee County winter refuge was not surveyed during the abbreviated December surveys. Southerly movements by manatees in the fall have been predicted, but were not observed.

Ninety-four percent of the manatee groups consisted of one to four animals. Group size varied little by month or county. A majority of the animals were sighted in marsh-river habitats and in brackish water. Few calves were sighted, and they did not indicate seasonal reproductive trends.

Numbers of bottlenose dolphins sighted increased from. July to November, but counts by county were inconsistent. Dolphin herd sizes differed by county and month and were generally smaller than herd sizes reported by surveys of other nearshore areas. Numbers of dolphins sighted per month varied significantly by habitat and salinity. Most dolphins were sighted offshore in northern areas, in bay-estuary habitats in central regions, and in marsh-river habits in southern areas. Relatively few calves were sighted compared to other surveys and seasonal reproductive trends were not apparent.

Most of the sea turtles sighted were loggerheads. A crocodile was observed in the Everglades National Park.

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16. Abstract (Limit: 200 words)

Low altitude aerial surveys were conducted at approximately monthly Intervals from August to December 1979 to count West Indian manatees (Trichechus manatus) and bottlenose dolphins (Tursiops truncatus) in western peninsular Florida. Sightings of sea turtles, turtle tracks, and a crocodile were also noted. A total of 554 manatees was observed in 297 groups. Fifty-eight percent of the manatees were sighted in the Collier-Monroe Counties area 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. Fifty-eight sea turtles (including 45 loggerheads, Caretta caretta) and 30 sets of turtle tracks were counted. One crocodile, probably Crocodilus acutus, was sighted in the Everglades National Park.

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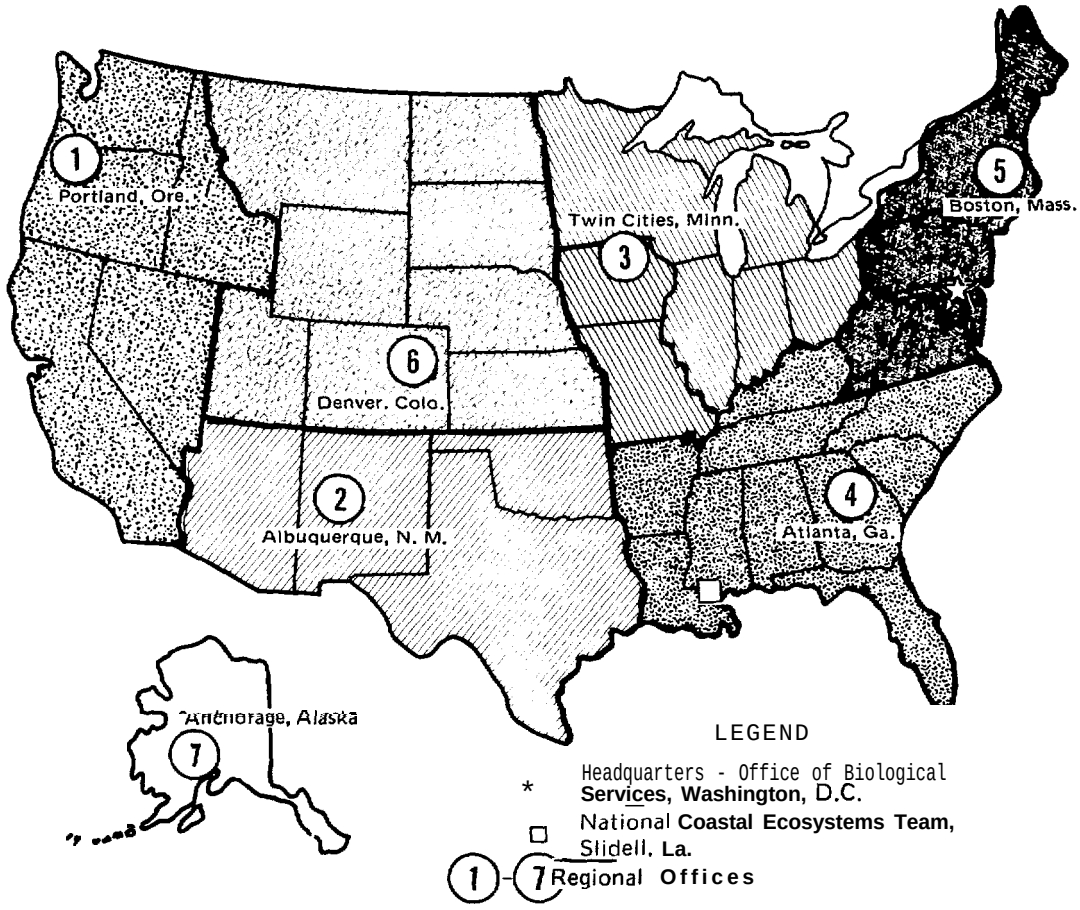

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