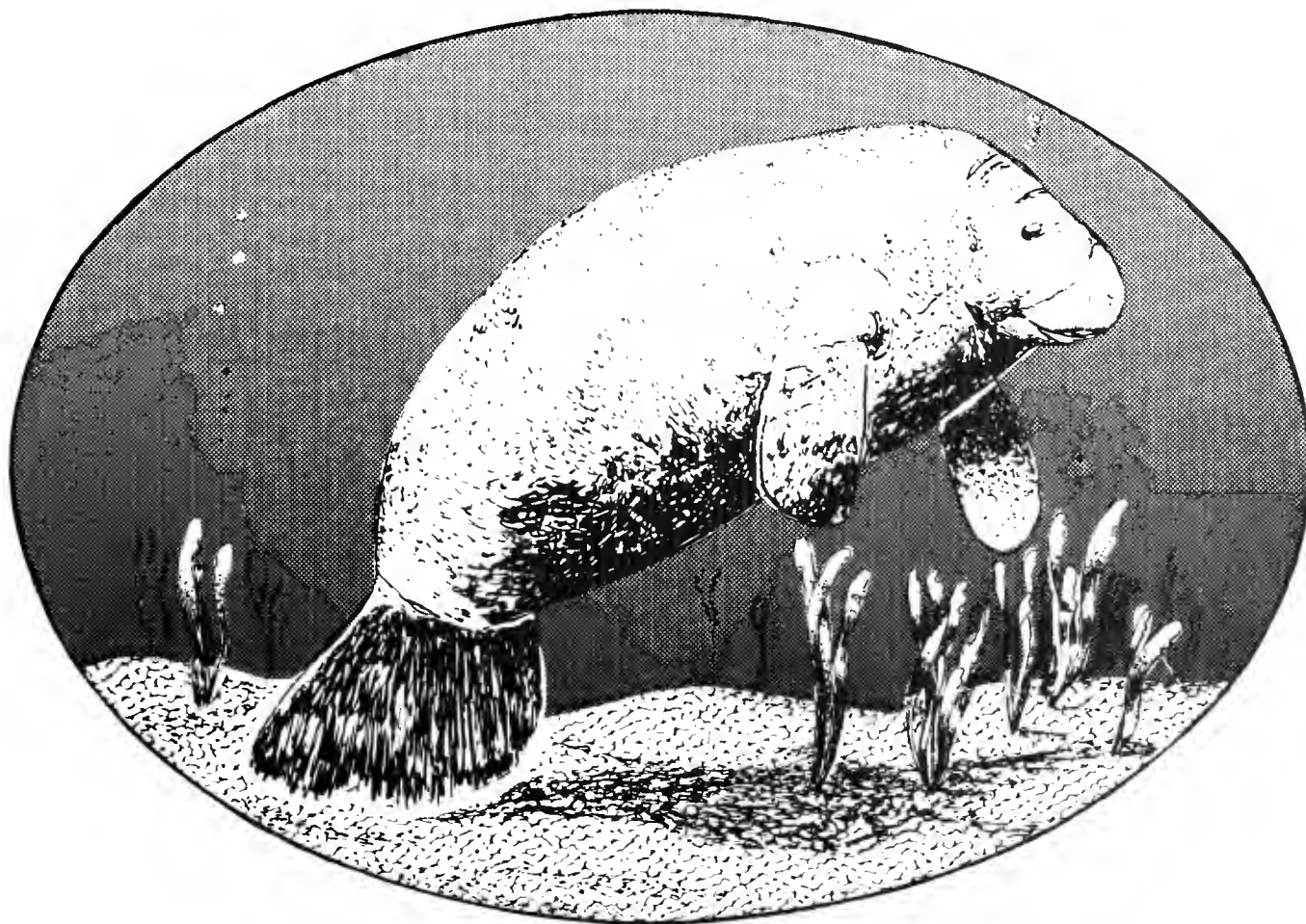


FWS/OBS-80/50
APR 81

Biological Services Program

FWS/OBS-80/50
April 1981

Aerial Surveys for Manatees and Dolphins in Western Peninsular Florida



Bureau of Land Management

Fish and Wildlife Service

J.S. Department of the Interior

QH
540
.U56
80/50

Errata: Page 2 of Aerial Surveys for Manatees and Dolphins in Western Peninsular Florida (FWS/OBS-80/50) should read as follows:

County, Florida (25° 08'N, 81° 02'W; Figure 1). We also noted incidental sightings of sea turtles, turtle tracks on beaches, and crocodiles.

The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues that impact fish and wildlife resources and their supporting ecosystems. The mission of the program is as follows:

- To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.
- To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major changes in land and water use.
- To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decisionmaking process to prevent or minimize the impact of development on fish and wildlife. Research activities and technical assistance services are based on an analysis of the issues, a determination of the decisionmakers involved and their information needs, and an evaluation of the state of the art to identify information gaps and to determine priorities. This is a strategy that will ensure that the products produced and disseminated are timely and useful.

Projects have been initiated in the following areas: coal extraction and conversion; power plants; geothermal, mineral and oil shale development; water resource analysis, including stream alterations and western water allocation; coastal ecosystems and Outer Continental Shelf development; and systems inventory, including National Wetland Inventory, habitat classification and analysis, and information transfer.

The Biological Services Program consists of the Office of Biological Services in Washington, D.C., which is responsible for overall planning and management; National Teams, which provide the Program's central scientific and technical expertise and arrange for contracting biological services studies with states, universities, consulting firms, and others; Regional Staffs, who provide a link to problems at the operating level; and staffs at certain Fish and Wildlife Service research facilities, who conduct in-house research studies.

This report should be cited as follows:

Irvine, A. B. , J. E. Caffin, and H. I. Kochman. 1981. Aerial Surveys for manatees and dolphins in western peninsular Florida : with notes on sightings of sea turtles and crocodiles. U. S. Fish and Wildlife Service, Office of Biological Services, Washington, D. C. FWS/OBS-80/50. 20 pp.

FWS/OBS-80/50
April 1981

AERIAL SURVEYS FOR MANATEES AND DOLPHINS
IN WESTERN PENINSULAR FLORIDA

(With Notes on Sightings of Sea Turtles and Crocodiles)

by

A. Blair Irvine, John E. Caffin and Howard I. Kochman
Gainesville Field Station, Denver Wildlife Research Center
412 N.E. 16th Avenue, Room 250
Gainesville, Florida 32601

Contract No. 14-16-009-79-951

In cooperation with:
U. S. Fish and Wildlife Service
Denver Wildlife Research Center
New Orleans Field Station
Belle Chasse, Louisiana 70037

Project Officers
David M. Smith and Cherry Keller
National Coastal Ecosystems Team
U.S. Fish and Wildlife Service

This project was sponsored by the
Bureau of Land Management

Prepared for
National Coastal Ecosystems Team
U.S. Fish and Wildlife Service
NASA-Slidell Computer Complex
1010 Gause Boulevard
Slidell, Louisiana 70458



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 Crocodilus acutus, was sighted in the Everglades National Park.

TABLE OF CONTENTS

	<u>Page</u>
PREFACE	iii
SUMMARY	iv
ACKNOWLEDGEMENTS	vi
INTRODUCTION	1
METHODS	4
RESULTS AND DISCUSSION	6
Manatees	6
Bottlenose Dolphins	14
Turtles	17
Crocodiles	17
SUMMARY AND CONCLUSIONS	18
REFERENCES CITED	19

ACKNOWLEDGEMENTS

This research was supported by the Bureau of Land Management under contract to the Denver Wildlife Research Center. Jean Duke and C. R. Smith participated in several flights. We thank James Kushland and Sonny Bass for assistance with flights over the Everglades National Park. Tom Fritts, Steve Leatherwood, James Powell, Tom O'Shea, Galen Rathbun, and Susan Shane made constructive comments on earlier versions of the manuscript. Howard Campbell identified the crocodile. Linda Dunn contributed technical assistance and Joan Randell typed the manuscript.

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 warm-water sources or in southwestern 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 impacted by Outer Continental Shelf (OCS) development, must therefore be identified. 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 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 information for comparison with more developed areas.

Especially over large areas, aerial surveys are the only cost-effective means 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 (Hartman 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 County, Florida (28°32'N, 82°39'W), south to Flamingo Ranger Station (ENP), Monroe

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 County, Florida ($28^{\circ}32'N$, $82^{\circ}39'W$), south to Flamingo Ranger Station (ENP), Monroe County, Florida ($25^{\circ}08'N$, $81^{\circ}02'W$; Figure 1). We also noted incidental sightings of sea turtles, turtle tracks on beaches, and crocodiles.

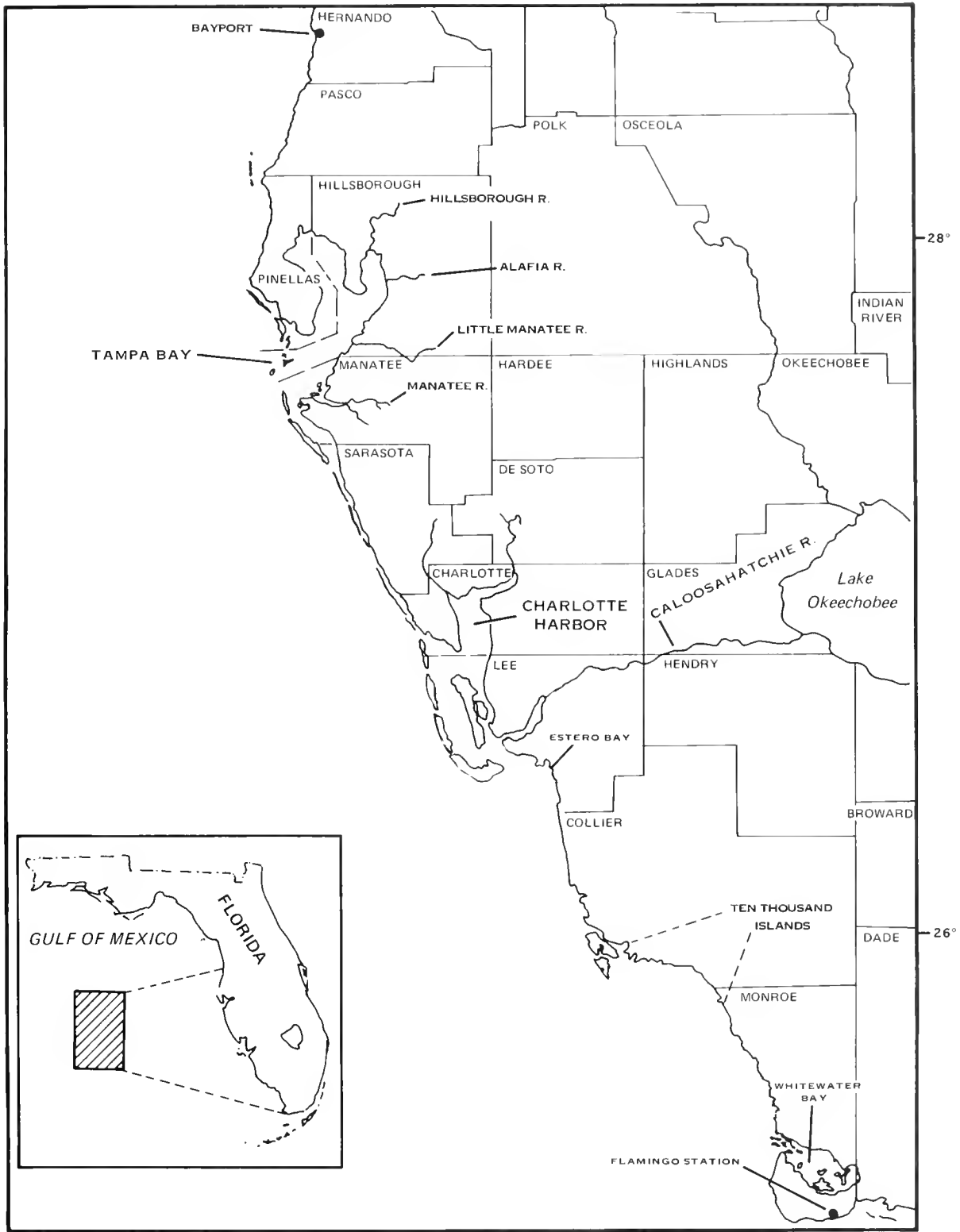


Figure 1. Map of the study area.

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 min).

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. 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 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 ($< 0.5^{\circ}/\text{oo}$ salt), brackish (0.5 to $30^{\circ}/\text{oo}$ salt), or marine ($> 30^{\circ}/\text{oo}$ 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 (ANOVA) 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 ($\sqrt{\text{herdsize} + 0.5}$) 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, Florida.

RESULTS AND DISCUSSION

MANATEES

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 November, but the total per county consistently 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 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. 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 0 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 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.

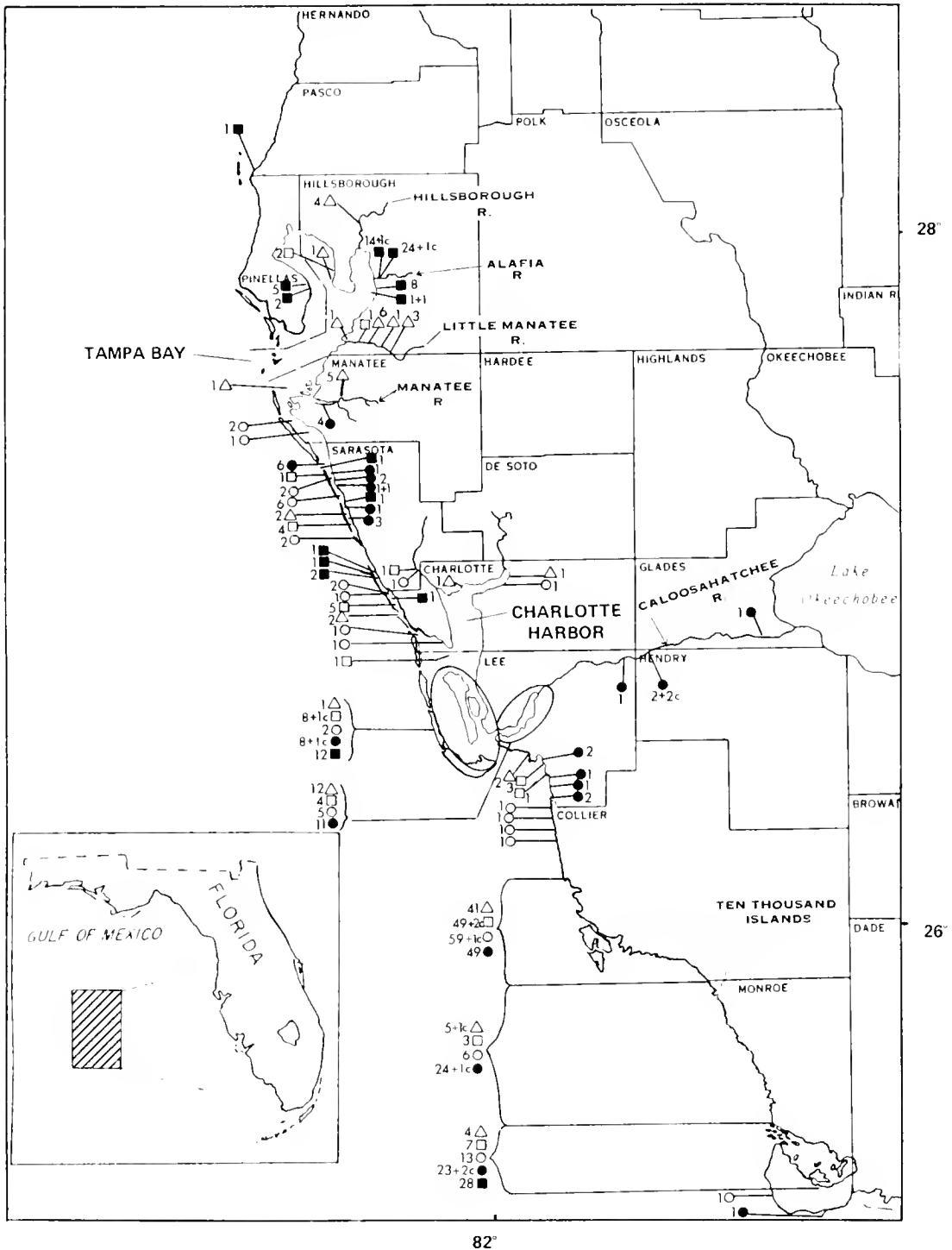


Figure 2. Location and numbers of manatees sighted during 1979 aerial surveys in western peninsular Florida. Symbols: \triangle July, \square September, \circ October, \bullet November, and \blacksquare December; c = calf. Multiple sightings in localized areas are summarized.

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

C O U N T Y	M A N A T E E S			B O T T L E N O S E			D O L P H I N S			T U R T L E S					
	July	Sept.	Oct.	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?	0	0	1 logg	1 logg*
Collier	41	49+2C ^a	63+1C	49	x	9	20	11	29+1	x	0	2 logg ^b	2 logg	1 logg	x
De Soto	0	0	0	0	x	0	0	0	0	x	0	0	0	0	x
Glades	0	0	0	1	x	0	0	0	0	x	0	0	0	0	x
Hendry	0	0	0	2+2C	x	0	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?	0	0	0	0
Lee	15	17+1C	7	26+1C	12*	34	37+1C	100+1C	32	62+5C*	0	0	2 logg	0	0*
Manatee	6	0	3	4	0	8+2C	6	44+5C	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	1 logg	3 logg	6 logg*
Pasco	0	0	0	0	1	2	17+1C	27	119+3C	59+3C	1?	0	0	5 logg	0
Pinellas	0	0	0	0	7	56+1C	36+3C	39	73+2C	53+1C	0	2 logg	2 logg	1 leather/d	ride
Sarasota	2	6	11	14+1C	6	12+1C	60+4C	23+1C	6	9	1?	2 logg	0	0	4 logg
TOTAL	93+1C	90+3C	110+1C	144+7C	102+3C	183+7C	250+14C	505+7C	347+6C	250+14C	2 logg	11 logg	9 logg	12 logg	11 logg
											6?	1 green	1?	1 leather	1 rid
												3?			

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	M A N A T E E S					B O T T L E N O S E D O L P H I N S					COMPOSITE AVERAGE
	JULY	SEPT.	OCT.	NOV.	DEC.	JULY	SEPT.	OCT.	NOV.	DEC.	
Charlotte	1.3 (0.33;3)	5.0 (--:1)	1.2 (0.20;5)	-	1.0 (--:1)	2.8 (0.86;5)	1.9 (0.49;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	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	-	-	-	-	X	-
Hendry	-	-	-	4.0 (--:1)	X	-	-	-	-	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)	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)	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)	-	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)	1.7 (0.33;9)	2.0 (0.58;19)	1.5 (.15;18)	1.9 (0.22;35)	2.1 (0.65;15)	1.9 (0.18;96)
Pasco	-	-	-	-	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)	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)	2.2 (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 Intercoastal 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 effluent 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 \pm 0.12). 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 frequency 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 numbers 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 (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).

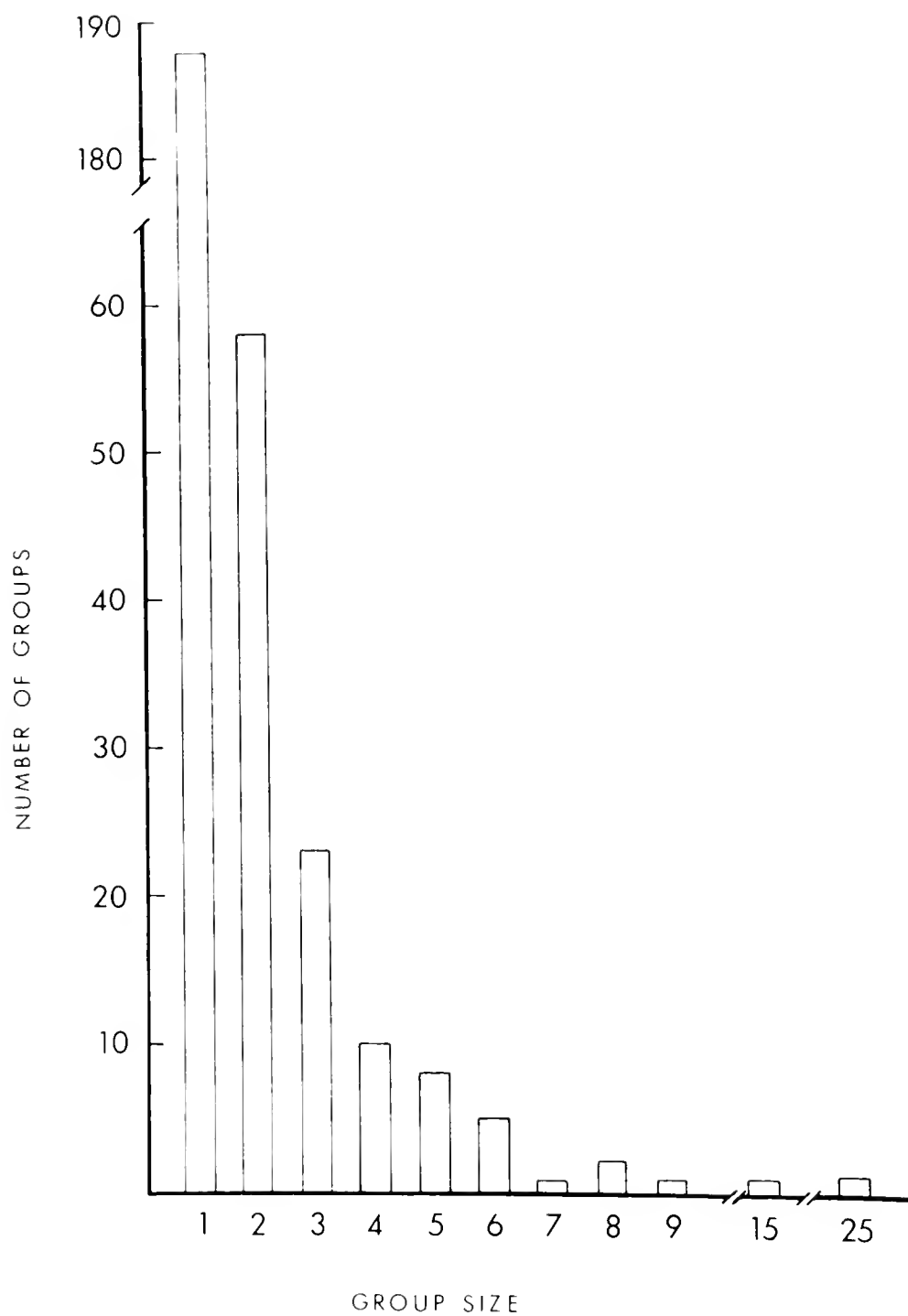


Figure 3. Group-size frequency distribution of manatees sighted during aerial surveys from July through December 1979. n = 297 groups.

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 < 0.50/00	Brackish 0.5-30.0/00	Salt > 30.0/00	Off Shore	Bay-Estuary	Marsh-River	Fresh < 0.50/00	Brackish 0.5-30.0/00	Salt > 30.0/00
Mean group or herd size (\pm 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 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 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

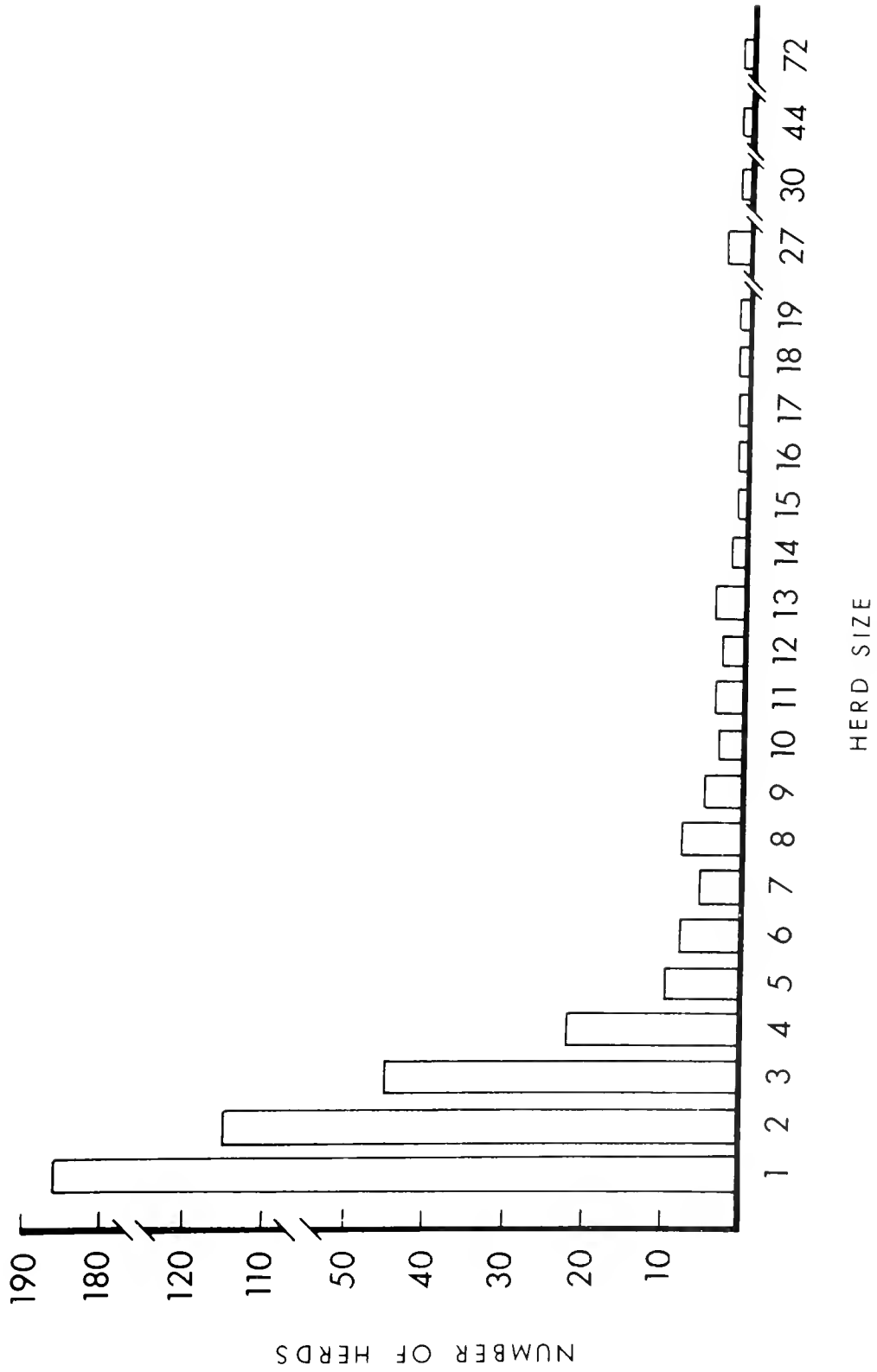


Figure 4. Herd-size frequency distribution of bottlenose dolphins sighted during aerial surveys from July through December 1979. n = 431 herds.

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, 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.

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 kempfi). 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 (Crocodylus 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 10% 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.

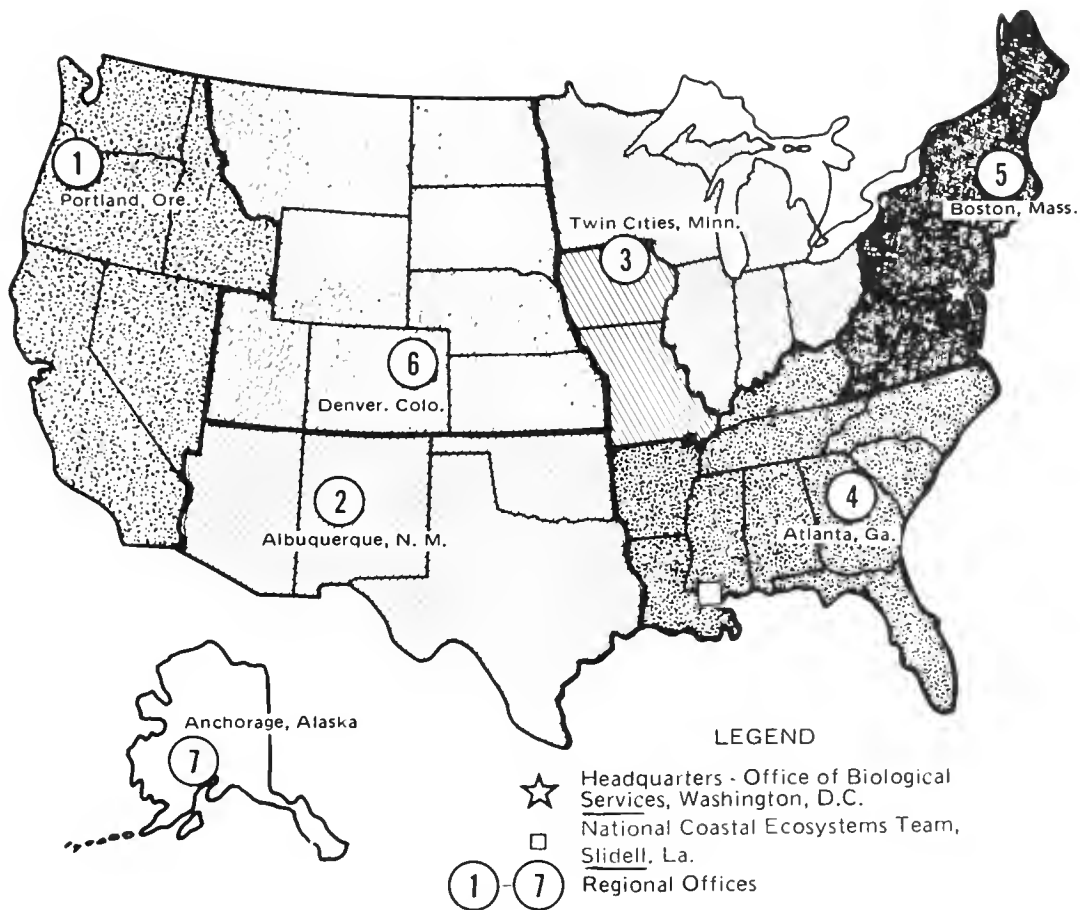
REFERENCES CITED

- Barham, E. G., J. C. Sweeney, S. Leatherwood, R. K. Beggs, and C. L. Barham. 1980. Aerial census of the bottlenose dolphin (Tursiops truncatus) in a region of the Texas coast. *Fish. Bull.* 77:585-595.
- Brownell, R. L., Jr., K. Ralls, and R. R. Reeves. 1978. Report of the West Indian manatee workshop, Orlando, Fla., 27-29 March 1978. U.S. Fish and Wildlife Service. Unpub. 37 pp.
- 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 Lab., Washington, D.C. Contract 14-16-0008-748. National Technical Information Service PB81-140725.
- Hartman, D. S. 1979. Ecology and behavior of the manatee, Trichechus manatus, in Florida. *Spec. Publ., Amer. Soc. Mamm.* 5:1-153.
- Helwig, J. T., and K. A. Council, eds. 1979. SAS users guide. SAS Institute Inc., Raleigh, N.C.
- Irvine, A. B., and H. W. Campbell. 1978. Aerial census of the West Indian manatee, Trichechus manatus, in the southeastern United States. *J. Mamm.* 59:613-617.
- 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 Lab. Final Draft Contract Report to John F. Kennedy Space Center, NASA, Kennedy Space Center, Fla. 33899. Contract CC 63426A; KSC-DF-112.
- 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, including an evaluation of tagging techniques. Report to U.S. Marine Mammal Commission, Washington, D.C. National Technical Information Service PB-298 042.
- Layne, J. N. 1965. Observations on marine mammals in Florida waters. *Bull. Florida State Mus. Biol. Sci.* 9:131-181.
- 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. Pages 143-167 in S. H. Ridgway and K. W. Benirshke, eds. *Breeding dolphins; Present status, suggestions for the future.* National Technical Information Service PB-273 673.

- Leatherwood, S. 1979. Aerial survey of the bottlenosed dolphin, Tursiops truncatus, and the West Indian manatee, Trichechus manatus, in the Indian and Banana Rivers, Florida. *Fish. Bull.* 77:47-59.
- Leatherwood, S., and M. F. Platter. 1979. Aerial assessment of bottlenose dolphins off Alabama, Mississippi and Louisiana. Pages 49-86 in D. K. Odell, D. B. Siniff, and G. H. Waring, eds. Tursiops truncatus assessment workshop. Report to U.S. Marine Mammal Commission, Washington, D.C., National Technical Information Service PB-291 161.
- Leatherwood, S., J. R. Gilbert, and D. G. Chapman. 1978. An evaluation of some techniques for aerial censuses of bottlenosed dolphins. *J. Wildl. Manage.* 42:239-250.
- Moore, J. C. 1951a. The status of the manatee in the Everglades National Park, with notes on its natural history. *J. Mamm.* 32:22-36.
- Moore, J. C. 1951b. The range of the Florida manatee. *Quart. J. Florida Acad. Sci.* 14:1-19.
- Moore, J. C. 1953a. Distribution of marine mammals to Florida waters. *Am. Midl. Nat.* 49:117-158.
- Moore, J. C. 1953b. The crocodile in the Everglades National Park. *Copeia* 1:54-59.
- Norris, K. S., and T. P. Dohl. 1980. Structure and functions of cetacean schools. Pages 211-261 in L. H. Herman, ed. Cetacean Behavior: Mechanisms and processes. John Wiley and Sons, New York.
- Odell, D. K. 1976. Distribution and abundance of marine mammals in south Florida: Preliminary Results. Pages 203-212 in Biscayne Bay: Past/Present/Future. Proceedings of a symposium. Univ. Miami Sea Grant Prog. Spec. Rep. 5.
- Odell, D. K. 1979. Distribution and abundance of marine mammals in the waters of the Everglades National Park. Pages 673-681 in R. M. Linn, ed. Proceedings of the First Conference on Scientific Research in National Parks. New Orleans, LA, 9-12 November 1976, U.S. Dep. Inter., Natl. Park Serv. Trans. Proc. Ser. 5(1).
- Odell, D. K., and J. R. Reynolds, III. 1980. Abundance of the bottlenose dolphin, Tursiops truncatus, on the West Coast of Florida. Report to U.S. Marine Mammal Commission, Washington, D.C. National Technical Information Service PB80-197650.
- Ogden, J. C. 1978. Status and nesting biology of the American crocodile, Crocodylus acutus (Reptilia, Crocodylidae) in Florida. *J. Herpetol.* 12:183-196.
- Payne, R., and D. Webb. 1971. Orientation by means of long range acoustic signalling in baleen whales. *Annals. N. Y. Acad. Sci.* 188:110-141.

- Powell, J. A. 1978. Status of the manatee population in Crystal River, Citrus County, Florida. Paper presented at West Indian manatee Workshop, 27-29 March 1978, Orlando, Fla. Unpub.
- Remane, A., and G. Schlieper. 1971. Biology of brackish water. Wiley-Interscience, New York.
- Reynolds, J. E., III. In press. Aspects of the social behavior and herd structure of a semi-isolated colony of West Indian manatees, Trichechus manatus. Mammalia.
- Shane, S. H. 1981. Abundance, distribution and use of power plant effluents by manatees (Trichechus manatus) in Brevard County, Florida. Report to Florida Power and Light Co., Miami. National Technical Information Service PB81-147019.
- Shane, S. H., and D. J. Schmidly. 1978. The population biology of the Atlantic bottlenose dolphin, Tursiops truncatus, in the Aransas Pass area of Texas. Report to U.S. Marine Mammal Commission, Washington, D.C. National Technical Information Service PB-283 393.
- 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, Fla. 33030. No. T-519. Unpub.
- Sokal, R. R., and F. J. Rohlf. 1969. Biometry, the principles and practice of statistics in biological research. W. H. Freeman and Co., San Francisco.
- Steel, R. D. G., and J. H. Torrie. 1960. Principles and practices of statistics. McGraw-Hill Book Co., New York.
- U.S. Department of Commerce. 1973. Surface water temperature and density, Atlantic Coast North and South America. National Oceanic and Atmospheric Administration, N.O.S. Pub. 31-1, 4th. ed.
- 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, Fla. 33577. Unpub.
- Weinstein, M. P., C. M. Courtney, and J. C. Kinch. 1977. The Marco Island estuary: a summary of physicochemical and biological parameters. Fla. Sci. 40:97-124.
- Wells, R. S., A. B. Irvine, and M. D. Scott. 1980. The social ecology of inshore odontocetes. Pages 263-317 in L. H. Herman, ed. Cetacean Behavior: Mechanisms and processes. John Wiley and Sons, New York.

REPORT DOCUMENTATION PAGE	1. REPORT NO. FWS/OBS-80/50	2.	3. Recipient's Accession No.
4. Title and Subtitle Aerial Surveys for Manatees and Dolphins in Western Peninsular Florida (With Notes on Sightings of Sea Turtles and Crocodiles)		5. Report Date April 1981	6.
7. Author(s) A. Blair Irvine, John E. Caffin and Howard I. Kochman		8. Performing Organization Rept. No.	
9. Performing Organization Name and Address Gainesville Field Station Denver Wildlife Research Center 412 N.E. 16th Avenue, Room 250 Gainesville, Florida 32601		10. Project/Task/Work Unit No.	11. Contract(C) or Grant(G) No. (C) 14-16-009-79-951 (G)
12. Sponsoring Organization Name and Address Bureau of Land Management and the Fish and Wildlife Service U.S. Department of the Interior Washington, DC 20240		13. Type of Report & Period Covered	
15. Supplementary Notes		14.	
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 (<u>Trichechus manatus</u>) and bottlenose dolphins (<u>Tursiops truncatus</u>) 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, <u>Caretta caretta</u>) and 30 sets of turtle tracks were counted. One crocodile, probably <u>Crocodilus acutus</u> , was sighted in the Everglades National Park.			
17. Document Analysis a. Descriptors Dolphins (mammals), Aquatic animals, Turtles b. Identifiers/Open-Ended Terms Manatees, Crocodile, Florida, Loggerheads c. COSATI Field/Group			
18. Availability Statement Unlimited		19. Security Class (This Report) Unclassified	21. No. of Pages 21
		20. Security Class (This Page)	22. Price



U.S. FISH AND WILDLIFE SERVICE REGIONAL OFFICES

REGION 1

Regional Director
U.S. Fish and Wildlife Service
Lloyd Five Hundred Building, Suite 1692
500 N.E. Multnomah Street
Portland, Oregon 97232

REGION 2

Regional Director
U.S. Fish and Wildlife Service
P.O. Box 1306
Albuquerque, New Mexico 87103

REGION 3

Regional Director
U.S. Fish and Wildlife Service
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

REGION 4

Regional Director
U.S. Fish and Wildlife Service
Richard B. Russell Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

REGION 5

Regional Director
U.S. Fish and Wildlife Service
One Gateway Center
Newton Corner, Massachusetts 02158

REGION 6

Regional Director
U.S. Fish and Wildlife Service
P.O. Box 25486
Denver Federal Center
Denver, Colorado 80225

REGION 7

Regional Director
U.S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, Alaska 99503



DEPARTMENT OF THE INTERIOR U.S. FISH AND WILDLIFE SERVICE



As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.