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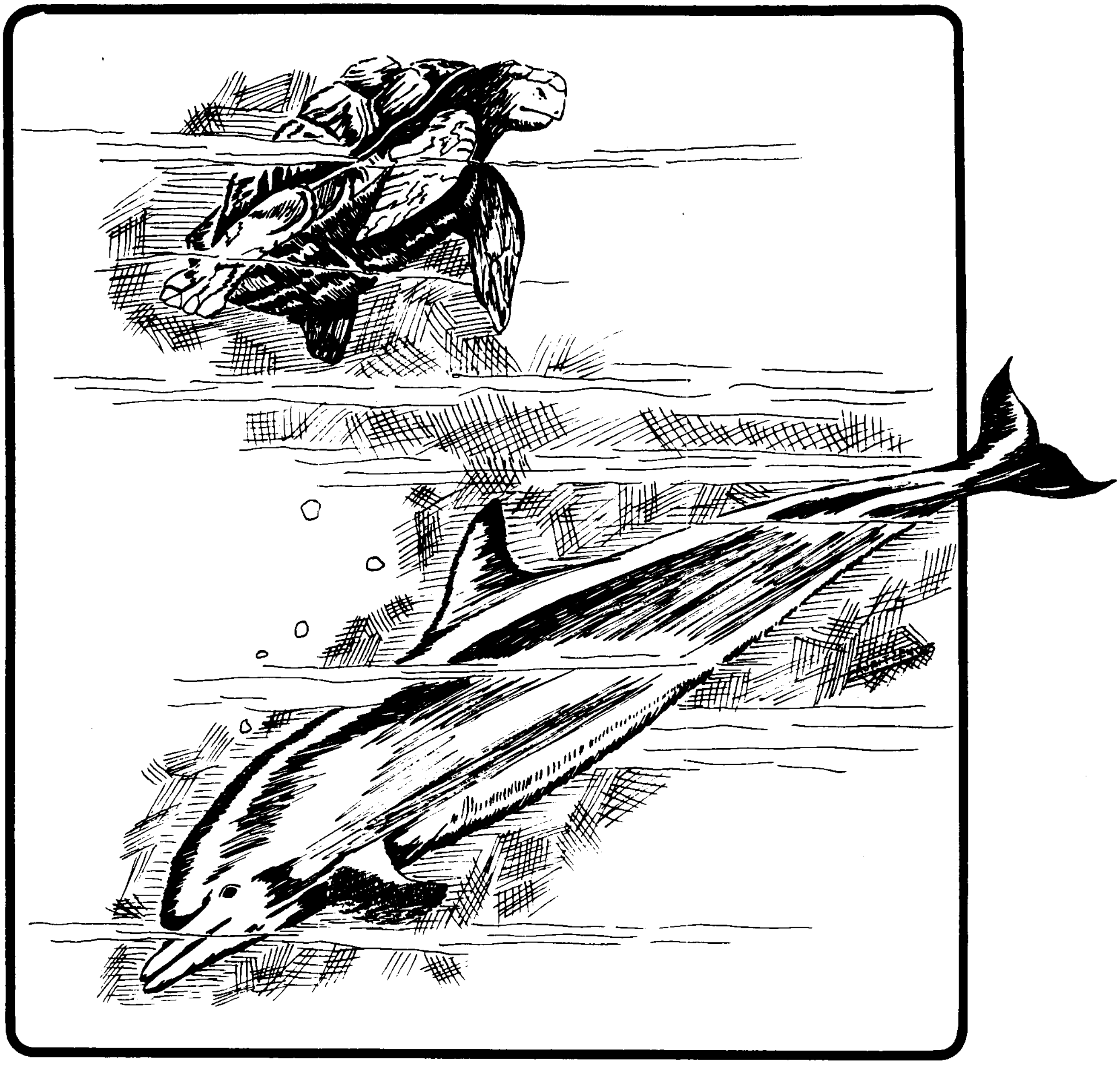

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TURTLES, BIRDS, AND MAMMALS IN THE NORTHERN GULF OF MEXICO AND NEARBY ATLANTIC WATERS

An overview based on aerial surveys of OCS areas, with emphasis on oil and gas effects

by

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SUMMARY

Aerial surveys of marine turtles, birds, and mammals were conducted in the Gulf of Mexico and nearby Atlantic waters from May 1980 to April 1981. The purpose of this study was to collect data on the distribution, abundance and ecology of the vertebrate fauna of outer continental shelf (OCS) waters. This information can serve as base-line data for comparisons with future studies on vertebrate faunas. By additional monitoring of populations, effects of oil and gas development in OCS areas may be evaluated.

Aerial line transect surveys were conducted in four subunits of the study area. Waters within 111 km of the coast were sampled more intensively than waters farther offshore. Three survey subunits were located in the Gulf of Mexico off the coasts of Southeast Texas, Louisiana, and Southwest Florida. One survey subunit was located in the Atlantic Ocean off the coast of East Florida. Observations were also made during flights between survey areas. Survey subunits off Southeast Texas and East Florida included a majority of waters beyond the continental shelf, while subunits off Louisiana and Southwest Florida were limited largely to waters of the continental shelf.

Observations were made on 4 turtle, 69 bird, and 15 mammal taxa. New data on the distribution, abundance, seasonal occurrence, and ecology were collected for many species. Marine turtles were abundant in the two Florida survey subunits, but few were seen in subunits off Texas and Louisiana. The diversity of marine birds was similar in all survey subunits, but the abundance of birds was about three times as great in the subunit off Louisiana. The greatest number of individuals and species of marine mammals occurred in the survey subunit off East Florida.

The data collected during this study will help indicate which species occur in areas considered for OCS development. Additional surveys providing data collected over several years will be required to distinguish long-term population trends from sporadic fluctuations that may have been detected during this study. Knowledge gained from future surveys may be used to make more informed and effective decisions relevant to OCS development.

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INTRODUCTION

The Bureau of Land Management requires information on the density and distribution of organisms that are vulnerable to activities resulting from oil and gas exploration and production in offshore areas of the Outer Continental Shelf (OCS). Emphasis must be on species protected by the Marine Mammal Protection Act of 1972 (MMPA) and the Endangered Species Act of 1973 (ESA) and all species that are vulnerable to OCS activities (i.e., candidates for ESA protection in the face of future environmental alterations). The MMPA pointed out the biological and aesthetic importance of marine mammals, and established a national policy to protect marine mammals and their habitats. The ESA provided for the conservation of all plant and animal species that are endangered or threatened. Implementation of both acts requires a deliberate consideration of information about organisms and their environments. Many marine animals are limited to specific habitats and food species; therefore, they are potentially vulnerable to catastrophic population declines as a result of environmental pollution. Consequently, a common species could suddenly become endangered by a rapid or previously undetected environmental change.

The investigation of biological phenomena in the marine environment has lagged far behind comparable fields of study in terrestrial situations. This lag results from the diversity of the marine fauna, the size of the world's oceans, the limitations of man in waters of extreme depth, and the cost of marine operations. Information on the distribution, abundance, and ecology of marine vertebrates, with the exception of principal commercial species, is sparse and inadequate for detection and management of pollution and biological problems. Much current knowledge of marine mammals is uneven in geographic coverage and largely based on data derived from commercial whalers in past centuries. Knowledge of marine birds is greatest for coastal species that can be studied from onshore areas, but is rudimentary for deep-water areas and pelagic species. Marine turtles have been studied on nesting beaches and in fisheries using captures of tagged turtles migrating from such beaches. However, little is known about habitat use, seasonal movements, and major open-water population concentrations for turtles, birds, or mammals.

Some bird populations have declined in numbers and have been extirpated locally by pesticides and petroleum. Other marine vertebrates (e.g., great whales and marine turtles) have undergone dramatic population reductions as a result of human exploitation and environmental alteration. Changes in marine environments are well documented in a few cases, but are likely to be more numerous and complex than existing data indicate.

There is a need for an orderly development of energy resources with minimal damage to the faunas of OCS areas. Consequently, basic information is needed on principal marine vertebrates subject to MMPA and ESA protection. The primary purpose of this study was to determine faunal composition, to estimate faunal densities related to geographic and seasonal parameters, and to identify areas of major biological importance.

The objectives of the study were to:

1. investigate the spatial distribution of marine turtles, birds, and mammals in

relation to physical parameters such as currents, bathymetric regions, and temperature regimes;

2. determine seasonal movements and changes in the distribution of species over time;
3. identify areas of special biological significance within the survey units for feeding, migration, and maintenance of the populations encountered;
4. provide a basis for estimating the density of individual species in various regions of the study area; and,
5. amplify our understanding of poorly known species.

PROJECT HISTORY

A pilot study of the seasonal distribution and abundance of marine turtles, birds, and mammals in the Gulf of Mexico was sponsored by the BLM and initiated in June 1979 (Fritts and Reynolds 1981). During the 1979 survey, background information was gathered, techniques were developed and tested, and data were collected in four areas of the Gulf of Mexico during August and November.

The present study commenced in April 1980 and continued on a bimonthly schedule through April 1981.

The reader is cautioned that variation in climate and oceanic systems are expected to influence biological fauna; consequently, further studies are necessary to support observations and trends in the present data set.

The study was conducted using observations of marine organisms from an aircraft. This technique maximized the amount of data gathered and minimized the cost and logistical problems which would be inherent in a study of this magnitude using surface vessels.

FORMAT OF THE REPORT

The Table of Contents outlines the organization of the report. The results of the study are primarily synthesized and presented by species. Consequently, species accounts are included for all species for which significant data were obtained. Within each species account, the data from this study are presented as a unit and subsequently compared with data and conclusions from previous studies and literature. Extralimital information from the literature is included when appropriate, but a comprehensive literature review for each species is beyond the scope of the present report.

Within each species account, emphasis has been placed on geographical, seasonal, and ecological variation. These factors are frequently interrelated and information has been integrated whenever possible. When the quantity of data across seasons and subunits is adequate, figures and tables have been prepared to facilitate comparisons. When minimal data are available for a species, relevant information has been presented in a brief paragraph rather than the format of a species account.

The discussions of geographical, seasonal, and ecological trends relevant to the areas studied are arranged in separate sections. The user interested in a particular area, season, or habitat should consult these sections to obtain an overview of the subject. Use of the sections on geography, season, and ecology will serve as an index to the primary data presented in the species accounts.

The specific potential impacts of OCS development are discussed within individual species accounts, but impacts that might affect several species are presented in a later section of the report. The general OCS discussion incorporates information from the species accounts into analyses of vulnerability of populations (turtles, birds, and mammals) and vulnerability of individuals (birds) to petroleum.

The vulnerability index for populations is calculated for all species based on characteristics of the species in limited geographic areas (i.e., in and near survey subunits). The index incorporates information on status, distribution, abundance, seasonality, and reproduction. Such factors vary from area to area and are of value in assessing the sensitivity of populations or groups of animals within particular geographic areas to environmental perturbation.

A vulnerability index for individuals was developed to illustrate the varying degrees of vulnerability of birds to petroleum in the marine environment. This index is based on characteristics of the species which are usually constant from area to area within the region of study. The index incorporates information on feeding, nesting, molting, seasonality, and activity. The index is similar to the oil vulnerability index developed by King and Sanger (1979), but has been simplified for application to the present study area and fauna. The vulnerability index for individuals focuses on aspects of the birds' biology that might expose them in varying degrees to petroleum. The emphasis is on how birds might contact petroleum and which species would be most affected. The development of a vulnerability index for birds, but not for mammals and turtles, is justified by the varying degrees of contact between birds and the ocean's water. Since the ocean is the principal medium of transport for spilled or leaked petroleum contaminants, it is appropriate to evaluate bird species from this perspective. Mammals and turtles are in nearly constant contact with marine waters. Consequently, such an index would be markedly different for these groups.

The vulnerability indices can be used to help identify species of potential risk from oil and gas impacts. Some species will have special characteristics that result in a high score in the vulnerability indices. In such instances the reader should refer back to the species accounts to evaluate the biological basis for a specific ranking in one or both indices.

MATERIALS AND METHODS

STUDY AREA

The overall area from which information was gathered included the OCS and adjacent waters of the western Atlantic Ocean from Cape Hatteras, North Carolina (35°17'N;75°30'W) to the Florida Keys, and through the Gulf of Mexico from the Florida Keys to the U.S.-Mexican border near Brownsville, Texas (25° 57'N;97°09'W). The size of the study area precluded complete sampling of the entire area; therefore, four subunits were selected for regular detailed surveys (Figure 1). These subunits were chosen with the objective of spanning the variation in location, ecology, bathymetry, and human use. Each subunit was a rectangular area 111 x 222 km with the long axis perpendicular to shore and parallel to either a latitudinal or longitudinal line. The total area of each survey subunit was 24,642 km². The inshore boundary was near the coast, but was not always in contact with land due to irregularities of the shoreline (Figure 1). The placement of each subunit minimized the number of sightings of terrestrial and strictly shore-based species, and emphasized sightings of coastal and marine species. The position of three subunits across the continental slope resulted in acquisition of data from both deep and shallow water species. The positions of the four subunits are given in Table 1.

9514.32 mi²

The individual subunits were named with acronyms composed of the first letter of nearby geographic names and the state. For example, the subunit near Merritt Island, Florida, was labeled MIFL (Merritt Island, Florida). The other subunits were BTEX Brownsville, Texas), MILA (Marsh Island, Lousiana), and NAFL (Naples, Florida).

Brownsville, Texas - BTEX

The southwest corner of the BTEX subunit is adjacent to the coast of Padre Island, and the northwest corner is 12 km from shore (Figure 2). The nearby waters of Laguna Madre, a hypersaline estuarine system between the island and the mainland, are not included in the survey subunit. The subunit lies in the northwestern region of the Gulf of Mexico and is the most westerly of those studied. It differs only slightly in position from the STEX survey subunit sampled in the 1979 surveys (Fritts and Reynolds 1981).

Marsh Island, Louisiana - MILA

The shoreward extreme includes a small area of Marsh Island near Vermilion and Atchafalaya Bays (Figure 3). The subunit includes numerous oil and gas platforms and Shell Keys, a part of the Shell Keys National Wildlife Refuge. The MILA subunit is the most northern subunit in the study area.

Naples, Florida - NAFL

The northeast corner of the subunit extends over the Gulf Coast of Florida near Naples, and the southeast corner lies 111 km south of Naples and 56 km off of the coastline (Figure 4). The Ten Thousand Island area lies east (shoreward) of the subunit. The Dry Tortugas and the Florida Straits are to the south and southeast, respectively. The Florida coast in this area is a mixture of residential development and natural areas including mangrove and barren sand islands and spits. A portion of the Everglades

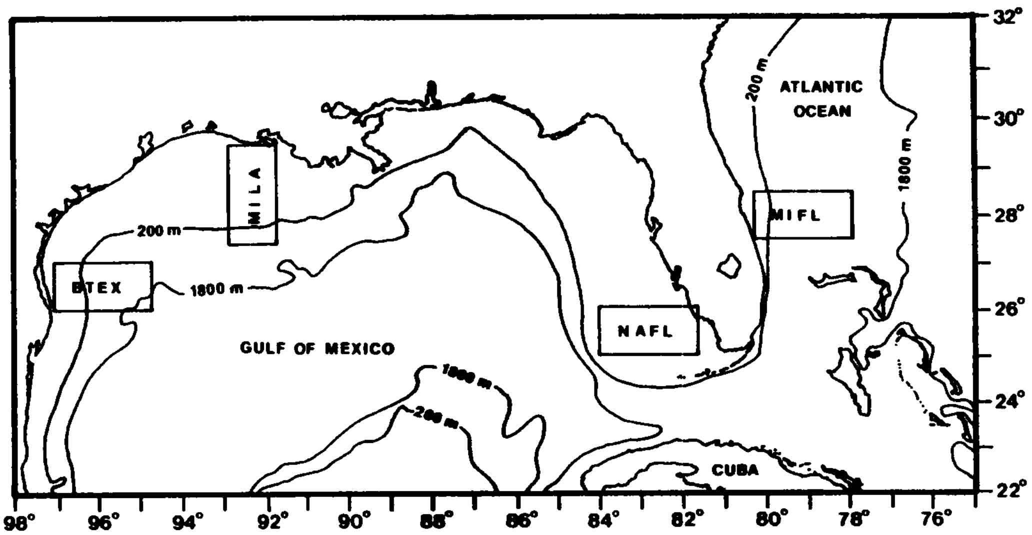


Figure 1. The survey subunits (quadrangles) sampled on a bimonthly schedule from May 1980 through April 1981: from left to right, Brownsville, Texas (BTEX), Marsh Island, Louisiana (MILA), Naples, Florida (NAFL), and Merritt Island, Florida (MIFL).

National Park extends along the adjacent Florida coast east of the southern end of the subunit.

Merritt Island, Florida - MIFL

The southwestern extreme of the subunit is adjacent to the barrier island east of Ft. Pierce, Florida, and the northwestern margin lies east of Cape Canaveral and Merritt Island (Figure 5). The offshore parts of the subunit lie north of the Bahamas Bank, but do not encroach on the shallow waters of this formation. The MIFL survey subunit is the only subunit in this study outside of the Gulf of Mexico. It occupies approximately the same latitudinal position as the MILA subunit. The Gulf Stream forms a conspicuous oceanographic feature in this area, flowing north through the middle of the subunit.

STUDY DESIGN

To obtain information on marine turtles, birds, and mammals in OCS areas, a systematic sampling plan was implemented for the four subunits. The primary data were collected by trained observers in a low-flying aircraft. The sampling design attempted to incorporate the many variables that are relevant to studying a diverse fauna including: taxonomic identification, location, seasonality, and ecology. A hierarchical data set was assembled, which included replicates allowing analysis of geographical, seasonal, and ecological trends (Figure 6). Comparison of the numbers and group sizes of each species encountered was possible because comparable surveys were conducted across geographic areas at regular sampling intervals. The basic survey design was similar to that employed in surveys in 1979 (Fritts and Reynolds 1981).

Table 1. Coordinates for the geographic limits of each of the survey subunits. Each subunit is 24,642 km^2.

Survey subunit	Geographic Limits			
	NE	NW	SE	SW
Brownsville, TX (BTEX)	27°02.0'N 94°56.0'W	27°02.0'N 97°09.3'W	26°02.0'N 94°56.0'W	26°02.0'N 97°09.3'W
Marsh Island, LA (MILA)	29°30.0'N 91°41.0'W	29°30.0'N 92°48.0'W	27°30.0'N 91°41.0'W	27°30.0'N 92°48.0'W
Naples, FL (NAFL)	26°10.5'N 81°43.4'W	26°10.5'N 83°53.7'W	25°10.5'N 81°43.4'W	26°10.5'N 83°53.7'W
Merritt Island, FL (MIFL)	28°35.0'N 78°04.0'W	28°35.0'N 80°20.0'W	27°35.0'N 78°04.0'W	27°35.0'N 80°20.0'W

Each survey subunit was sampled using a similar flight pattern on a bimonthly schedule (alternating months) instead of a quarterly schedule (3-month intervals) used by Fritts and Reynolds (1981). Sampling consisted of scheduled surveys in the four subunits as well as opportunistic flights within subunits and in nearby areas. Opportunistic flights were conducted to answer specific questions and to take advantage of exceptional conditions.

Each day's flight included six transects (three roundtrips) flown perpendicular to the predominant bathymetric contours of the area and parallel to either latitudinal or longitudinal lines. For this study inshore habitats are defined as those within 6 km of shore and usually having waters less than 9 m in depth. Nearshore habitats are seaward of inshore areas and extend from 6 km offshore to the continental shelf break (i.e., 200-m bathymetric contour). Offshore areas are those with waters beyond the 200-m contour. In the NAFL survey subunit few flights reached waters over 200 m deep because of the extreme width of the continental shelf in this area.

Each day four transects extending 111 km from the landward extreme of the subunit and two transects extending 222 km from the landward extreme were sampled. The half of the subunit nearest shore was therefore sampled three times as intensively as the offshore half (Figure 7). This stratified sampling was justified by the prevalence of oil and gas exploration and production in areas within 111 km of shore. Flights were conducted at an airspeed of 222 km/h at altitudes of 91 m and 228 m to maximize observation of animals of various sizes. One transect of each roundtrip was at 91-m altitude and the other transect was at 228 m; the order was reversed on subsequent flights to avoid having all transects at a specific altitude flown in the same direction.

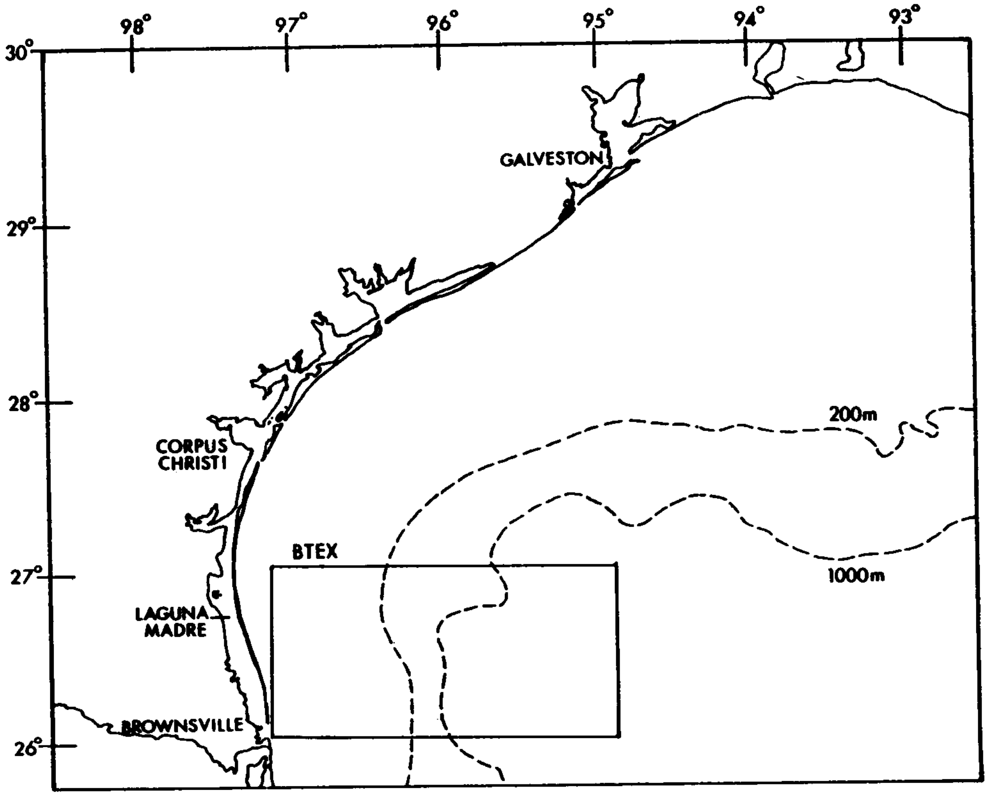


Figure 2. The position of the BTEX survey subunit (quadrangle) in relation to the coast of Texas and major bathymetric contours.

The starting position was determined randomly each day. The first transect was positioned along 1 of 10 nautical mile intervals (18 km) at the landward edge of the survey subunit. A random number between 1 and 10 determined which line was flown and the position of subsequent transects that day. The six transects in a survey day were spaced at intervals of 18 km from one another and were distributed uniformly along the width (111 km) of the subunit. The position of the two long transects in relation to the four short transects was also randomized but during any 3-day survey period, the long lines were positioned in each of the three thirds that made up the width (111 km) of the subunit.

Bimonthly samples usually consisted of three consecutive survey days. In order to maximize the statistical comparability of data, an attempt was made to collect data only under specified environmental conditions. Flights were scheduled only during hours when the sun angle was high enough for observations and were cancelled whenever fog or rain hampered visibility. Data collection was stopped whenever sea states exceeded a Beaufort 3. When weather and sea conditions or other factors prevented flights or acquisition of adequate data, surveys were delayed or repeated within a 2-week period. Occasionally, transects which had missing data for up to one third of the transect length were considered complete and were not repeated. Such instances usually involved transects disrupted by thunderstorms, fog, rain, or rough seas.

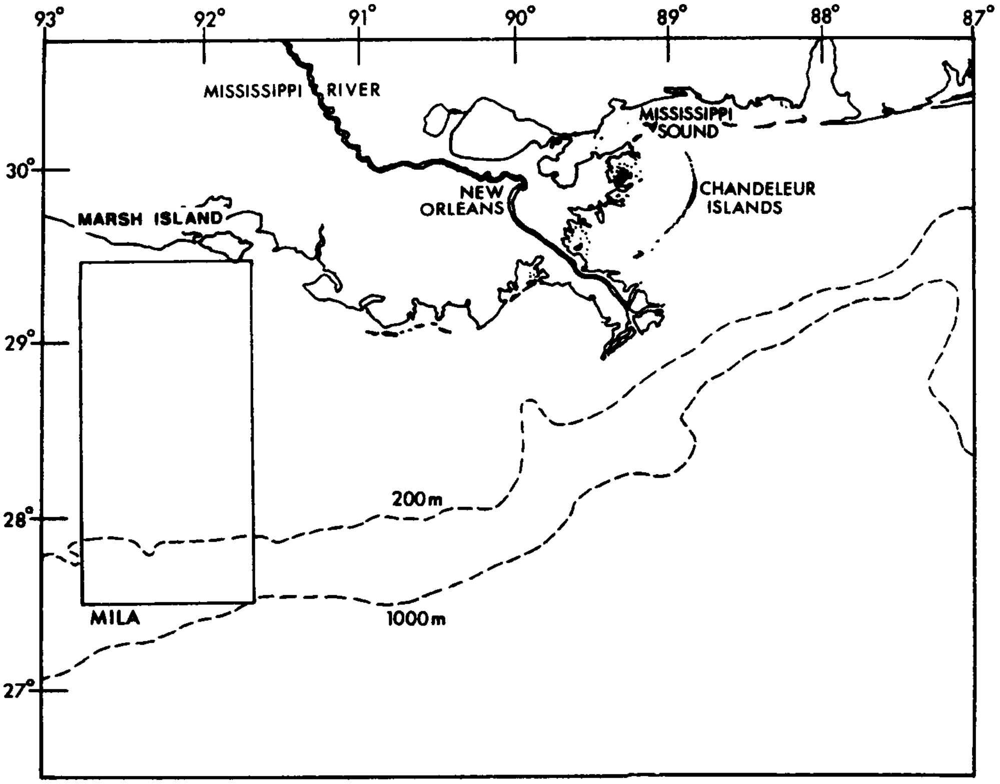


Figure 3. The position of the MILA survey subunit (quadrangle) in relation to the coast of Louisiana and major bathymetric contours.

SURVEY SCHEDULE

Most data were obtained in June, August, October, and December 1980, and February and April 1981. Since the present report focuses primarily on these sampling periods, the year (1980 or 1981) is usually not specified during reference to survey months in the text. Occasionally, scheduled surveys were postponed and extended into intervening months by poor weather conditions or mechanical difficulties. Opportunistic flights were scheduled irregularly during survey and intervening months. Table 2 lists the dates during which surveys were conducted. All surveys were completed within a period of 33 days except for the December sampling period, which was hampered by both mechanical and weather problems. During December, surveys were flown in the NAFL and MIFL subunits but not in MILA and BTEX. The December survey data from MIFL were excluded from statistical analyses due to poor conditions (rough seas) which hampered accuracy of data collection.

Opportunistic flights were conducted off North Carolina, off the mouth of the Mississippi River, near the Dry Tortugas, and in several areas between survey subunits. The central Gulf of Mexico was examined during August when a direct flight was completed from Naples, Florida to Brownsville, Texas.

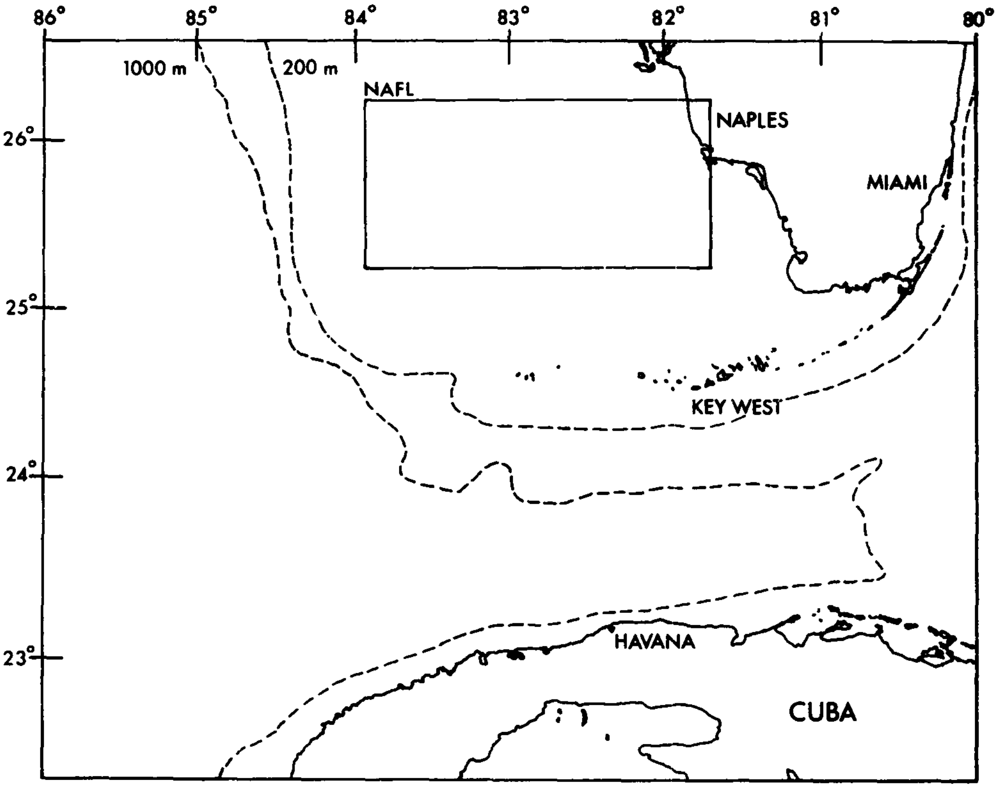


Figure 4. The position of the NAFL survey subunit (quadrangle) in relation to the coast of Florida and major bathymetric contours.

AIRCRAFT

All flights were conducted in a twin engine Beechcraft (Model AT-11) equipped with a plexiglass observation dome in the nose of the aircraft. The observation dome held two observers and provided visibility at angles of 30° to 120° from the vertical. Visibility on the horizontal plane was possible over a 180° spectrum (i.e., all forward angles back to an angle perpendicular to the transect line).

The aircraft was equipped with a Barnes PRT-55 radiometer, which allowed measurement of sea surface temperatures based on infrared radiation from the sea surface. An aviation Loran C unit with a microprocessor (TDL-711) capable of providing instantaneous latitude and longitude coordinates was used to maintain the transect course, to determine the position of all sightings, and to navigate the aircraft. Survey altitude was strictly controlled using a radar altimeter.

The aircraft usually carried a crew of six (pilot, co-pilot, and four technical observers). Two observers occupied the observation dome during surveys. A third observer recorded data, and the fourth observer occupied an aft position near a window where observations by the primary observers could be confirmed or amplified.

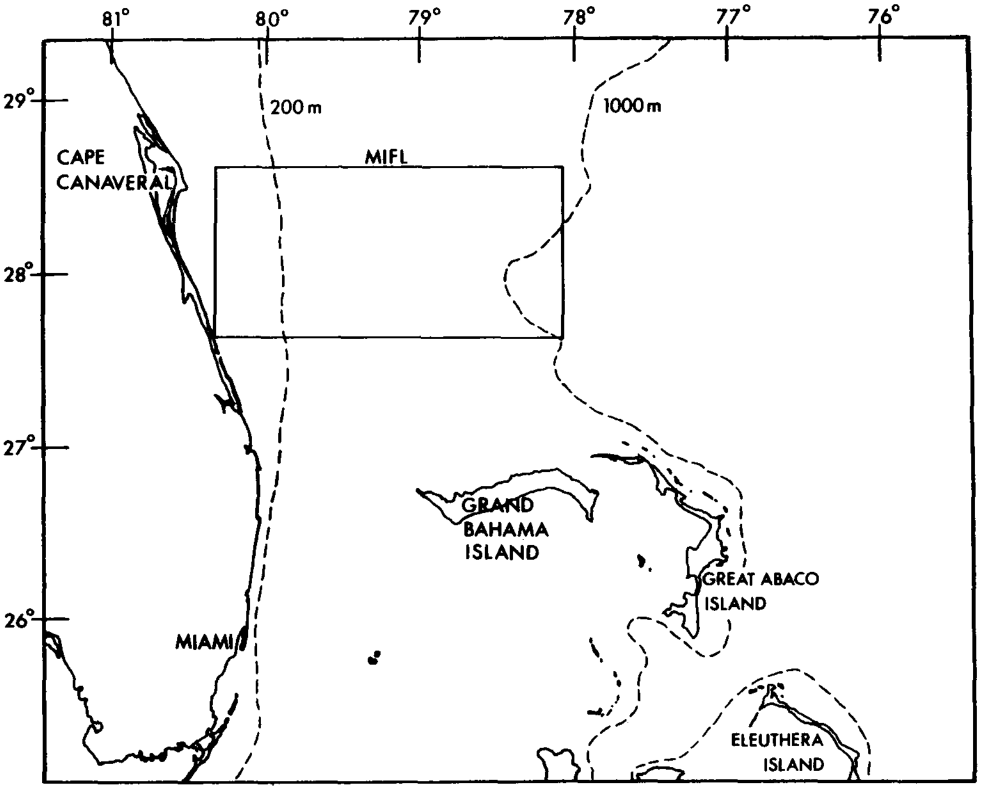


Figure 5. The position of the MIFL survey subunit (quadrangle) in relation to the coast of Florida and major bathymetric contours.

Observations from the aft position were recorded, but not used in density calculations or other quantitative analyses where uniform coverage was essential. All observers were rotated into new positions after 222 km of transect flight to reduce fatigue. The aft observer was allowed to use the period in this position resting or observing, depending upon the circumstances at the time.

Photographs were taken using 35-mm SLR cameras with 200-mm lenses and automatic winders. Cameras were held by hand in the observation dome and the aft windows.

OBSERVER TRAINING

Since the study involved equal emphasis on turtles, birds, and mammals, and few persons had equal experience in all three groups, special attention was given to preliminary training in field identification. Field guides and other materials were reviewed and studied for characteristics and cues of value in aerial survey identification. Due to the special problems in identifying animals from directly above, in varying light and glare conditions, and at varying distances, biologists familiar with

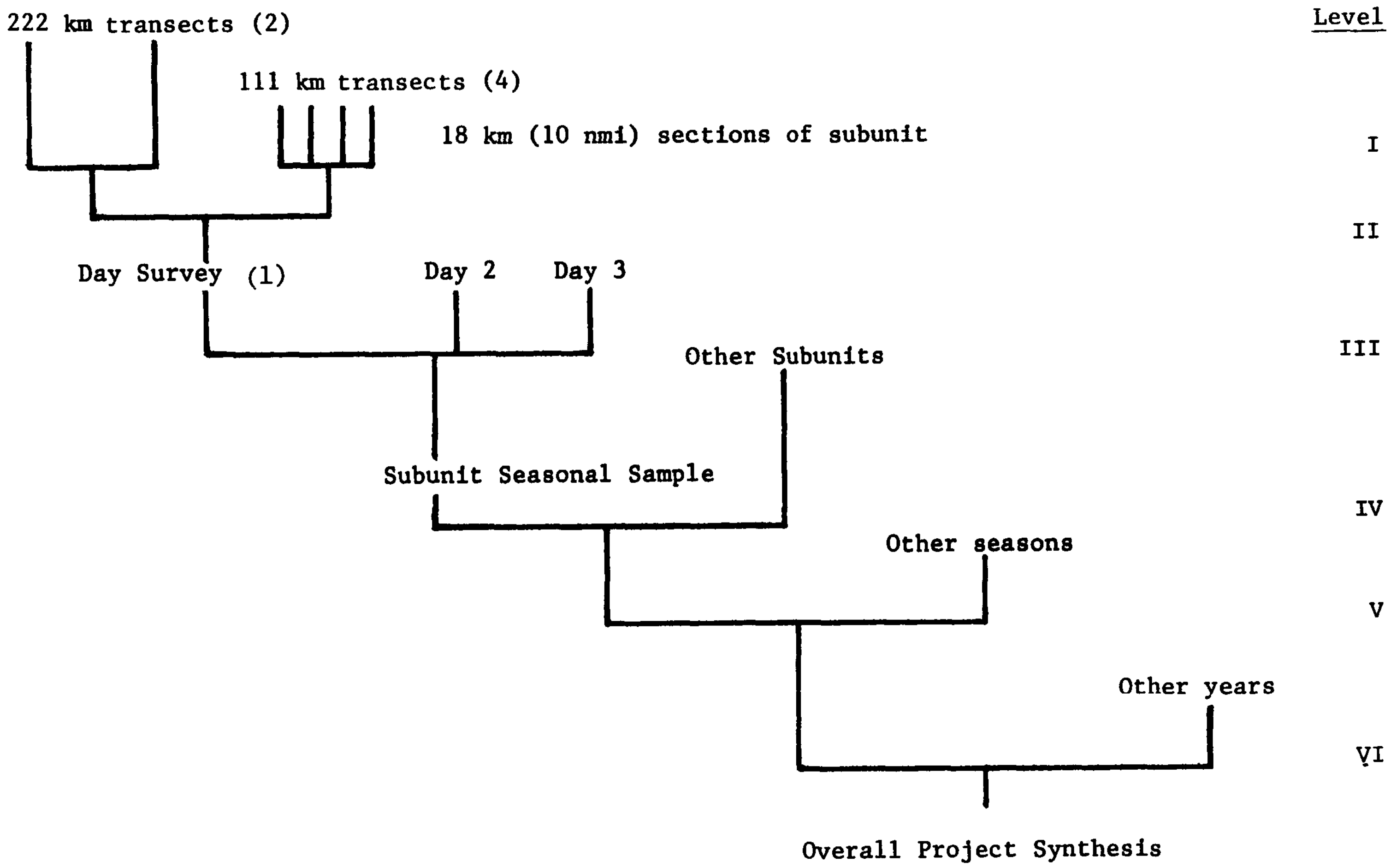


Figure 6. A hierarchical scheme of data comparability for the study. Level I, ecological samples; Level II, daily samples; Level III, geographic samples; Level IV, seasonal samples; Level V, annual sample; Level VI, annual replicates.

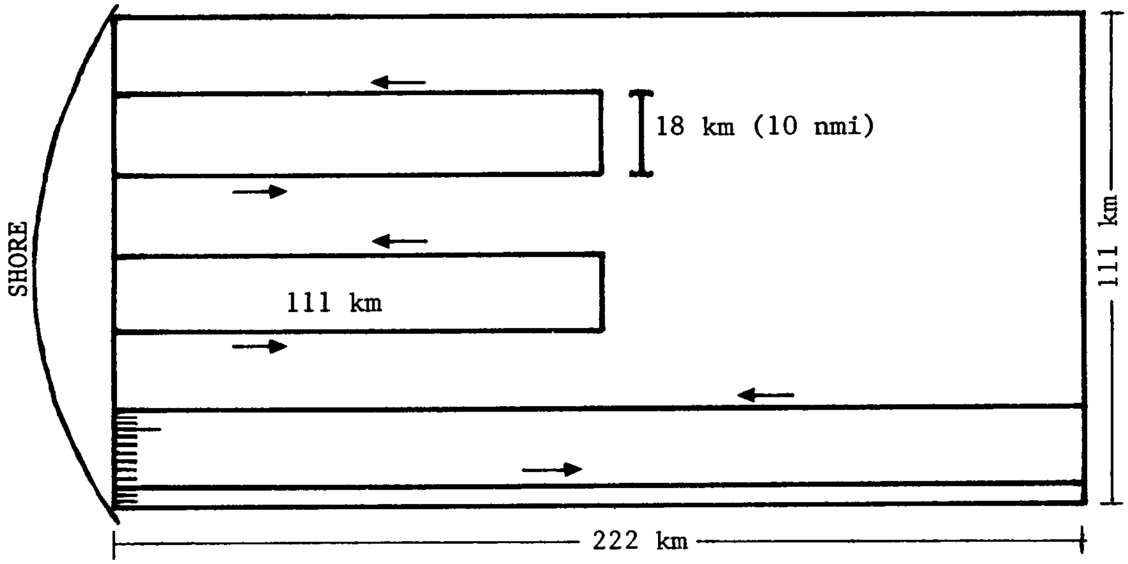


Figure 7. An example of a daily survey in which it was randomly determined that sampling would: (1) start at the lower margin of the subunit, (2) begin at nmi 3 of first 10 nmi section paralleling the coast, and (3) that the first and second transects would be 222 km in length. Also determined randomly but not shown is the sequence of high (228 m) and low (91 m) altitude flights. The starting point on days two and three also would be randomly determined but the order of long and short transect legs would change systematically to insure that the 222 km transects were conducted in each of outer and middle thirds of the subunit.

individual faunal groups conducted training sessions to discuss identification cues, such as behavior, flight characteristics, and ontogenetic changes in coloration which would aid observers in correct identifications. Training included slide and photographic studies in classrooms, terrestrial field trips, boat trips, and aerial training sessions in the survey aircraft.

DATA COLLECTION

The data recorded during a flight can be grouped into four general categories:

1. biological data - species identification, number of organisms, group formation, age structure, identification cues, behavior, location, direction of movement, position in or over water, day, hour;
2. environmental data - sea surface temperature, water depth, glare conditions, sea state, water color, visibility (haze, clouds, fog, and light intensity), associated species and features (sargassum, water masses, litter, etc.), weather conditions;
3. survey data - observer, observer position, reliability of identification, range of group size estimate, aircraft direction, sighting direction, altitude, leg (transect) number; and,

Table 2. Summary of flights during the present study.

Date	Locality	Type of flight
30 May to 04 June	MIFL	Transit, training, and scheduled
12 June to 14 June	MILA	Scheduled
15 June to 19 June	NAFL	Transit and scheduled
21 June to 30 June	BTEX	Transit and scheduled
05 Aug. to 09 Aug.	MILA	Scheduled
09 Aug. to 14 Aug.	MIFL	Transit, scheduled, and opportunistic
14 Aug. to 18 Aug.	NAFL	Transit and scheduled
18 Aug. to 23 Aug.	BTEX	Transit and scheduled
23 Aug.	MILA	Transit and scheduled
07 Oct. to 17 Oct.	MIFL	Transit, scheduled, and opportunistic
17 Oct. to 20 Oct.	NAFL	Transit and scheduled
20 Oct. to 25 Oct.	MILA	Transit and scheduled
25 Oct. to 02 Nov.	BTEX	Transit and scheduled
09 Dec. to 12 Dec.	MIFL	Scheduled
12 Dec. to 15 Dec.	NAFL	Transit, scheduled, and opportunistic
15 Dec. to 16 Dec.	MIFL	Transit and scheduled
02 Feb. to 13 Feb.	BTEX	Transit and scheduled
13 Feb. to 20 Feb.	MILA	Transit, scheduled and opportunistic
20 Feb. to 22 Feb.	Mississippi Sound	Opportunistic
22 Feb. to 02 Mar.	MIFL	Transit, scheduled, and opportunistic
02 Mar. to 08 Mar.	NAFL	Transit, scheduled, and opportunistic
09 Mar. to 11 Mar.	Mississippi Sound	Opportunistic
27 Mar. to 29 Mar.	North Carolina	Opportunistic and transit
31 Mar. to 03 Apr.	MIFL	Scheduled
03 Apr. to 10 Apr.	NAFL	Transit, scheduled, and opportunistic
13 Apr. to 20 Apr.	MILA	Transit and scheduled
20 Apr. to 29 Apr.	BTEX	Transit and scheduled
30 Apr. to 02 May	MIFL	Transit and scheduled

4. density data - position of sighting in relation to transect line (radial and perpendicular distances), best estimate of group size, number of transects completed (distance).

The biological and environmental data describe the sighting and add to the biological understanding of each species sighted. The survey data are of secondary importance, focusing on factors that might affect survey techniques and the reliability of the data. The density data are of special utility in computation of densities using line transect theory and techniques. The present report presents a summary and synthesis of all biological and environmental data. Survey and density data have been used in evaluating survey methods and in estimating the densities of species when possible.

Water depth where sightings occurred was determined on the basis of latitude and longitude using bathymetric charts distributed by the National Oceanic and Atmospheric Administration (NOAA). Distance from shore for sightings was estimated using a computer algorithm modified for each survey subunit. The actual shape of the shoreline in each subunit was simplified schematically and minimal distance estimates were calculated from the shore to each sighting location.

Summary statistics for distance from shore and water depth were calculated on the basis of all available data for each species. For species which occurred in both inshore and offshore halves of the survey units, these statistics will be skewed toward inshore distances and shallower waters. This results from the increased sampling of waters in the inshore half of the subunits in relation to the offshore half. For many species that are predominantly distributed in the inshore waters with only occasional individuals in waters in the offshore half of the survey subunit, the error in estimating mean distance from shore and mean water depth will be minimal. For other species distributed only in the inshore or offshore half of any subunit summary statistics would not be skewed. The reader is cautioned to consider the distribution of a species in relation to the inshore and offshore halves of the subunits in interpreting summaries of distance from shore and water depth.

The number of animals of a single species present at a particular sighting was recorded as the group size. All sightings of small cetaceans were categorized as "herds" to remain consistent with existing nomenclature in other aerial survey studies (see discussion in Leatherwood and Reeves in press). Dolphin herds may also represent social groups (sensu Norris and Dohl 1980a), but social interactions were not inferred for herds sighted in this study.

In situations where a reliable species identification was not possible, the identification was made at a more general level. For example, species of the genus Stenella were often difficult to distinguish. In some sightings, species were identified whereas others were recorded as Stenella sp. (species undetermined), or if the dolphin was not certain to be a Stenella, as unidentified dolphin.

Four species of terns were sufficiently similar from the air that no attempt was made to distinguish them from each other. Individuals representing Forester's Tern (Sterna forsteri), Common Tern (S. hirundo), Artic Tern (S. paradisaea), and Roseate Tern (S. dougalli) were grouped as Common-group Terns.

Data were tabulated on a data collection form (Figure 8) similar to that used by Fritts and Reynolds (1981). Data were subsequently transcribed onto computer coding sheets and entered into data records on the DEC-20 computer at Tulane University. Data were verified and monthly summaries were prepared using the subprogram Frequencies and subprogram Crosstabs of the Statistical Package for the Social Sciences (SPSS) (Nie et al. 1975). The former subprogram provided descriptive statistics (range, frequencies, and means) for all variables allowing identification of outliers. The subprogram Crosstabs was used to compile a summary breakdown of all variables by species. The SPSS package was also used to convert several variables from nautical and U.S. units into metric equivalents. Analysis of variance (ANOVA) was performed using BMDP-2V in the Biomedical Computer Programs (Dixon 1975). Differences in means of more than two samples were tested using Newman-Keuls multiple range test (Sokal and Rohlf 1969). The algorithm for multiple range analysis was written by the staff of the Department of Psychology, Tulane University. In all statistical analyses, a probability of less than 0.05 was considered significant and others were labeled as not significant (n.s.).

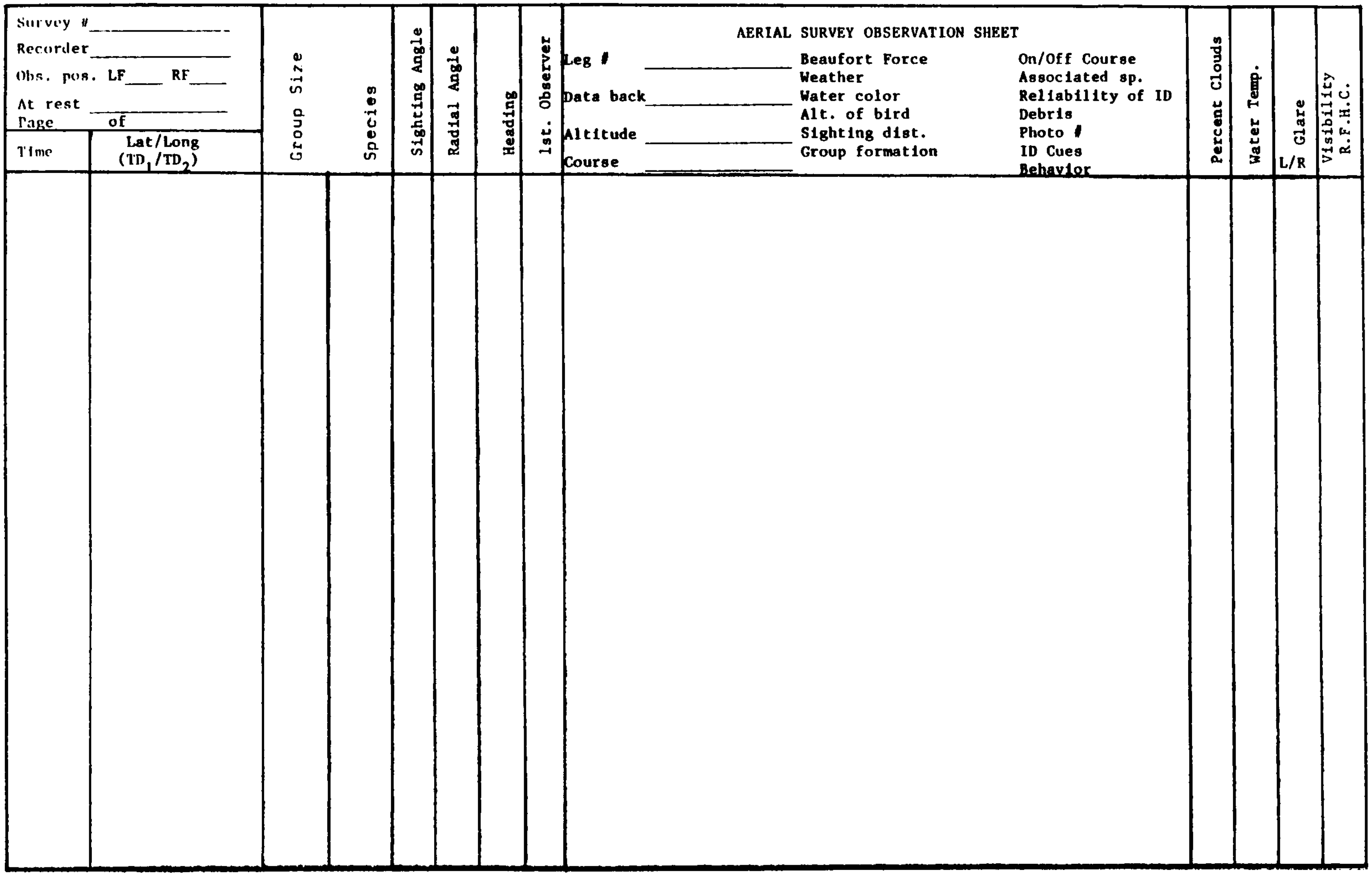
Data were summarized for each survey subunit and survey month. Thus, for most species, data are presented allowing comparisons between geographic and between seasonal samples. In order to facilitate such comparisons, figures summarizing means, ranges, and standard deviations for each seasonal geographic sample are presented when appropriate. Standard deviations were omitted from figures whenever the sample size was five or less. For species represented by few observations, data are presented in the text only.

Although the survey design called for an equal sampling effort (number of days, number of kilometers flown) in each survey month and survey subunit, some variation did occur. Observations made before or between transects, secondary sightings made while circling important sightings, sightings made during transit to and from survey areas, and observations made on opportunistic flights were also recorded. Flights that were aborted due to inclement weather or mechanical problems often resulted in useful data. Although these data are not statistically comparable, they allow general faunal comparisons. For most species, all available sightings are summarized and considered in the discussion except when rigorous statistical comparisons are required. In this report, only sightings by forward observers during transects under acceptable conditions are termed on-line data. For extremely abundant species, discussions have been limited to on-line sightings to allow more detailed comparisons across seasons and survey subunits.

The location of all sightings within survey subunits were mapped to illustrate the distribution of most species. However, the number of sightings visible on the maps is often smaller than the actual number available due to the small scale of the maps and occasional missing data elements. In all cases, statements about the number of sightings, the distance from shore, and depth characteristics are made on the basis of the data summaries rather than the maps illustrated in the report.

In all cases where appropriate, density estimates have been modified to correct for unequal sampling of inshore and offshore halves of the subunits.

The summaries discussed in this report are based on the maximal number of observations available, but the sample size for a given species at a particular locality may vary depending on the completeness of the data for each sighting. Missing data elements frequently prevented use of a sighting in one or more analyses but not in



Survey #____________
Recorder____________
Obs. pos. LF____ RF____
At rest ____________
Page of

AERIAL SURVEY OBSERVATION SHEET

Leg # ____________
Data back____________
Altitude ____________
Course ____________

Beaufort Force
Weather
Water color
Alt. of bird
Sighting dist.
Group formation

On/Off Course
Associated sp.
Reliability of ID
Debris
Photo #
ID Cues
Behavior

Time	Lat/Long (TD_1/TD_2)	Group Size	Species	Sighting Angle	Radial Angle	Heading	1st. Observer		Percent Clouds	Water Temp.	Glare L/R	Visibility R.F.H.C.

Figure 8. A coding sheet used for recording observations during aerial surveys.

others. The phrase "all sightings" refers to the inclusion of all data available whether collected during actual transect surveys (on-line) or in transit to and from the transect lines, while circling for other animals and during periods of marginal weather conditions (off-line). Only the data from actual transects were used in density estimates whereas all appropriate data were used in discussing group size, distribution, and seasonality of most species.

DENSITY ESTIMATES

Density estimates were calculated for species with sufficient sightings. Whenever possible, perpendicular and radial distances from the transect line were determined for on-line sightings. Perpendicular and radial distances were computed using the sighting angle (angle of sight on vertical scale from aircraft), radial angle (angle of sight on horizontal scale), and altitude of aircraft in basic trigonometric relationships. Sighting angles were determined using previously calibrated marks on the surface of the observation dome. Radial angles were estimated by visualizing a 12-h clock horizontal to the aircraft. A radar altimeter provided accurate estimates of altitude.

Line transect statistics were computed using the Linetran algorithm written by Charles Gates available at Texas A & M University (Gates 1981). The general characteristics and applicability of line transect calculations were outlined by Gates (1979) and Burnham et al. (1980).

Line transect methods allow the effective sighting distance for a species to be determined and thus facilitate the computation of the area actually sampled. This feature is particularly important in the present study where turtles, birds, and mammals of widely varying sizes and visibility were being surveyed. For many species considered herein, density estimates have never been attempted and few quantitative data exist to guide the selection of strip width.

Line transect techniques allow the area surveyed to vary among animals which are detectable to varying degrees because of differences in size, coloration, behavior, or group size. In line transect studies, the total area surveyed for each species is computed after the data are collected. Coverage during an aerial survey for a species with a conspicuous coloration and behavior may be several times greater than that for an inconspicuous species visible only at short distances from the transect line. In theory and in practice, an equal number of sightings would result in a higher density estimate for a species seen only in a narrow strip than for a species seen over a wide strip.

Density estimates presented in this report are based on the Fourier Series (Crain et al. 1978; Burnham et al. 1980). Although the Linetran algorithm potentially allowed the computation of densities using various techniques, the Fourier Series was selected for a number of reasons. The Fourier Series technique is a robust, nonparametric test that is efficient with both large and small sample sizes and can truncate data to remove outliers. Since sightings were sometimes composed of more than one individual of the same species, densities were calculated originally as group densities (i.e., number of groups per square kilometer). In all tables with density information, the density of individuals is also presented (group density multiplied by average group size).

When sample sizes permitted, densities were calculated for individual subunits during a specific month. Calculations based on data from all sampling periods for an individual subunit were also calculated for the most frequently sighted species. However, such compilations are best viewed as hypothetical annual averages, which do not reflect seasonality and therefore are probably only accurate for year-round resident populations (Burnham et al. 1980). Each group density estimate is accompanied by a variance. Meaningful variances could not be calculated when sample sizes of less than 20 were analyzed. The reader is cautioned against applying density estimates to rigorous interpretation when variances are large or not available.

The following assumptions, summarized by Gates (1981) and Burnham et al. (1980), underlie the accuracy of line transect methods for estimating densities:

1. the transect is randomly located in the survey area;
2. the sighting of one animal (or group) is independent of the sighting of another;
3. no animal is counted more than once;
4. when animals are seen by being flushed, each is seen in the exact position it occupied prior to being startled (this presumes that right angle or radial distances are unbiased);
5. the probability of an animal being seen at a given right angle distance from the transect line is a function of that distance; and,
6. the probability of seeing an animal on the transect line is unity.

In the present study not all assumptions are met. Transect lines were randomly selected but were always parallel with the subunit (i.e., perpendicular to bathymetric variation), thereby causing density estimates to reflect generalized differences in habitat characteristics.

In general, the study met the assumption that the sighting of one animal or group was independent of the sighting of others. The area surveyed was visually searched whether or not animals were known to be present. However, observer acuity may have varied slightly in relation to fatigue, motivation, and circumstances. Fatigue and mental concentration are especially important in aerial surveys of large monotonous areas such as the ocean's surface.

In this study, animals ranged from large cetaceans to small, dark bird species. The probability of counting any animal more than once is estimated to be low. All transects flown on any one day were at least 18 km (10 nmi) apart. Transects on subsequent days potentially were near (0 to 18 km) to previous transects, but the distance was randomly determined. The actual size of the survey subunits (24,642 km^2) suggests that the probability of repeated sighting of an individual or group is low. Three of four sightings of Short-finned Pilot Whales in the BTEX subunit and adjacent waters over a period of 20 months in 1979, 1980, and 1981 were within 11 km of each other. This potentially represents resightings, but on the other hand possibly reflects exceptional ecological conditions which attract transients or support resident animals. The chance of resighting animals is probably elevated for large animals that can be sighted from long distances. Repeat sightings are possible in different survey months, but would be expected to account for a small percentage of all sightings. Repeat sightings across seasons would not affect seasonal density estimates.

The assumption that an animal is detected at or near the position where it was flushed is relevant to aerial surveys where the noise and shadow of an aircraft can affect animals' behavior. The forward visibility of observers in the dome of the Beechcraft AT-11 allowed detection of most animals before or at the same time that they reacted to the aircraft.

If avoidance resulted in animals being sighted farther from the transect line than they actually were prior to the detection of the aircraft and in lowering group size estimates, density figures will be underestimates of actual densities. There is a need for future studies which evaluate movements of marine organisms in response to survey aircraft to determine if movements are random or biased away from the transect line. On several occasions, the sizes of mammal groups were underestimated until photographs demonstrated the presence of calves and other submerged animals that were not seen at the time of the observation.

Whether the probability of an organism being sighted at a given perpendicular distance from the transect line is a function of that distance is unclear. Marine mammals and turtles in the study area are conspicuous at the surface, but inconspicuous or undetectable at varying depths under the water. Detection would vary less for most birds that fly over or rest on the water. However, certain dark birds are more detectable during flight than when on the water. Detectability of some diving birds (e.g., loons) varies in relation to their activity and behavior. Detectability generally decreases with increased perpendicular or radial distances.

The assumption that the probability of sighting an animal located on the transect line is unity deserves comment. The Beechcraft AT-11 aircraft allowed an adequate view of the transect line by both primary observers. Some aircraft used for aerial surveys have downward visibility limited by side windows. Consequently, the animals on the transect line are not usually visible from side window aircrafts, and the surveys are limited to strips on either side of the aircraft (strip transects; see Leatherwood et al. 1978).

Because marine turtles and mammals, and to a lesser extent birds, submerge and remain undetected for long periods, not all animals on the transect line are visible. Density calculations are not assessments of the total population of a species but rather are densities of the animals on or near the surface. Therefore, sightings of animals at the surface would result in observed densities that were underestimates of total population densities (Burnham et al. 1980). The degree of error would be directly correlated with the percentage of time spent by the animal below the surface where detection is unlikely. Consequently, knowledge of the diurnal activity patterns and relative diving times for individual species is essential to detailed analysis of abundance and density. Unfortunately, submergence time data are not available for any species.

Despite the considerations mentioned above, line transect methods are applicable to aerial surveys of marine vertebrates. The advantages of being able to collect data on animal species with widely divergent sizes, behaviors, and colorations are important to survey efficiency. The estimates derived from the present study are limited more by our poor knowledge of habitat use and migrations than by statistical limitations.

SPECIES ACCOUNTS

GREEN SEA TURTLE, Chelonia mydas

The Green Sea Turtle is recognized by the U.S. Fish and Wildlife Service (USFWS) as an endangered species in Florida and as a threatened species elsewhere in the study area.

Description

The Green Sea Turtle is a medium- to large-sized marine turtle, 76 to 153 cm carapace length (Ernst and Barbour 1972). The carapace is oval in shape, pointed posteriorly, and extremely variable in coloration. In the Indian Ocean, the carapace scutes may include any shade or mixture of black, brown, gray, or green in a mottled, streaked, or radiating pattern (Frazier 1971). Comparable studies of variation in Atlantic populations have not been made. The head is relatively small (12 to 15 cm wide in adults) (Ehrhart 1980), and the limbs are long and paddlelike. The skin may be colored similar to the carapace with the addition of a yellowish tint. Hatchlings and small turtles tend to appear very dark gray-green in color. Larger juveniles may be red-brown on the carapace, head, and limbs, and this color morph could be confused with that of Loggerheads. As in other species of marine turtles, the male Green Sea Turtle has a particularly long tail, but no male Green Sea Turtles were discerned during the surveys.

The Green Sea Turtle may be identified from an aircraft by its carapace shape and small head, but the variable coloration can make it difficult to distinguish from other species of sea turtles.

Distribution

Green Sea Turtles were identified only in the NAFL and MIFL survey subunits where three sightings occurred in each subunit, and during two opportunistic surveys near MIFL (five sightings). Henceforth, sightings of Green Sea Turtles in the MIFL survey subunit and opportunistic flights, because of their proximity to each other, will be referred to collectively as observations from the Atlantic coast or East Florida.

Green Sea Turtles are chiefly pantropical in distribution, but do range into temperate waters. They are known to range throughout the study area. They have been recorded in the Gulf of Mexico and in the western Atlantic from Massachusetts to Argentina (Carr 1952). On the Atlantic coast of the U.S., nesting is confined mostly to the east coast of Florida from Brevard to Broward County (Carr et al. 1979), adjacent to the MIFL survey subunit. The northernmost record of Green Sea Turtle nesting is from Georgia (Litwin in press, cited by Shoop et al. 1981). Catch statistics from presently defunct turtle fisheries indicate that Green Sea Turtles were formerly present in numbers off Louisiana and Texas (Rebel 1974), but they are now relatively rare.

The Green Sea Turtle feeds in coastal areas (Rebel 1974) and therefore may be seen close to shore (e.g., within a few kilometers) as in the surveys of East Florida. However, Green Sea Turtles may be encountered hundreds of kilometers out to sea (Carr et al. 1979). Many adults potentially make seasonal migrations of up to several thousand kilometers to reach nesting beaches in Central America and on oceanic islands in the Atlantic (Carr 1965, 1967; Hirth 1971).

In the NAFL survey subunit, Green Sea Turtles were seen during August 1980 and April 1981. In waters off eastern Florida, they were sighted during August and October 1980 (Table 3). Although data are few, Green Sea Turtles in East Florida ranged over twice as far from land in October as in August. Seasonal changes in offshore distribution for Green Sea Turtles have not been described in the literature. The August sightings comprise 73% of all Green Sea Turtles recorded whereas October and April sightings account for 18% and 9%, respectively.

The population of Green Sea Turtles encountered by fishermen in waters off Cedar Key in West Florida was comprised mostly of immature animals (Carr and Caldwell 1956). These turtles were presumed to be in a feeding habitat for juveniles, and since most were not reproductively mature, they would not be involved in seasonal movements to nesting beaches. However, catches of immature and adult turtles at the fishery in West Florida indicated that Green Sea Turtles were present there only from April to October (Carr and Caldwell 1956), a seasonal occurrence consistent with the survey data. However, turtles observed off the Atlantic coast in August may be involved in the season's reproductive effort, which lasts from June to August in Florida (Ehrhart 1980).

The turtles sighted off the Atlantic coast in August were probably aggregated there for mating and nesting (Carr and Carr 1977). The absence of Green Sea Turtles in winter may be a result of seasonal migrations or winter dormancy (Carr and Caldwell 1956; Carr et al. 1979). However, stranding records and cold-stun episodes indicate that the species is present in Florida waters year-round (Ehrhart 1977; Pringle 1981).

Based on the absence of winter sightings and the occasional discovery of turtles in the spring with mud on their carapaces, turtle fishermen presumed that the turtles buried themselves in the mud in a state of winter dormancy (Carr and Caldwell 1956). The same phenomenon may apply to Green Sea Turtles on the eastern shore (Ehrhart 1977).

Abundance

Green Sea Turtles were most abundant on the Atlantic coast of Florida (Table 3). All sightings were of solitary animals. The number of sightings were too few to permit density calculations. Due to the difficulty in distinguishing Loggerhead and Green Sea Turtles from the air, it is possible that other sightings of Green Sea Turtles were recorded as unidentified turtles.

The world population of mature Green Sea Turtles was estimated at 100,000 to 400,000 animals (Ehrenfeld 1974). Numbers of Green Sea Turtles in waters off Florida and on the west coast of Mexico have declined to an endangered state because of exploitation of eggs and adults on nesting beaches and mortality due to fisheries (Carr 1967; Rebel 1974). The population nesting in Florida in 1974 was estimated at less than 50 females (Lund 1974). A total of 348 nests of this species were reported in Florida in 1980 (Huff et al. 1981), but this probably reflects better coverage of nesting areas rather than increasing populations. On the basis of turtle fishery data, the west coast population of Green Sea Turtles in Florida was estimated at 5,600 (Carr and Caldwell

Table 3. Sighting information on the Green Turtle. Dash means no data. OPPO = opportunistic flight.

Survey subunit	Date	Position (Latitude/Longitude)	Distance from shore (km)	Water depth (m)	Sea surface temperature (° C)
NAFL	16 Aug. 1980	26°03.7'N/82°59.3'W	117	42	27
NAFL	16 Aug. 1980	25°23.5'N/82°46.4'W	161	44	27
NAFL	05 Apr. 1980	25°21.8'N/81°44.0'W	57	11	-
MIFL	10 Aug. 1980	27°46.9'N/80°20.3'W	7	15	26
MIFL	12 Aug. 1980	27°51.6'N/80°09.9'W	23	26	-
MIFL	11 Oct. 1980	28°08.0'N/79°45.5'W	79	461	26
OPPO	13 Aug. 1980	27°32.1'N/80°17.5'W	3	12	-
OPPO	13 Aug. 1980	27°22.8'N/80°13.8'W	4	12	-
OPPO	13 Aug. 1980	27°44.5'N/80°18.5'W	8	15	24
OPPO	13 Aug. 1980	27°46.5'N/80°22.8'W	3	13	24
OPPO	12 Oct. 1980	29°12.0'N/80°22.8'W	46	28	25

1956). The west coast estimate is outdated and refers mostly to immature animals, and therefore, is not comparable with the estimates for females nesting on the east coast. The number of immature Green Sea Turtles on the Atlantic coast of Florida is not known, but Ehrhart (1977) has studied immature Green Sea Turtles in coastal lagoons and discovered 100 Green Sea Turtles in a small area of the Mosquito Lagoon system during a cold period which stunned both Green and Loggerhead Turtles. Turtle fishery data detailing numbers of Green Sea Turtles taken near Florida indicated that over 10 times as many turtles were captured on the west coast as on the eastern shore (Rebel 1974). These data conflict with the survey results. Fishing effort on the west coast apparently was more intensive than on the Atlantic side of Florida and may not accurately reflect the relative abundance between the two areas.

The absence of Green Sea Turtle sightings in Louisiana and Texas may be a result of a low abundance in the western Gulf of Mexico as well as the problem of identifying species. High pesticide levels occur in Laguna Madre and other coastal bays and estuaries of Texas, and the coastal area has been degraded ecologically during this century through dredging, landfills, and associated changes in salinity levels and siltation (Simmons 1957; Breuer 1962; Childress 1967). These factors may have contributed to the decline in the numbers of several marine turtle species in the western Gulf of Mexico. Records from turtle fisheries and strandings of Green Sea Turtles were well over three times as abundant in Florida waters as in Louisiana and Texas combined (Rebel 1974; Pringle 1981).

Habitat Use

Distance from shore of Green Sea Turtle sighting locations (Table 3) ranged from 57 to 161 km in the NAFL survey subunit ($\bar{x}$ = 112 km; n = 3; Figure 9) and from 7 to 79 km in East Florida ($\bar{x}$ = 22 km; SD = 27.5; n = 8). Seven (88%) of the eight Green Sea Turtles observed off the Atlantic coast were inshore of the Gulf Stream (Figure 10). It is possible that Green Sea Turtles were responding to the western boundary of the Gulf Stream and avoiding the main current in a manner similar to Loggerheads (see Loggerhead Turtle species account). If so, the Green Sea Turtle sighted within the Gulf Stream may have been in transit to another area.

The greatest range of water depths at sighting locations of Green Sea Turtles (Table 3) was 12 to 461 m off the Atlantic coast of Florida ($\bar{x}$ = 76 m; SD = 157; n = 8). In the NAFL survey subunit, they occurred in waters 11 to 44 m deep ($\bar{x}$ = 32 m; n = 3).

All but one of the Green Sea Turtles were sighted in waters less than 50 m deep (Figures 9 and 10). The Green Sea Turtles observed in the 1979 surveys (Fritts and Reynolds 1981) were in waters 20 to 50 m deep.

During the first year of life, Green Sea Turtles are thought to feed primarily on marine invertebrates (Carr 1965). Larger Green Sea Turtles, such as those observed in the surveys, apparently prefer an herbivorous diet and frequent shallow water grass flats for feeding (Carr 1952; Rebel 1974). Such habitat is common in the coastal waters of Florida, particularly in the Gulf of Mexico. Beaches in Brevard, St. Lucie, and Martin Counties on the Atlantic coast have been proposed as critical habitat for the Green Sea Turtle (Dodd 1978). Fritts (1981a) reported a subadult Green Sea Turtle from the eastern Pacific with a large quantity of fish eggs in the gut. The turtle had fed on the eggs presumably in a pelagic situation.

Sea surface temperatures at sighting locations of Green Sea Turtles (Table 3) ranged from 24° to 27° C ($\bar{x}$ = 26° C; SD = 1.3; n = 7). Carr et al. (1979) reported that Green Sea Turtles are found in waters that remain above 20° C during the coldest weather, but significant evidence suggests that they may be present embedded in the mud in a torpid state in waters down to 10° C (Ehrhart 1977). In water temperatures of 9° to 10° C, Green Sea Turtles floated stunned and immobile at the surface (Ehrhart 1977; Schwartz 1978). Death occurred during exposure to water temperatures of 5° to 6° C (Schwartz 1978). According to McGinnis (1968), Green Sea Turtles became torpid when exposed to water temperatures of 26° to 30° C, but this observation has not been confirmed.

Reproduction

Green Sea Turtles mate offshore from the nesting beaches (Hirth 1971). Several times during a season, the female crawls ashore at night and deposits about 110 eggs in the sand (Carr and Hirth 1962). Incubation lasts 48 to 70 days (Carr and Hirth 1962), after which the hatchlings dig out of the sand and enter the sea. It is suspected that the hatchlings are pelagic and associate with sargassum rafts (Carr 1967; Frick 1976; Carr and Meylan 1980). As in other species of marine turtles, age at maturity potentially depends on growth rate. Green Sea Turtles may mature at 8 to 13 years in temperate waters (Caldwell 1962a) or by the time they reach a carapace length of 80 cm (Hirth

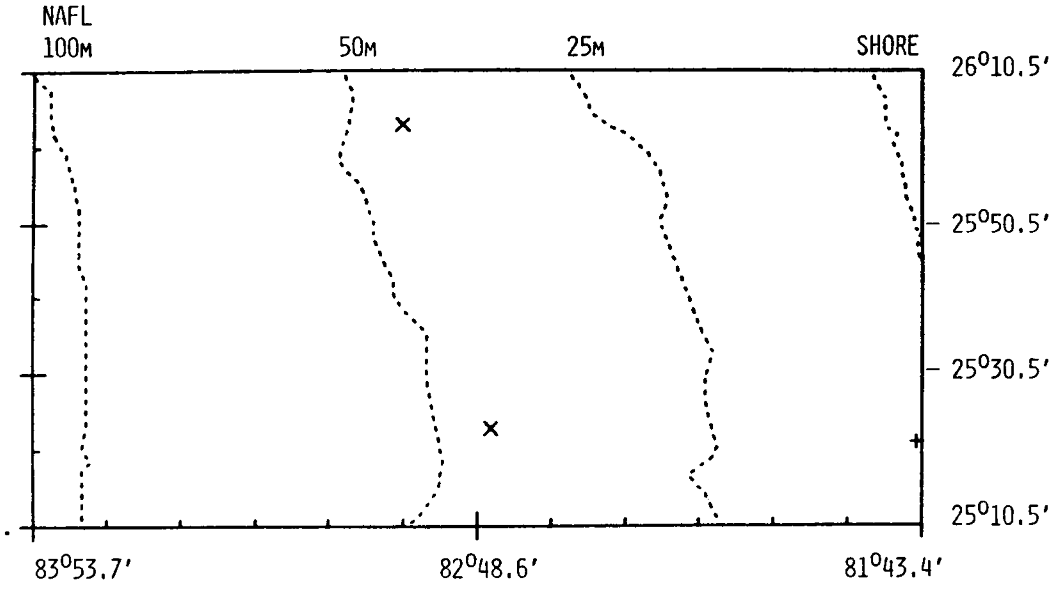


Figure 9. Distribution of all Green Turtle sightings in the NAFL survey subunit during August (X) and April (+).

1971). Slower rates of maturation have been suggested (Mendonca 1981), and the entire subject of age structure of marine turtles is highly speculative.

Behavior

During surveys, Green Sea Turtles were observed at or near the surface of the water. Green Sea Turtles in the Pacific Ocean are known to come ashore and into shallow water near beaches and reefs to bask in the sun (Bustard 1973; Balazs 1980; Fritts 1981b). It is possible that turtles observed at the surface during aerial surveys were basking at sea.

Potential Impacts of OCS Development

Green Sea Turtles sometimes associate with reefs (Rebel 1974) and may approach oil rigs because of the reef-community organisms living on or near the structures. Hatchlings and older Green Sea Turtles can contact oil in the marine environment. Fouling with oil or tar may result from passive contact with floating oil or from active ingestion of petroleum during feeding. In Florida and Texas, young Green Sea Turtles have been found fouled with oil, and some had tar in their mouths; some of these turtles have died (Witham 1978; Rabalais and Rabalais 1980; SEAN 1981). Green Sea Turtles have been found with plastic bags in their gut (Fritts in press). Nesting females and hatchlings can be disturbed or disoriented by artificial lights or construction work (Mann 1978) which may be associated with OCS development near nesting beaches. Green Sea Turtles have been found in the spoil from dredging activities (SEAN 1981; L. M. Ehrhart,

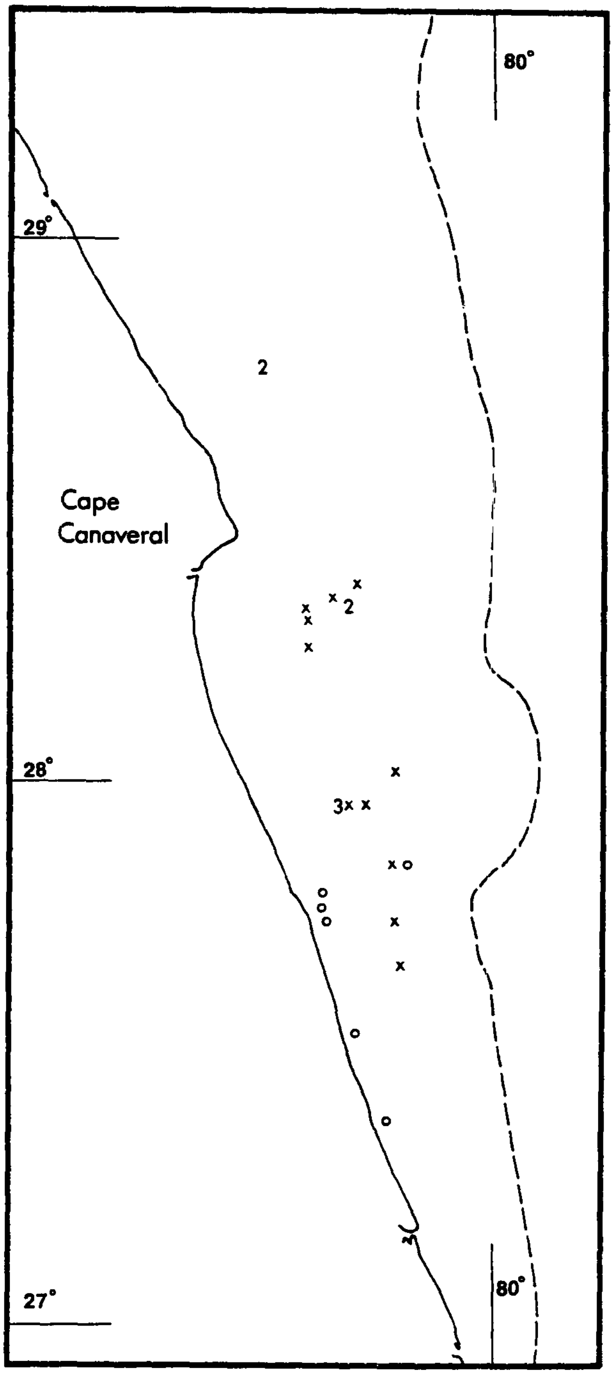


Figure 10. Distribution of the Green Turtle (circles) and Leatherback Turtle (x's and numbers) in and near the M[illegible]FL survey subunit in August 1980 during scheduled surveys and an opportunistic survey. Numbers represent Leatherbacks seen in close proximity. The dashed line represents the western boundary of the Gulf Stream.

University of Central Florida, Orlando, pers. comm.). Green Sea Turtles buried in the mud in a state of winter dormancy would be extremely vulnerable to dredges. Green Sea Turtles may also be subject to collisions with boat traffic. The significance of Green Sea Turtles' vulnerability to petroleum effects is magnified because of the low population levels and the local concentration of nesting beaches.

Summary

Green Sea Turtles are difficult to distinguish from Loggerhead Turtles and may be much more common than suggested by aerial survey data. A total of 11 Green Sea Turtles were sighted in the NAFL and MIFL survey subunits, and during two opportunistic surveys near MIFL. They were observed during August 1980 and April 1981 in the NAFL survey subunit, and during August and October 1980 in East Florida. The absence of Green Sea Turtle sightings during the winter may be a result of migration out of the area or, more likely, winter dormancy. The majority of turtles (six animals) were seen off the Atlantic coast in August 1980; these Green Sea Turtles probably were involved with the reproductive activity on the nesting beach adjacent to the MIFL survey subunit. Most of the Green Sea Turtles were seen in nearshore shallow waters. The nesting beaches, eggs, hatchlings, and older Green Sea Turtles all may be vulnerable to the effects of OCS development.

LOGGERHEAD TURTLE, *Caretta caretta*

The Loggerhead Turtle is listed as a threatened species by the USFWS.

Description

The Loggerhead Turtle has a large body, 71 to 213 cm carapace length (Ernst and Barbour 1972) with a proportionately large head, 14 to 26 cm wide (Ehrhart and Yoder 1978). The carapace appears as an elongate oval in silhouette and generally is reddish brown in color. The limbs are paddlelike and often yellowish in contrast with the darker color of the carapace. Young Loggerheads are similar to adults in coloration. As in other sea turtles, adult male Loggerheads have a conspicuously long tail that generally extends beyond the edge of the carapace.

The adult Loggerhead is similar in size to the Green Sea Turtle and is larger than the Ridley and Hawksbill Turtles. The adult Leatherback Turtle is larger and often darker than the Loggerhead. The reddish-brown coloration is most characteristic of the Loggerhead, but some individuals of the Hawksbill and Green Sea Turtle may be colored similarly. However, the Loggerhead Turtle has the largest relative head size. The Loggerhead's carapace is often covered with epizoans and algae, more so than in other species of marine turtles. The type and degree of epibiotic growth may affect coloration, making the turtle appear lighter or darker than normal.

From an aircraft, the Loggerhead's color and large head and body size are useful identification cues. The reddish-brown coloration of the carapace may be variable under water and at times has appeared pale grayish-brown.

Distribution

Loggerhead Turtles were sighted in all survey subunits at varying distances from shore (Figure 11) and were conspicuous in opportunistic surveys off North Carolina. The species occurs in coastal waters throughout the study area and occasionally was recorded in small numbers during transit and other opportunistic flights. Loggerheads were seldom encountered in the waters off Louisiana and Texas (Figure 12), but they were abundant in waters off Florida (Figures 13-19). Similar distributional patterns were observed in the 1979 surveys of Florida and Texas (Fritts and Reynolds 1981).

Loggerhead Turtles were sighted over 50 times as frequently in the Florida subunits as in Louisiana and Texas (Table 4). Excluding opportunistic surveys, about 56% of all Loggerhead Turtles (973 turtles) were seen in the NAFL subunit, and 42% (727 turtles) were encountered in the MIFL subunit. About 1% (15 turtles) was sighted in the MILA subunit and an equal number was sighted in the BTEX subunit. On at least five occasions in Florida, Loggerhead Turtles were observed as paired animals within one body length of each other. Other sightings were of single animals. Non-breeding adults are thought to range widely as solitary individuals (Caldwell et al. 1955).

Loggerhead Turtles are distributed throughout the warm and temperate seas of the world (Caldwell et al. 1955). In the western Atlantic, they range from Newfoundland to Argentina (Carr 1952), including the Gulf of Mexico and the Caribbean Sea. The Loggerhead has the northernmost nesting range of all marine turtles. Major nesting areas are located on the coasts of Florida, Georgia, and the Carolinas. Sporadic nesting occurs in the Gulf of Mexico as far west as Texas and on the Atlantic coast from North Carolina to New Jersey (Lund 1974; Pritchard 1979; Rabalais and Rabalais 1980). Some nesting occurs on the Atlantic shores of Central and South America (Pritchard 1979).

Loggerhead Turtles were recorded in all subunits during each survey month except June in the MILA subunit. The survey data do not show seasonal movements of turtles from one subunit to any other subunit. According to two-way ANOVA and Newman-Keuls tests of on-line sightings, distance from shore of Loggerhead Turtles did not vary significantly between survey months in the MIFL or NAFL subunits (no on-line sightings were available for December in the MIFL subunit).

In both the MIFL and NAFL subunits, Loggerhead Turtles were sighted least frequently during December 1980, and most frequently during April 1981 (Figure 20). It appears that a seasonal cycle was operant in both Florida survey subunits. The highest numbers of Loggerheads were seen in the spring and summer months, decreasing to the lowest abundance in fall and early winter and increasing again as spring approached. The low and high peaks of the cycle were most extreme in the MIFL subunit (a range of 163 turtles). It seems unusual that the numbers of Loggerheads observed in the MIFL subunit was much lower in June 1980 (114 turtles) than in April 1981 or August 1980 (208 and 199 turtles, respectively).

Seasonal shifts in abundance of Loggerhead Turtles have been documented in this and other investigations. In aerial surveys off the coasts of the Atlantic Ocean (Shoop et al. 1981) and the Gulf of Mexico (Fritts and Reynolds 1981), the highest numbers of Loggerheads were observed during the summer months.

Loggerhead Turtles are known to travel over long distances, but Rebel (1974) and Carr et al. (1979) contended that there is no evidence of regular seasonal migrations.

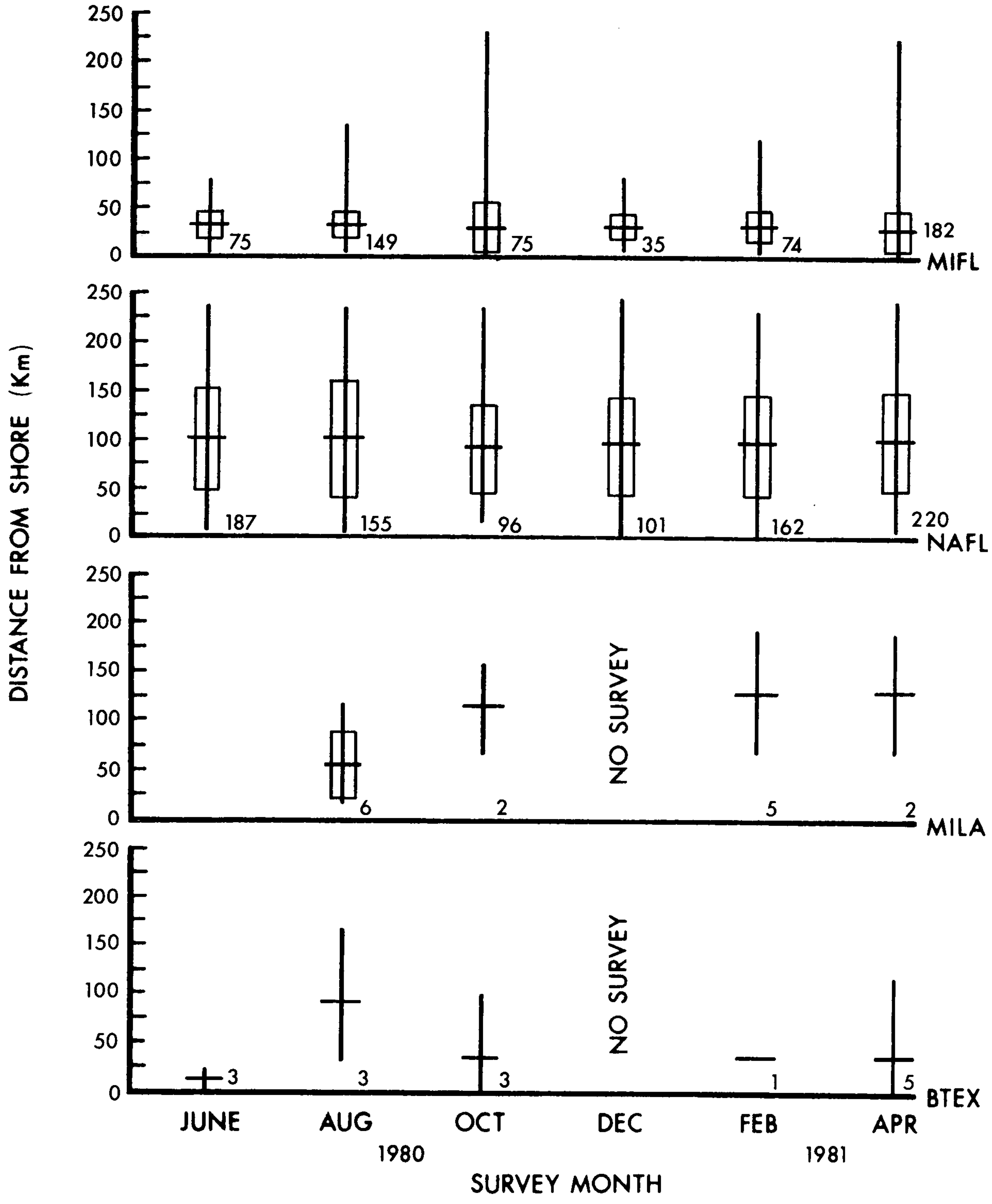


Figure 11. Distance from shore for all sightings of Loggerhead Turtles by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

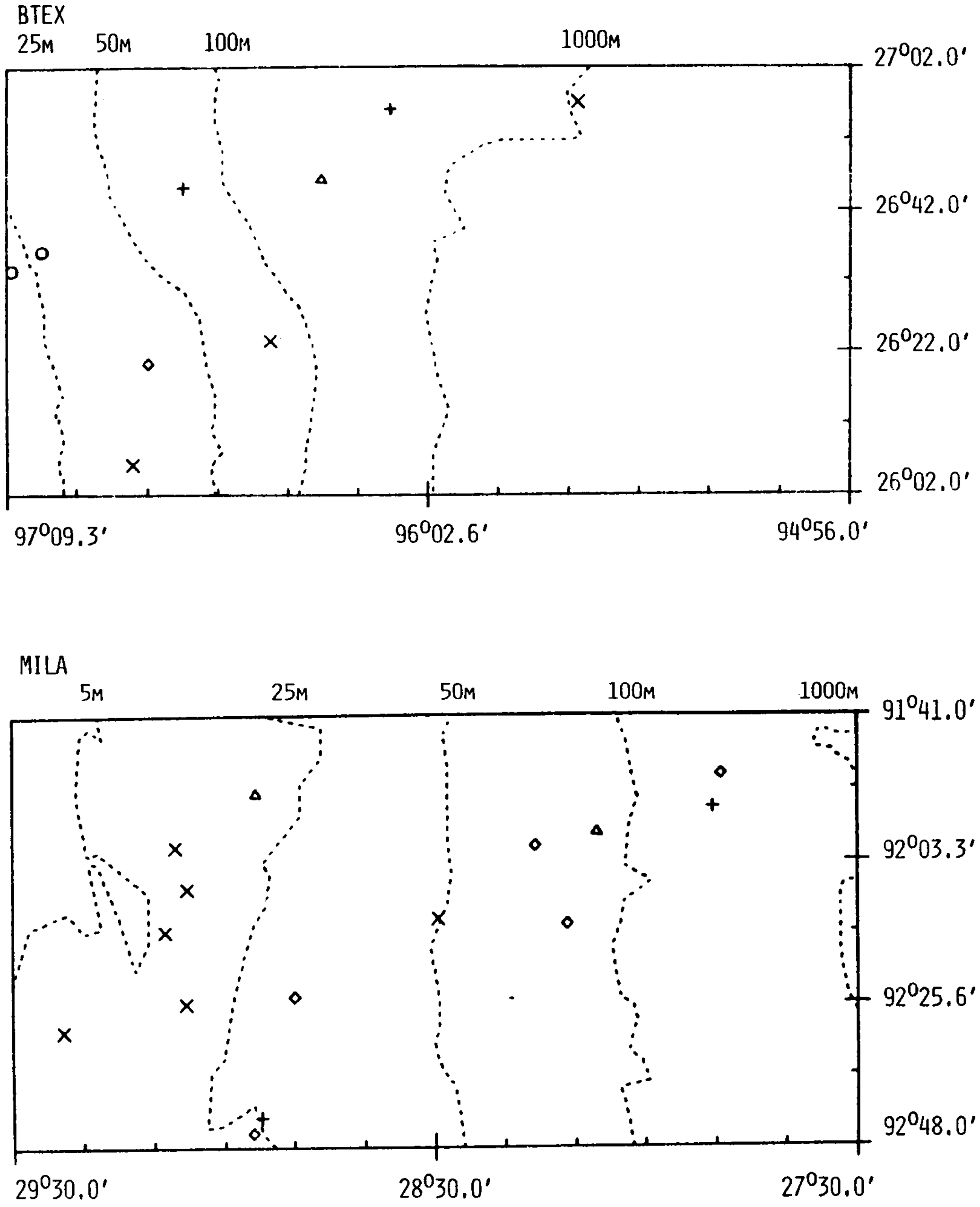


Figure 12. Distribution of all Loggerhead Turtle sightings in the BTEX and MILA survey subunits during June (O), August (X), October (△), February (◇), and April (+).

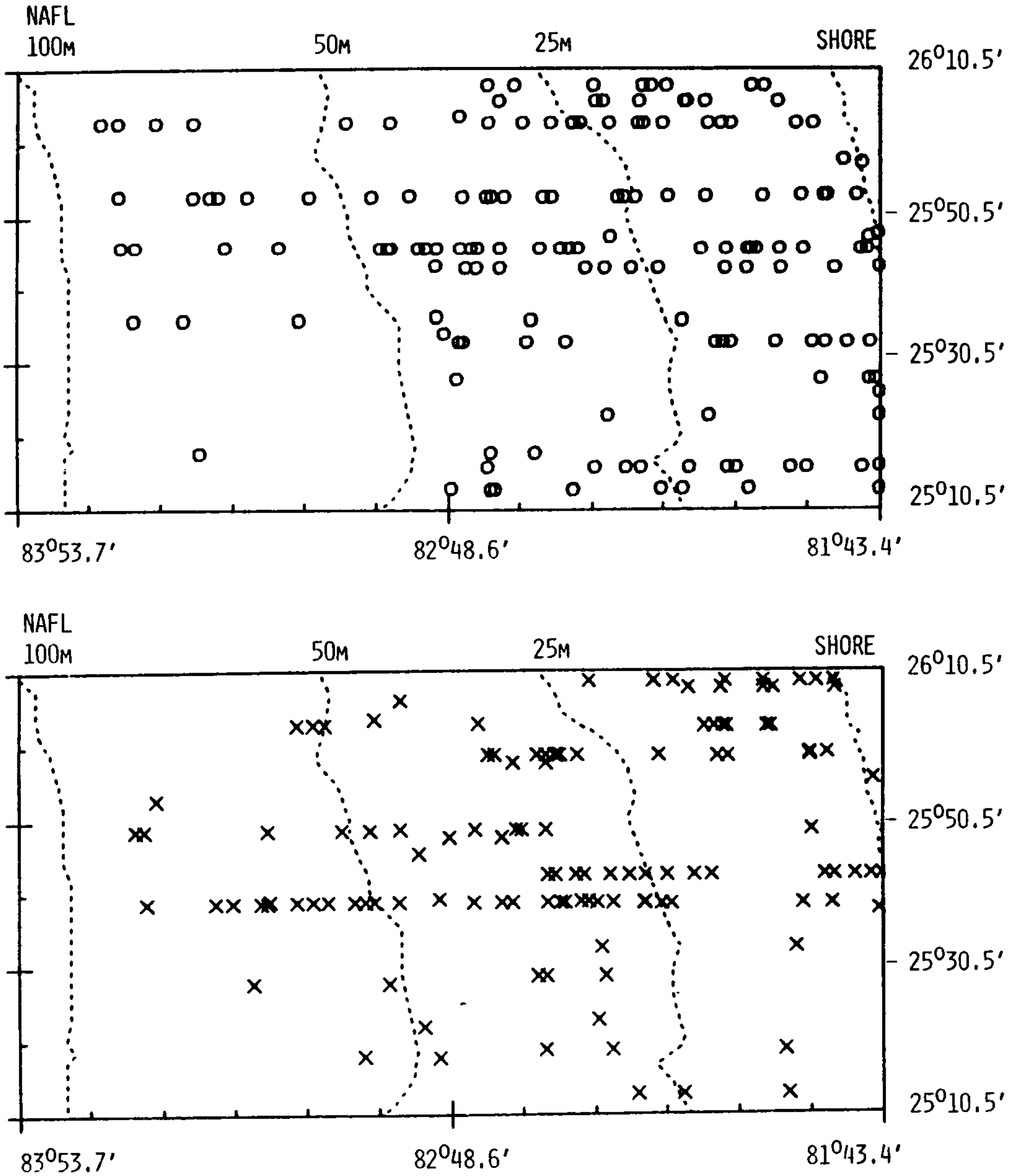


Figure 13. Distribution of all Loggerhead Turtle sightings in the NAFL survey subunit during June (O) and August (X).

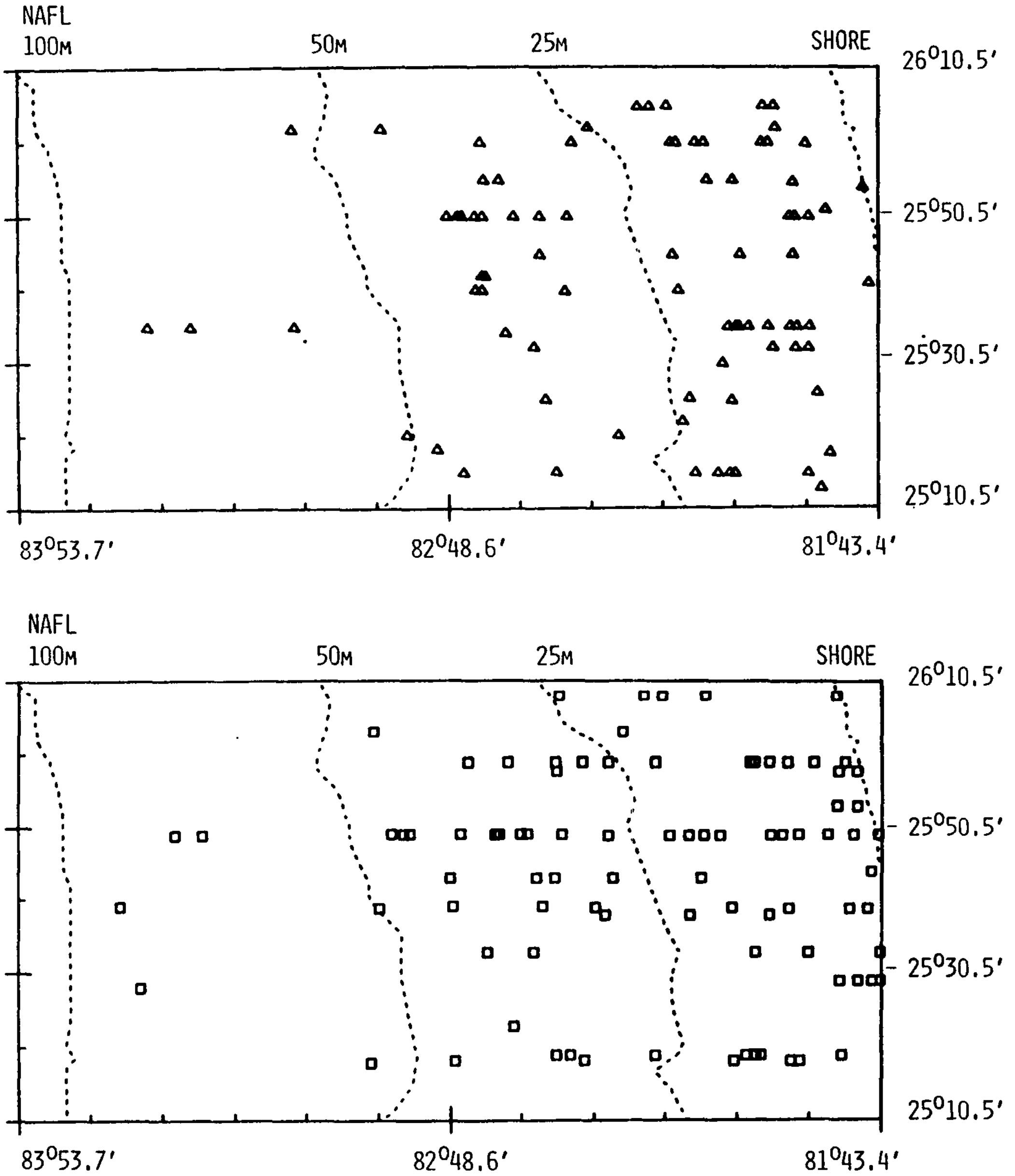


Figure 14. Distribution of all Loggerhead Turtle sightings in the NAFL survey subunit during October (△) and December (□).

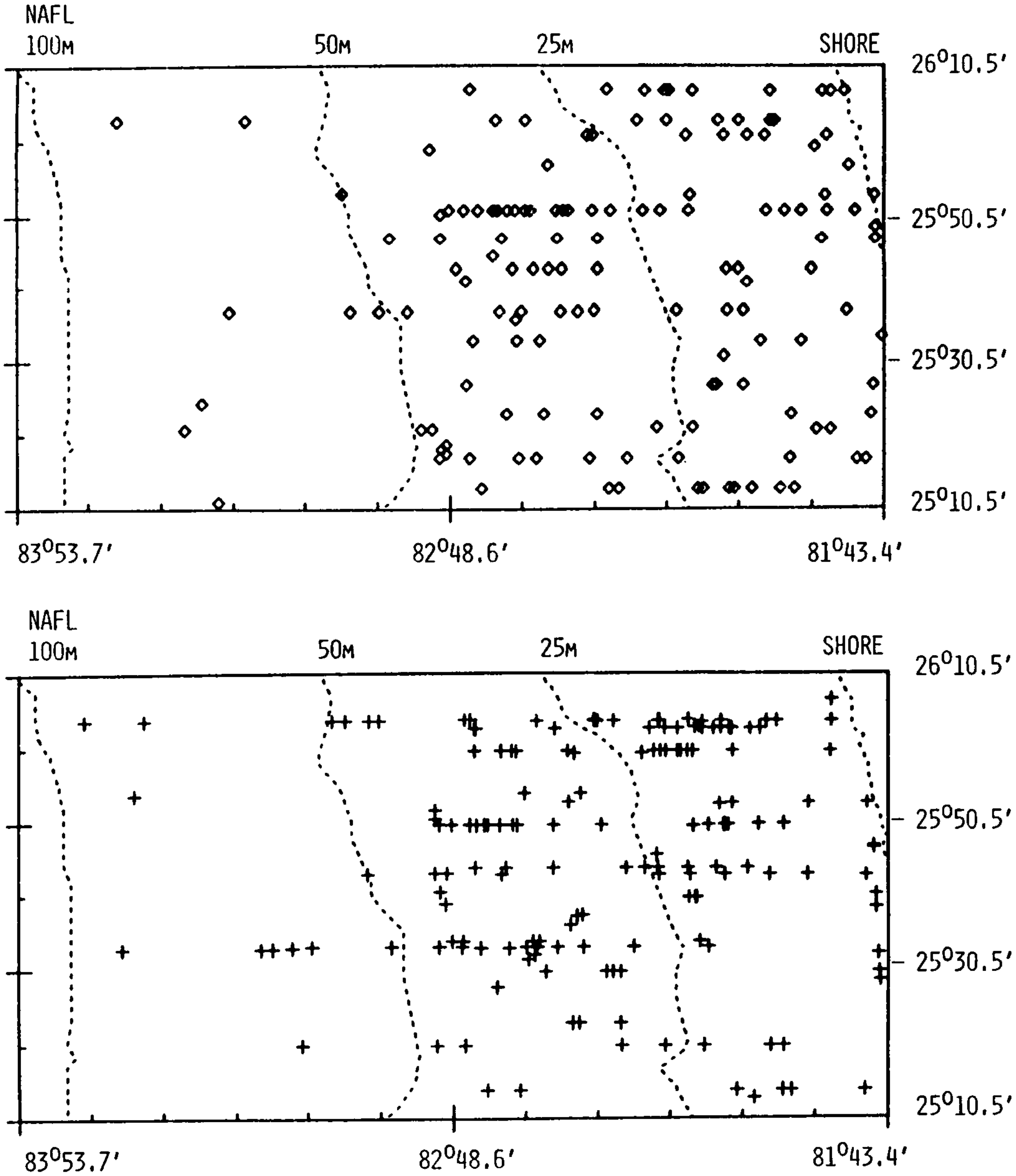


Figure 15. Distribution of all Loggerhead Turtle sightings in the NAFL survey subunit during February (◇) and April (+).

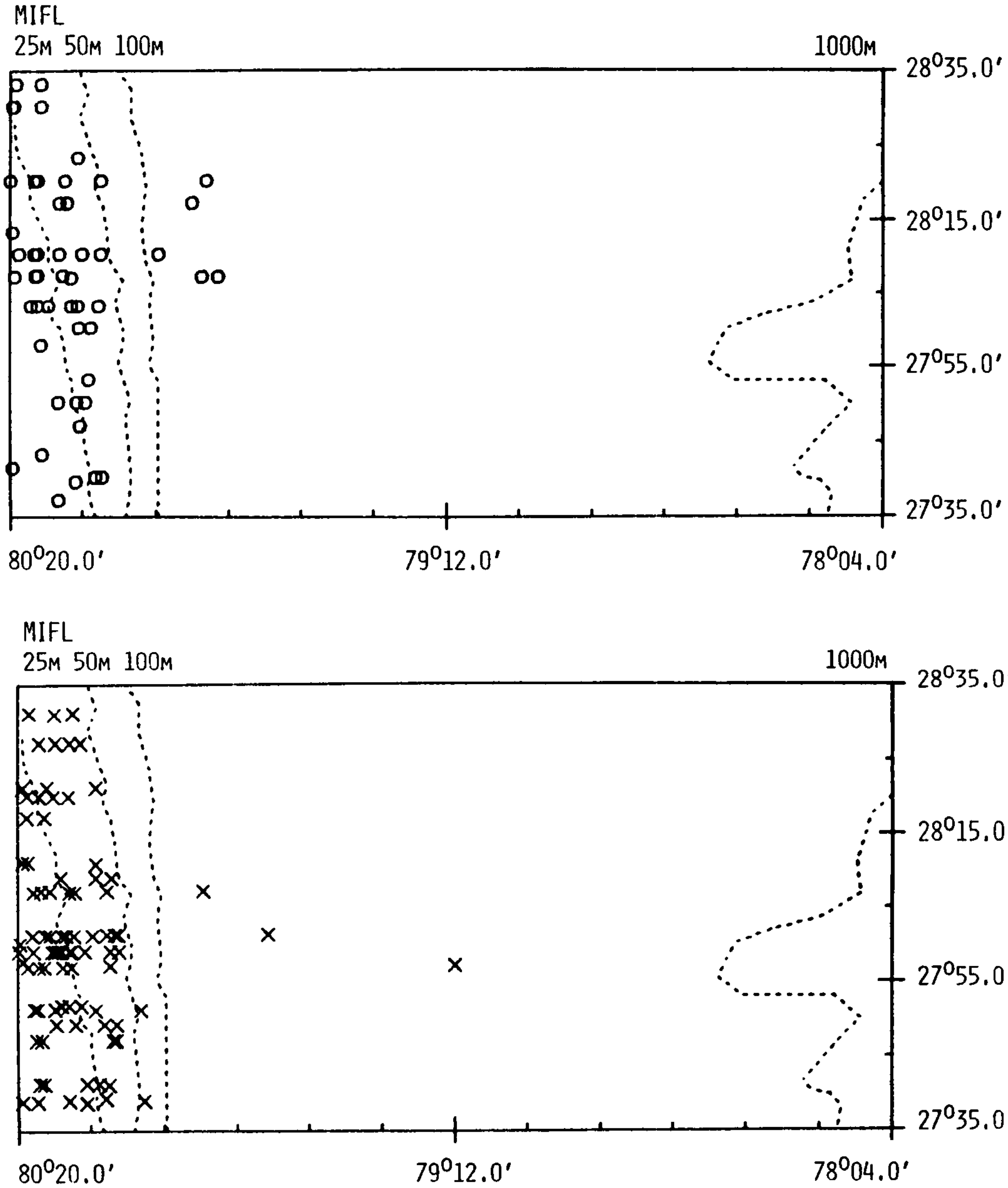


Figure 16. Distribution of all Loggerhead Turtle sightings in the MIFL survey subunit during June (O) and August (X).

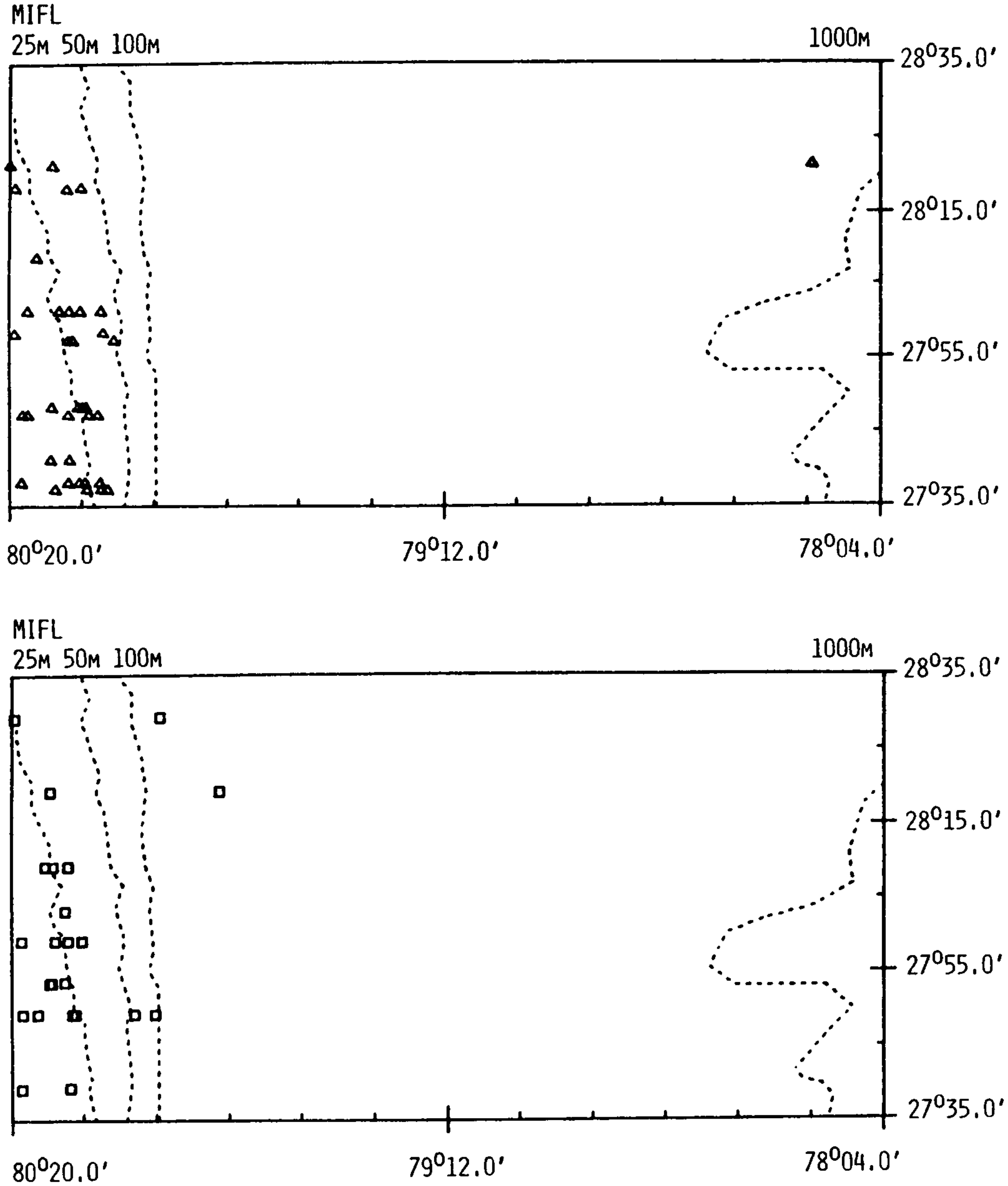


Figure 17. Distribution of all Loggerhead Turtle sightings in the MIFL survey subunit during October (△) and December (□).

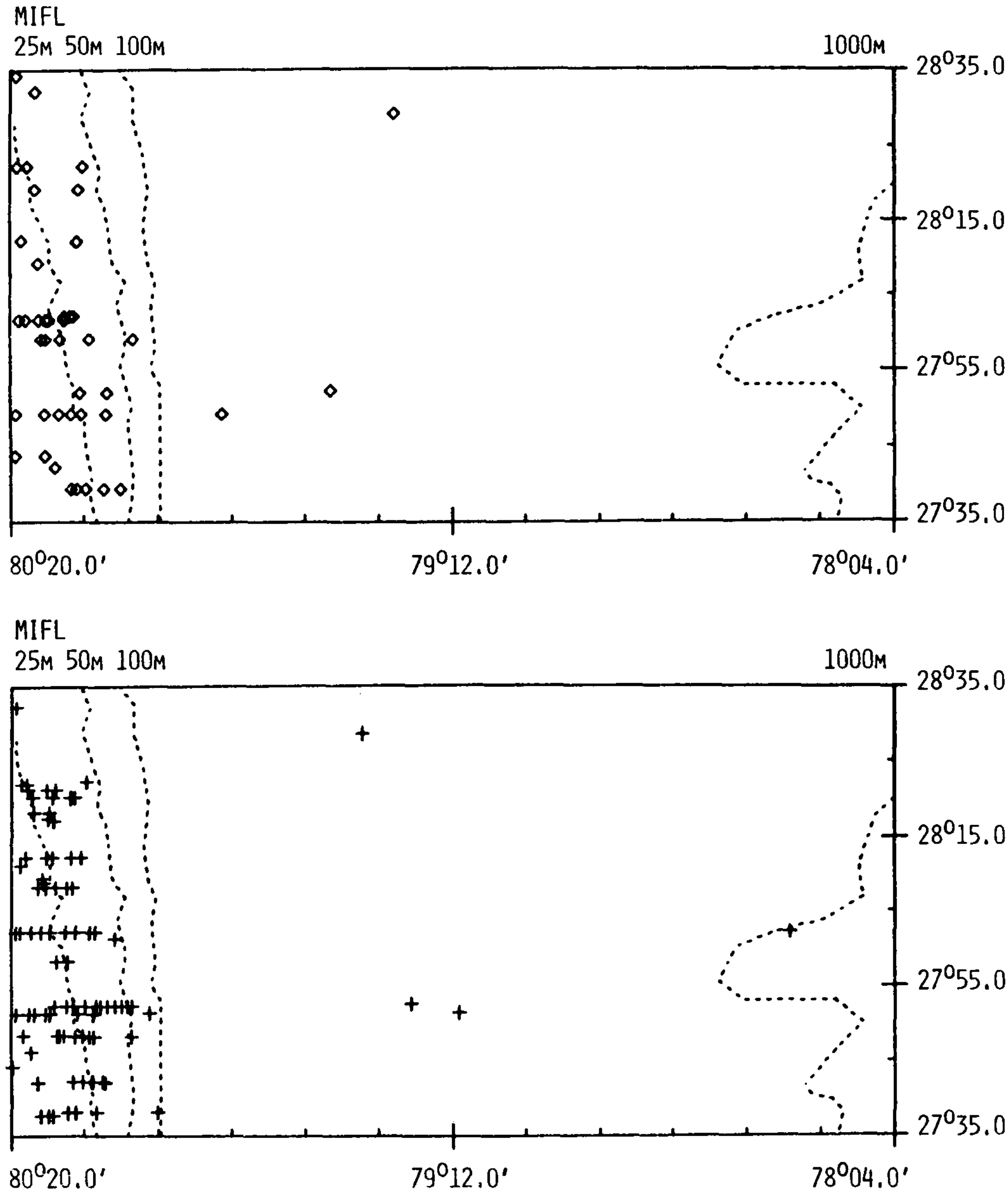


Figure 18. Distribution of all Loggerhead Turtle sightings in the MIFL survey subunit during February (◇) and April (+).

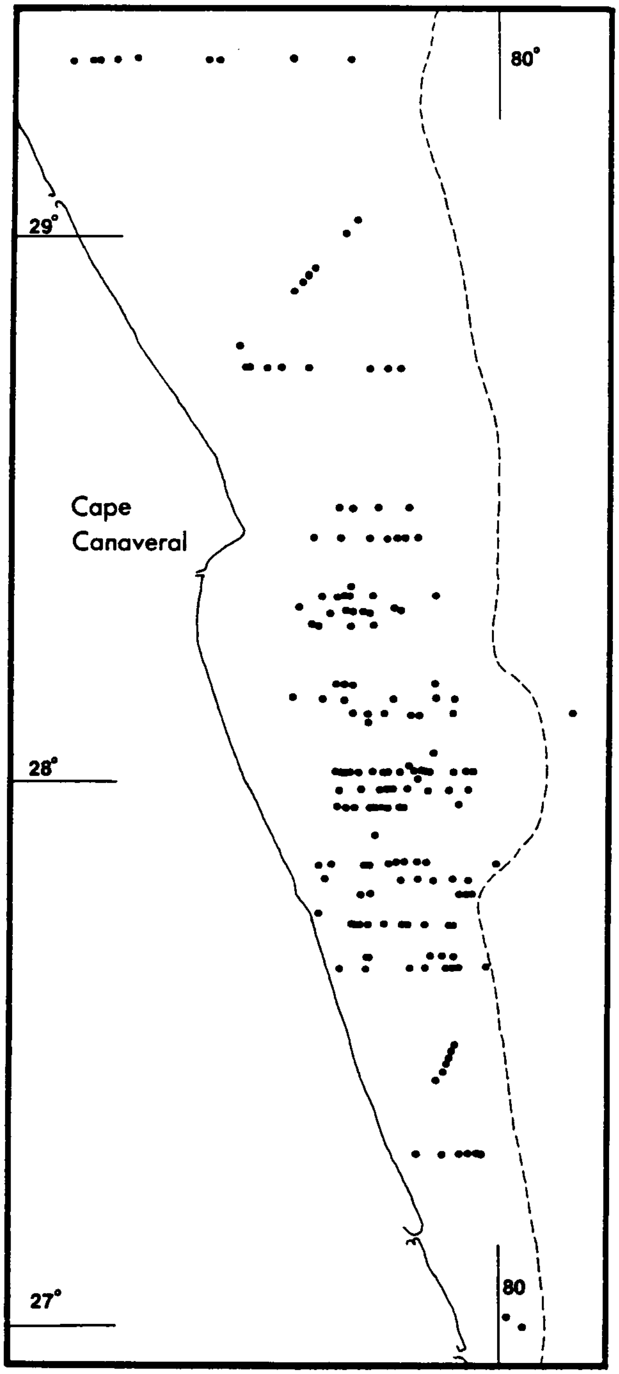


Figure 19. Distribution of Loggerhead Turtles (●) in and near the MIFL subunit in August 1980 during scheduled surveys and an opportunistic survey. Dashed line represents the western boundary of the Gulf Stream. Two turtles sighted farther east of the Gulf Stream Boundary have been omitted.

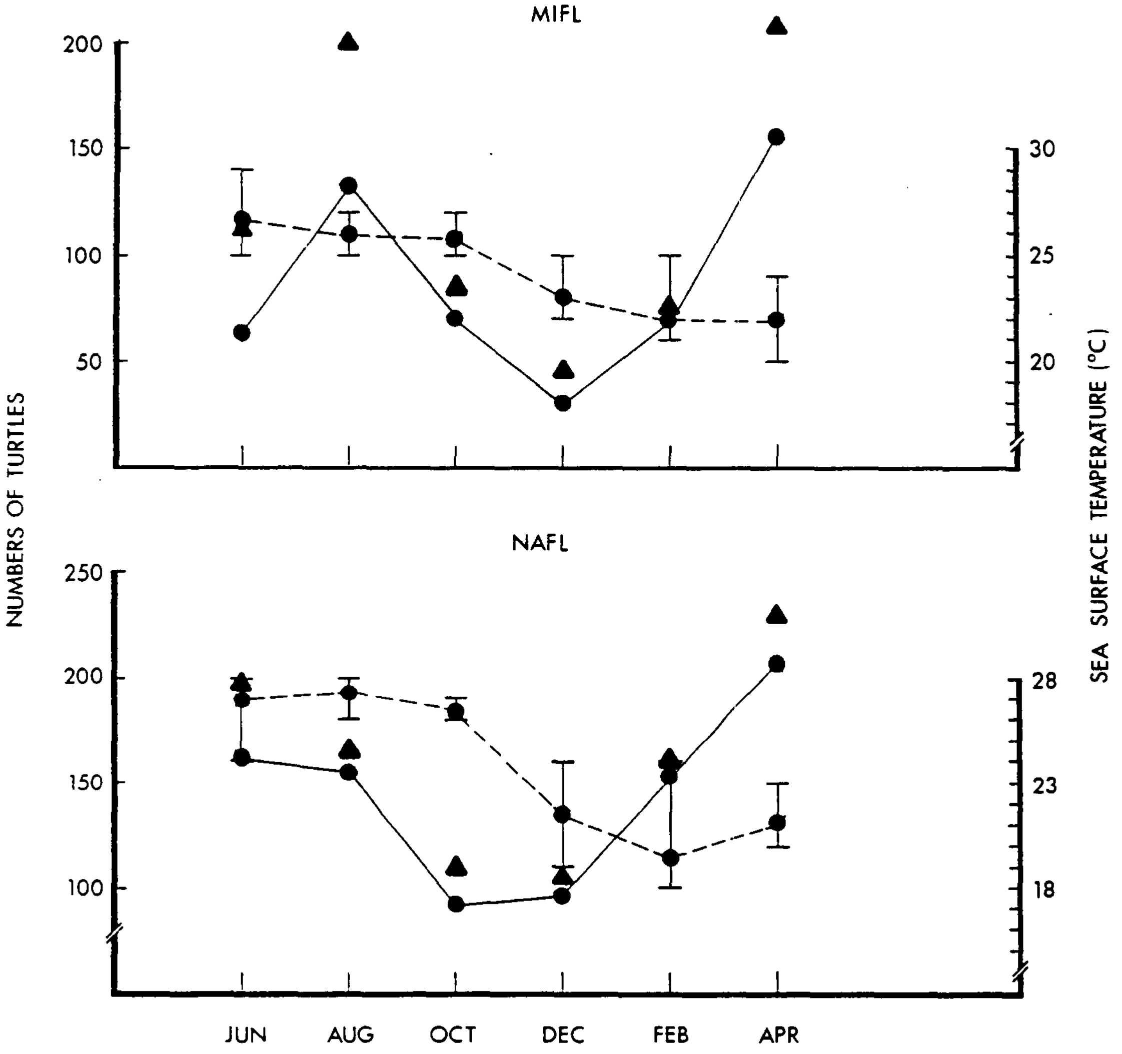


Figure 20. Relationship of sea surface temperatures (dashed lines) at sighting locations of Loggerhead Turtles and numbers of Loggerheads (solid lines) for which sea surface temperatures were available by month in the MIFL and NAFL subunits. Means (circles) and ranges (vertical bars) of temperatures are presented. Triangles represent numbers of Loggerheads in all sightings by month for each subunit.

Table 4. The number of Loggerhead Turtles sighted during this study. Dash means no survey.

	Survey subunits			
Month	BTEX	MILA	NAFL	MIFL
June	3	0	199	114
August	3	6	166	199
October	3	2	110	85
December	-	-	106	45
February	1	5	162	76
April	5	2	230	208
TOTAL	15	15	973	727

However, Carr and Carr (1977) and Pritchard (1979), without presenting data, suggested that Loggerheads migrate into Florida waters in summer where they congregate offshore for mating and nesting, particularly on the Atlantic coast. Tagging studies have indicated that at least some Loggerhead Turtles return to the same nesting beach over periods of several years (Caldwell 1962b; Richardson et al. 1978).

Abundance

Density estimates for Loggerhead Turtles were possible in the MILA, NAFL, and MIFL subunits (Table 5). In the MILA subunit, the individual density was 0.21 x 10^{-2} turtles/km^2 for combined survey months. In NAFL, individual densities ranged from 0.61 x 10^{-1} turtles/km^2 in October 1980 to 0.22 turtles/km^2 in February 1981. In MIFL, individual densities ranged from 0.23 x 10^{-1} turtles/km^2 in October to 0.76 x 10^{-1} turtles/km^2 in both August 1980 and February 1981. Nearly all of the Loggerheads sighted in the MIFL subunit were within the 50-m isobath, which comprises 12% of the total subunit. Based on this proportion, the densities of individuals were recalculated to account for only the area occupied by turtles (i.e., density/0.12). Recalculated densities for the occupied portion of the MIFL subunit ranged from 0.19 to 0.63 turtles/km^2.

The situation in the NAFL subunit is more complex. Loggerheads occupied nearly all of the subunit, but apparently were more abundant inside the 50-m isobath than in deeper waters. The 50-m isobath approximately coincides with the middle of the subunit, which demarcates the short transects from the long transects. The inshore half of the subunit was sampled three times as often as the offshore half, but even when sighting frequencies were adjusted to reflect unequal sampling effort, Loggerheads were three times as abundant in the inshore half as in the offshore half. Consequently, the original

Table 5. Density and group size estimates for on-line sightings of Loggerhead Turtles. "All" represents combined months. * = variance too small for calculations.

Survey subunit	Month	No. of sightings	Group density (groups/km^2)	Variance	Mean group size	Standard error	Individual density (turtles/km^2)
MILA	All	9	$0.21\mathrm{x}10^{-2}$	*	1.0	0.00	$0.21\mathrm{x}10^{-2}$
NAFL	June	135	0.15	$0.18\mathrm{x}10^{-2}$	1.0	0.02	0.15
NAFL	August	100	$0.82\mathrm{x}10^{-1}$	$0.13\mathrm{x}10^{-2}$	1.0	0.01	$0.82\mathrm{x}10^{-1}$
NAFL	October	63	$0.61\mathrm{x}10^{-1}$	$0.10\mathrm{x}10^{-2}$	1.0	0.00	$0.61\mathrm{x}10^{-1}$
NAFL	December	71	$0.96\mathrm{x}10^{-1}$	$0.91\mathrm{x}10^{-3}$	1.0	0.01	$0.96\mathrm{x}10^{-1}$
NAFL	February	114	0.22	$0.13\mathrm{x}10^{-1}$	1.0	0.00	0.22
NAFL	April	109	$0.70\mathrm{x}10^{-1}$	$0.67\mathrm{x}10^{-3}$	1.0	0.01	$0.70\mathrm{x}10^{-1}$
NAFL	All	592	0.14	$0.10\mathrm{x}10^{-2}$	1.0	0.01	0.14
MIFL	June	42	$0.29\mathrm{x}10^{-1}$	$0.22\mathrm{x}10^{-3}$	1.1	0.10	$0.32\mathrm{x}10^{-1}$
MIFL	August	86	$0.70\mathrm{x}10^{-1}$	$0.50\mathrm{x}10^{-1}$	1.1	0.05	$0.76\mathrm{x}10^{-1}$
MIFL	October	18	$0.21\mathrm{x}10^{-1}$	*	1.1	0.06	$0.23\mathrm{x}10^{-1}$
MIFL	February	35	$0.76\mathrm{x}10^{-1}$	$0.23\mathrm{x}10^{-2}$	1.0	0.03	$0.76\mathrm{x}10^{-1}$
MIFL	April	84	$0.53\mathrm{x}10^{-1}$	$0.99\mathrm{x}10^{-4}$	1.1	0.03	$0.58\mathrm{x}10^{-1}$
MIFL	All	265	$0.41\mathrm{x}10^{-1}$	$0.70\mathrm{x}10^{-4}$	1.1	0.02	$0.44\mathrm{x}10^{-1}$

density calculated for all months (0.14 turtles/km^2) suggests actual densities of 0.21 turtles/km^2 in the inshore half and 0.07 turtles/km^2 in the offshore half of the NAFL subunit. Adjusted densities ranged from 0.92 x 10^{-1} turtles/km^2 (inshore) and 0.31 x 10^{-1} turtles/km^2 (offshore) in October to 0.33 turtles/km^2 (inshore) and 0.11 turtles/km^2 (offshore) in February.

In surveys of the northern Atlantic, Shoop et al. (1981) calculated density estimates for Loggerhead Turtles by the Cox method. Their survey area was divided into cells, and average density/km^2 was calculated for each cell. Densities were not computed for individual survey months. Densities for cells in which Loggerheads were sighted ranged from 0.15 x 10^{-2} turtles/km^2 (variance = 0.22 x 10^{-5}) to 0.15 turtles/km^2 (variance = 0.28 x 10^{-2}). According to these data, Loggerheads generally were less dense in the northern Atlantic than in the waters off Florida.

The survey data from the MILA and BTEX subunits substantiate the scarcity of Loggerhead Turtles in the western Gulf of Mexico noted in the 1979 surveys (Fritts and Reynolds 1981); in that study, less than 1% of the Loggerhead sightings (one turtle) was near Texas. Stranding records for 1980 indicated that about three times as many turtles stranded off Florida as off Texas and Louisiana combined (Pringle 1981). However, strandings are likely to vary with intensity of fishing as well as with differences in abundance. Annual catch statistics of commerical turtle fisheries beginning in 1880 in

Texas and Louisiana (Rebel 1974) suggested a decline in numbers of turtles until the fisheries ceased operations. The small number of Loggerheads observed in the surveys in the western Gulf of Mexico point to a perilously low population that potentially reflects conflict between turtle populations and fisheries.

About 250 dead Loggerhead Turtles were stranded on the Texas coast from 1976 through 1980 (Rabalais and Rabalais 1980; Pringle 1981). The mortality of Loggerheads in Texas appears disproportionately high when compared with the low numbers of turtles observed in the surveys. This disparity between the frequencies of sightings and strandings suggests that the few turtles in waters off Texas have a much higher mortality than those in waters off Florida. Many of the turtle strandings appear to be the result of shrimp trawling activities. In Texas, an increase in Loggerhead strandings was noted along with an increase in shrimp trawling (Rabalais and Rabalais 1980). Therefore, strandings should not be used as an index of population size. However, the potential depletion of the turtle population by trawling appears likely if incidental catch and mortality are not reduced in the near future.

In 1980, about 45 Loggerheads stranded in Texas and 2 stranded in Louisiana (Pringle 1981). However, the coastline in Louisiana is less accessible and is less utilized by humans than in Texas. Thus, stranded animals may be more likely to go unnoticed in Louisiana. The survey data indicated equal numbers of Loggerheads in the BTEX and MILA subunits. Almost twice as many shrimp trawlers were seen operating in the BTEX subunit as in the MILA subunit (Table 6) suggesting that the number of strandings may be a better indication of the relative degree of trawling activity than of the abundance of turtles. Similar problems exist in comparing stranding data from the east and west coasts of Florida. Differences exist in accessibility of beaches, human use patterns, and surveillance intensity. Commercial fishing trawlers are active in Florida waters, but the trawling activity is less than in the western Gulf of Mexico (Table 6). Because of these limitations, it appears that aerial surveys are capable of providing better indices of Loggerhead abundance than do stranding frequencies.

Although Loggerhead Turtles were exploited commercially in the now defunct turtle fishery in Florida (see review by Rebel 1974), the coasts of Florida still include one of the largest populations of Loggerheads in the study area. The population of female Loggerheads nesting in Florida was estimated to be at 20,000 turtles (Carr and Carr 1977). Assuming a sex ratio of 1:1, the total mature population in Florida would include over 40,000 individuals. Loggerheads can travel between the Atlantic coast and the Gulf of Mexico (Caldwell et al. 1959), but the degree of movement between the two areas is unknown.

The greater abundance of turtles in the MIFL and NAFL subunits when compared with that in the MILA and BTEX subunits may in part be associated with the proximity to nesting beaches in Florida. Loggerhead nesting is presently uncommon in Louisiana and rare in Texas (Lund 1974; Rabalais and Rabalais 1980). However, the large numbers of Loggerhead Turtles in Florida cannot be attributed entirely to nesting. Based on aerial surveys of sea turtle tracks on Florida beaches in 1980, it was determined that the density of Loggerhead nests on the east coast was at least seven times greater than that on the western shore (Fritts 1980). Annual catch statistics of the turtle fishery in Florida (Rebel 1974) indicated relative densities similar to those in the surveys: over twice as many Loggerheads were caught on the west coast as on the Atlantic shore. The large numbers of turtles seen in the NAFL subunit is in contrast to the low level of

Table 6. The number of fishing boats (mostly shrimp trawlers) sighted during this study. Dash means no survey.

Month	Survey subunits			
	BTEX	MILA	NAFL	MIFL
June	130	109	28	34
August	473	109	30	31
October	145	142	8	49
December	-	-	54	60
February	9	30	53	80
April	41	29	109	35
TOTAL	798	419	282	289

nesting on the southwest coast of Florida. The waters near the NAFL survey subunit probably serve as a major feeding area for turtles when they are not nesting. Loggerheads tend to nest in 2- to 3-year cycles (Caldwell 1962b), and many turtles may spend the interim between nesting seasons in feeding habitats such as the Florida west coast.

In Florida, at least some of the Loggerhead Turtles undergo winter dormancy by burrowing into the mud in shallow water areas (Ehrhart 1977; Carr et al. 1980). Pritchard (1979) speculated that some Loggerheads migrate from the southeastern U.S. toward the Bahamas in the winter. Other Loggerheads may migrate to the southern Gulf of Mexico. To date, few data exist to support these hypothetical migrations. Both dormancy and a southward migration would result in lower numbers observed during fall and winter periods. The increase in numbers during spring and summer may reflect increased activity or increased abundance due to migration from other areas.

Habitat Use

The distances from shore at which Loggerhead Turtles were sighted varied between subunits (Figure 11). In the BTEX subunit, Loggerhead Turtles were seen as far out as 169 km from shore, but 67% of the sightings in the BTEX subunit (10 individuals) were within 50 km of land (Figure 12). In the MILA subunit, they ranged farther out to sea (up to 191 km), and only 33% of the Loggerheads in the MILA subunit (five turtles) were encountered in waters less than 50 km from shore (Figure 12). Loggerhead Turtles consistently ranged farther from shore in the NAFL subunit (up to 240 km offshore; Figure 11). Approximately 54% of the Loggerheads in the NAFL subunit (about 530 turtles) occurred within 100 km of the coast (Figures 13 through 15). In the MIFL subunit, Loggerhead Turtles ranged out to 227 km from the coast, but the mean distances from shore for all seasons in the MIFL subunit were lower than those for the NAFL subunit (Figure 11). In contrast to other subunits, about 98% of the Loggerheads in the MIFL subunit (709 turtles) were sighted within 50 km of land. The nearshore concentration of Loggerhead Turtles in the MIFL subunit is apparent in Figures 16 through 18.

Two-way ANOVA of distance from shore data for on-line sightings in the NAFL and MIFL subunits indicated that Loggerheads in the NAFL subunit ranged significantly farther from land and exhibited significantly greater variation in distance from shore than Loggerheads in the MIFL subunit. Newman-Keuls tests indicated the same significant results.

Loggerhead Turtles are known to wander widely throughout their range and have been sighted as far as 800 km out to sea (Murphy 1914; Ernst and Barbour 1972). However, they are encountered most often in inshore and nearshore waters (Carr and Carr 1977; Bullis and Drummond 1978; Fritts and Reynolds 1981). Loggerhead Turtles may wander between subunits. A Loggerhead tagged on the east coast of Florida was recaptured near the mouth of the Mississippi River (Caldwell et al. 1959). A Loggerhead tagged with a satellite transmitter and released in the Mississippi Delta area moved to an area off Corpus Christi, Texas (Solt 1981).

The relatively inshore and nearshore distribution of Loggerhead Turtles in the MIFL subunit was apparent throughout the scheduled surveys (Figure 11) and was confirmed during an August 1980 opportunistic survey designed specificially to investigate the phenomenon (Figure 19). The majority of turtles seen off the east coast of Florida appeared to be confined to waters inshore of the Gulf Stream. A definite temperature gradient is associated with the boundary of the Gulf Stream waters, and the turtles appeared to avoid the warm water or associated features of the current. However, Loggerheads were observed throughout a wider range of temperatures than those represented across the Gulf Stream boundary. Therefore, they probably did not avoid the current because of the temperature gradient. Loggerhead Turtles are known to associate with the continental shelf (Rebel 1974; Shoop et al. 1981) and along the Florida coast, the edge of the continental shelf parallels the Gulf Stream. Loggerhead Turtles may be selecting shallow nearshore waters of the continental shelf to feed on benthic organisms (Shoop et al. 1981), however, this does not completely explain their relative absence from the Gulf Stream near the MIFL subunit. They have been observed in waters deeper than the shallowest areas of the Gulf Stream. It is possible that at least in some months the turtles were actively avoiding the Gulf Stream current. The northbound current would transport the turtles to temperate regions characterized by seasonal temperature extremes. The few Loggerheads (about 10 turtles) sighted in or east of the Gulf Stream may have been traveling to or from the area of the Bahamas in a migratory route similar to that postulated by Pritchard (1979).

Association of Loggerhead Turtles with the continental shelf (Rebel 1974; Shoop et al. 1981) may affect the distance from shore of their sighting locations. The edge of the shelf, defined by the 200-m isobath (Ashmole 1971), bisects the BTEX subunit near the middle and the MILA subunit near the offshore (southern) boundary. The continental shelf in the MIFL subunit ends relatively close to the nearshore boundary of the subunit. In the NAFL subunit, the continental shelf extends beyond the subunit boundaries. Loggerhead Turtles can range throughout the NAFL survey subunit and still be over the continental shelf. The shelf is slightly narrower in the MILA subunit, and an even narrower shelf exists in the BTEX subunit. The distance from shore of most Loggerhead sightings was distributed proportionately in these subunits. The narrowest continental shelf is in the MIFL subunit where the distance from shore of Loggerhead observations appeared to be most restricted, but loggerheads were quite abundant in the narrow area inhabited.

Loggerhead Turtles appear to prefer relatively shallow waters. About 96% of the Loggerheads sighted in the MIFL subunit (699 individuals) were in water less than 50 m deep (Figures 16 through 18). About 93% of the Loggerheads in the NAFL subunit (906 animals) were encountered in water depths less than 50 m (Figures 13 through 15). In both the MILA and BTEX subunits, 67% of the Loggerheads in each subunit (10 turtles each) were observed in waters less than 50 m deep (Figure 12). Two-way ANOVA of water depth data (Figure 21) from the MIFL and NAFL subunits indicated that Loggerhead Turtles in the MIFL subunit were sighted in significantly deeper waters than those in the NAFL subunit. Overall, Loggerheads were observed in shallower waters in the NAFL subunit than in any other survey subunit. The maximum depths at sighting locations of Loggerhead Turtles was 121 m in the NAFL subunit, 271 m in the MILA subunit, 1,015 m in the BTEX subunit, and 1,030 m in the MIFL subunit (Figure 21). The possibility exists that the Loggerhead Turtles seen in deep waters represented migratory individuals. However, the telemetry data obtained from a Loggerhead moving from coastal Mississippi to Texas waters suggested a shallow water route of movement (Solt 1981).

The Loggerhead Turtle is omnivorous (Ernst and Barbour 1972), but prefers a carnivorous diet (Carr 1952) which centers on shellfish and mollusks (especially clams, oysters, and crabs). Since their preferred food items are largely bottom-dwelling organisms, the Loggerhead's feeding habitat may be limited by the turtle's diving ability. Loggerhead Turtles have been observed at depths of 30 m (Caldwell et al. 1955) but may be able to dive as deep as 50 to 70 m (Rebel 1974). If the turtle's sounding limit is 50 to 70 m, the need to feed in benthic situations could be responsible for the concentrations of turtles in waters less than 50 m deep. The habitat used by Loggerheads and their distribution within it probably are delimited by water depth more than distance from shore. The NAFL survey subunit included substantially more shallow water than any other subunit, which may account for the greater abundance of turtles in the NAFL subunits.

The Loggerhead's preference for shallow coastal waters suggested by the survey data is substantiated by the literature (Carr 1952; Ernst and Barbour 1972; Carr et al. 1979; Rabalais and Rabalais 1980). In a study of trawling activities, the highest numbers of Loggerhead Turtles were captured in depths less than 40 m (Bullis and Drummond 1978). In the 1979 surveys (Fritts and Reynolds 1981), almost 70% of the Loggerheads were seen in waters 50 m deep or less. The majority of Loggerhead Turtles observed in aerial surveys off the northern Atlantic coast were in waters less than 60 m deep (Shoop et al. 1981). Shoop et al. (1981) suggested that Loggerheads sighted in pelagic waters were probably in transit to other areas. The concentration of Loggerhead Turtles in shallow waters in the MIFL subunit coincides with the location of an important offshore area for scallops, oysters, and crabs on the Atlantic coast south of the Carolinas (U.S. Department of the Interior (USDOI) 1977). Several regions in Florida included in the MIFL and NAFL subunits are under review as potential critical habitats for the Loggerhead Turtle (Hynson 1979; Dodd 1978).

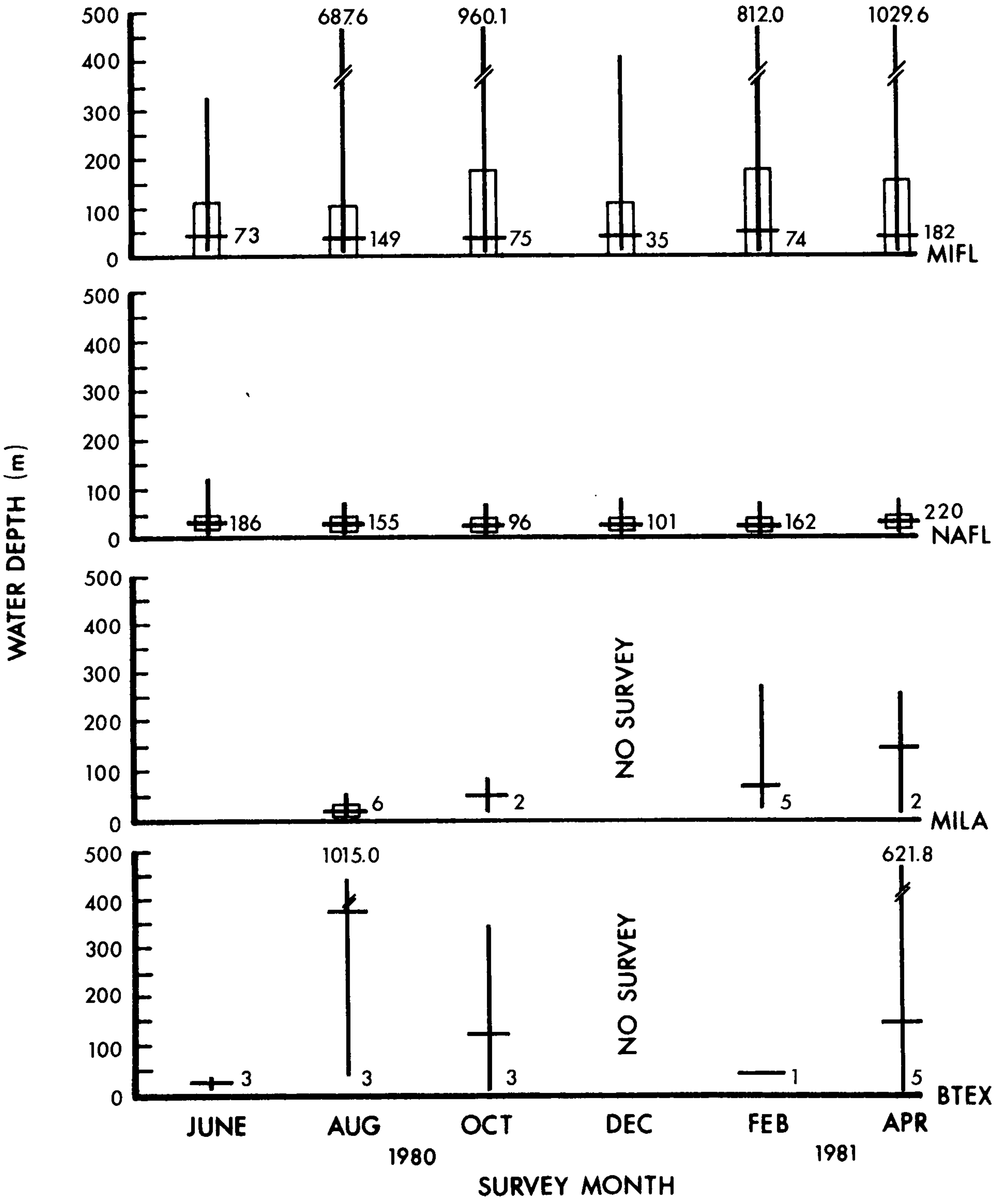


Figure 21. Water depth for all sightings of Loggerhead Turtles by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

Sea surface temperatures at sighting locations of Loggerheads in the MIFL subunit were highest in June 1980 and lowest in February and April 1981 (Figure 22). The greatest abundance of turtles was encountered in April. According to Newman-Keuls tests, the temperature data for Loggerheads in the MIFL subunit were not significantly different between February and April 1981, yet the abundance of turtles sighted in April was over twice that in February in the MIFL subunit (Figure 20). Thus, temperature did not appear to be the primary factor affecting movements of Loggerheads. The sea surface temperatures for Loggerhead sightings in the NAFL subunit (Figure 20) were lowest in February 1981 when abundance was at an intermediate level, and highest in August 1980 when abundance was only slightly higher than in February. Turtles in the NAFL subunit were least abundant in December 1980 and most common in April 1981.

Newman-Keuls tests revealed that mean temperatures at Loggerhead sighting locations in the NAFL subunit were significantly higher than those in the MIFL subunit during August and October 1980, and significantly lower than those in the MIFL subunit during February and April 1981. The relatively narrow extremes in temperatures in the MIFL subunit may be a result of a buffering effect from the Gulf Stream. Despite the temperature differences between the two subunits, the number of Loggerhead Turtles in the NAFL subunit was higher than that in the MIFL subunit during every survey month except August (Table 4). Apparently, Loggerheads were not exhibiting a temperature preference between the MIFL and NAFL subunits. Some of the Loggerhead Turtles may be migratory or dormant during the winter, but others apparently are able to tolerate the seasonal changes in temperature since the turtles were present in Florida during every survey month. As in the NAFL subunit, sea surface temperatures at locations of Loggerhead sightings in the MILA and BTEX subunits were lowest in February 1981 and highest in August 1980 (Table 7). However, temperature data for turtles in the MILA and BTEX subunits were insufficient for analyses, and relationships between temperature and abundance of Loggerheads were not apparent in those subunits. The lowest temperatures at sighting locations of Loggerhead Turtles were recorded during opportunistic surveys in North Carolina during late March (range 13° to 20° C; $\bar{x} = 16$; SD = 1.8; n = 67).

The abundance of Loggerhead Turtles in the MIFL and NAFL subunits was somewhat concordant with the seasonal changes in temperatures (Figure 20). The number of turtles declined before the decrease in temperatures during the fall, and they increased before the rise of temperatures in the spring. Possibly, turtles anticipated temperature changes related to seasons. This trend has not been described in the literature. Loggerheads seem to respond to cues other than water temperature.

In aerial surveys of the North Atlantic (Shoop et al. 1981), Loggerhead Turtles were present in the southern part of the study area year-round but were absent from the northern part during the winter. It was believed that "the gradual northward expansion of the Loggerhead range during the warmer months probably reflected utilization of food organisms as water temperatures permitted" (Shoop et al. 1981). However, this possibility may not apply to the waters off Florida and the Gulf of Mexico because they do not reflect the same temperature extremes that exist in the North Atlantic.

Although they are ectothermic animals, Loggerhead Turtles are able to thermoregulate to some extent (Mrosovsky 1980). Loggerheads can attain body temperatures 3° to 4° C higher than the surrounding water temperature (Sapsford and Hughes 1978; Sapsford and van der Riet 1979). However, Loggerheads became stunned and floated immobile at the surface when water temperatures dropped to 9° to 10° C in

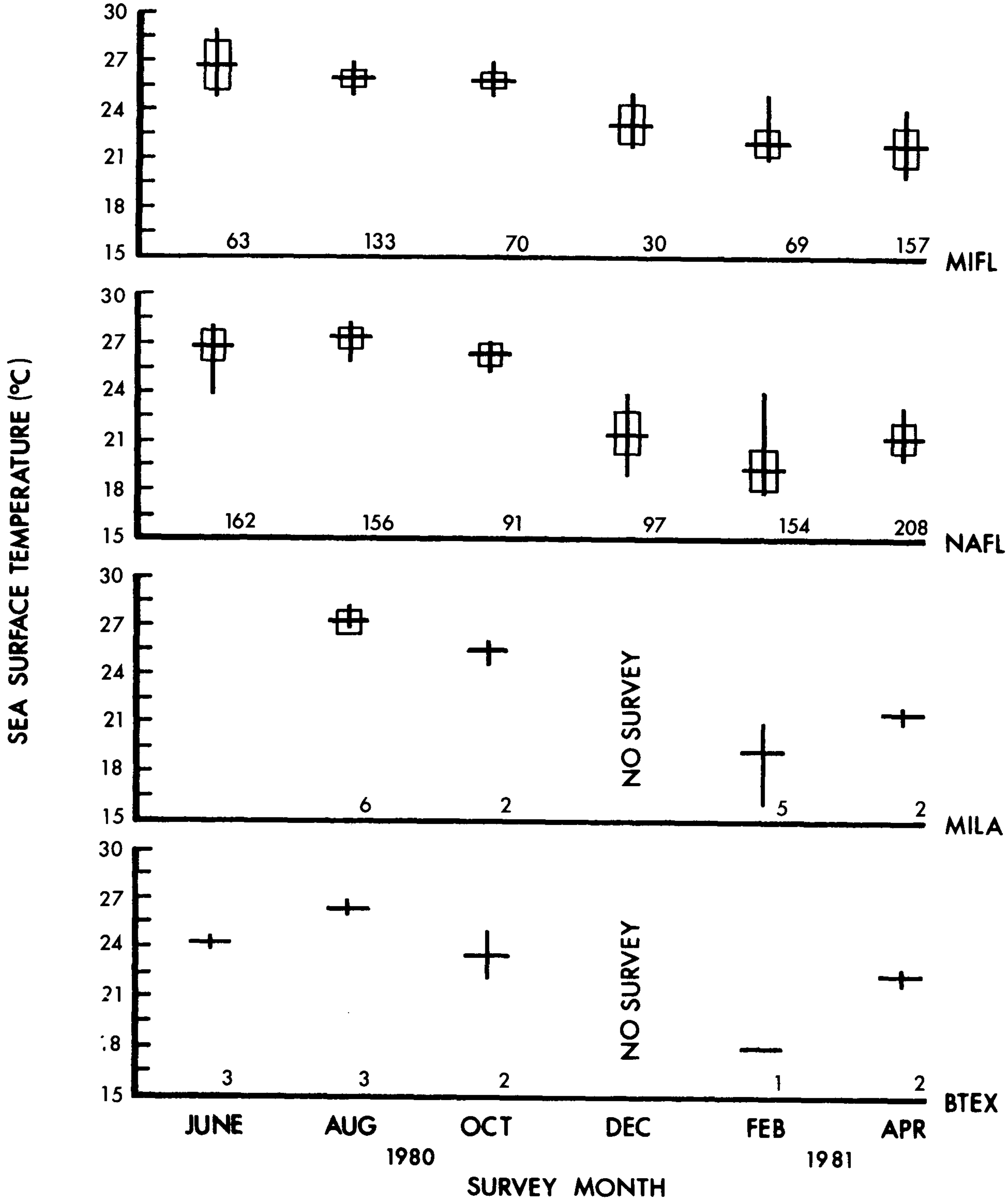


Figure 22. Sea surface temperature for all sightings of Loggerhead Turtles by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

Table 7. Sea surface temperatures (° C) of Loggerhead Turtle sighting locations by month in the BTEX and MILA subunits.

	BTEX				MILA			
	n	$\bar{x}$	SD	Range	n	$\bar{x}$	SD	Range
June	3	24	0.6	24 to 25	0			
August	3	26	0.6	26 to 27	6	27	0.5	27 to 28
October	2	24	2.1	22 to 25	2	26	0.7	25 to 26
December								
February	1	18			5	19	1.8	17 to 21
April	2	23	0.7	22 to 23	2	22	0.7	21 to 22

Florida and North Carolina (Ehrhart 1977; Schwartz 1978). Schwartz (1978) determined that Loggerhead Turtles died within 24 h during exposure to water of 4° to 5° C. Loggerheads in East Florida were found in an apparent dormant state when the water temperature was about 11° C; however, the cloacal temperatures of these turtles were 13° to 15° C, nearly identical to temperatures in the mud where they had been embedded (Carr et al. 1980). Our sighting of a Loggerhead Turtle in North Carolina at a sea surface temperature of 12.5° C was probably not unusual. Loggerheads in North Carolina have been observed in water of 12.8° C during February (Schwartz 1978).

Associations

Despite the observation of hundreds of Loggerhead turtles in the MIFL and NAFL survey subunits, only a few sightings were in the vicinity of water mass boundaries or sargassum windrows. On three occasions in the NAFL subunit, Loggerheads floating at the surface were observed to be used as perches by solitary seabirds. The birds were a Herring Gull, a Royal Tern, and a Common-group Tern.

In the NAFL subunit, Loggerhead Turtles were noted near marine mammals on three occasions. The individual associations included a single Bottlenose Dolphin, 2 *Stenella* spp., and 20 to 25 *Stenella* spp., respectively. One large aggregation of animals in the MIFL survey subunit included 3 Loggerhead Turtles, 10 unidentified dolphins, 25 unidentified pale terns, 2 Royal Terns, 2 Common-group Terns, 1 Audubon's Shearwater, 5 Cory's Shearwaters, 2 Manta Rays, a school of Cow-nose Rays, and a large school of fish. Apparently, the turtles, birds, and mammals were attracted to a feeding situation involving the fish school. Loggerheads were sighted in proximity to fish schools on two other occasions in the NAFL subunit, once in the MIFL subunit, and once in the MILA subunit. Loggerheads were observed in proximity to small sharks twice in the NAFL survey subunit.

The literature does not mention associations of Loggerhead Turtles with birds or mammals, although a Loggerhead has been found with bird feathers in its stomach (Rabalais and Rabalais 1980).

Loggerhead Turtles sometimes associate with natural and artifical reefs and outcrops as well as oil rigs (Caldwell et al. 1955; Rabalais and Rabalais 1980), probably to feed on the organisms abundant there. However, associations of turtles with structures or features on the ocean bottom were not obvious in the surveys.

Reproduction

In the MIFL survey subunit, Loggerhead Turtles were observed mating in June 1980 and April 1981. Although the sex of turtles could not always be determined, the highest incidence of male Loggerheads was encountered on the east coast of Florida. Over twice as many male turtles were identified in the MIFL subunit in April than in any other survey month (Table 8).

As observed in the surveys, Loggerhead Turtles mate at the surface of the water offshore near the nesting beaches before and during the nesting season (Caldwell et al. 1959; Ernst and Barbour 1972; Rebel 1974). In the Southeast U.S., nesting lasts from May to August (Carr et al. 1979). The most important nesting beaches for Loggerhead Turtles in North America are adjacent to the MIFL survey subunit (Carr and Carr 1977). These factors are probably responsible for the relative abundance of male turtles observed in the MIFL subunit during April 1981 in relation to the number of males in other areas.

Nesting usually occurs at night, but diurnal nesting does occur (Fritts and Hoffman in press). Several times in a season, the female Loggerhead crawls ashore and deposits an average of 110 eggs in the sand (Ehrhart 1979). Incubation lasts about 50 to 70 days (Carr et al. 1979) after which the hatchlings dig out of the sand and crawl to the ocean. The movements of hatchlings after they enter the sea are poorly known. Witham (1980) felt that "the initial post-hatchling period...is a period of oceanic existence when turtles opportunistically use oceanic currents and food resources for dispersal and survival"; however, few data are available. Loggerhead hatchlings have been found in association with sargassum rafts (Caldwell 1968; Smith 1968; Fletemeyer 1978) and may seek these rafts for shelter and a source of food organisms while in the open ocean.

Age at maturity appears to vary with growth rate (Rebel 1974; Mendonca 1981). In nature Loggerhead Turtles have been reported to be mature at a carapace length of about 79 cm (Caldwell et al. 1959). Captive Loggerheads have attained egg-laying size in 6 to 7 years (Uchida 1967).

Behavior

Loggerhead Turtles often were sighted floating at the surface of the water. Sometimes they were observed underwater or diving from the surface apparently to avoid the aircraft. Chi-square analyses indicated significant differences between numbers of Loggerhead sightings according to the hour of the day in the MIFL subunit and in the NAFL subunit. The largest number of turtles was observed about mid-day between 1100 and 1300 h (Table 9). Data from June were not included in the analyses because the aircraft had to land around mid-day for refueling; therefore, sampling during June was not evenly distributed across hours of the day.

Table 8. Number of sightings of male Loggerhead Turtles by month in the MIFL and NAFL subunits. No male turtles were identified in the MILA or BTEX subunits.

Month	MIFL	NAFL
June	2	2
August	3	4
October	5	2
December	3	3
February	8	9
April	22	5
TOTAL	43	25

Loggerhead Turtles frequently float on the surface in the open sea (Carr 1952). This behavior in Loggerheads has been described as voluntary basking and results in an increase of body temperature above the water temperature when basking in the sunlight (Sapsford and van der Riet 1979). The greatest amount of direct sunlight and the highest environmental temperatures tend to occur around mid-day when the largest number of turtles were sighted. A similar propensity for Loggerheads to be sighted at mid-day was observed in aerial surveys off the northern Atlantic coast (Shoop et al. 1981). Many turtles seen floating at the surface during surveys probably were basking.

Potential Impacts of OCS Development

Although Loggerhead Turtles may be attracted to oil rigs as artificial reefs (Rabalais and Rabalais 1980), they may be adversely affected by other aspects of OCS development. The attraction of Loggerheads to oil rigs may expose the turtles to higher concentrations of petroleum contaminants. Loggerhead nesting beaches are vulnerable to marine petroleum spills. Loggerhead eggs in sand exposed to crude oil during incubation suffer significant mortality and produce smaller hatchlings than eggs which received no exposure to oil (Fritts and McGehee 1981). Dead Loggerheads of various ages that were fouled with petroleum have stranded in Florida (SEAN 1981; R. Witham, Florida Department of Natural Resources, Jensen Beach, pers. comm.). The incidence of fouling and ingestion of oil by hatchlings, young, and adults is unknown but warrants investigation. Another cause of Loggerhead mortality is dredging (Rudloe 1981), an activity sometimes associated with OCS development. Loggerheads bearing propeller injuries (SEAN 1981) are evidence of boat collisions with turtles. Collisions are likely to become more numerous with increased boat traffic in areas where turtles are concentrated. Construction and artificial lights from urban development near Loggerhead nesting beaches have been known to disturb nesting females (Caldwell 1962b;

Table 9. Number of Loggerhead Turtles sighted by hour of the day during each survey month in the MIFL and NAFL subunits. Dash means no survey.

Month	Hour of the day										
	8	9	10	11	12	13	14	15	16	17	18
MIFL											
June	1	6	11	4	28	—	26	10	3	8	3
August	4	26	3	32	57	20	7	—	—	—	—
October	16	12	20	12	9	9	—	—	—	—	—
December	4	1	16	1	8	10	1	0	—	—	—
February	5	3	20	8	22	8	1	6	2	—	—
April	9	14	25	31	17	13	53	20	0	—	—
NAFL											
June	1	28	24	20	3	29	43	40	1	—	—
August	12	11	28	33	23	32	17	—	—	—	—
October	4	11	5	11	20	16	9	3	13	8	—
December	8	9	12	12	40	14	3	3	4	—	—
February	10	5	16	13	13	16	27	46	15	1	—
April	21	18	3	4	15	43	29	58	20	9	—

Worth and Smith 1976) and disorient the movements of the hatchling turtles (McFarlane 1963; Mann 1978). OCS development near nesting beaches could similarly affect turtles. Loggerhead Turtles are considered to be a threatened species, and the populations nesting in the southeastern United States constitute a major reproductive concentration on a worldwide scale. In contrast to other marine turtles, OCS development and incidental catch by fishing vessels are the only major threats to loggerhead populations in the southeastern United States.

Summary

Loggerhead Turtles were sighted throughout the study area in all survey subunits. Loggerheads were most conspicuous in waters off Florida and during opportunistic surveys in North Carolina. They appeared to prefer the shallow coastal waters associated with the continental shelf. Loggerheads in the MIFL subunit were largely concentrated inshore of the Gulf Stream boundary. The majority of turtles were sighted in the MIFL and NAFL subunits during spring and summer. The MIFL subunit is adjacent to the major nesting beaches, and the NAFL subunit appears to be an important feeding area for turtles not involved in the season's reproductive effort. The low numbers observed in winter may have resulted from dormancy and/or migration out of the study area.

Sea surface temperatures did not appear to influence directly the seasonal abundance of turtles. Mating Loggerheads were seen in the MIFL subunit during June and April, and the highest number of male turtles were identified in the MIFL subunit during April. These observations were probably associated with the proximity of nesting beaches and the beginning of the nesting season in May. Loggerhead Turtles often were observed floating at the surface, and the largest numbers were seen between 1100 and 1300 h. These observations suggest that Loggerheads were most active and possibly were encountered basking when temperatures were highest around mid-day. Most Loggerheads were encountered in waters less than 50 m deep, probably because their preferred diet consists of benthic organisms. Although Loggerheads may be attracted to oil rigs as artificial reefs, they are potentially vulnerable to OCS development through the effects of oil contamination on the eggs, young, and adult turtles. Dredging and boat traffic has been a cause of Loggerhead mortality, and artificial lights from OCS activities near nesting beaches may disturb nesting females and disorient hatchlings.

KEMP'S RIDLEY TURTLE, Lepidochelys kempi

Kemp's Ridley Turtle is recognized as an endangered species by the USFWS.

Description

Kemp's Ridley Turtle is the smallest of the sea turtles. When viewed from above, the carapace appears nearly round in silhouette. Adult carapace length is 50 to 70 cm (Ernst and Barbour 1972), and carapace width may be equal to carapace length. The head is wide, average 14 cm (Pritchard and Marquez 1973), and the limbs are paddle-shaped. Color of the head, limbs, and carapace of adults appears slate gray to pale gray. Young and subadults may be dark gray to black. The adult male has the conspicuously long tail characteristic of all male sea turtles, but no male Ridleys were identified in the surveys.

From an aircraft, the relatively small size, round carapace, and gray coloration are the distinctive characteristics. Adult Ridleys generally have a paler coloration than other turtles in the study area.

Distribution

Kemp's Ridley Turtles were seen in all survey subunits except MILA. The greatest abundance of Kemp's Ridley Turtles was encountered off the west coast of Florida: six turtles were seen in the NAFL survey subunit and two during opportunistic flights (Table 10). Two Ridleys were sighted in the MIFL survey subunit and an equal number in the BTEX survey subunit.

Ridley Turtles were sighted in the BTEX survey subunit during June and October 1980, and in the MIFL survey subunit during October 1980 and May 1981 (Table 10). In the NAFL survey subunit, Ridleys were encountered during August and October 1980, and in transit and opportunistic flights north of the NAFL survey subunit during December 1980 and April 1981 (Table 10). The largest number of Ridleys (six turtles) was sighted in

Table 10. Sighting information on Kemp's Ridley Turtle. Dash means no data. OPPO = opportunistic flight.

Survey subunit	Date	No. of turtles	Position (Latitude/Longitude)	Distance from shore (km)	Water depth (m)	Sea surface temperature (° C)
BTEX	29 June 1980	1	26°42.9'N/97°17.4'W	7	18	-
BTEX	31 Oct. 1980	1	26°21.0'N/96°26.4'W	73	77	-
NAFL	16 Aug. 1980	1	25°53.5'N/82°51.2'W	118	44	27
NAFL	16 Aug. 1980	1	26°04.3'N/82°59.6'W	127	44	27
NAFL	17 Oct. 1980	1	25°55.5'N/82°09.3'W	41	19	26
NAFL	17 Oct. 1980	2	25°48.7'N/81°50.8'W	17	11	26
NAFL	17 Oct. 1980	1	25°15.5'N/82°41.3'W	121	40	26
MIFL	16 Oct. 1980	1	28°18.6'N/80°25.2'W	15	12	-
MIFL	01 May 1981	1	27°58.6'N/80°20.8'W	21	17	23
OPPO	14 Dec. 1980	1	26°22.7'N/83°12.8'W	106	49	22
OPPO	30 Apr. 1981	1	28°12.9'N/84°03.0'W	124	37	22

October 1980 (Table 10). Two Ridleys were encountered in August 1980, and single turtles were seen in June and December 1980 and in May and April 1981. A relative abundance of Kemp's Ridleys in October has not been reported elsewhere.

Kemp's Ridley Turtles occur frequently along the western Atlantic shore from southern Canada to Mexico and infrequently along European coasts (Bleakney 1955; Ernst and Barbour 1972). Ridleys have been stranded or captured (captures include dead and live turtles taken by fisheries, trawls, and other nets, or during cold-stun episodes) in the vicinity of all survey subunits of the study area (Ehrhart 1977; Zwinenberg 1977; Pringle 1981). The major nesting area consists of about 15 km of beach near Rancho Nuevo, Tamaulipas, Mexico (Chavez et al. 1968a), but nesting also occurs less frequently in South Texas and in other areas of the Mexican coast (Carr 1961; Hildebrand 1963; Francis 1978). Ridleys nest from April to July (Chavez et al. 1968b). Turtles tagged near Rancho Nuevo have been recaptured off Texas, Louisiana, Florida, and as far south as the Bay of Campeche (Chavez 1969). In previous aerial surveys (Fritts and Reynolds 1981), Ridleys were reported from the BTEX survey subunit, but not off western Florida; single turtles were sighted 29 and 100 km from shore in August 1979 and 24 km from shore in November 1979. Mature Ridleys appear to remain in the Gulf of Mexico (Pritchard and Marquez 1973; Zwinenberg 1977). Most of the animals on the Atlantic coast are immature (Carr 1957, 1967). Small dark unidentified turtles observed near the MIFL survey subunit in June 1980 most closely resembled young Ridleys and were within the known range of the species. A tagged yearling Ridley released off West Florida was recaptured in Chesapeake Bay (Richard A. Byles, Virginia Institute of Marine Science, Gloucester Point, pers. comm.), demonstrating movement between the Gulf of Mexico and the Atlantic Ocean. Others released from the same site have been recovered off western Louisiana and eastern Texas.

Kemp's Ridley Turtles apparently travel along the coast throughout the study area. Pritchard and Marquez (1973) postulated that young Ridleys leaving the nesting beach are carried by currents around the Gulf of Mexico to the Florida Keys and then up the U.S. east coast as far as Canada. A few may be carried by the Gulf Stream to European waters. Most eventually migrate back to the Gulf of Mexico to Rancho Nuevo to reproduce.

Ridleys generally are found within a few kilometers of shore, supporting theories that they migrate along the coast (Carr 1961; Chavez 1969; Pritchard and Marquez 1973), but a few have been encountered well offshore. Yearling Ridleys tracked with radio transmitters off West Florida ranged up to 240 km out to sea (Timko and DeBlanc 1981). A female tagged in Rancho Nuevo was recaptured between the Dry Tortugas and the Marquesas Keys (Sweat 1968).

Stranding and capture records of Kemp's Ridleys are evidence that the range includes Louisiana waters (Liner 1954; Carr and Caldwell 1958; Chavez 1969; Pritchard and Marquez 1973; Pringle 1981). Shrimp trawling activities have been responsible for most of the captures (Carr 1961; Pritchard and Marquez 1973), and possibly for many of the strandings.

On the basis of the coastal migratory pattern proposed by Pritchard and Marquez (1973), the Ridleys observed in the MIFL survey subunit were not involved in the season's reproductive effort. Tagging studies indicated that Ridleys may travel an average of 29.5 km per day from the nesting beach (Chavez 1969). Because of the distance required to travel, it is unlikely that Ridley Turtles seen off Florida during August 1980 and April and May 1981 could have been in Rancho Nuevo for nesting during April through July of these years. The Ridley sighted in the BTEX survey subunit during June 1980 was relatively close to the nesting beach and may have reproduced during that season. Ridley Turtles seen in the Gulf of Mexico during October and December 1980 conceivably could have reached Rancho Nuevo for the 1981 nesting season. A female tagged at Rancho Nuevo was recaptured off the Florida Keys after traveling an estimated distance of 2,761 km in about 7 months (Chavez 1969). If the turtle had maintained a maximum traveling speed along the coast, it could have arrived in Florida in as little as 3 to 4 months. Therefore, turtles leaving Rancho Nuevo after the breeding season could arrive in the waters off West Florida as soon as the following October.

Abundance

All turtles were solitary animals. The numbers of sightings were too few to permit density calculations. More ridleys were seen in the NAFL subunit than any other subunit (Table 10).

Kemp's Ridleys are the most endangered species of sea turtles (Zwinenberg 1977). Less than 1,000 nesting females are estimated to survive (Pritchard and Gicca 1978) in contrast with estimates of over 40,000 that existed about 20 years ago (Carr 1963, 1967, 1977; Hildebrand 1963). The population decline has been attributed to human predation on both eggs and turtles (Zwinenberg 1977).

Carr (1957) considered the coast of West Florida as the area of "maximum abundance" of Kemp's Ridleys in the U.S. Although Carr (1957) is an old reference, our survey data also show relatively more Ridleys off West Florida than in other subunits; however, the sample size is small. The Crystal River-Cedar Key region of West Florida was once the site of a commercial turtle fishery which regularly included Ridleys in its catch (Carr and Caldwell 1956). From catch statistics, that Ridley population was estimated to be 3,750 turtles (Carr and Caldwell 1956). However, the number of Ridleys in Florida has declined markedly since then (Carr and Carr 1977).

The absence of Ridley sightings in the MILA survey subunit seems unusual. Occasional records of Ridley strandings and captures in Louisiana waters are available (Liner 1954; Carr and Caldwell 1958; Dobie et al. 1961; Chavez 1969; Pritchard and Marquez 1973; Pringle 1981). A partial explanation of the lack of sightings may be that the water in the MILA survey subunit was generally muddy within 60 km of shore. Because Ridley coloration is a dull grey or green, the turbidity in the MILA survey subunit may have hampered sightings.

The dearth of Ridley Turtles in the BTEX survey subunit observed in this study and by Fritts and Reynolds (1981) is noteworthy, particularly during the nesting season. The BTEX survey subunit is the closest subunit to the nesting beach in Mexico (within 400 km), and South Texas has been the site of Ridley nesting on rare occasions (Hildebrand 1963; Francis 1978). Ridley Turtles could be expected to be more abundant near known nesting sites.

The fact that Ridleys were sighted more frequently in waters off Florida than off Louisiana and Texas but strand less frequently on the coast of Florida suggests that this turtle has a higher mortality rate in the western Gulf of Mexico. Shrimp trawling activity, which is responsible for many sea turtle strandings, appears to be more common in the western Gulf of Mexico than in the waters off Florida (Table 6).

The stranding and capture records (Liner 1954; Carr and Caldwell 1956; Carr 1961; Dobie et al. 1961; Chavez 1969; Rabalais and Rabalais 1980; Pringle 1981) indicated that Ridleys were most often encountered in the late spring and summer. Although the data are tenuous, the lack of Ridley sightings in the February surveys suggests that they may have been absent from the study area in winter. However, they may have been present but embedded in the mud below the water. A decline in turtle abundance during winter was apparent in the turtle fishery in West Florida, and it was suggested that the turtles buried themselves in the mud and became dormant in the winter (Carr and Caldwell 1956; Pritchard and Marquez 1973). Winter dormancy of Kemp's Ridleys near the MIFL survey subunit was evident when turtles were found with mud on their backs (Ehrhart 1977; Carr et al. 1980). Kemp's Ridley Turtles also appear to occur seasonally in the western Gulf of Mexico: strandings and captures of Ridleys in both Louisiana and Texas have not been recorded during January or February (Liner 1954; Dobie et al. 1961; Chavez 1969; Rabalais and Rabalais 1980; Pringle 1981).

Habitat Use

Ridleys were observed the greatest distance from land off the west coast of Florida (Table 10). In the NAFL survey subunit (Figure 23), Ridleys were sighted 17 to 127 km out to sea ($\bar{x}$ = 73 km; SD = 54.0; n = 6). In transit and opportunistic flights off West Florida, a Ridley Turtle was encountered 124 km off of Tarpon Springs, and another was

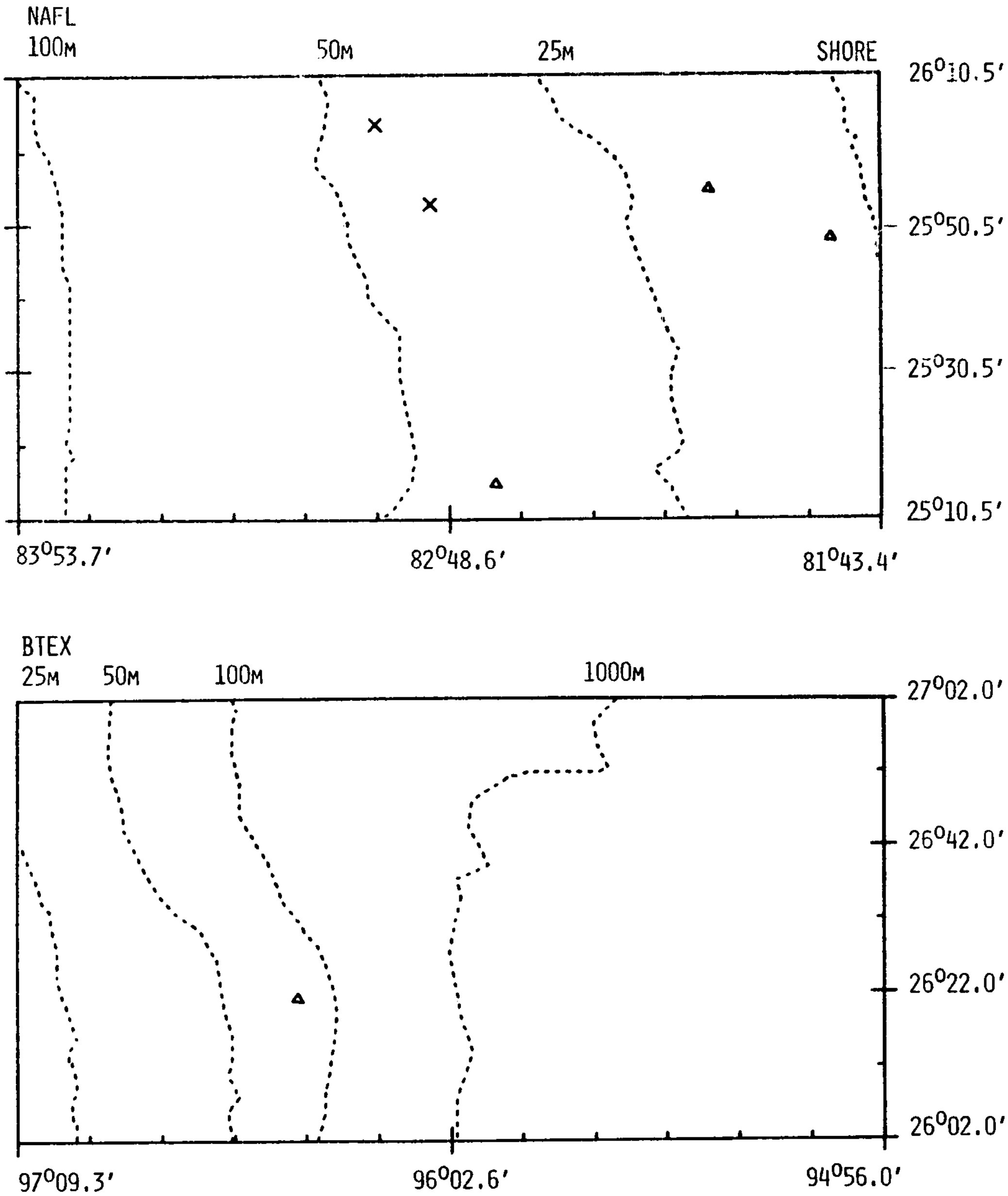


Figure 23. Distribution of all Kemp's Ridley Turtle sightings in the NAFL and BTEX survey subunits during August (X) and October (△).

sighted 106 km from shore about 22 km north of the NAFL subunit boundary. A total of two Ridleys in the MIFL survey subunit were sighted 15 and 21 km from the coast. In the BTEX survey subunit (Figure 23), Ridleys were observed at 7 and 73 km from shore. All sightings of Kemp's Ridley Turtles were over the continental shelf.

The water at Kemp's Ridley sighting locations ranged from 11 m (the NAFL survey subunit) to 77 m (the BTEX survey subunit) in depth (Table 10). The average sighting location depth in the NAFL survey subunit, where most observations occurred, was 28 m (range 11 to 44 m; SD = 16.2; n = 6; Table 10). In the MIFL survey subunit, Ridleys were seen in water with depths of 12 and 17 m. During opportunistic flights off west Florida, they were observed in water with depths of 37 m and 49 m (Table 10). The young seen in June near the MIFL survey subunit were in coastal waters near the surface. A preponderance of Ridleys in Florida are immature (Carr 1957, 1967). This suggests that waters off Florida may be a "developmental habitat" (Carr and Carr 1977) in which Ridleys spend their subadult years.

Kemp's Ridley Turtles appear to prefer shallow water (Carr 1952, 1957; Chavez 1969; Ernst and Barbour 1972). Except for one sighting in the BTEX survey subunit, all Ridleys were observed in waters less than 50 m deep. During the 1979 aerial surveys (Fritts and Reynolds 1981), one Ridley Turtle was reported in water 409 m deep in the BTEX survey subunit, but the other two were in water 31 m. Ridleys are mostly bottom-feeders (Ernst and Barbour 1972). Their diet consists largely of crustaceans and mollusks, as well as jellyfish and fish (Pritchard 1979). The coastal areas of the Gulf of Mexico, particularly around Louisiana, have been cited as important feeding grounds (Ernst and Barbour 1972; Pritchard and Marquez 1973; Zwinenberg 1977). Ridleys also seem to concentrate near mangrove shorelines around the Florida Keys and shallow water flats off West Florida, such as in the NAFL survey subunit (Carr 1952, 1957; Carr and Caldwell 1956).

Sea surface temperatures at sighting locations ranged from 22° to 27° C ($\bar{x} = 25$; SD = 2.1; n = 9; Table 10). Relationships between sea surface temperature and abundance of Ridley Turtles were not apparent in the survey data.

Kemp's Ridleys have been found with Loggerhead Turtles in an apparent state of winter dormancy in water of 11° C in Florida; however, the cloacal temperatures of these turtles were 13° to 15° C, the same temperatures of the mud in which they were buried (Carr et al. 1980). Dormant periods in the mud may be an adaptive response to avoid cold shock. In water temperatures of 10° C or less, Ridleys have become stunned and floated immobile at the surface (Ehrhart 1977; Schwartz 1978). Ridley Turtles died within 24 h during exposure to water temperatures of 5° to 6° C (Schwartz 1978).

Associations

In the NAFL survey subunit during October 1980, a Kemp's Ridley was observed near a school of jellyfish, a known food item in the diet of Kemp's Ridley (Pritchard 1979).

Reproduction

Mating takes place offshore of the nesting beach. Ridleys tend to nest in aggregations called arribadas (Spanish for "arrival"). Sporadic nesting occurs in Texas, but arribadas of Kemp's Ridley Turtles apparently occur only on the beach near Rancho Nuevo in Mexico. Ridley nesting characteristics have been described by Hildebrand (1963), Carr (1967), Chavez et al. (1968a, 1968b), and Pritchard and Gicca (1978). About 20 years ago, as many as 40,000 Kemp's Ridleys would nest in a single day, but now arribadas of more than 150 turtles in a day are rare.

About three times a season, the female crawls ashore and deposits an average of 110 eggs in the sand (Chavez et al. 1968b). Incubation time is about 50 days (Pritchard and Gicca 1978), after which the hatchlings crawl out of the sand and into the sea. Efforts to supplement the nesting population in Texas by transporting eggs and hatchlings from Rancho Nuevo have been under way since 1968 (Francis 1978). Age at maturity in Ridleys may depend on growth rate. Apparently, the carapace of a mature Kemp's Ridley is at least 58 cm long and the turtle is at least 5½ years old (Marquez 1972).

Behavior

Kemp's Ridleys were observed swimming or floating at the surface. Basking has not been described for Kemp's Ridley but has been reported for Loggerheads (Sapsford and van der Riet 1979) and Green Sea Turtles (Balazs 1980; Fritts 1981b).

Potential Impacts of OCS Development

The highly endangered status of the species makes the population especially sensitive to potential impact of OCS development. Since Kemp's Ridleys nest primarily in one small area in Mexico, their reproductive efforts are more vulnerable to the effects of a marine oil spill than those of any other species of sea turtle. Fresh crude oil can cause significant mortality in marine turtle eggs (Fritts and McGehee 1981). The nesting beach at Rancho Nuevo received oil from the IXTOC blowout in 1979. However, the oil arrived after the nesting season ended, and apparently had weathered to a nontoxic state before the next nesting season began in 1980 (Fritts and McGehee 1981).

The Ridley's preference for coastal areas may increase the likelihood of contact with oil spills. Ridleys in a state of winter dormancy also may be vulnerable to being fouled or caught in dredging activities in harbors or channels used as OCS development staging areas. Like other marine turtles, Ridleys are subject to collisions with boat traffic.

Summary

Twelve individuals of the endangered Kemp's Ridley Turtle were sighted in nearshore areas (< 50-m deep) in the MIFL, NAFL, and BTEX survey subunits, and during opportunistic flights off West Florida. Ridleys are known to occur throughout the study area, including Louisiana, although they were not sighted in the MILA survey subunit. They were most abundant in the NAFL survey subunit during October 1980. Migration to and from the nesting beach in Mexico appears to occur along the coasts of the Gulf of Mexico. Ridleys were not seen during winter months and may enter into a state of winter dormancy. Ridleys may be impacted by dredging activity during winter dormancy. The coastal areas of the Gulf of Mexico are important feeding grounds, and shallow water flats off West Florida appear to be a developmental habitat for immature Ridleys. The concentration of nesting on one beach in northern Mexico makes Kemp's Ridley particuarly vulnerable to the effects of marine oil spills.

LEATHERBACK TURTLE, *Dermochelys coriacea*

The Leatherback Turtle is listed as an endangered species by the USFWS.

Description

The Leatherback Turtle is the largest and most easily identifiable of the sea turtles. The carapace is shield-shaped and has seven prominent ridges running from its leading margin back toward its posterior tip. The carapace and extremities are covered with smooth skin and lack scutes. The Leatherback is generally black above and variably marked with small pale spots. Ventrally it is white and variably mottled with black. The front flippers are greatly elongated.

From the air, Leatherback Turtles were recognized by their elongate, ridged carapace and by their extremely long front flippers. The carapace appeared charcoal gray or dark muddy brown, and on some individuals the head and front flippers appeared uniform pale gray.

Distribution

Leatherback Turtles were observed in all survey subunits except BTEX (Figures 24 and 25). They were seen only during April in the MILA subunit, during all months except February and April in the NAFL subunit, and during all months but June in the MIFL subunit. In addition, 13 Leatherback Turtles were sighted on opportunistic flights: in the northeastern Gulf of Mexico, west of the Dry Tortugas, north of the MIFL subunit off the Atlantic coast of Florida, off South Carolina, and off North Carolina.

The absence of Leatherback sightings in the BTEX survey subunit is surprising. Gunter and Hildebrand (1951) reported a large Leatherback Turtle washing ashore inside Copano Bay, Texas, in February 1951. Leary (1957) reported about 100 Leatherbacks apparently feeding on jellyfish in the surf north of Port Aransas. This location is about 100 km north of the subunit. Pritchard (1976) reported a Leatherback Turtle tag recovery during August 1973 off Freeport, Texas, about 200 km north of the survey subunit, and another from the Bay of Campeche, a few hundred kilometers to the south.

During scheduled surveys, a total of 23 turtles were recorded in the MIFL subunit during the following months: June (0), August (11), October (1), December (2), February (4), and April (5). Seven others were seen on opportunistic flights in the MIFL subunit during August. The nine Leatherback Turtles recorded in the NAFL subunit were seen during the following months: June (3), August (1), October (2), and December (3). Two Leatherback Turtles were seen in the MILA subunit during April.

Outside of the survey subunits, observations of individual turtles were widely scattered: northeastern Gulf of Mexico (2), west of the Dry Tortugas (1), north of the MIFL subunit off the Atlantic coast of Florida (1), off South Carolina (1), and off North Carolina (1).

The apparent concentration of observations in the MIFL subunit during August suggests that density may be much higher in this period, but the small sample size prevents calculations of a seasonal density estimate.

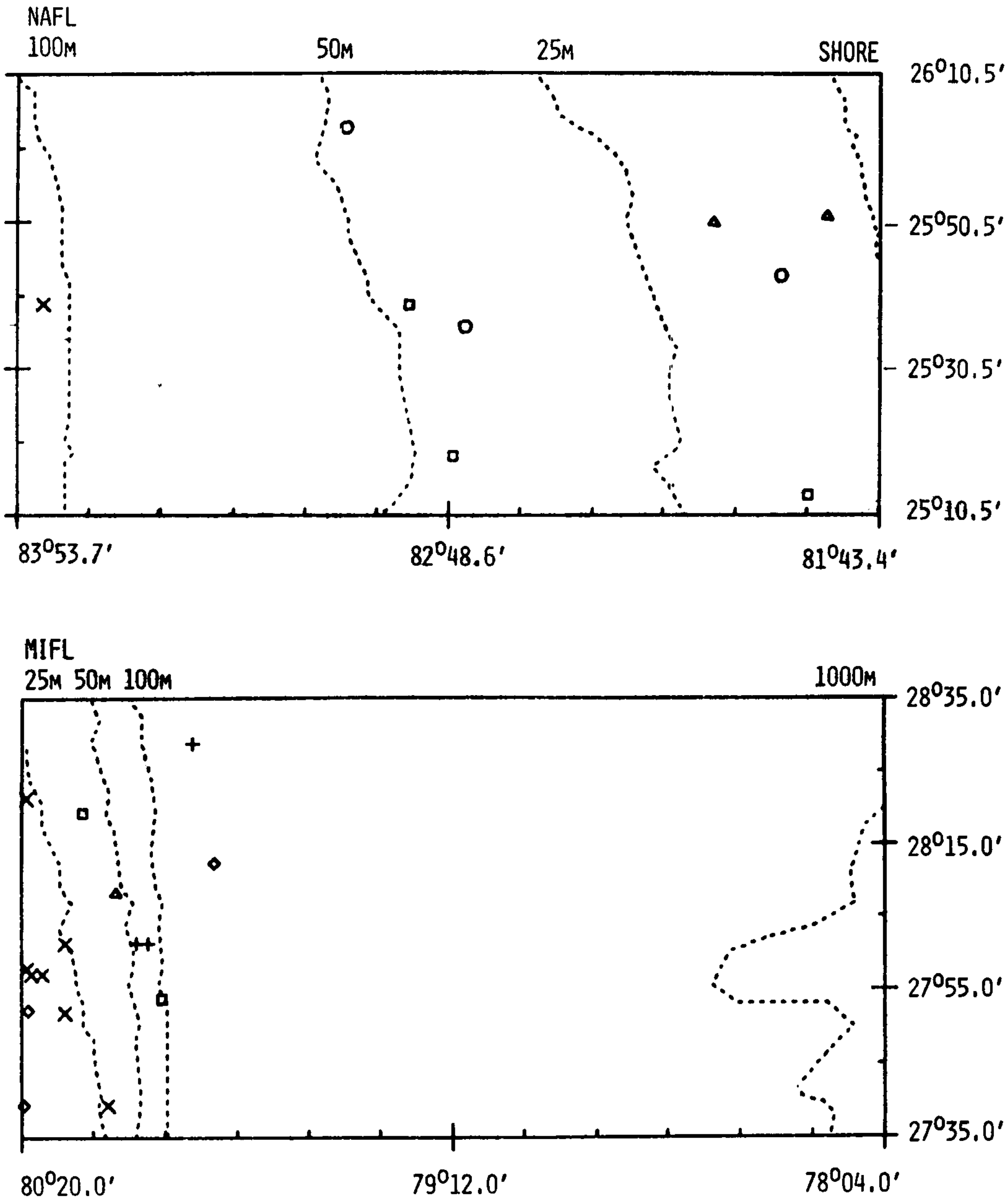


Figure 24. Distribution of all Leatherback Turtle sightings in the NAFL and MIFL survey subunits during June (O), August (X), October (△), December (□), February (◇), and April (+).

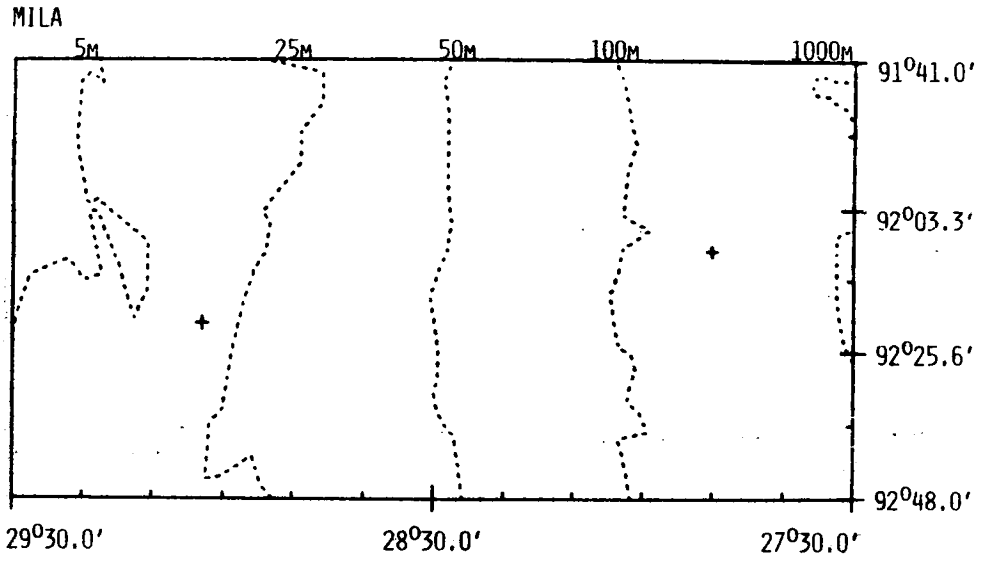


Figure 25. Distribution of all Leatherback Turtle sightings in the MILA survey subunit during April (+).

The April 1981 sightings in the MILA subunit may have been the result of a substantial spring movement onto the Louisiana continental shelf. In late May and early June 1981, we examined three carcasses of D. coriacea on beaches in southwestern Louisiana. They were apparently victims of shrimp trawling.

Leatherback Turtles have a pantropical breeding distribution, but they range far into temperate and subarctic waters during summer. Except as noted the following summary of breeding distribution is largely from Pritchard (1979). In the Caribbean, colonies are known on the shores of Costa Rica, Colombia, Surinam, French Guiana, and Trinidad. Scattered nesting occurs elsewhere, including the Atlantic (Caldwell et al. 1955) and Gulf (Yerger 1965) coasts of Florida. Leatherback Turtles also nest on the coast of West Africa at least from Senegal to Angola; in the Indian Ocean on beaches of Tongaland (Natal province of South Africa), Sri Lanka, Malasia, and New Guinea, and in the eastern Pacific from Baja California (Fritts et al. in press) to Ecuador or perhaps Peru. Major rookeries are rare, and dispersed nesting is common in this species. Pritchard (1971) estimated the world population of breeding females at 29,000 to 40,000. Recently, Pritchard (1981) updated the estimate to 104,000 breeding females after the discovery of major nesting beaches on the Pacific coast of Mexico.

Leatherback Turtles wander widely and may regularly migrate long distances (Pritchard 1976; Lazell 1980). In the Atlantic, they occur regularly north to Nova Scotia (Lazell 1980), and east as far as western Europe (Brongersma 1969). They have been found as far north as Labrador and even the Barents Sea (Threlfall 1978; Bannikov et al. 1971, cited by Lazell 1980). Pritchard (1976) reported six recoveries of female Leatherback Turtles tagged in the Guianas. Five had traveled more than 5,000 km (1 to

West Africa, 2 to the Gulf of Mexico, and 2 to the eastern seaboard of the United States). Similar migrations are suspected in the Indian, Pacific, and South Atlantic Oceans (Pritchard 1971, 1979).

Abundance

Due to the low number of sightings, density estimates were only possible by grouping all seasons for the MIFL subunit. In this subunit, density was calculated at 0.32×10^{-2} turtles/km^2 (n = 8), but a meaningful variance was unavailable. Leatherback Turtles were only sighted in the western 16% of this subunit. Thus, the actual density would be nearly six times the calculated figure (i.e., 0.2×10^{-1} turtles/km^2) in the portion of the MIFL subunit where the turtles occurred. This is a surprisingly high density estimate, but it is supported by the prevalence of Leatherback Turtles in close proximity to shore in the MIFL subunit (Figure 10).

The 47 turtles seen were recorded in 44 sightings. Sightings of more than one individual occurred in only two instances, and were judged to reflect the density of animals rather than actual groups.

Habitat Use

Most of the Leatherbacks seen were in shallow, continental shelf waters (Figures 24 and 25). In the MIFL subunit, all of the Leatherbacks were within 72 km of shore ($\bar{x}$ = 29 km, range = 5 to 72 km, n = 27). In the NAFL subunit, where the continental shelf extends over 230 km from shore, the turtles were seen 27 to 166 km from shore ($\bar{x}$ = 118 km, n = 9). The two Leatherbacks seen off the MILA subunit were 55 and 190 km from shore.

Forty of the 47 Leatherback Turtles seen were in relatively shallow continental shelf waters (<100 m deep) (Figure 26), and about half of them were in waters less than 30 m deep. Mean depths of waters where Leatherback Turtles were sighted were 47 m (MIFL), 39 m (NAFL), and 176 m (MILA). The distribution of Leatherback Turtles with respect to depth differs from that described by Pritchard (1976, 1979) and Hendrickson (1980).

According to Pritchard (1976:752), Leatherbacks "remain relatively inaccessible to fishermen, probably in deep water...prolonged or preferred sojourn in shallow waters is improbable...". Later, Pritchard (1979:730) suggested that "it is probable that these young remain at great depths in the ocean, as do the adults except when in the vicinity of a nesting beach", and that (1979:726) "all evidence points to this being a deepwater species, to which marked bouyancy would have a definite disadvantage". Hendrickson (1980) described *Dermochelys* as having "a wide ranging life on the high seas, where accessible food items of suitable size are sparsely distributed or patchy".

Recent studies off New England and the central Atlantic states (Lazell 1980; Shoop et al. 1981) indicate that Leatherback Turtles preferentially use continental shelf and even inshore waters. Indeed, 18 of the 32 Leatherback Turtles (56%) reported from Cetacean and Turtle Assessment Program (CETAP) flights (Shoop et al. 1981) were in water less than 40 m deep, and only seven (22%) were in water deeper than 100 m. Lee and Palmer (1981) reviewed Leatherback Turtle records for waters off North and South Carolina. They concluded that the Leatherback is primarily found in shallow, nearshore

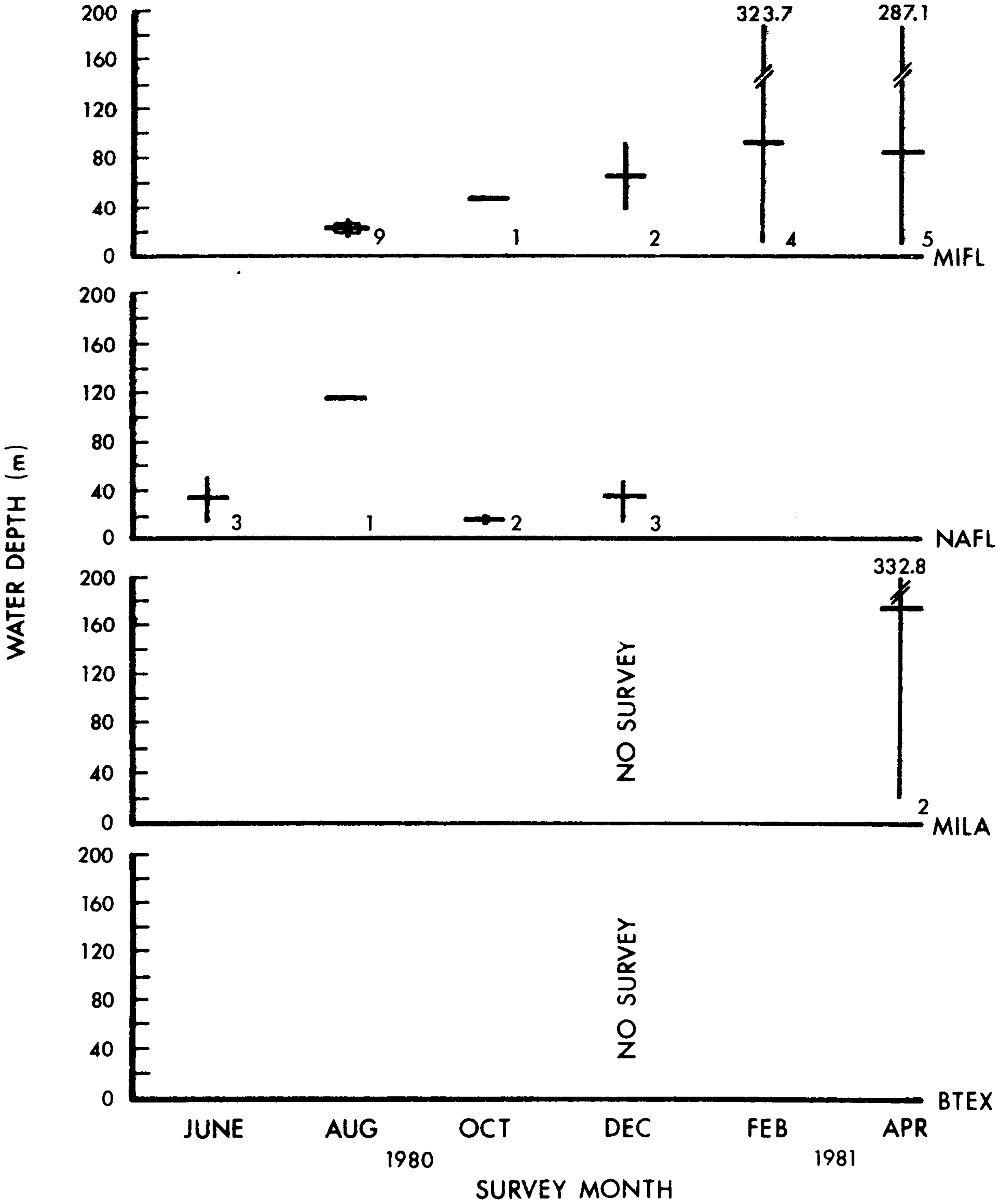


Figure 26. Water depth for all sightings of Leatherback Turtles by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

waters. These reports agree substantially with the results of the present study. Yerger (1965) summarized records of Leatherbacks from the Gulf coast of Florida. These included several individuals inside bays, two of which were netted separately in only 8 ft (2.4 m) of water.

Jellyfish are the primary food of Leatherback Turtles (Brongersma 1969). Concentrations of *Physalia* spp. and scyphozoans were observed in the shallow neritic waters usually close to shore. Thus, most of the Leatherback Turtles observed were in a habitat occupied by their preferred prey.

Leatherback Turtles were observed in waters with surface temperatures of 18° to 28° C ($\bar{x}$ = 24° C). They are capable of survival and activity in much colder water (Frair et al. 1972; Threlfall 1978), so perhaps no part of the study area at any season is unavailable to them because of unfavorable temperatures.

Most of the Leatherback Turtles seen in MIFL were inshore of the Gulf Stream (i.e., Florida Current), but three (one each in December, February, and April) were in Gulf Stream waters.

Associations

Four Leatherback Turtles were near water-mass boundaries. No particular association with sargassum was noted. At least four (9%) of the turtles were accompanied by large remoras. Six Leatherback Turtles (13%) were seen while the survey aircraft was circling dolphins. Nine (19%) were observed in areas of jellyfish (*Physalia* spp. and scyphozoans) concentrations.

Reproduction

Size estimates were made for 14 Leatherback Turtles. Two of them were estimated to have carapace lengths less than 1 m. The rest had carapace lengths between 1 and 2 m. The size estimates for the two smallest Leatherback Turtles probably were not underestimates, as both appeared smaller than adult Loggerhead Turtles seen on the same transects. These individuals probably were immature turtles. Sightings of immature Leatherback Turtles are extremely rare (Pritchard 1979).

Behavior

Most Leatherback Turtles observed were solitary individuals, but two areas in the MIFL subunit during August had several sightings each, suggesting local concentrations. All Leatherback Turtles seen were motionless at or just beneath the surface, swimming just beneath the surface, or diving. The survey aircraft circled several Leatherback Turtles and others were seen while the plane circled dolphins. Of these, several were not seen on subsequent passes, suggesting that they had dived in response to the plane. However, at least four remained visible during repeated circling without visible response. One turtle was observed to raise its head out of the water as the plane passed by.

Feeding behavior was not observed, although the most notable concentrations of Leatherback Turtles were in areas with abundant jellyfish.

Potential Impacts of OCS Development

The ecology of Leatherback Turtles at sea is poorly known, so potential sources of impact may be totally unrecognized. The regular use of continental shelf waters by Leatherback Turtles will bring the turtles frequently into proximity with OCS development activities.

Leatherback Turtles are known to ingest plastic bags and other plastic trash (Brongersma 1969; Mrosovsky 1981; Fritts in press). Ingestion of foreign objects can cause intestinal blockage or other digestive problems. Drilling rigs and production platforms appeared to be a major source of floating plastic trash in the MILA survey subunit. If Leatherback Turtles, as Brongersma (1969) indicated, regularly sample floating objects as potential food, they may also ingest tar balls or oil pancakes. In addition to having toxic effects, such ingestion of petroleum contaminants would potentially interfere with gut absorption and normal feeding.

Hendrickson (1980) noted that Leatherback Turtles are at the top of "a distinctive marine food chain" leading from nannoplankton up through jellyfish. Hendrickson suggested that this food chain may be more susceptible to disruption from environmental contamination than the more familiar oceanic food chains.

Summary

Leatherback Turtles were most common in Florida subunits (MIFL and NAFL). The density of Leatherback Turtles in the MIFL subunit was 0.32 x 1^{-2} turtles/km^2, but may be as high as 0.2 x 10^{-1} turtles/km^2 in the habitats where this species was sighted. Despite previous descriptions of this turtle as a pelagic species, most individuals were found in relatively shallow waters and at moderate distances from land. As a predator of coelenterates, the Leatherback Turtle appears to actively feed on plastic and other trash in marine waters. A similar tendency to sample or consume oil globules is expected.

COMMON LOON, *Gavia immer*

Description

Common Loons are large (1,600 to 4,200 g; body length 71 to 91 cm; wingspan to 147 cm), foot-propelled, diving birds (Olson and Marshall 1952; Terres 1980). Their bodies are long and dorsoventrally compressed so that they float very low in the water. They have rather long but thick necks, moderately large heads, and straight, pointed bills.

In winter, the forehead, crown, hindneck, and upper body are dark brown with gray highlights. The throat and underparts are white. The bill appears pale with a dark tip. The feet are dark laterally and white medially. In definitive alternate plumage, the bill, head, and neck are black. An incomplete collar of white marks encircles the lower neck, and a bar of white streaks crosses the upper throat. The back is blackish brown with numerous white spots. The breast and belly are white. For more complete descriptions, see Palmer (1962) and Cramp et al. (1977).

All Common Loons observed in this study were in winter plumage, and most were sitting on the water. The characteristic long-oval body shape usually was diagnostic. The white throats and pale bills usually were apparent, especially because many birds turned their heads to look at the plane. Sometimes the legs and feet were visible in the water. The only birds observed in these surveys which might be confused with loons on the water are ducks, cormorants, and juvenile gannets. Ducks and cormorants have shorter, more rounded bodies. Cormorants can be recognized by their extremely long, thin necks and by their long, fanned tails. Young gannets float much higher in the water, and the tips of their long wings cross over their tails.

Distribution

Common Loons were seen in only three survey subunits (NAFL, MIFL, and MILA), and only in December, February, and April (Figures 27 and 28; Table 11). They also were seen on opportunistic flights off southwestern Florida in December and February, in Mississippi Sound in February, off North Carolina in March, and in the northeastern Gulf of Mexico in April. Common Loons were seen in numbers only in the NAFL survey subunit and on the North Carolina opportunistic flights.

Abundance

Density estimates could be calculated for sightings of Common Loons only in the NAFL survey subunit during December (0.50×10^{-1} birds/km^2) and February (0.38×10^{-1} birds/km^2). In both months, the birds were concentrated within the inshore 95 km of the subunit (43% of the subunit). When individual densities for December and February are adjusted to reflect the portion of the subunit utilized by Common Loons (density/percent of subunit utilized), the adjusted densities are 0.12 birds/km^2 and 0.088 birds/km^2, respectively.

Groups of one or two birds were most common. Average group sizes in the NAFL subunit ranged from 1.1 during April to 1.4 during February. Loons were seen singly in the Mississippi Sound during February and averaged 1.9 per group off North Carolina during April. Of 229 observations, 194 were of single birds but group sizes varied from 1 to 45. Cramp et al. (1977) noted that loons "occur singly, in pairs, or in small flocks outside breeding season".

Habitat Use

In the NAFL survey subunit, Common Loons were observed as far as 114 km from shore (Figure 29). This is quite surprising since loons tend to remain within a few kilometers of shore in most of their winter range (e.g., Cramp et al. 1977). In Florida Common Loons begin arriving during late October and remain into May, although occasionally nonbreeding birds spend the summer there (Clapp et al. 1982).

With the exception of a single bird in the MIFL survey subunit during April, all Common Loons observed were in water less than 40 m deep (Figure 30). In such depths, loons should be able to dive to the bottom without difficulty (Cramp et al. 1977).

Common Loons were observed in water with surface temperatures of 12° to 23° C. This is almost the complete range of temperatures recorded in shallow inshore waters from December through March.

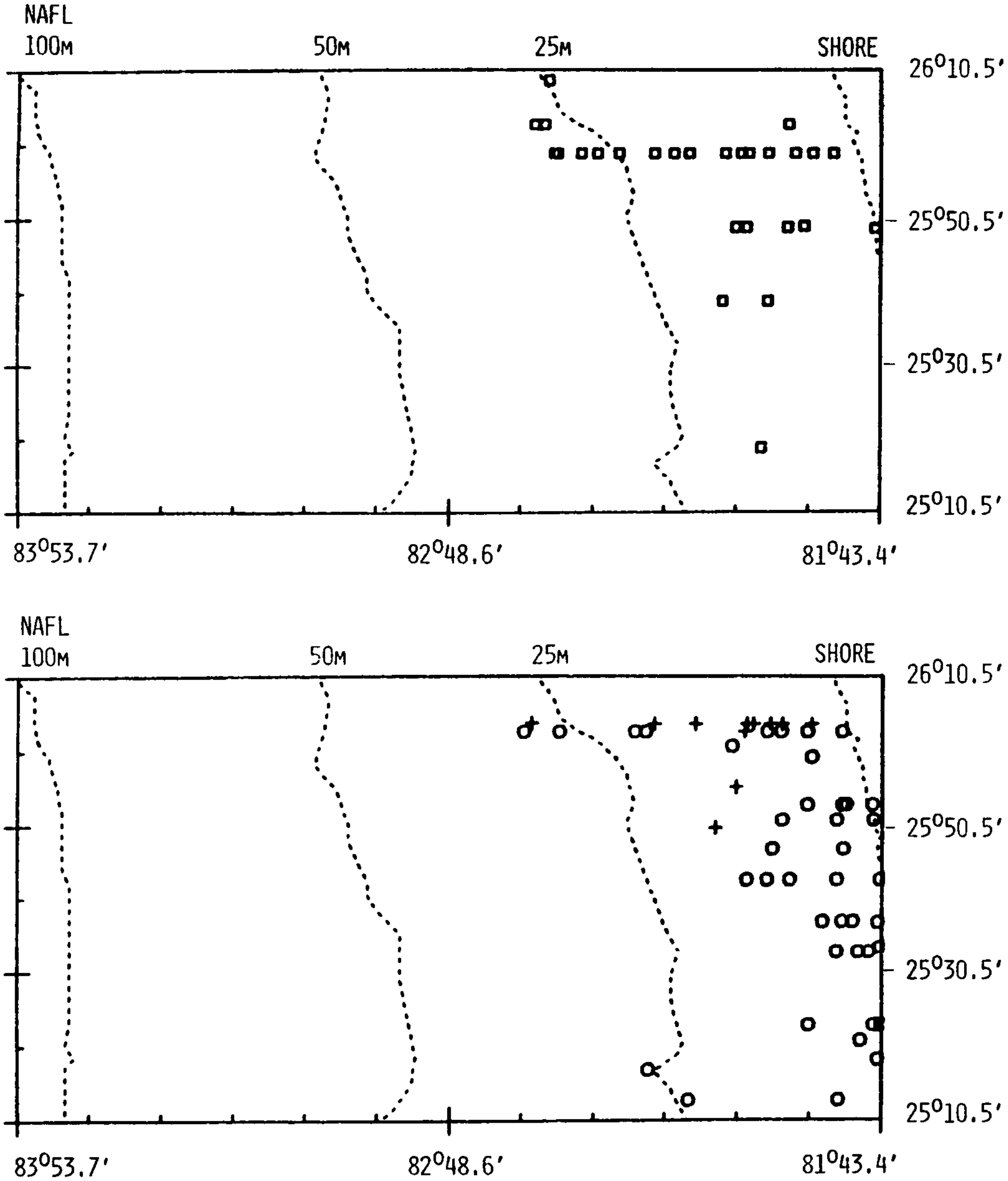


Figure 27. Distribution of all Common Loon sightings in the NAFL survey subunit during December (□), February (O), and April (+).

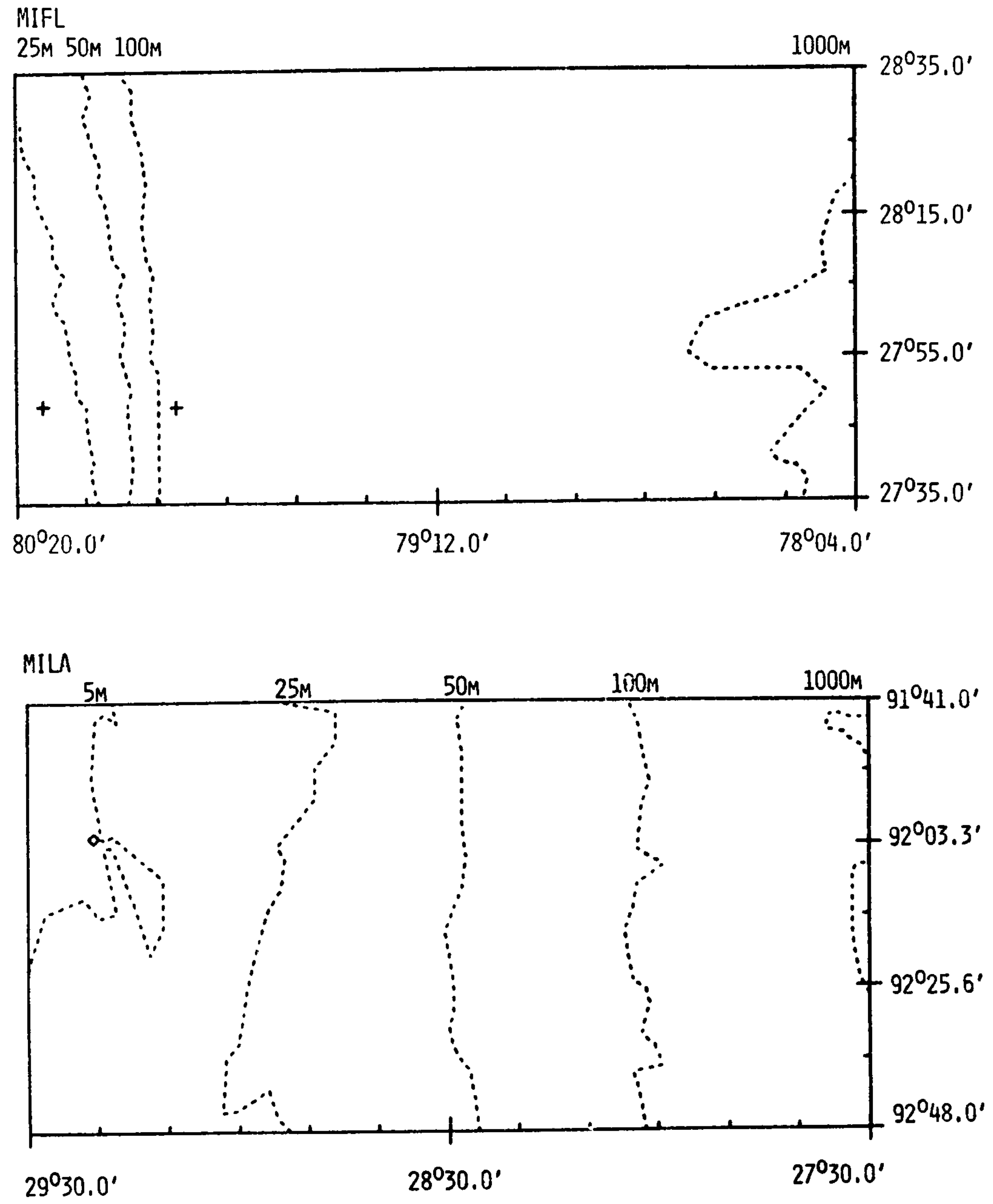


Figure 28. Distribution of all Common Loon sightings in the MIFL and MILA survey subunits during February (◇) and April (+).

Table 11. The number of Common Loons sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits							
	BTEX		MILA		NAFL		MIFL	
June	0		0		0		0	
August	0		0		0		0	
October	0		0		0		0	
December	-		-		48	(38)	0	
February	0		1	(1)	66	(46)	0	
April	0		0		16	(15)	3	(3)
TOTAL	0		1	(1)	130	(99)	3	(3)

Associations

Common Loons were rather solitary with most sightings involving single birds. On an opportunistic flight near the Mississippi Sound on 20 February 1981, one Common Loon was observed along a prominent water mass boundary near an estimated 5,000 Bonaparte's Gulls. Off North Carolina on 29 March 1981, a flock of 40 to 50 Common Loons along with 5 Herring Gulls and 50 to 60 Northern Gannets were feeding on a fish school.

Reproduction

Age classes could not be distinguished among the loons observed, and no inferences can be made about reproductive parameters or age structure of the population. Common Loons nest on the shores (they prefer island shores) of freshwater lakes in boreal forest and tundra (Bent 1922; Palmer 1962; Cramp et al. 1977).

Behavior

Three loons were recorded flying and the rest were sitting on the water. Most were not observed feeding, although 40 to 50 were present in a feeding flock off North Carolina. A few loons dived as the plane passed over, and others turned their heads to look up at the plane.

Loons are restricted to aquatic environments. They are incapable of efficient locomotion on land, and normally come ashore only to nest. They are capable of strong,

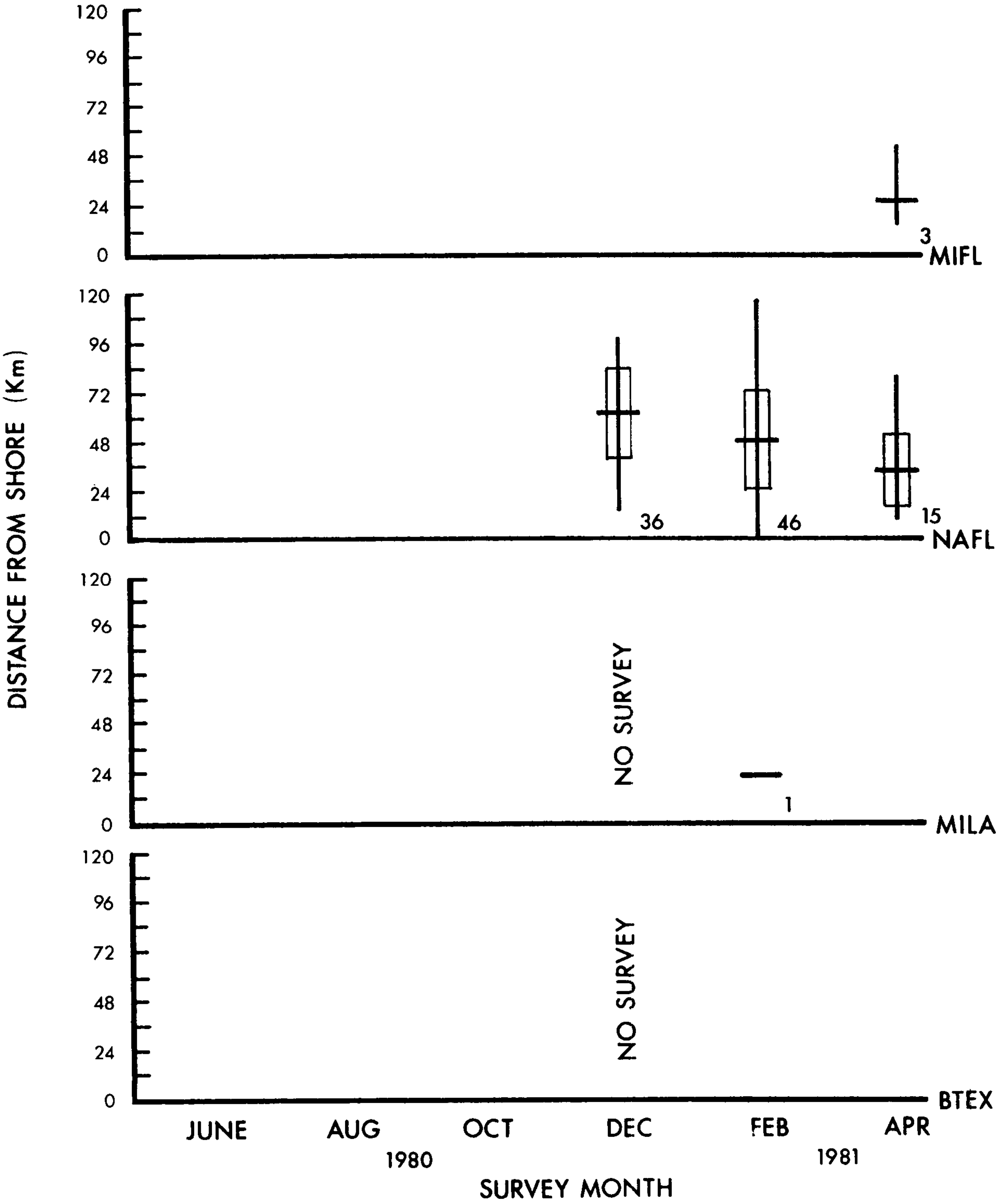


Figure 29. Distance from shore for all sightings of Common Loons by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

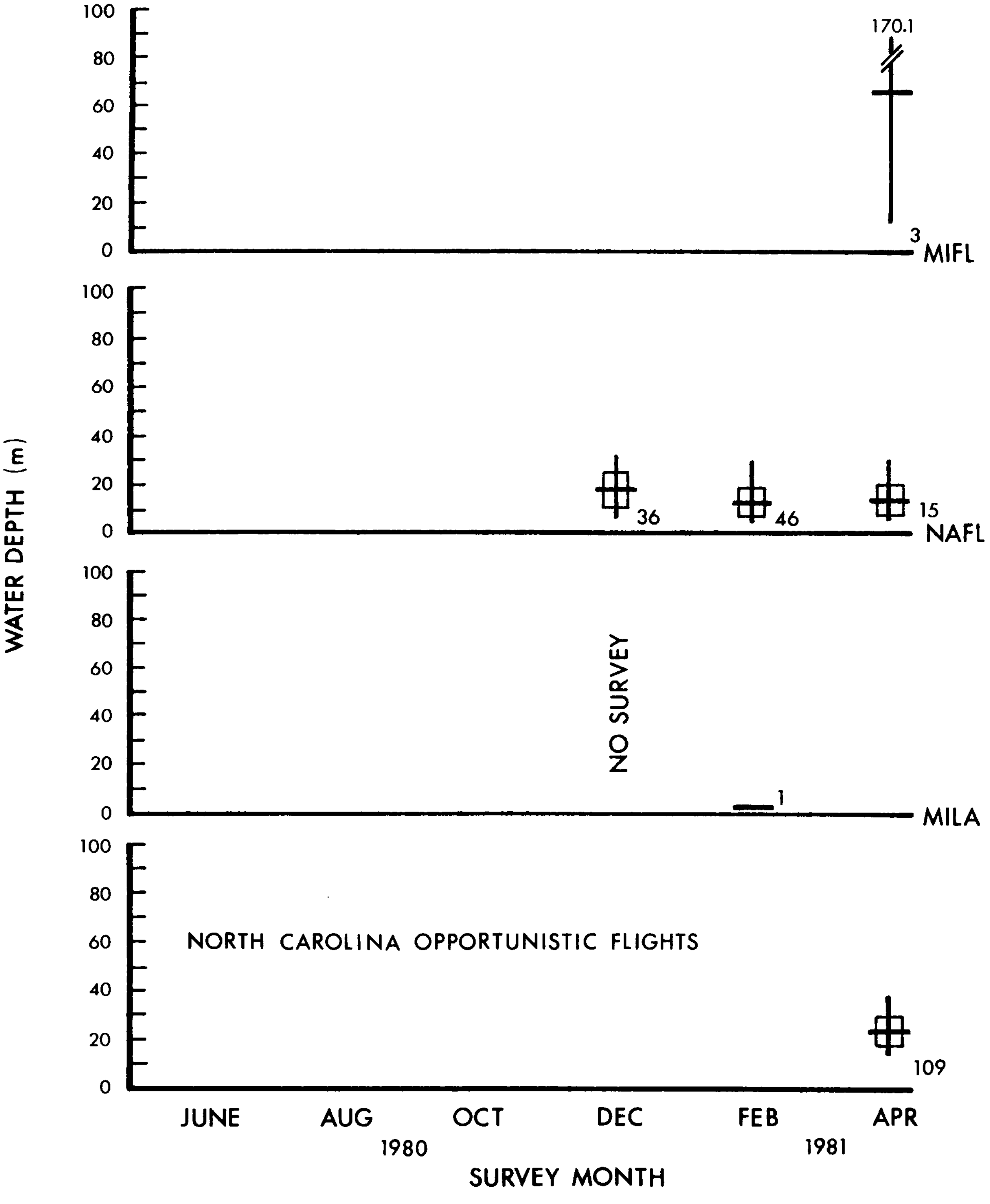


Figure 30. Water depth for all sightings of Common Loons by month and survey subunit, including North Carolina opportunistic flights. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

sustained flight and migrate long distances. They feed by pursuit diving. Their primary foods in marine waters are fishes and crustaceans (Palmer 1962; Cramp et al. 1977).

Potential Impacts of OCS Development

Several major oiling incidents have been reported in our study area. The best documented, and apparently most severe, occurred in Tampa Bay during 1970, and involved more than 500 loons (Sims 1970). Circumstantial evidence suggests that this incident may have reduced the size of the wintering population of the bay for several years (Clapp et al. 1982).

Information from Europe supports the contention that loons are extremely vulnerable to oiling. Of 152 loons found over the years on British beached-bird surveys, 94% were oiled (Bourne 1976). This is the highest percentage of oiling of any family reported. An oil spill near Shetland in December 1978 apparently killed 25% to 50% of the loons wintering in that area (Stowe and Morgan 1979).

The occurrence of a large wintering population of loons over the outer continental shelf off Naples, Florida, is of particular significance in light of the present interest in oil exploration in that area.

Summary

The majority of Common Loon sightings occurred in the NAFL subunit with lower numbers in the MILA and MIFL subunits. Sightings occurred from December to April. Common Loon sightings were usually of solitary animals or pairs and ranged out to 114 km from the shore. Loons feed by diving from the surface after fishes and crustaceans. The Common Loon is highly susceptible to the effects of OCS development, especially in the NAFL survey subunit where significant numbers of loons occur.

NORTHERN FULMAR, Fulmarus glacialis

On 26 March 1981, 207 Northern Fulmars (60 sightings) were seen over pelagic waters from a boat during an opportunistic survey off Cape Hatteras, North Carolina. Group sizes ranged from 1 to about 50 birds. The largest groups were attracted by chum or seen near water mass boundaries. All fulmars were in light-phase plumage.

The expansion of the range and breeding sites of the Northern Fulmar is well documented (Salomonsen 1965; Murphy 1967; Cramp et al. 1977). Historically, the range of the fulmar in the North Atlantic Ocean has been largely confined to the Arctic (Salomonsen 1965; Murphy 1967). Since about 1750, the fulmar has expanded its range southward in the eastern and western Atlantic Ocean (Salomonsen 1965; Cramp et al. 1977; Clapp et al. 1982). The range expansion probably is due to a genotypic variation in the light-phase morph (considered a subspecies F. g. glacialis by Salomonsen 1965), which allowed it to occupy a more boreal niche (Salomonsen 1965; Murphy 1967). The expansion during this period may have been accelerated by the presence of offal from whaling ships and fishing vessels which provided a new food source (Salomonsen 1965; Murphy 1967). The first occurrence of the Northern Fulmar off North Carolina in 1973 was documented by Lee and Rowlett (1979). Based on subsequent sightings, the Northern Fulmar has been considered a winter visitor (Lee and Booth 1979) in low numbers (Clapp et al. 1982). All but one of the records from North Carolina was of light-phase birds (Lee and Booth 1979).

CORY'S SHEARWATER, Calonectris diomedea

There are three recognized subspecies of C. diomedea including C. d. diomedea of the Mediterranean Sea, C. d. borealis of the subtropical east Atlantic Ocean, and C. d. edwardsii of the Cape Verde Islands (Cramp et al. 1977). The subspecies most commonly seen off the coasts of North America is believed to be C. d. borealis, although C. d. diomedea is also reported (Clapp et al. 1982). Identification to subspecies was not possible from the air.

Description

Cory's Shearwater is a large shearwater with long, pointed wings and a wedge-shaped tail (body length 45 to 46 cm; wingspan 100 to 125 cm) (Cramp et al. 1977). It is dark dorsally and white ventrally without a distinct border at the interface. It can have a grayish white band at the base of the tail (Palmer 1962). The upperparts are grayish brown with darker flight feathers on the wings. The tail is black-brown. The flanks and sides of the undertail coverts have faint grayish brown borders (Cramp et al. 1977). The bill is massive, hook-tipped, and fleshy yellow with inconspicuous tubed nostrils. The legs and feet are primarily flesh colored. Cory's Shearwater has a lighter, more bouyant flight than other shearwaters with more gliding, and fewer, slower wingbeats (Palmer 1962; Cramp et al. 1977). It also soars higher above the water than other shearwaters (Watson 1966).

From the air the shearwater body shape and its usual occurrence close to the water are distinctive. The brownish head, neck, back, wings, and tail, and if present, pale grayish rump bands were often visible identification cues. Cory's Shearwater could be confused with the Greater Shearwater (Puffinus gravis). For details see the description section of the Greater Shearwater species account.

Distribution

Cory's Shearwater was seen in all subunits but was most common in the Atlantic portion of the study area (Table 12). During opportunistic surveys in Florida waters Cory's Shearwater was seen north of the MIFL survey subunit, and off the Gulf Coast of Florida from Port Saint Joe to Venice Inlet. One also was observed south of the MILA survey subunit. Sightings off Louisiana were the first records for the state (22 October 1980 at 27°36.1' N, 92°26.5' W; 23 October 1980 at 28°00.7' N, 91°59.0' W and 28°26.5' N, 91°58.9' W; 25 October 1980 at 27°30.0' N, 91°52.4' W). Cory's Shearwater was seen within the study area in low numbers from April through February (Table 12). During October, it was seen in all survey subunits and in greatest numbers. The majority of sightings occurred in the MIFL survey subunit and during an opportunistic survey (838 birds, 24 sightings) north of the MIFL survey subunit. Cory's Shearwater occurred in low numbers, but most regularly in the BTEX survey subunit (Table 12). Sightings during August in the 1979 survey by Fritts and Reynolds (1981) and October (off Port Aransas) (Clapp et al. 1982) indicate that Cory's Shearwaters are occasionally numerous off Texas in the Gulf of Mexico.

Table 12. The number of Cory's Shearwaters sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits								Opportunistic flight	
	BTEX		MILA		NAFL		MIFL			
June	7	(5)	0		1	(1)	2	(2)	0	
August	10	(6)	0		0		0		1	(1)
October	2	(2)	7	(3)	5	(5)	145	(52)	838	(24)
December	-		-		0		1	(1)	0	
February	9	(7)	0		0		1	(1)	0	
April	0		0		0		0		1	(1)
TOTAL	28	(20)	7	(3)	6	(6)	149	(56)	840	(26)

Cory's Shearwater breeds in the eastern North Atlantic Ocean generally on isolated oceanic islands including the Selvagens Islands, the Desertas, the Cape Verde group, the Porto Santo group, the Canaries, Madeira, and the Azores (Palmer 1962; Zino 1971; Cramp et al. 1977; Clapp et al. 1982). Breeding sites are also reported on islands in the Mediterranean Sea from the Balearic Islands in the west to Turkey in the east (Clapp et al. 1982).

Caldonectris d. edwardsii, which breeds on the Cape Verde Islands, may be non-migratory (Clapp et al. 1982). *Calonectris d. diomedea* and *C. d. borealis* are migratory and some cross the Atlantic Ocean to the United States from May to December (Cramp et al. 1977; Clapp et al. 1982). They arrive back at breeding sites from February to March and are found there through October or November (Palmer 1962; Cramp et al. 1977). Migrants off North America in the summer and fall may be prebreeders or nonbreeders (Palmer 1962; Cramp et al. 1977).

Sightings of Cory's Shearwater from June through December in the MIFL and NAFL survey subunits correspond with published records (Clapp et al. 1982). Clapp et al. (1982) does not report any sightings during February. Cory's Shearwater has been reported off the Texas coast from August to October (Clapp et al. 1982), but data from aerial surveys also document their occurrence in June and February.

Abundance

Density estimates for Cory's Shearwater were calculated for the MIFL and BTEX subunits. In the MIFL subunit during October, when Cory's Shearwaters occurred in greatest numbers, the density estimate was 0.17 birds/km^2. In the MIFL subunit for all months combined, the density estimate was 0.035 birds/km^2. Both of these density estimates are larger than the estimate for all months combined in the BTEX subunit (0.76 x 10^{-3} birds/km^2) where Cory's Shearwater was seen regularly, but in low numbers.

Available records of Cory's Shearwater off North America suggest this species may be expanding its range. Bent (1922) and Palmer (1962) reported that Cory's Shearwater occurs off the Atlantic coasts from Newfoundland to North Carolina primarily from New York to Massachusetts during August through November. More recently, it has been described as a common resident and often abundant migrant off North Carolina (Lee and Booth 1979) with large numbers also reported off the east coast of Florida (Clapp et al. 1982). Clapp et al. (1982) cautioned that increased sightings may be the result of increased pelagic observations.

Although Cory's Shearwater has been described as regular but rare in the northern Gulf of Mexico (Duncan and Havard 1980), its status is not well understood due to a lack of systematic data collection (Clapp et al. 1982). Sightings in this study, supported by the 1979 aerial survey of Fritts and Reynolds (1981) and other available records (Clapp et al. 1982), suggest that the Cory's Shearwater is a regular visitor in low numbers in the Gulf of Mexico during the summer and fall. Occasionally, it also is seen in large flocks.

An increase in group size was associated with the increased numbers of Cory's Shearwater sightings. During June, August, December, and February, group sizes ranged from 1 to 3 birds (Figure 31). During October, group sizes ranged from 1 to 50 birds (Figure 31). During an opportunistic survey north of the MIFL subunit in October, a flock of 400 Cory's Shearwaters was seen. Large flocks are not exceptional. Rowlett (1978, cited by Lee and Booth 1979) reported 8,850 Cory's Shearwater counted off North Carolina during 7 h of observations in October 1974.

Habitat Use

During aerial surveys Cory's Shearwater sightings ranged 7 km from shore in the BTEX subunit to 230 km from shore in the MIFL subunit (Figure 32). This was not unexpected since this bird is reported to range from nearshore to well offshore (Cramp et al. 1977). However, Lee and Booth (1979) and Palmer (1962) suggest that an offshore distribution is more common.

Cory's Shearwater was seen over waters where depths ranged from 16 m in the MIFL subunit during October to 1,646 m in the BTEX subunit during August (Figure 33). Sightings in the MIFL and BTEX survey subunits occurred over waters with a broad range of depths (Figure 34). Sightings in the NAFL survey subunit occurred over relatively shallow waters ranging from 21 to 58 m (Figure 33). These data suggest that water depth is not a limiting factor in the distribution of Cory's Shearwater.

Cory's Shearwaters were seen over waters with surface temperature ranging from 26° to 28° C in the summer to 17° to 21° C in the winter. Cory's Shearwater usually occurs in warm (temperate to subtropical) marine waters and avoids colder seas (Cramp et al. 1977).

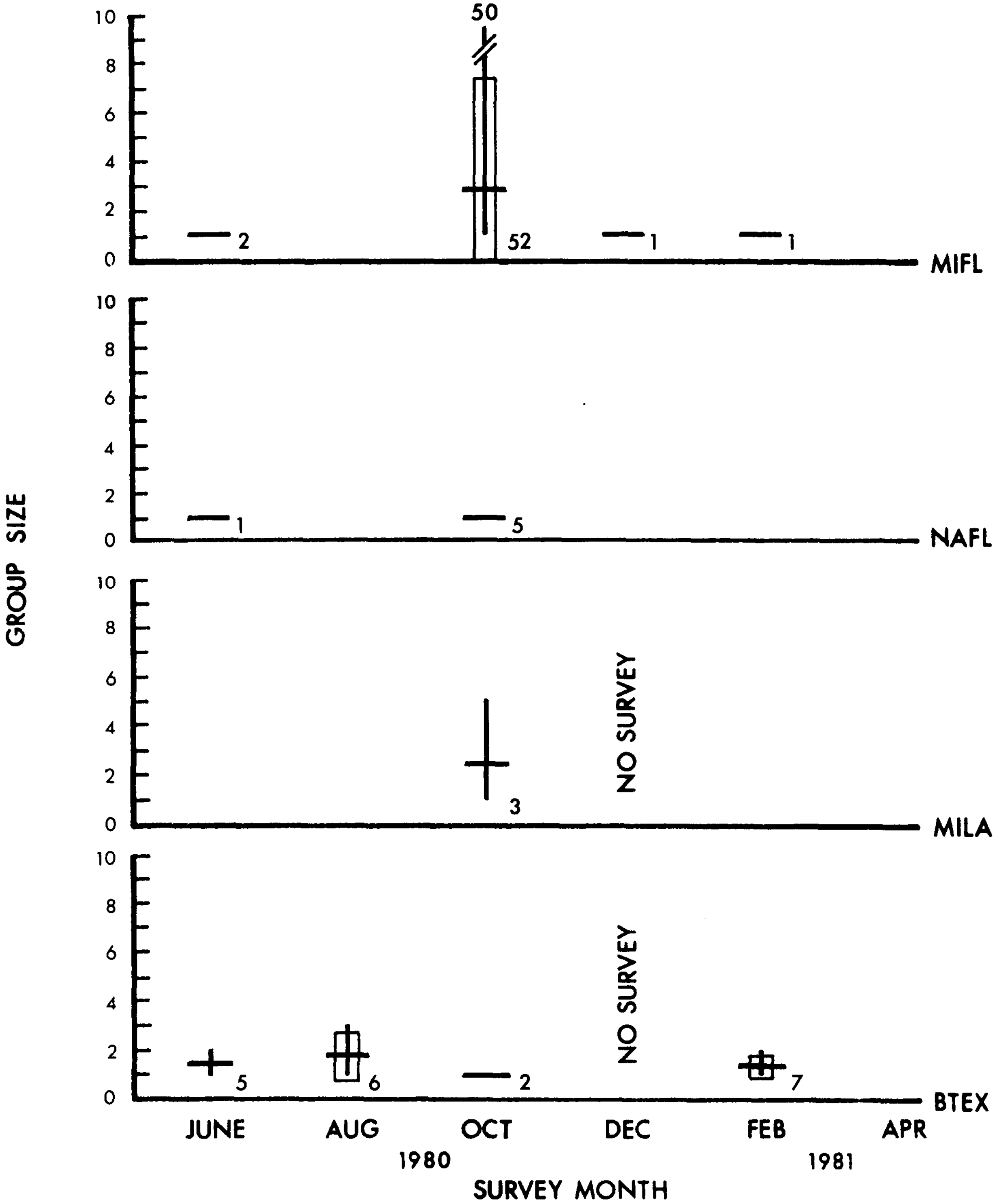


Figure 31. Group size for all sightings of Cory's Shearwaters by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

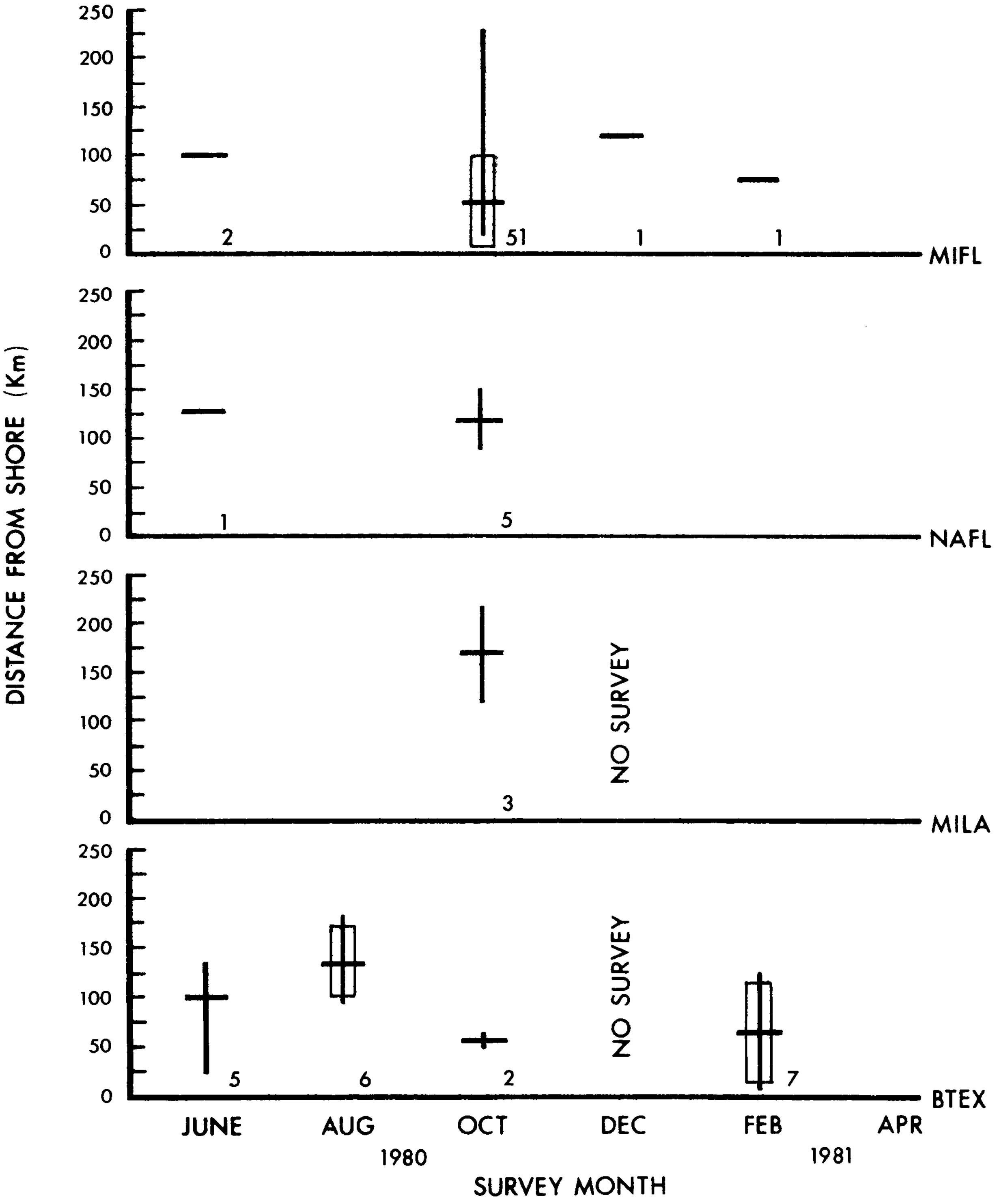


Figure 32. Distance from shore for all sightings of Cory's Shearwaters by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

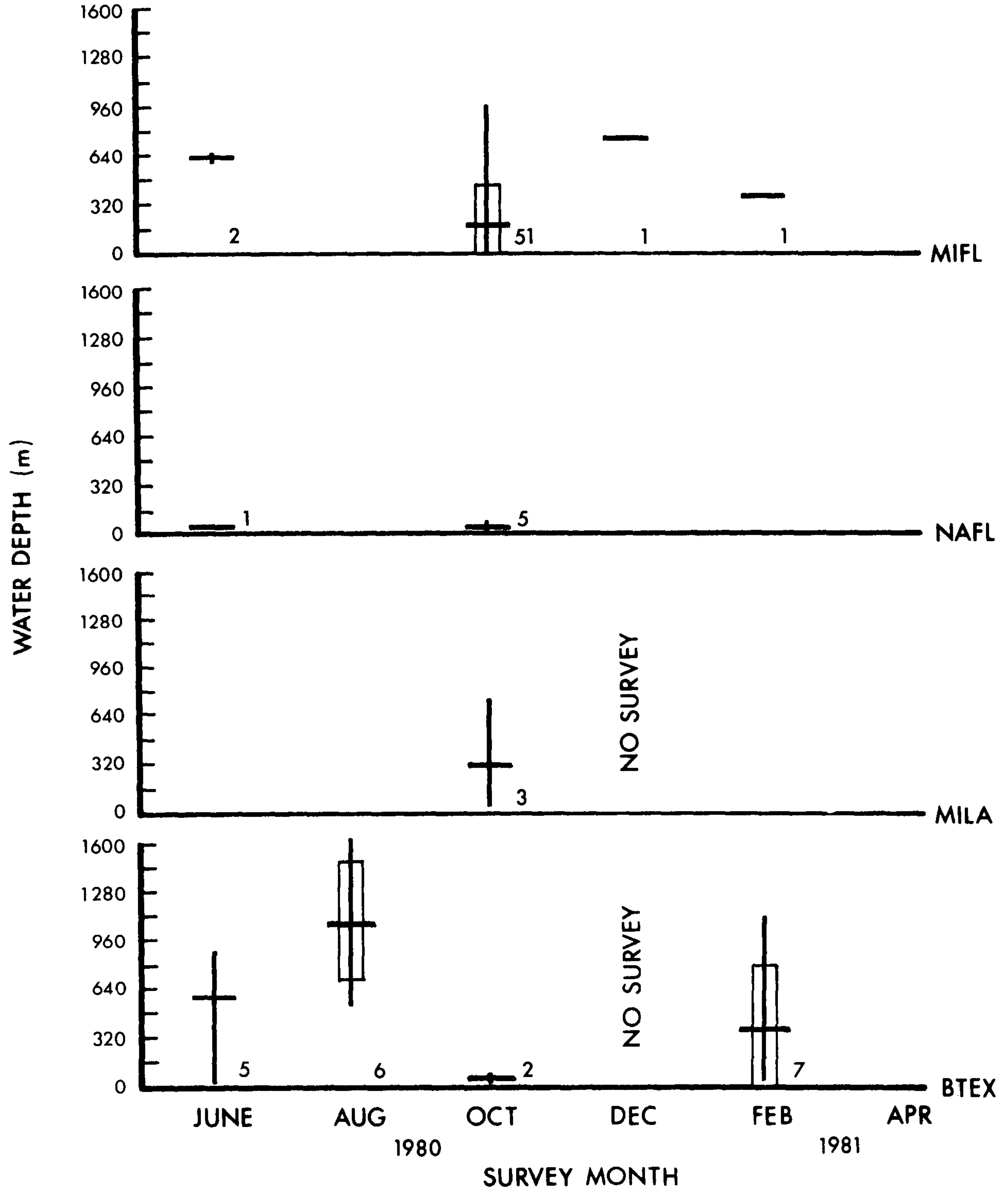
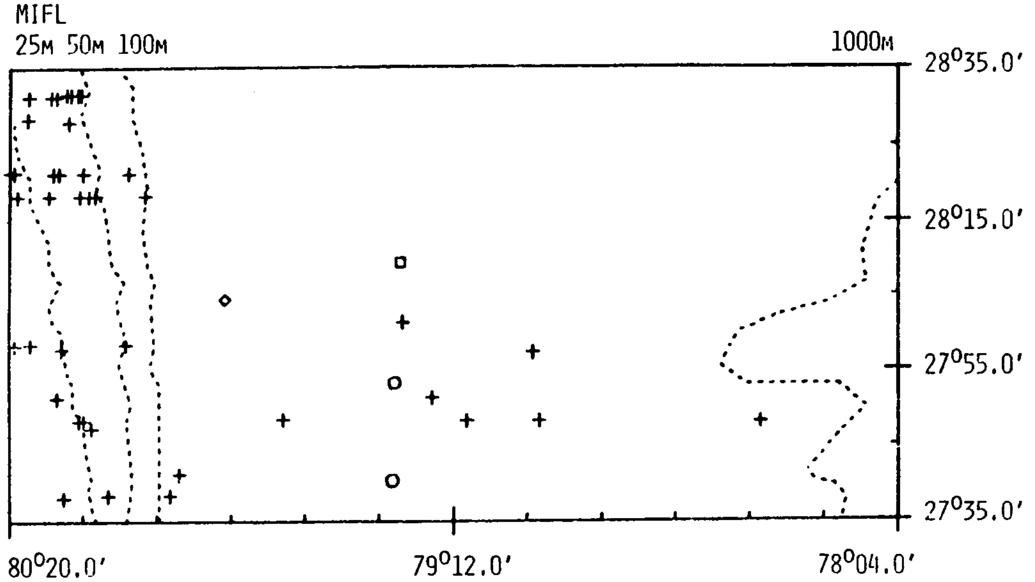


Figure 33. Water depth for all sightings of Cory's Shearwaters by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).



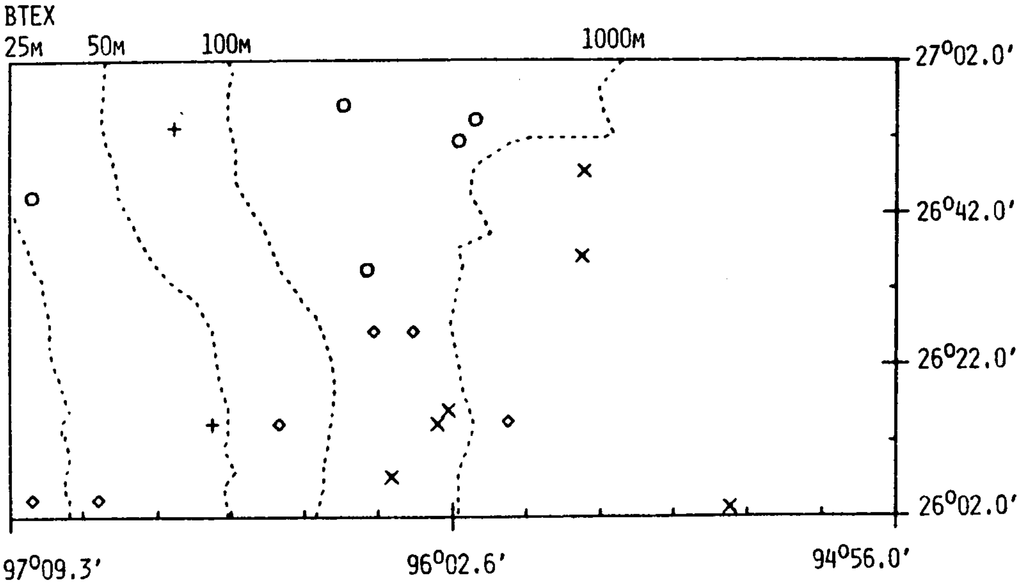


Figure 34. Distribution of all Cory's Shearwater sightings in the BTEX and MIFL survey subunits during June (O), August (X), October (+), December (□), and February (◇).

Associations

About 20% of all Cory's Shearwater sightings (79% of all individuals) were near or associated with other animals (Table 13). Occasionally associations were complex aggregations and included cetaceans, birds, bony fish, and sharks. Most associations were focused around unidentified fish and other birds (Figure 35). Group sizes of Cory's Shearwater in associations tended to be large ($\bar{x} = 43$ birds/group, SD = 110.1, n = 19).

Reproduction

No data were obtained on the reproductive biology of Cory's Shearwater during aerial surveys. It is known that they come ashore at some breeding grounds in March (Palmer 1962). Nests are in crevices, caves, or burrows, or on isolated cliffs and open ground of remote islands (Palmer 1962). They lay one egg and laying is highly synchronized in late May to early June on the Selvagen Islands (Zino 1971), but patterns are unreported elsewhere. Incubation lasts about 54 days and is performed by both sexes (Zino 1971). On Crete, after hatching, chicks gained weight rapidly and peaked at weights well above average adult weights. Nestling weights decreased somewhat prior to fledging, but at fledging averaged greater than adult weights (Round and Swann 1977). The fledging period on Crete ranged from 83 to 98 days and commenced during early October in 1974 (Round and Swann 1977).

Since Cory's Shearwater lays only one egg and several breeding populations are already decreasing in numbers (Cramp et al. 1977), recovery from a dramatic reduction in numbers would be expected to be slow.

Behavior

The Cory's Shearwaters seen in associations seemed to be focused primarily around schooling fish (Figure 35). Cory's Shearwaters are known to feed on small fish forced to the surface by large predaceous fish. They also pick up food scraps from feeding cetaceans (Bent 1922; Palmer 1962; Cramp et al. 1977). Feeding associations often include other procellariiforms and gulls (Cramp et al. 1977). Foraging methods include surface-skimming, surface-seizing, or plunging (Cramp et al. 1977; Clapp et al. 1982).

During aerial surveys, Cory's Shearwaters occasionally were seen resting or feeding on the water singularly or in flocks. One bird followed a ship that was discharging an oil slick in its wake. Procellariiforms are known to be attracted to oil slicks of a biological origin (i.e., a floating carcass or garbage). Olfaction plays a major role in location of such potential food resources (Grubb 1972; Hutchison and Wenzel 1980). In the case of the bird following the ship, it could not be determined from the air whether additional attractants, such as garbage, were present that might explain the birds' behavior.

Potential Impacts of OCS Development

Cory's Shearwater is susceptible to oiling while feeding or resting on the water (Clapp et al. 1982). A raft of birds so large "that it was mistaken for land" has been reported (Palmer 1962). One case of an oiled Cory's Shearwater has been recorded (Hudson 1963) from Ormond Beach, Florida, but Clapp et al. (1982) warned that due to the largely pelagic existence of this species, mortality due to oiling may go unnoticed. If

Table 13. The number of sightings and percentages of associations of Cory's Shearwater with other groups of animals. Some sightings were of associations including two or more faunal elements, so the subtotals are not cumulative.

Cory's Shearwater Associated with	No. of Cory's Shearwater sightings	Percentage of Cory's Shearwater sightings	Percentage of all Cory's Shearwaters sighted
Other fauna (totals)	18	20	79
Marine mammals: Sperm Whale, False Killer Whale, Short-finned Pilot Whale, and unidentified dolphin	7	8	2
Birds: Masked Booby, Audubon's Shearwater, Common Tern, Royal Tern, unidentified gull	9	10	74
Fish: schooling fish, Whale Shark, unidentified shark	11	12	78

an oil or chemical spill occurred where birds were highly concentrated during migrations, the effects could be severe and the recovery slow.

Summary

Cory's Shearwater seems to be a regular visitor within the study area during the summer and fall. Large numbers of sightings occurred in the Atlantic Ocean and low numbers occurred in the Gulf of Mexico, including the first records for the state of Louisiana. Throughout the study area, numbers peaked around October. Cory's Shearwater was frequently seen in associations with other fauna and occasionally in flocks on the waters. Oil impacts are poorly understood, but potential effects of coastal or offshore spills are severe.

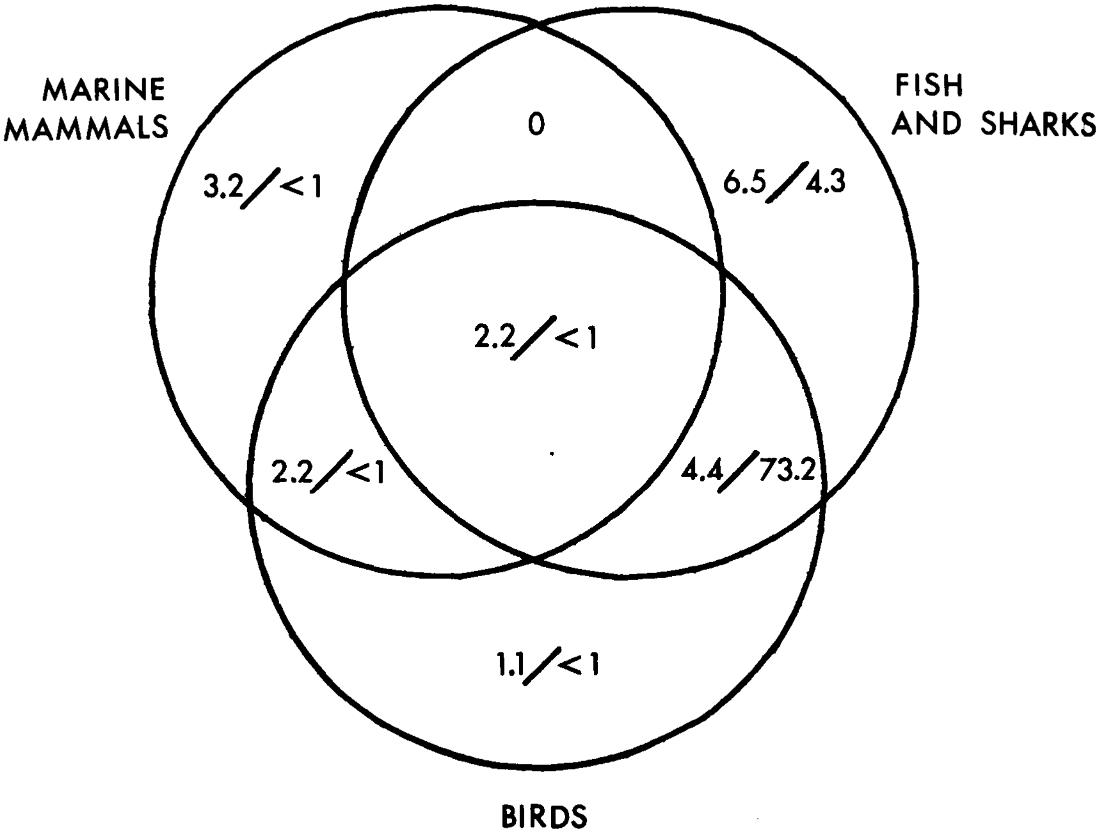


Figure 35. Associations of Cory's Shearwaters with mammals, fish and other birds. A/B: A depicts percentages based on the total number of sightings of Cory's Shearwaters and B represents percentages based on the total number of individuals seen.

GREATER SHEARWATER, Puffinus gravis

Description

The following description is derived from Palmer (1962) and Cramp et al. (1977). Puffinus gravis is heavily built for a shearwater; it has long wings and a short tail (body length 43 to 51 cm; wingspan 100 to 118 cm). The Greater Shearwater is brown above and white below with a well-defined dark brown cap, a dark grayish brown back and a brown-black tail. The collar and rump have conspicuous white bands. The upper wings are brown with brown-black flight feathers. Underparts are mostly white with dark areas on the mid-belly, flanks, and undertail. The underwing is white, but has dark margins and a dark patch from the wing pit to the carpal joint. The bill is thin and straight with inconspicuous tubed nostrils and a hooked tip; it can be black to dark horn color. The feet and legs are bicolored: fleshy to bright pink and dark. Sexes are alike, and subadults are similar to adults. Flight is characterized by rapid, stiff wing beats interspersed with gliding and banking usually near the water.

From the air the large shearwater body shape, dark cap, white collar, and white tail band were diagnostic. Cory's Shearwater (Calonectris diomedea) was most likely to be confused with the Greater Shearwater. The two birds are of similar size and coloration, and the Cory's Shearwater may also have a pale rump patch that is visible from the air. The dark cap and collar of the Greater Shearwater separate the two species.

Distribution

Five Greater Shearwaters were seen: 2 in the NAFL survey subunit during June, 2 in the MIFL survey subunit during June and December, and 1 during an April opportunistic survey off Hudson, Florida. These birds were seen from 2 to 84 km from shore. Clapp et al. (1982) reported sightings for the Atlantic coast of Florida from May to February, and the west coast of Florida from April to October. This species is often referred to as a pelagic species (Bent 1922; Cramp et al. 1977; Clapp et al. 1982).

Greater Shearwaters are known to breed on Nightingale Island and Inaccessible Island of the Tristan da Cunha group, Gough Island, and Kidney Island of the Falkland Islands (Cramp et al. 1977; Woods 1970). After breeding, most migrate rapidly north off the western Atlantic coast to Labrador and Greenland. Some also move north in the eastern Atlantic (Cramp et al. 1977). They reach the North Atlantic coast about May to June, and spend the summer in the western North Atlantic Ocean. During July and August they spread across the North Atlantic Ocean to the European coast where they are seen through October. The route from this point back to the breeding areas is not well-known, but some birds arrive by August and most have returned by September (Cramp et al. 1977; Clapp et al. 1982). Greater Shearwaters in the Gulf of Mexico may be stragglers from the seasonal migration (Palmer 1962), but the distribution in this area is not well known (Clapp et al. 1982). They have been sighted off the Gulf coasts of Texas, Louisiana, Alabama, and Florida mostly during summer months (Duncan and Havard 1980).

Abundance

Sightings of the Greater Shearwater were not unexpected since the Greater Shearwater is a migrant in U.S. waters. During migration, large aggregations (e.g., 200 birds on 1 July 1975 off North Carolina) have been seen off the Atlantic coast in the study area, especially from May to August (Clapp et al. 1982).

Habitat Use

Greater Shearwaters were seen over waters that were 3 to 329 m in depth with surface temperatures ranging from 24° to 27° C. Greater Shearwaters seem to prefer cool pelagic waters in the North Atlantic Ocean, and may proceed rapidly along portions of their migration route that are over warm waters (Cramp et al. 1977).

Reproduction

Breeding is extralimital to this study. The Greater Shearwater nests in burrows (Cramp et al. 1977). It is thought to have a synchronized egg-laying period starting from 9 November to mid-November (Palmer 1962). It lays one egg, and incubation is about 55 days (Clapp et al. 1982). Duration of the fledging period is uncertain, but estimates of about 84 to 120 days were suggested by Palmer (1962) and Clapp et al. (1982).

Behavior

Greater Shearwaters were seen flying low over the water. Feeding is primarily diurnal and on fish and cephalopods (Bent 1922; Cramp et al. 1977). Greater Shearwaters may follow boats; one was seen for a month from the Mobile Bay Pilot Ship, but "it met its demise when it fell through a ventilator into the galley and hit the cook on the head" (Duncan and Havard 1980).

Potential Impacts of OCS Development

Greater Shearwaters feed by pursuit plunging, pursuit diving, and surface seizing (Cramp et al. 1977; Brown et al. 1981), and are therefore susceptible to oiling, especially if an offshore oil or chemical spill occurred during a period of peak migration in the study area. Greater Shearwaters are also scavengers, taking the offal of fishing vessels (Brown et al. 1981), and could ingest oil-fouled prey. No reports of the effects of oil or oiling have been found for this species (Clapp et al. 1982).

Summary

Five Greater Shearwaters were seen during aerial surveys; all were off the coast of Florida. The birds were generally more than 10 km from shore. Evaluation of OCS development impact is difficult because of a lack of data and the seasonal occurrence of Greater Shearwaters in the study area.

AUDUBON'S SHEARWATER, *Puffinus lherminieri*

Audubon's Shearwater closely resembles the Manx Shearwater, *Puffinus puffinus*. Sightings of Manx Shearwater are rare in the study area (Clapp et al. 1982). All sightings from the air were considered to be of Audubon's Shearwater. Audubon's Shearwater is comprised of nine subspecies (Palmer 1962). *Puffinus l. lherminieri* occurs in the study area (AOU 1957; Palmer 1962).

Description

Audubon's Shearwater is a small seabird (body length 31 cm; wingspan 69 cm) (Terres 1980) that is dark brown-black dorsally and white ventrally. The underwings have broad, dark margins, and there is no white on the tail. The bill is dark brownish black or bluish gray. The feet and legs are primarily flesh colored (Palmer 1962). Adult and subadult plumages are similar (Palmer 1962). These birds fly low over the water, using rapid and frequent flapping interspersed with short periods of shallow banking and gliding.

In contrast to the Audubon's Shearwater, the Manx Shearwater has slightly longer wings, a somewhat shorter tail, white undertail coverts, and underwing margins that are thinner and lighter (Harper and Kinsky 1978). The subtlety of these differences makes reliable distinction of these two species difficult from the air.

The small shearwater body shape and almost black dorsal coloration were obvious from the air. When Audubon's Shearwaters were seen in the proper attitude, the contrasting white underparts were also visible. If seen for only a short period or at a distance, Audubon's Shearwater appeared similar to the Sooty Tern, *Sterna fuscata*. The rapid wingbeat and flight patterns of the Audubon's Shearwater were distinctive.

Distribution

Audubon's Shearwater was seen in largest numbers in the Atlantic portions of the study area. Sixty shearwaters (30 sightings) were seen in the MIFL survey subunit (Table 14), and 405 shearwaters (6 sightings) were seen during an opportunistic survey in October north of the MIFL survey subunit. Fewer sightings occurred in survey subunits in the Gulf of Mexico; but of those sightings, most were in the NAFL survey subunit (Table 14). Sightings were most frequent from October to April.

Puffinus lherminieri breeds on islands in the Pacific Ocean, Indian Ocean, Caribbean Sea, and North Atlantic Ocean (AOU 1957; Clapp et al. 1982). *Puffinus l. lherminieri* breeds or formerly bred on Bermuda, Mona Island, the Virgin Islands, the Lesser Antilles, and the Bahama Islands (Bent 1922; Murphy 1936; AOU 1957; Palmer 1962; Clapp et al. 1982). Audubon's Shearwater probably is not migratory, but disperses unknown distances from breeding sites (Palmer 1962; Clapp et al. 1982). On the Atlantic coast of the United States it occurs from the Gulf of Maine to South Florida (Palmer 1962). Although no records exist for Mississippi, the Audubon's Shearwater probably occurs throughout the Gulf of Mexico (Clapp et al. 1982).

The Manx Shearwater breeds on islands of the eastern North Atlantic Ocean, Mediterranean Sea, and Pacific Ocean (Clapp et al. 1982). Manx Shearwater is rarely sighted off the southeastern United States, but this species may be more common than the lack of sightings suggests (Clapp et al. 1982). Only one record (from Texas) exists for the Gulf of Mexico (Duncan and Havard 1980; Clapp et al. 1982).

Audubon's Shearwater was seen throughout the year only in the MIFL survey subunit (Table 14). In other subunits and during opportunistic surveys, Audubon's Shearwater was seen from October through April. Clapp et al. (1982) reported sightings throughout the year in the Gulf of Mexico and in the Atlantic Ocean off Florida.

Table 14. The number of Audubon's Shearwaters sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month		Survey subunits			
		BTEX	MILA	NAFL	MIFL
June		0	0	0	1 (1)
August		0	0	0	1 (1)
October		0	1 (1)	0	44 (15)
December		-	-	4 (4)	2 (2)
February		4 (4)	0	1 (1)	7 (6)
April		0	0	40 (7)	5 (5)
	TOTAL	4 (4)	1 (1)	45 (12)	60 (30)

Abundance

A density calculation for Audubon's Shearwater for the MIFL subunit using pooled data from all surveys resulted in an estimate of 0.0053 birds/km^2. Sightings were insufficient for density calculations in other survey subunits.

Audubon's Shearwater was described as "very numerous" during June 1826 in the Gulf of Mexico off West Florida (see review by Bent 1922). Subsequently, the number of Audubon's Shearwaters declined (Murphy 1936; Palmer 1962; Clapp et al. 1982). The decline was attributed in part to predation by rats and feral cats introduced onto islands where nesting occurred, and to human consumption of nestlings (Murphy 1936; Clapp et al. 1982). Palmer (1962) noted that an Aububon's Shearwater found at Harlingen, Texas, in 1947 was the first record in the Gulf of Mexico since 1826, and that the species was rare on Bermuda. More recently, this species was regarded as common to abundant off North Carolina from mid-May to early June and throughout the fall (Lee and Booth 1979). Audubon's Shearwater is probably seasonally common to abundant in the Atlantic Ocean off the southeastern United States (Clapp et al. 1982). In the Gulf of Mexico, it is thought to be "casual year-round" (Duncan and Havard 1980). Clapp et al. (1982) considered this species to be a regular inhabitant in the Gulf of Mexico, but probably in lower numbers than off the Atlantic coast.

The period of peak abundance during aerial surveys (October to April) was unexpected because Clapp et al. (1982) reported that peak numbers occurred from May to October. Aerial data may be skewed in part due to increased sighting efficiency in identifying this species. Training in the identification of shearwaters may have increased the numbers seen during surveys performed after September. If this is true, a comparable drop in the number or percentage of unidentified shearwaters should have occurred as well. No such drop is apparent (Table 15), and the discrepancy in the peak abundance requires clarification.

Habitat Use

Audubon's Shearwater is usually found in pelagic waters (Palmer 1962; Clapp et al. 1982). During October in the MIFL subunit, sightings were predominately nearshore and ranged 18 to 164 km from shore ($\bar{x} = 65$; SD = 50.9). Mean distances from shore in the MIFL subunit during other months ranged from 43 to 137 km (Figures 36 and 37). During October, more than 53% of the sightings were in the landward one third of the MIFL subunit. The mean distance from shore in the NAFL subunit in April (Figure 36) was 205.5 km.

The depth of waters over which Audubon's Shearwaters were seen varied considerably between survey subunits and between seasons (Figure 38). Sightings in the NAFL subunit occurred over waters 9 to 110 m deep, whereas those in the MIFL subunit were over waters 14 to 914 m deep. In the MIFL subunit, the only sightings in waters less than 50 m deep occurred during October when such sightings constituted 54% of the birds seen. The mean water depth for sightings during October in the MIFL subunit (268 m) is less than half those for February and April (730 and 564 m, respectively). Other months cannot be compared due to inadequate sample sizes. During an opportunistic survey near the Dry Tortugas, this species was observed over waters 2,195 m deep.

Audubon's Shearwater has been characterized as a pelagic species (Bent 1922; Palmer 1962; Clapp et al. 1982). The present study suggests that the species may range over waters of varying depths.

Aubudon's Shearwater was seen over waters where surface temperatures ranged from 19^{o} C during February to 27^{o} C during summer months. Audubon's Shearwater was described as a warm water species by Bent (1922) and Palmer (1962).

Associations

Over 85% of the Audubon's Shearwaters seen were associated with other animals and occasionally with water mass boundaries and sargassum (Table 16). Although association with other animals occasionally included mammals and fish, other bird species were present in all such associations (Table 16). These associations included other shearwater species, gulls, and terns. Unidentified dolphins were noted with Audubon's Shearwater on two occasions. Fish schools were included in 40% of the sightings (93% of the birds) that were associated with other animals. When associated with fish schools, Audubon's Shearwater seemed to be feeding on fish or other prey. These aggregations of birds and mammals may have been responding to concentrations of a common prey. On three occasions, Audubon's Shearwater was seen associated with water mass boundaries. Bent (1922) and Palmer (1962) reported this species in association with sargassum and upwellings where it was probably feeding. Audubon's Shearwater feeds on small and larval fishes and cephalopods (Palmer 1962; Harris 1969) that may be concentrated at water mass boundaries and near sargassum.

Table 15. The number of Unidentified Shearwaters sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits							
	BTEX		MILA		NAFL		MIFL	
June	0		0		0		13	(8)
August	11	(4)	0		1	(1)	0	
October	0		0		0		101	(2)
December	-		-		3	(3)	9	(3)
February	3	(3)	0		3	(3)	3	(3)
April	1	(1)	0		0		4	(4)
TOTAL	15	(8)	0		7	(7)	130	(20)

Reproduction

Audubon's Shearwater nests in rocky crevices, on the ground, under dense vegetation, and in soil burrows (Bent 1922; Murphy 1936; Palmer 1962; Harris 1969; Hatch 1974). They lay one egg in mid-March in the Caribbean and Atlantic breeding sites (Bent 1922; Murphy 1936; Palmer 1962), although extralimital breeding sites may have year-round reproduction (Snow 1965; Harris 1969). Incubation is about 51 days on Bermuda (Palmer 1962), but may vary from from about 40 to 65 days on the Galapagos Islands (Snow 1965; Harris 1969). Adults stop feeding young after about 69 days, and young fledge at about 72 days on Bermuda (Palmer 1962).

Behavior

Audubon's Shearwater was commonly seen as a solitary individual or in small groups. During October, when larger numbers were seen, group sizes were also larger. Feeding aggregations similar to these large flocks are common, but short-lived, off the Galapagos Islands (Harris 1969).

During aerial surveys Audubon's Shearwaters were observed flying and sitting on the water. They dive for prey from the air and from the surface of the water (Murphy 1936; Brown et al. 1978). They also catch flying fish in the air by leaping after them from the surface of the water (Jehl 1974).

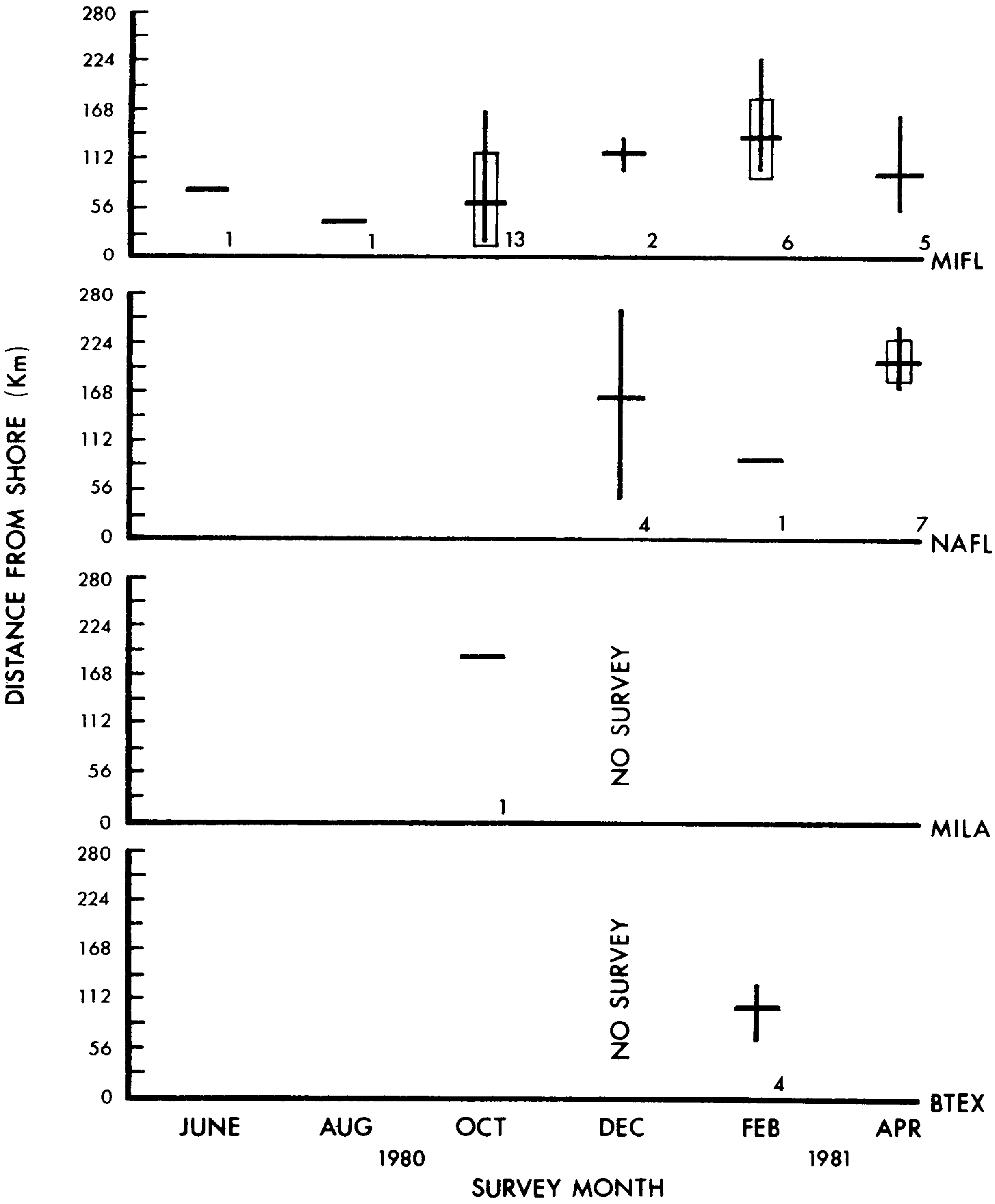


Figure 36. Distance from shore for all sightings of Audubon's Shearwaters by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

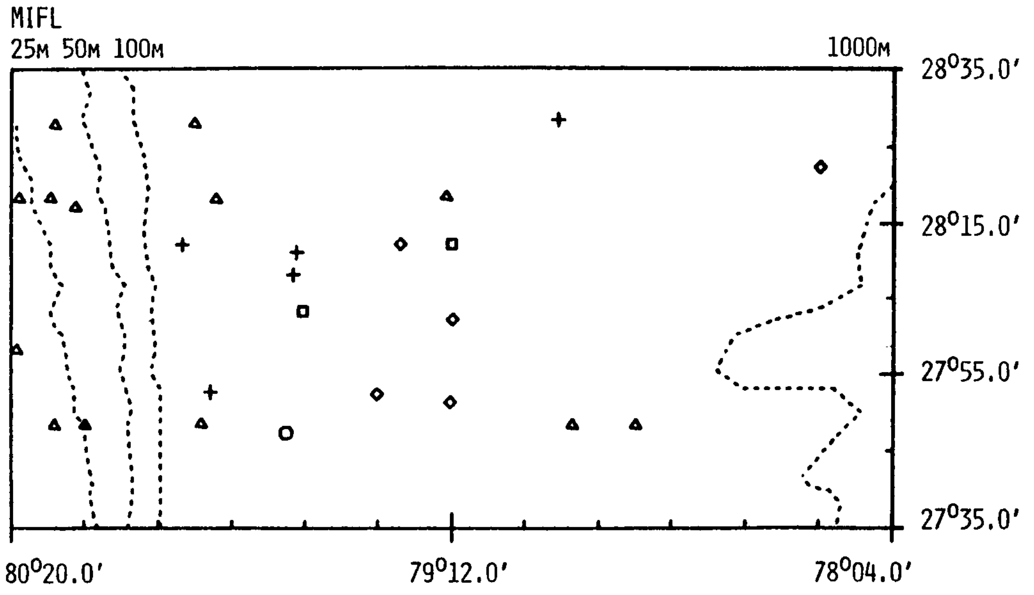


Figure 37. The distribution of Audubon's Shearwater sightings in the MIFL survey subunit in June (O), October (△), December (□), February (◇), and April (+).

Potential Impacts of OCS Development

There are no records of oiling for the Audubon's Shearwater (Clapp et al. 1982). Within the southeastern United States, Clapp et al. (1982) considered the waters adjacent to the Florida Keys of special concern because large numbers of Audubon's Shearwaters occasionally occur there. Since Aubudon's Shearwaters dive for prey, they are particularly vulnerable to direct oiling. Large aggregations of Audubon's Shearwaters are known to occur close to several nesting sites (e.g., colonies in the Bahamas). If an oil spill occurred during the nesting season in areas where such aggregations are common, adults may transport oil back to the nest, eggs, and nestlings. Small amounts of oil are known to cause egg failure in marine birds (White et al. 1979).

Summary

Audubon's Shearwater was seen in all survey subunits, with most sightings occurring in the MIFL and NAFL subunits. This species was most abundant from October to April, although sightings occurred throughout the year in the MIFL survey subunit. Audubon's Shearwater usually was seen over warm pelagic waters. It was occasionally associated with other marine birds and unidentified fish in possible feeding aggregations. Audubon's Shearwaters were usually seen singly or in small flocks. Occasionally they were sitting on the water. Although oil impacts on this species are poorly understood, the proximity of breeding sites to potential oil spills increases potential negative effects of OCS development.

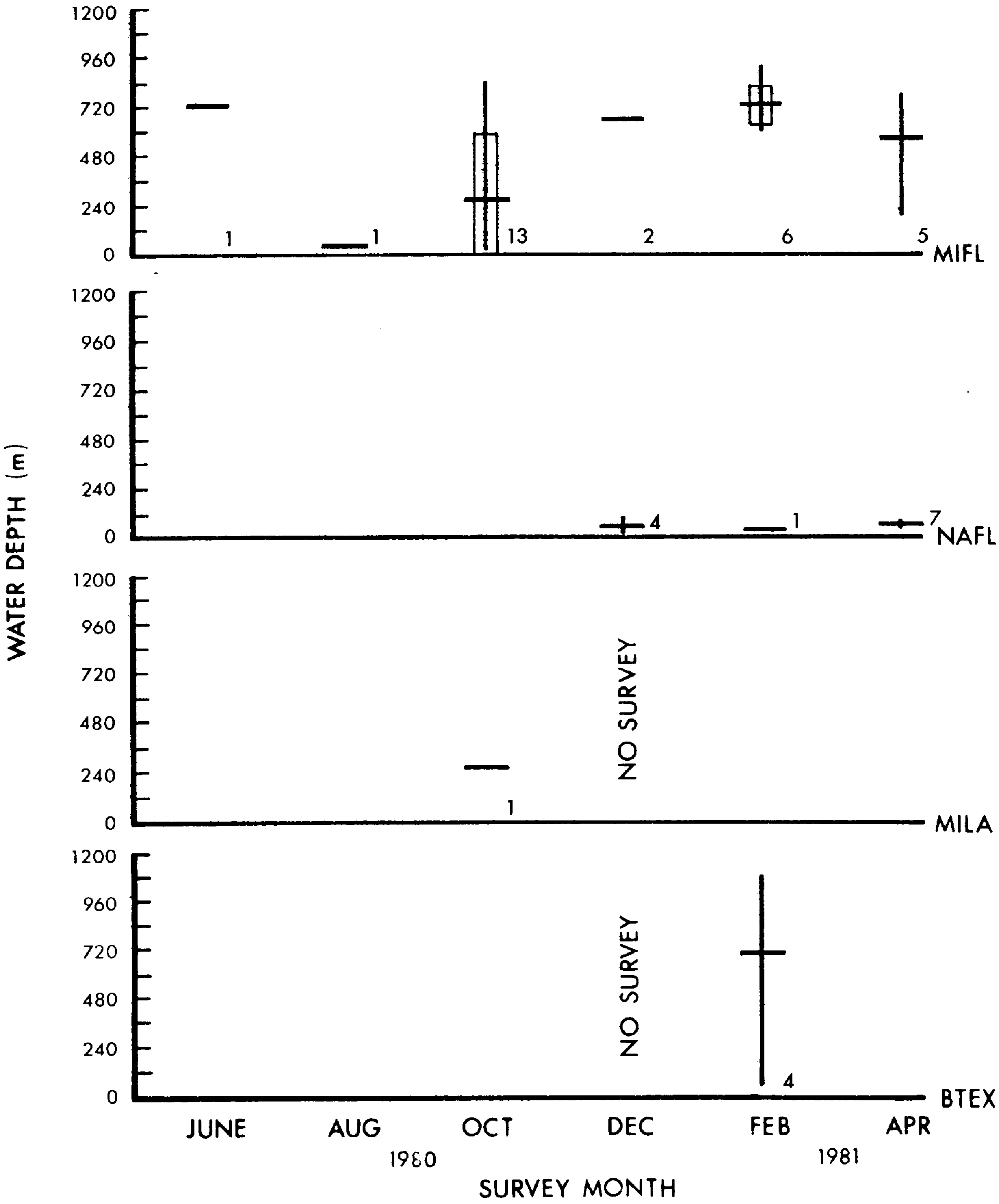


Figure 38. Water depth for all sightings of Audubon's Shearwaters by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

Table 16. A summary of associations between Audubon's Shearwater and other organisms or environmental features (i.e., water mass boundaries and sargassum). Some sightings were of associations including two or more animal groups, thus the subtotals are not cumulative. Other animals include marine mammals, birds, and fish. Other birds include Laughing Gull, Ring-billed Gull, Royal Tern, Sooty Tern, and Cory's Shearwater.

Audubon's Shearwater associations with	No. of shearwater sightings	Percentage of shearwater sightings	No. of birds	Percentage of birds
Other fauna (totals)	10	15	467	88
Unidentified fish	4	6	432	81
Other birds	10	15	467	88
Unidentified dolphins	2	3	2	1
Water mass boundaries and sargassum	3	4	32	6

BLACK-CAPPED PETREL, Pterodroma hasitata

The taxonomy of the Black-capped Petrel is uncertain. The AOU checklist (1957) recognized the Black-capped Petrel, Pterodroma hasitata, as a monotypic species. Palmer (1962) included six other forms as subspecies of P. hasitata including three which might occur in the study area: the Black-capped Petrel, P. h. hasitata, a dark-phase of the Black-capped Petrel, P. h. caribbaea (possibly extinct), and the Bermuda Petrel or Cahow, P. h. cahow. Sightings during aerial surveys were of the nominate, subspecies P. h. hasitata.

Description

The Black-capped Petrel is a heavy-bodied seabird with a relatively long, wedge-shaped tail and long, pointed wings (body length 35 to 46 cm; wingspan 89 to 102 cm) (Terres 1980). It is dark above with a distinct black cap, dark brownish gray back and wings, and a blackish tail. The dark upper parts are interrupted by a white forehead, a variable (light gray to white) collar, and a bold, white, rump patch. The underparts are white with broad dark margins on the wings. The bill is short and black with a hooked tip. The legs are pink and the feet are black. Flight is strong and fast with short sequences of wingbeats followed by gliding and banking (Palmer 1962). Frequent steep ascents to about 12 m above the sea surface followed by banking and rapid descending glides make this bird's flight distinctive.

From the air, the body shape and contrasting dorsal coloration are visible. Confusion with the Audubon's Shearwater, Greater Shearwater, and Cahow is possible if the bird is not seen clearly. The prominence of the collar varies. The large, white rump patch set against an almost black back and tail, and the black cap are distinctive.

Distribution

During aerial surveys, nine Black-capped Petrels were seen, five in the MIFL survey subunit and four off Onslow Bay, North Carolina. Supplementary sightings from boats include 1 off Daytona Beach, Florida, and 73 off Cape Hatteras, North Carolina (David Lee, North Carolina State Museum; pers. comm.). The large numbers seen during boat surveys off Cape Hatteras may have been attracted to the boat by chum. Five sightings during February, April, and June in the MIFL survey subunit ranged 90 to 188 km from shore.

During nonbreeding periods Black-capped Petrels may range off the Atlantic coast of North America from Florida to southern Canada (Clapp et al. 1982). They are found primarily over the Gulf Stream and occur nearshore only when sick or storm driven (Clapp et al. 1982). The only record for the Gulf of Mexico is of a bird that struck a television tower in the Florida Panhandle (Leon County) in the fall of 1964 (Stoddard and Norris 1967).

Breeding activity has been reported between early November and mid-May (Wingate 1964). Thus, birds seen in waters off the United States during the breeding season may be pre-breeders or nonbreeders (Clapp et al. 1982). Previously, breeding occurred on many islands in the West Indies, including Guadeloupe, Dominica, and possibly Martinique (Bent 1922; Murphy 1936). Presently the only known breeding areas are on the relatively inaccessible slopes of the La Selle Ridge, Haiti, and possibly in the Dominican Republic (Wingate 1964). The reduction of the breeding range has been related to the introduction of mongoose on several Caribbean islands (Bent 1922; Murphy 1936; Wingate 1964).

Abundance

Wingate (1964) estimated the breeding population of Black-capped Petrels on Haiti to be about 4,000 birds in 40 colonies. Off North Carolina, Black-capped Petrels are considered regular, but uncommon migrants (Lee and Booth 1979).

Black-capped Petrels were seen in the MIFL survey subunit from February to June. Sightings off North Carolina (Lee and Booth 1979) were most abundant during the spring (April to June) and the fall (September and October). The relative abundance of Black-capped Petrels in the spring coincides with the end of peak breeding activity (early April) in Haitian colonies (Wingate 1964). Florida's proximity to Haiti could explain the earlier occurrence in Florida waters, if Black-capped Petrels migrated or dispersed northward after the breeding season as suggested by Clapp et al. (1982).

Habitat Use

Black-capped Petrels in the MIFL survey subunit were seen over waters where surface temperatures ranged from 22° C in February to 27° C in June. Water depths ranged from 658 to 925 m. These data support reports that this species uses warm waters, generally off the continental shelf (Clapp et al. 1982).

Associations

During aerial surveys, two sightings were of birds over water mass boundaries. Lee and Booth (1979) reported that most sightings of Black-capped Petrels occurred near the western boundary of the Gulf Stream. More birds may be seen in these areas because food resources may be more abundant due to the increased productivity at current boundaries (Dustan et al. 1981).

Reproduction

No reproductive data were collected during aerial surveys. Black-capped Petrels nest in burrows in mountainous forests of Haiti where they are limited to sites with enough soil for digging (Wingate 1964). The breeding biology of the Black-capped Petrel is incompletely known, but is thought to be similar to that of the closely allied Cahow (Palmer 1962; Wingate 1964).

Behavior

Seven of eight sightings during aerial surveys were of single birds. The eighth sighting was of a pair of Black-capped Petrels. Little is known about group size of Black-capped Petrels, but sightings off North Carolina were frequently of single birds (Lee and Booth 1979).

The Black-capped Petrel is not adapted for diving (Clapp et al. 1982), and is thought to feed largely on squid taken at the surface of the water (Wingate 1964; Watson 1966). During aerial surveys, no sightings were of birds resting on the water. Feeding is probably crepuscular or noctural (Clapp et al. 1982).

Potential Impacts of OCS Development

Little data are available about the susceptibility of Black-capped Petrels to OCS development, but Clapp et al. (1982) considered *P. hasitata* relatively "invulnerable" to spilled oil. A single bird washed ashore "smeared with fuel oil" on Fairfield Beach, Connecticut, in October 1938 (Holman 1952). The cause of death could not be determined. The bird may have been killed by a hurricane that passed through the petrel's normal range, and subsequently grounded the bird on the Fairfield Beach. Oiling may have occurred after death. Because Black-capped Petrels feed by surface seizing, the direct effect of an oil or chemical spill on feeding would probably be minimal.

Summary

Nine Black-capped Petrels were seen from the air over the Gulf Stream in the MIFL survey subunit and off Onslow Bay, North Carolina. One was seen from a boat off Daytona Beach, Florida, and 73 were seen from boats off Cape Hatteras, North Carolina. Seasonal abundances could be related to migratory movement. The potential effects of oil development are not thought to be significant.

STORM PETRELS, Oceanodroma spp. and Oceanites sp.

Includes:
Leach's Storm Petrel, Oceanodroma leucorhoa
Harcourt's Storm Petrel, Oceanodroma castro
Wilson's Storm Petrel, Oceanites oceanicus

These three species of the Family Hydrobatidae are the storm petrels most likely to be seen in the study area. They are discussed together because individual species cannot be reliably distinguished when seen from the air.

Description

Storm petrels are small birds averaging about 18 cm in length; wingspans average 43 cm. Wilson's Storm Petrel is the smallest, with a body length of 15 to 19 cm, and a wingspan of 38 to 42 cm. Leach's Storm Petrel ranges from 19 to 21 cm in length and has a wingspan of 45 to 48 cm. Harcourt's Storm Petrel measures 19 to 21 cm in length and has a wingspan of 44 to 46 cm (Cramp et al. 1977). All three species are sooty brown to black with a prominent white rump patch. Tail shape varies in storm petrels: the tail is square in Wilson's, slightly forked in Harcourt's and deeply forked in Leach's. Wilson's Storm Petrel has longer legs than the other two species, and its feet extend beyond the tail when it flies. Wilson's Storm Petrel also has yellow patches on the webbing between each toe. The other two species have plain black feet. Storm petrels have a characteristically erratic fluttering flight and usually fly close to the water. The combination of small size, dark coloration, white rump patch, and erratic flight close to the water distinguish these birds when seen from the air. Detection from an aircraft is usually difficult because they are small and do not contrast well with the water.

Distribution

Storm petrels were sighted in the BTEX and MIFL subunits during April, June, August, and October, and in the MILA and NAFL subunits only during June (Figures 39 and 40). Since Leach's and Harcourt's Storm Petrels breed well away from the study area during these months, the species that was observed was probably Wilson's Storm Petrel.

Storm petrels were unevenly distributed over the study area. Of the 39 storm petrels sighted, 26 (67%) were sighted in and adjacent to the MIFL survey subunit, 8 (20%) were sighted in the BTEX subunit, 4 (10%) were sighted in the MILA subunit, and only 1 (3%) was sighted in the NAFL subunit.

More storm petrels were seen in June than in other survey months. Sixteen (41%) were seen in June surveys, 8 (21%) were seen in August surveys, 13 (33%) were seen in October surveys, and 2 (5%) were seen in April surveys. None were sighted during December and February surveys when Leach's and Harcourt's Storm Petrels are most likely to be in the study area (Clapp et al. 1982).

Wilson's Storm Petrel breeds in the Antarctic, north to about the subarctic convergence (Palmer 1962). It winters along the eastern and western shores of the Atlantic Ocean, in the Gulf of Mexico, in the Indian Ocean, and in the South Pacific Ocean.

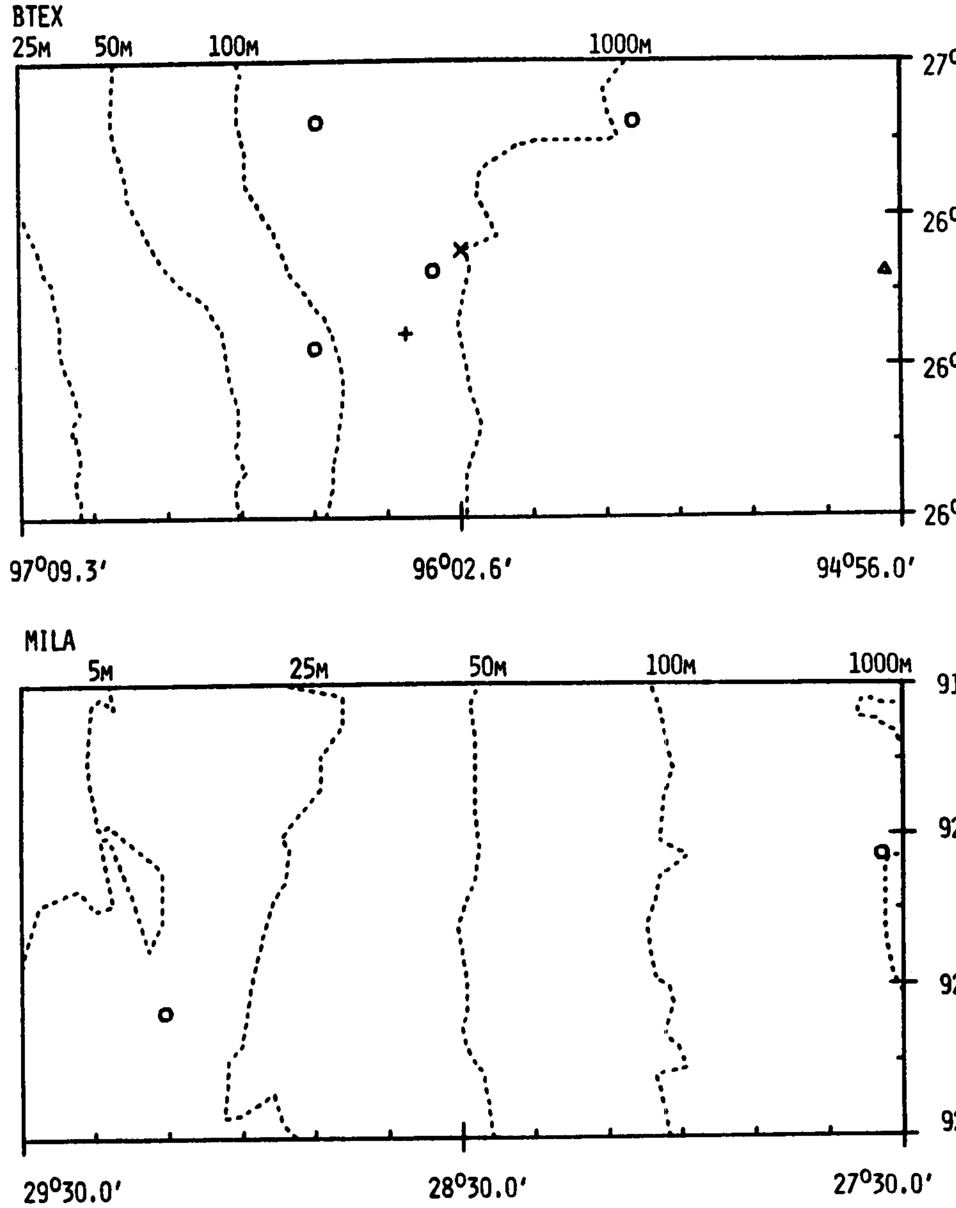


Figure 39. Distribution of all storm petrel sightings in the BTEX and MILA survey subunits during June (O), August (X), October (△), and April (+).

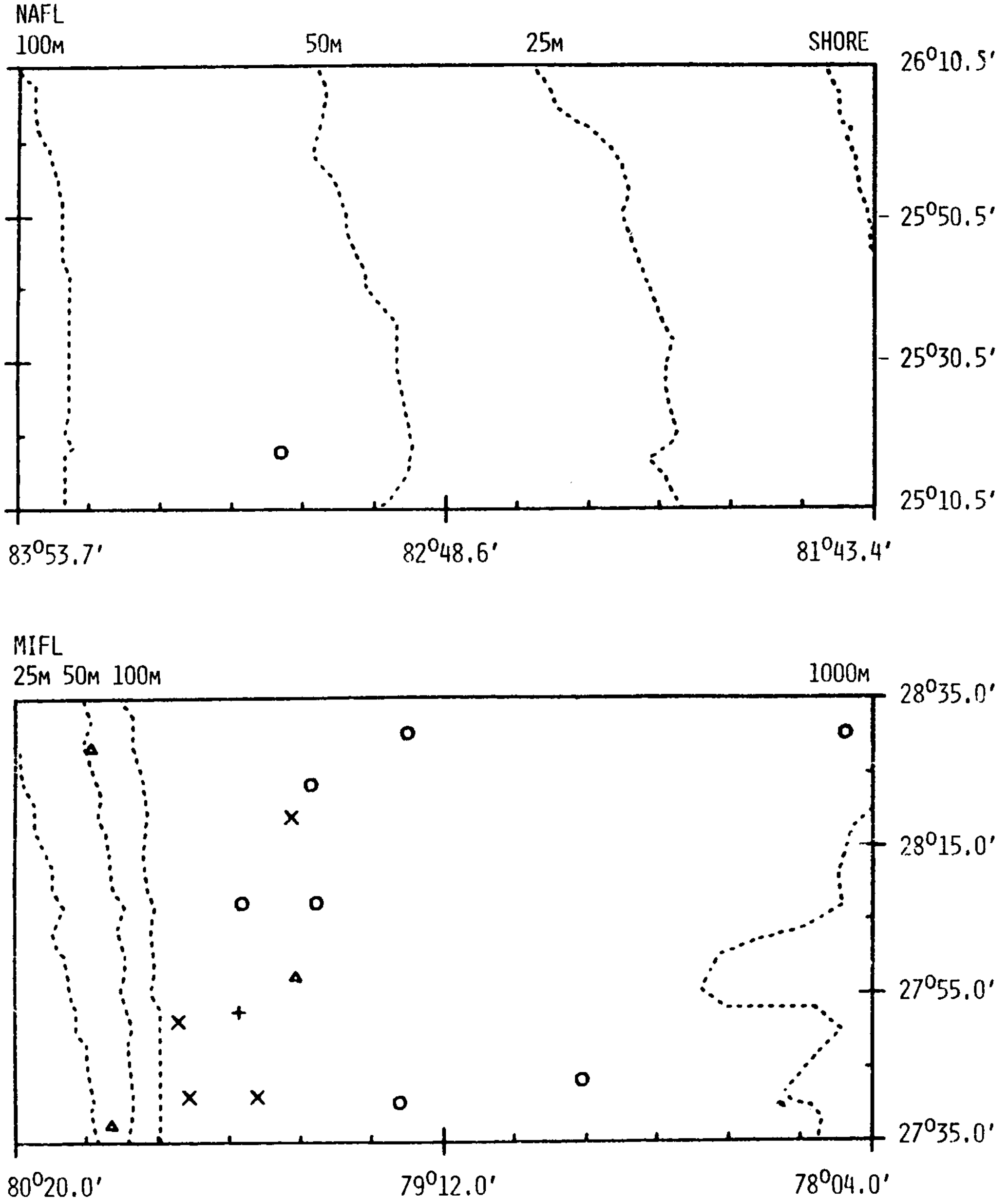


Figure 40. Distribution of all storm petrel sightings in the MIFL and NAFL survey subunits during June (O), August (X), October (△), and April (+).

Leach's Storm Petrel breeds on islands in or near the North Atlantic and North Pacific Oceans (Clapp et al. 1982). Its wintering range extends into the Southern Hemisphere. Although this storm petrel also occurs in Caribbean waters during winter, it is uncommon in the Gulf of Mexico (Clapp et al. 1982).

Harcourt's Storm Petrel is a straggler to eastern North America (Clapp et al. 1982), but its range at sea is poorly known. It breeds on oceanic islands in the Atlantic from St. Helena to the Azores, and in the Pacific Ocean on the Galapagos Islands, the Hawaiian Islands, and off Japan (Palmer 1962, Cramp et al. 1977).

Abundance

Many storm petrels may have been missed because they are difficult to sight from the air. Also, no birds were observed sitting on the water, which storm petrels are known to do. Therefore, there are probably more storm petrels in the study area than the survey results indicate.

The great abundance of storm petrels observed in the MIFL survey subunit is compatible with literature reports. Clapp et al. (1982) reported them to be more common in the Atlantic Ocean than in the Gulf of Mexico. The greater abundance in the BTEX subunit than in the NAFL subunit is surprising and conflicts with the report by Duncan and Havard (1980) that Wilson's Storm Petrels are more numerous in the eastern Gulf of Mexico, yet this survey is the first to look at these birds off the continental shelf of Texas.

Habitat Use

Storm petrels ranged 88 to 232 km from shore in the BTEX survey subunit, 40 to 228 km from shore in the MILA subunit, and from 31 to 236 km from shore in MIFL subunit (Figure 41). A single bird was sighted 206 km from shore in the NAFL survey subunit. Mean distances from shore, by month, ranged from 57 km offshore in October in the MIFL subunit to 163 km offshore in June in the MILA subunit. However, data are of limited value to describe distribution because relatively few storm petrels were sighted.

Except in breeding season, storm petrels are pelagic birds that only come ashore as wrecks (sick or storm-driven birds) (Palmer 1962). Wilson's Storm Petrel occurs inshore more often than Leach's Storm Petrel. The latter species often occurs over the continental shelf. Harcourt's Storm Petrel is highly oceanic and may spend little time over waters of the continental shelf (Clapp et al. 1982).

Storm petrels were sighted over waters ranging from 16 to 1,737 m in depth. Seventy-seven percent of the sightings occurred over waters greater than 100 m in depth. Average water depths for monthly surveys in the MIFL survey subunit ranged from 224 to 701 m (SD = 174). In the BTEX survey subunit, water depths ranged from 82 to 1,737 m (Figure 42). Although sample sizes are small, the average water depths at sighting locations indicate the pelagic distribution of storm petrels. Sea surface temperatures at locations where storm petrels were observed ranged from 23^{o} to 28^{o} C (Figure 43).

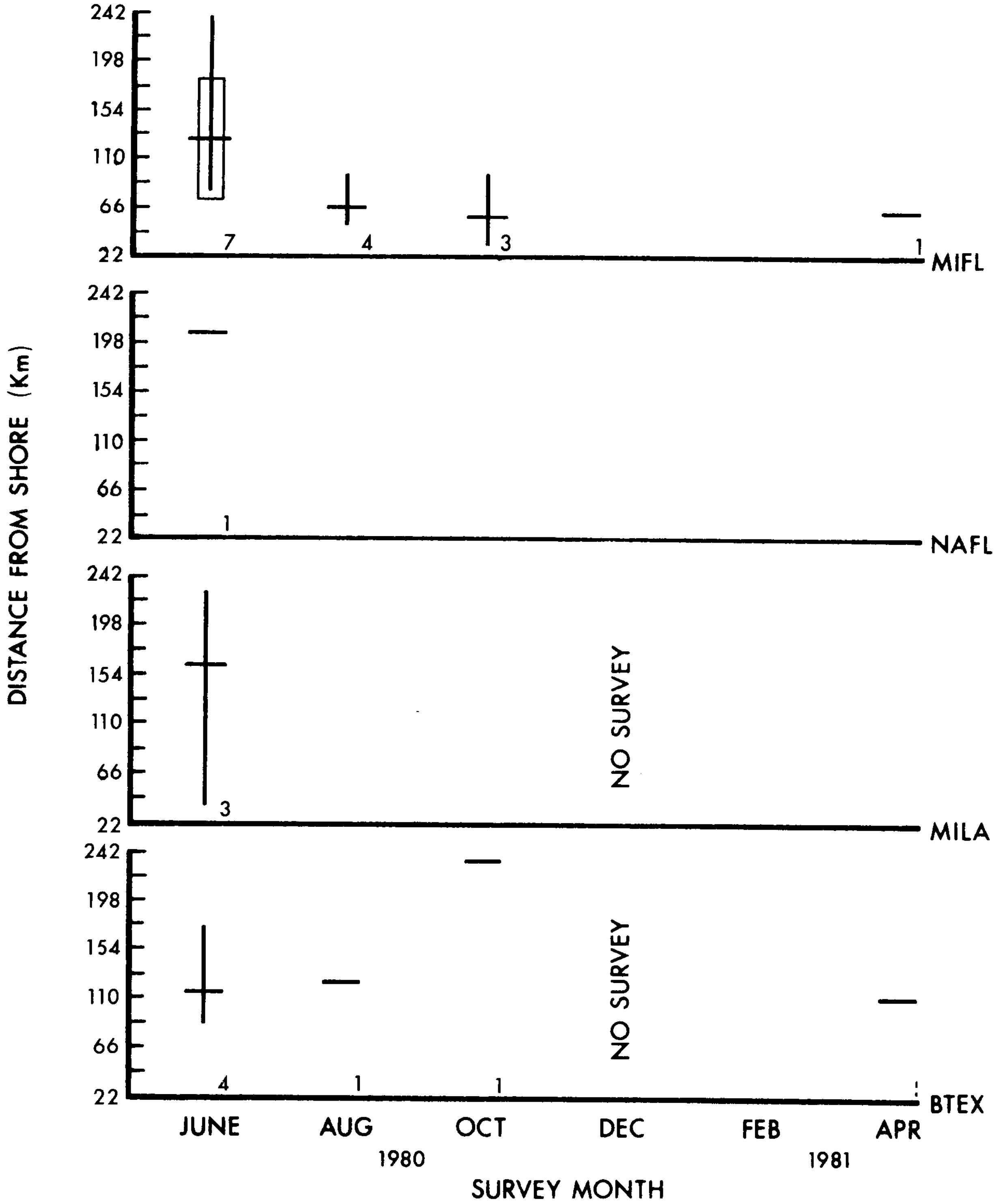


Figure 41. Distance from shore for all sightings of storm petrels by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

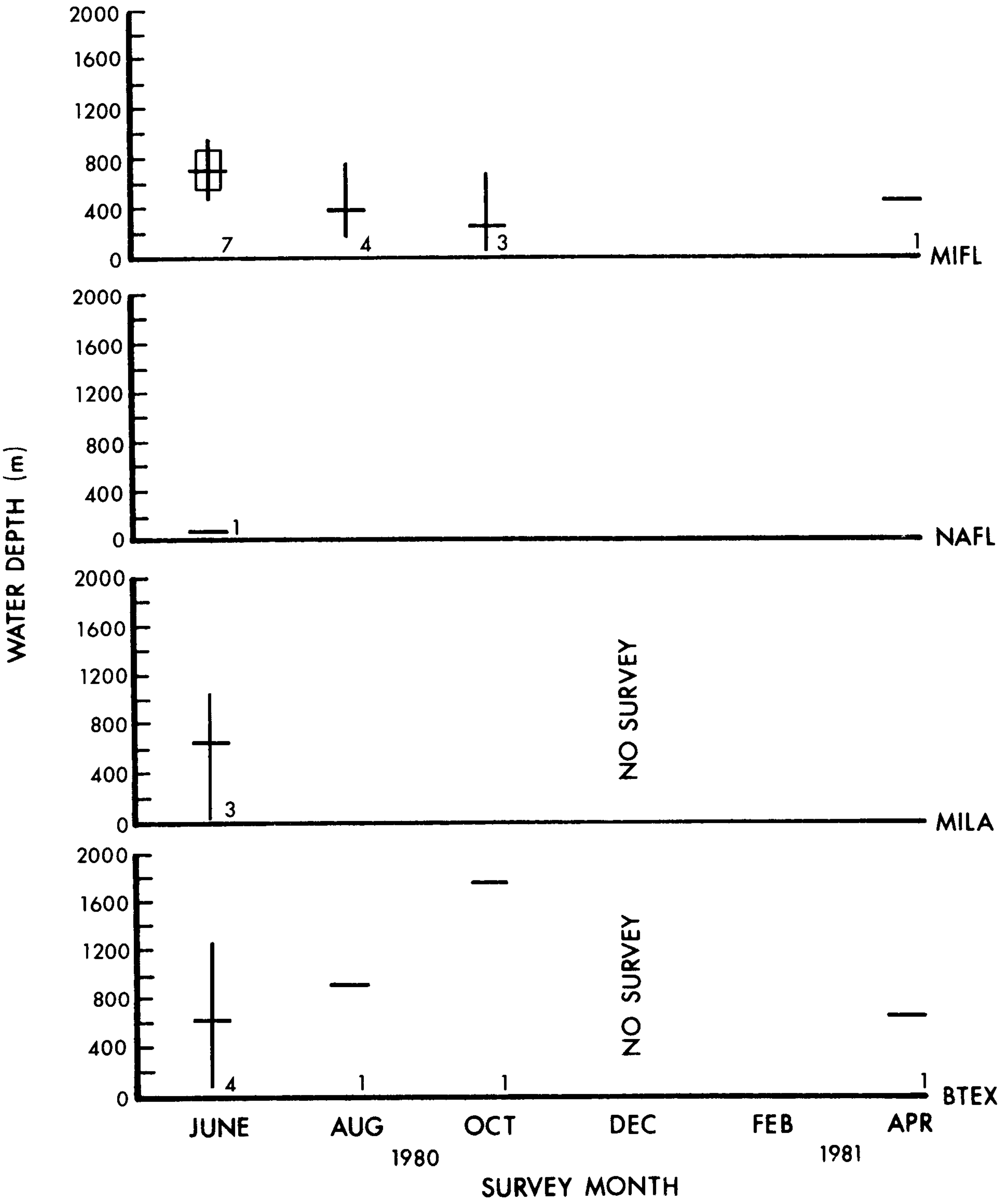


Figure 42. Water depth for all sightings of storm petrels by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

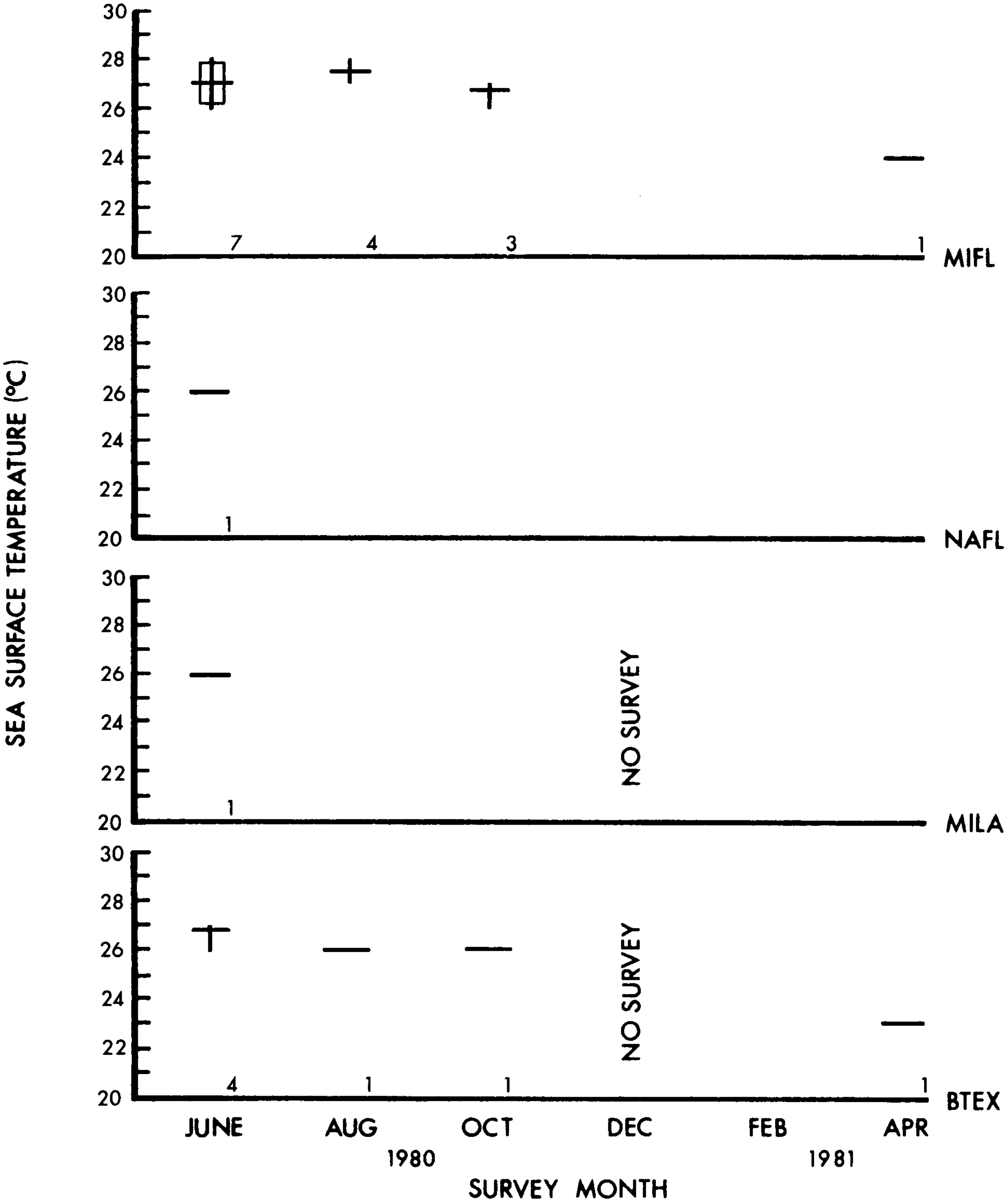


Figure 43. Sea surface temperature for all sightings of storm petrels by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

Associations

Seventeen of 31 sightings (55%) of storm petrels occurred near sargassum windrows and water masses. One storm petrel sighted during the 1979 aerial surveys (Fritts and Reynolds 1981) was flying over oil slicks.

Storm petrels tend to congregate near convergences of cold and warm water (water masses) where food organisms are most abundant (Palmer 1962). Storm petrels eat organisms such as crustaceans, cephalopods, eggs of mollusks, small fish, and some vegetation (Bent 1922; Palmer 1962) that can occur in these areas. They also eat fatty substances such as animal fats (blubber), and have been known to follow ships to eat waste dumped overboard (Palmer 1962).

Reproduction

None of the storm petrels considered here nest within the study area. All three species nest in burrows or in rock crevices, and lay only one egg per clutch. Wilson's Storm Petrels lay eggs from November to February, depending on latitude. Leach's Storm Petrels lay eggs from May to June. Time of nesting for Harcourt's Storm Petrel varies with the breeding area and population. For example, it seems there are two populations of Harcourt's Storm Petrel that nest on Galapagos, each breeding annually, but six months out of phase (Cramp et al. 1977). The incubation period for all three species is 42 to 45 days. Age at fledging is about 46 to 70 days (Cramp et al. 1977; Clapp et al. 1982).

Behavior

Available information suggests that storm petrels travel singly or in small flocks, but congregate near food sources. Wilson's Storm Petrel flies close to the water's surface and sometimes patters its feet on the surface when feeding (Bent 1922). Leach's and Harcourt's Storm Petrels also fly low over the water, but their feet do not touch the water while feeding. Wilson's Storm Petrels circle over the wake of ships, looking for waste dropped overboard.

Wilson's and Leach's Storm Petrels feed mostly by dipping (picking organisms from the surface of the water while in flight). They also land on the water to feed. Not much is known of the feeding behavior of Harcourt's Storm Petrel, but it is assumed to be similar to that of other storm petrels. Only Wilson's Storm Petrel is known to dive beneath the surface for food (Bent 1922).

Recent studies by Grubb (1972) and Hutchison and Wenzel (1980) demonstrated that Procellariiforms use olfaction in search of food. The importance of visual cues, such as slicks from a carcass, to the foraging of storm petrels and other procellariiforms is unknown.

Potential Impacts of OCS Development

Of the three species of storm petrel under consideration here, only the Leach's Storm Petrel has been found fouled by oil (Clapp et al. 1982). Although the other two species have not been reported to be directly impacted, their similar habits, such as surface feeding, make fouling a possibility. A bird fouled by oil at sea can transfer oil to its eggs or young, its mate, and its burrow. Olfaction is used to locate the nest burrow (Grubb 1974). Storm petrels might have difficulty relocating a burrow fouled with oil. Storm Petrels are known to locate food, such as fatty substances, by smell although visual cues, such as a slick from the fatty substances, may attract them.

As mentioned above, Wilson's Storm Petrels follow ships. Ships "cleaning out" tanks or otherwise releasing oil could pose a hazard to storm petrels. It is not known if storm petrels would be attracted to or would avoid oil slicks. Clapp et al. (1982) reported that storm petrels are attracted to lighthouses and the lights of ships at night, and that they may be attracted to oil rigs and platforms, and possibly gas flares.

Summary

Leach's, Harcourt's, and Wilson's Storm Petrels are difficult to differentiate when observed from the air. Storm petrels were observed in all four survey subunits, and in April, June, August, and October. Wilson's Storm Petrels are reported to be more common than the other species in the study area. Effects of OCS development include fouling of birds, and indirect fouling of eggs, young, and nesting burrows.

TROPICBIRDS, *Phaethon* spp.

Includes: White-tailed Tropicbird, *Phaethon lepturus*
Red-billed Tropicbird, *Phaethon aethereus*

Because tropicbirds could not always be identified to species and were uncommon in the aerial surveys, White-tailed Tropicbirds, Red-billed Tropicbirds, and unidentified tropicbirds are discussed together.

Description

Tropicbirds were reviewed by Palmer (1962) from which the following descriptions were summarized. Adult tropicbirds are white tern-like seabirds with two long (over 30 cm) central tail feathers, pointed wings, heavy bills, and a lateral black stripe through the eye. The White-tailed Tropicbird has an orange bill, a white back, black on the outer primaries, and a black stripe on the wing from the wrist feathers to the scapulars. The Red-billed Tropicbird has a red bill, black barring on the back, and black wingtips. Immatures of both species have variable black bars on the neck and back, and lack the long tail feathers. Adult plumage is attained during the third year in White-tailed Tropicbirds, but age at maturity is not known for Red-billed Tropicbirds. Tropicbirds in general are solitary and pelagic. They fly with rapid pigeon-like wingbeats and seldom glide.

From an aircraft, a tropicbird's white color and long tail feathers are distinctive. The location of the black markings, either on the wings or on the back, are useful to differentiate the species. Bill color is difficult to see from the air. The Red-billed Tropicbird was not identified in the study area but may have been included in sightings of unidentified tropicbirds.

Distribution

A total of six tropicbirds was sighted in the study area (Table 17). A single White-tailed Tropicbird was observed in the MILA survey subunit, and another was seen near the Dry Tortugas. Three unidentified tropicbirds were sighted in the MIFL survey subunit and one was sighted in the NAFL survey subunit.

White-tailed Tropicbirds were sighted in the MILA survey subunit during August 1980 and near the Dry Tortugas during April 1981. Unidentified tropicbirds were observed in the MIFL survey subunit during August and October 1980, and in the NAFL survey subunit during April 1981. There are not enough sightings to distinguish any seasonal distribution patterns. The single White-tailed Tropicbird sighted in the MILA survey subunit is important since there is only one other record of this species from Louisiana waters (Lowery 1974b).

Tropicbirds generally are associated with warm tropical waters (Bent 1922). The White-tailed Tropicbird has a widespread distribution and is more likely to be seen in the study area than the Red-billed Tropicbird. In the western Atlantic, White-tailed Tropicbirds are distributed around Bermuda, the Bahamas, and other islands in the Caribbean, south to Ascension Island; Red-billed Tropicbirds are found in the West Indies and off South America (Palmer 1962; Terres 1980; Clapp et al. 1982). Both species of tropicbirds are most often sighted offshore (Clapp et al. 1982), and they are known to range hundreds of kilometers from land (Terres 1980).

White-tailed Tropicbirds are migratory in the northern part of their range, moving south in the fall. Seasonal movements are not known for Red-tailed Tropicbirds (Bent 1922; Palmer 1962).

Abundance

The number of sightings was too few to permit density calculations. Tropicbirds are sighted only occasionally in the eastern U.S. Only 87 records of White-tailed Tropicbirds are available for the study area, and these are from every coastal state except Mississippi (Clapp et al. 1982). Over half of the records are from Florida. Only four Red-billed Tropicbirds have been reported in the study area (two from East Florida and two from North Carolina) (Clapp et al. 1982).

Seasonal patterns are not obvious from the aerial survey data. Tropicbirds have not been reported in the study area during the months of January and February (Clapp et al. 1982). This suggests that they are absent during the winter.

Habitat Use

The locations of all tropicbird sightings (Table 17) were 64 to 94 km offshore in the MIFL survey subunit ($\bar{x}$ = 76 km; n = 3), 98 km offshore in the NAFL survey subunit (n = 1), 37 km offshore in the MILA survey subunit (n = 1), and 6 km from the Dry Tortugas (n = 1).

Water depth at the locations of White-tailed Tropicbird sightings was 7 m in the MILA survey subunit (n = 1) and 18 m near the Dry Tortugas (n = 1). Unidentified

Table 17. Sighting information on the White-tailed Tropicbird and unidentified tropicbirds. OPPO = opportunistic flight.

Survey subunit	Date	No. of birds	Position (Latitude/Longitude)	Distance from shore (km)	Water depth (m)	Sea surface temperature (° C)
WHITE-TAILED TROPICBIRDS						
MILA	05 Aug. 1980	1	29°09.7'N/92°01.2'W	37	7	28
OPPO	09 Apr. 1981	1	24°35.4'N/82°51.7'W	6	18	23
UNIDENTIFIED TROPICBIRDS						
NAFL	08 Apr. 1981	1	25°33.7'N/82°35.0'W	98	34	21
MIFL	11 Aug. 1980	1	28°18.5'N/79°48.5'W	64	311	27
MIFL	12 Aug. 1980	1	27°40.9'N/79°'30.8'W	94	732	27
MIFL	11 Oct. 1980	1	28°08.0'N/79°50.7'W	70	307	26

tropicbirds were observed over water depths of 307 to 732 m in the MIFL survey subunit ($\bar{x} = 450$; n = 3) and 34 m in the NAFL survey subunit (n = 1; Table 17).

Tropicbirds generally range over pelagic waters. Inshore and nearshore records are few (Palmer 1962; Clapp et al. 1982). They require clear water for sighting prey, and avoid continental coasts and associated murky waters (Oberholser 1974). Even though the sighting in the MILA survey subunit was in shallow water, it was about 37 km from land.

The sea surface temperatures at locations of all tropicbird sightings ranged from 21° to 28° C (Table 17). Generally, tropicbirds are dispersed in warm oceanic waters (Clapp et al. 1982).

Associations

The White-tailed Tropicbird sighted in the MILA survey subunit was associated with a mixed flock of about 150 Laughing Gulls and Royal Terns flying behind a shrimp boat.

Reproduction

Tropicbirds generally nest on oceanic islands (Bent 1922; Palmer 1962; Clapp et al. 1982). The breeding season is variable. Tropicbirds are sometimes gregarious at breeding sites. They do not build nests and usually lay a single egg on bare rock or soil, often on cliff edges. Incubation is about 40 to 45 days. The eggs are tended by both sexes. The young are fed by regurgitation. Age at fledging is about 70 to 80 days.

Behavior

Except for the individual in the MILA survey subunit, all tropicbirds sighted in the surveys were solitary when sighted. Tropicbirds are generally pelagic wanderers that are sighted as singles or pairs outside breeding areas (Palmer 1962). Tropicbirds feed by diving from a height and capturing prey (usually squid or small fish) underwater. They eat while on the water and do not fly with prey in their beaks (Palmer 1962).

Potential Impacts of OCS Development

The effects of oil and OCS development on Red-billed Tropicbirds are not clearcut, but oiled White-tailed Tropicbirds have been reported in Bermuda (Wingate 1978). Heavy concentrations of tar have been recorded in the Sargasso Sea which is the summer habitat for the small population of White-tailed Tropicbirds from Bermuda. Floating tar may stick to the feathers when the birds are sitting on the water and could affect plumage water-repellency, thermoregulation, and perhaps reproductive success if passed on to chicks during nesting.

The tropicbird's habit of diving for food could bring it in contact with an oil spill. However, the risk of contact with an oil spill is probably minimal because most oil spills occur in nearshore areas (Sowls et al. 1980), and tropicbirds prefer pelagic environments.

Summary

Two White-tailed Tropicbirds were sighted, including one which is the second record for the species in Louisiana. Four unidentified tropicbirds also were sighted in the study area. Tropicbirds were observed in August, October, and April.

AMERICAN WHITE PELICAN, *Pelecanus erythrorhynchos*

Description

The American White Pelican is one of the largest birds in the study area (1.3 to 1.6 m long, 2.4 to 2.9 m in wingspan) (Palmer 1962). Adults are white with black on the wing primaries and secondaries. The long bill (26 to 36 cm) (Palmer 1962) is orange and has a conspicuous throat pouch used in catching fish. Immature coloration is dusky with a streaked dark head and gray bill. The white coloration of adults is attained in the first year (Palmer 1962). Sexual maturity is reached at 3 years of age. White Pelicans are gregarious and often fly in flocks in single file or V-formation. In flight, the head is drawn back so that the bill rests on the breast. They do not plunge for food as Brown Pelicans do, but feed while sitting on the surface of the water. White Pelicans are found most frequently over shallow coastal areas and interior bodies of water (Palmer 1962).

From an aircraft, the White Pelican is distinguished from all other birds by its large size, orange bill, and white coloration with black on the wings.

Distribution

White Pelicans were seen near all survey subunits except NAFL but only one group of three birds was sighted during on-line surveys. White Pelicans were sighted most often near the MILA survey subunit (10 sightings, 395 birds; Table 18). However, more birds were sighted near the BTEX survey subunit (seven sightings, 453 birds). Near the MIFL survey subunit, 139 White Pelicans were observed in five sightings. In opportunistic flights near the MIFL subunit and Mississippi Sound, 228 White Pelicans were sighted. White Pelicans were rarely observed as single animals. Sometimes groups of 200 to 400 birds were seen over distances of several kilometers.

White Pelicans were sighted in October and December 1980 and February 1981 near the MIFL survey subunit and in the October, February, and April surveys near both the MILA and BTEX subunits. The birds probably were present near MILA and BTEX during December, but December surveys were not flown there.

The seasonal distribution of aerial survey sightings is compatible with literature on movements of White Pelicans from coastal areas in spring and summer months. The range of the White Pelican extends from Canada to Central America, and they have been reported from nearly all parts of the U.S. (Palmer 1962). Breeding areas are located primarily in the north, but a few birds nest in South Texas (Sloan 1973; Oberholser 1974). Most migrate south in the fall. Generally, breeding pelicans return north in the early spring, but immature birds may not migrate until late spring (Bent 1922; Palmer 1962; Clapp et al. 1982). On the west coast of Florida, White Pelicans tend to winter in the Cape Sable area (Clapp et al. 1982).

White Pelicans may not have been observed near the NAFL survey subunit because transit routes were through unsuitable habitat. Most of the inshore boundary of the NAFL subunit was further from shore than the inshore boundaries of other subunits. Due to the location of the study area in relation to the primary airport used, transits to and from the NAFL survey subunit were flown mostly over open waters where White Pelicans are uncommon. Transits to and from the other subunits generally were flown parallel to the coast over coastal and inland waters, which are frequented by White Pelicans.

Abundance

The number of on-line sightings (one sighting of three birds in the MILA subunit) was too few to permit density calculations. The U.S. breeding population of White Pelicans was estimated to include over 33,000 birds (Sloan 1973). The total adult population of breeding and nonbreeding White Pelicans in the United States was estimated at over 40,000 (Lies and Behle 1966). Few detailed estimates of abundance near survey subunits exist, but concentrations of birds are known in East and West Florida, South Louisiana, and South Texas (Oberholser 1938, 1974; Lies and Behle 1966; Sloan 1973).

No White Pelicans were seen during the summer (Table 18) probably because of migration to northern breeding areas. The birds sighted during April 1981 suggest that some White Pelicans do not leave the Louisiana coast until late spring.

Table 18. The number of American White Pelicans sighted near subunits during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits							
	BTEX		MILA		NAFL		MIFL	
June	0		0		0		0	
August	0		0		0		0	
October	52	(3)	221	(6)	0		30	(1)
December	-		-		0		22	(1)
February	34	(2)	70	(2)	0		87	(3)
April	367	(2)	104	(2)	0		0	
TOTAL	453	(7)	395	(10)	0		139	(5)

Habitat Use

Of the White Pelicans seen on scheduled surveys, over 99% (984 birds) were sighted offline (i.e., outside subunit boundaries) over coastal or inland waters. Near the MIFL survey subunit, they were observed 0 to 5 km from shore ($\bar{x}$ = 2 km, n = 2 sightings). Near the MILA survey subunit, White Pelicans were seen 0 to 23 km from land ($\bar{x}$ = 6 km, SD = 8.9, n = 7 sightings). Near the BTEX survey subunit, they were sighted only in inland locations and were not seen offshore. The sighting locations are compatible with reported preferences of White Pelicans for nearshore and inland areas (Palmer 1962; Clapp et al. 1982).

Two White Pelicans near the MIFL survey subunit were sighted over water 0 and 11 m deep. Near the MILA survey subunit, they were seen over water of 0 to 5 m deep ($\bar{x}$ = 1.6 m, n = 5 sightings). Near the BTEX survey subunit, White Pelicans were observed only over land or extremely shallow inland waters for which water depth data were not recorded.

Sea surface temperatures at locations where White Pelicans were sighted are available only for the MILA survey subunit. The single on-line sighting in October was over 22° C water, and the two outside the subunit in February were over 13° C water. Temperature preferences of White Pelicans are not apparent in the literature. Because White Pelicans winter in coastal areas where waters are susceptible to marked temperature changes, sea surface temperatures for White Pelican sightings are expected to span a wider range than we observed.

Reproduction

White Pelicans rarely breed in coastal areas, but the nesting area in Laguna Madre of South Texas is an exception (Oberholser 1974). Nesting is generally near inland lakes in the northern parts of the range (Knopf 1979; Knopf and Kennedy in press). Usually, White Pelicans nest on the ground and lay two eggs (Palmer 1962). Incubation is about 30 days, and the nest is tended by both sexes (Knopf 1979). The young are fed by regurgitation and fledge about 3 months after hatching (Knopf 1979). Disturbance by humans is a major contribution to nest loss (Knopf and Kennedy in press).

Behavior

White Pelicans were often observed on the shore, on sandbars, and on the water. Other sightings involved birds flying over coastal waters and the shore line. In one sighting, White Pelicans were observed flying in a V-formation. Similar behavior has been described by Palmer (1962). White Pelicans often synchronize their movements when flying or feeding in flocks. They feed on fish by plunging the head underwater from a sitting position and scooping up prey in the pouch (Palmer 1962). They limit feeding to within 1 m of the water's surface (Knopf in press; Knopf and Kennedy in press).

Potential Impacts of OCS Development

There is one report of a White Pelican becoming too oiled to fly (Behle 1958); otherwise, the effects of OCS development on this species have not been documented. The preference of White Pelicans for coastal waters and the habit of feeding from the surface of the water increases their vulnerability to oil spills and especially during winter months when numbers are elevated by migrants. The colony breeding in southern Texas would be susceptible to contact with coastal oil and gas activities on a year-round basis.

Summary

White Pelicans were sighted near the MIFL, MILA, and BTEX survey subunits from the October 1980 through April 1981. The lack of sightings in the NAFL survey subunit may have resulted from the placement of transit routes through inappropriate habitats. The absence of White Pelicans in the summer corresponds with their seasonal migration to northern areas. White Pelicans were most common over shallow coastal areas and inland bodies of water outside of the regular survey subunits used in this study.

BROWN PELICAN, *Pelecanus occidentalis*

Description

The Brown Pelican is a large bird (over 1 m long) with a broad wingspan (about 2 m) and a long bill (28 to 34 cm) (Palmer 1962). Adult coloration is generally brown tinged with silvery gray. Primaries are blackish brown, and the feet and legs are black. The head and neck of adults are white to pale yellow, but the neck becomes reddish brown in breeding birds. Immature birds are brown to grayish brown on the head and neck, and attain adult coloration at about 2 to 4 years of age (Clapp et al. 1982). The sexes are similar in appearance, but males are slightly larger (Terres 1980).

Brown Pelicans are gregarious and often fly in flocks, usually in single file. Generally, they fly with the head hunched back on the shoulders and the bill resting on the breast. They feed on fish by plunging into the water from the air. They may be seen gliding (often low to the water), sitting on land or structures near the water, or floating on the water.

From the air the Brown Pelican is distinctive and unlikely to be confused with other birds because of its large size, long bill, coloration, and flight characteristics.

Distribution

Brown Pelicans were observed in all survey subunits. They also were sighted during opportunistic surveys north of the MIFL survey subunit, south of the NAFL survey subunit, and near the north end of the Chandeleur Islands in Louisiana.

A total of 1,252 Brown Pelicans were sighted during scheduled surveys: 987 near the MIFL survey subunit, 243 in the NAFL survey subunit, 1 in the MILA survey subunit, and 21 in the BTEX survey subunit (Table 19). During opportunistic surveys, 25 Brown Pelicans were observed north of the MIFL survey subunit, 67 south of the NAFL survey subunit, and 4 near the Chandeleur Islands in Louisiana.

The greater abundance of Brown Pelicans in the Florida subunits compared with other subunits corresponds to reports from other sources. The population of Brown Pelicans in Florida is essentially stable (Schreiber and Risebrough 1972; Williams 1978), and is estimated to consist of approximately 30,000 birds (Schreiber 1978). This is the largest population in the United States.

Over four times as many Brown Pelicans were seen in the MIFL survey subunit as in the NAFL survey subunit. This conflicts with estimates of relative abundance from the literature (National Fish and Wildlife Service 1980a; Clapp et al. 1982). According to Clapp et al. (1982), Brown Pelicans are more abundant in western Florida: about two-thirds of the Florida colonies are on the Gulf of Mexico coast. Colonies in eastern and western Florida apparently do not mix (NFWL 1980a). Most (84%) of the Brown Pelicans sighted during the surveys were seen offline. Transits to and within the MIFL subunit often were flown along the coastline where Brown Pelicans were prevalent, whereas transits to and within the NAFL survey subunits were flown mostly over open water where Brown Pelicans were less common. The difference in transit routes probably resulted in the disproportionate abundance of Brown Pelicans between the two Florida subunits.

Brown Pelicans were once prevalent in Louisiana, including the MILA subunit, but became virtually extinct in the late 1950's. Early estimates placed the number of breeding Brown Pelicans in Louisiana at 75,000 to 85,000 (Arthur 1931), but 10,000 (Oberholser 1938) is probably a more accurate estimate for the time (Williams 1978). The number had decreased to about four birds by 1960 (NFWL 1980a). The population decline was largely the result of natural phenomena (i.e., hurricanes and freezes) and chemical pollutants in the environment (Schreiber and Risebrough 1972; Lowery 1974b; Blus et al. 1975, 1979; King et al. 1977; NFWL 1980a). Efforts began in 1968 to reestablish a breeding population of Brown Pelicans in Louisiana by introducing birds from Florida (Nesbitt et al. 1978). These efforts have continued with varying success to the present. In 1976, the number of Brown Pelicans in Louisiana was estimated to be

Table 19. The number of Brown Pelicans sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits			
	BTEX	MILA	NAFL	MIFL
June	0	0	19 (14)	3 (3)
August	15 (3)	0	63 (7)	5 (3)
October	6 (4)	0	8 (1)	80 (1)
December	-	-	8 (6)	223 (6)
February	0	0	35 (13)	92 (21)
April	0	1 (1)	110 (61)	584 (36)
TOTAL	21 (7)	1 (1)	243 (102)	987 (70)

about 400 birds (Williams 1978). All nesting colonies are located well away from the MILA survey subunit.

Only about 2% of the Brown Pelicans seen were in the BTEX survey subunit. Apparently, the population of Brown Pelicans in Texas has never been as large as the Florida population. On the Texas coast, the breeding population was once estimated to be about 5,000 birds (Pearson 1921), but the number began declining during the 1920's and 1930's largely because of disturbance by humans (Oberholser 1974; King et al. 1977). The decline continued in part as a result of pesticide pollution in the 1940's, according to the Texas Parks and Wildlife Department (TPWD 1979). By the early 1960's, annual bird counts recorded no Brown Pelicans on the Texas coast (Oberholser 1974). Currently, the Texas population appears to be slowly increasing. In 1978, there were 25 breeding pairs, and the summer and fall population included as many as 400 birds (TPWD 1979). Banding studies indicated that most of the summer and fall population came from outside the State, and most of the Brown Pelicans in Texas are now in the southern part of the State (TPWD 1979) near the BTEX survey subunit.

In the Florida subunits, Brown Pelicans were seen during every survey month. The Brown Pelican sighted in the MILA survey subunit was seen during April 1981. In the BTEX survey subunit, Brown Pelicans were observed only in August and October 1980. More Brown Pelicans (56% of all observations) were seen in the MIFL and NAFL survey subunits in April than in any other survey month (Table 19). The abundance of Brown Pelican sightings during April may be associated with the nesting season (Schreiber 1980).

The largest variation in distance from shore for Brown Pelicans was consistently in the NAFL survey subunit (ranging from 0 to 99 km; Figures 44 and 45). Brown Pelicans

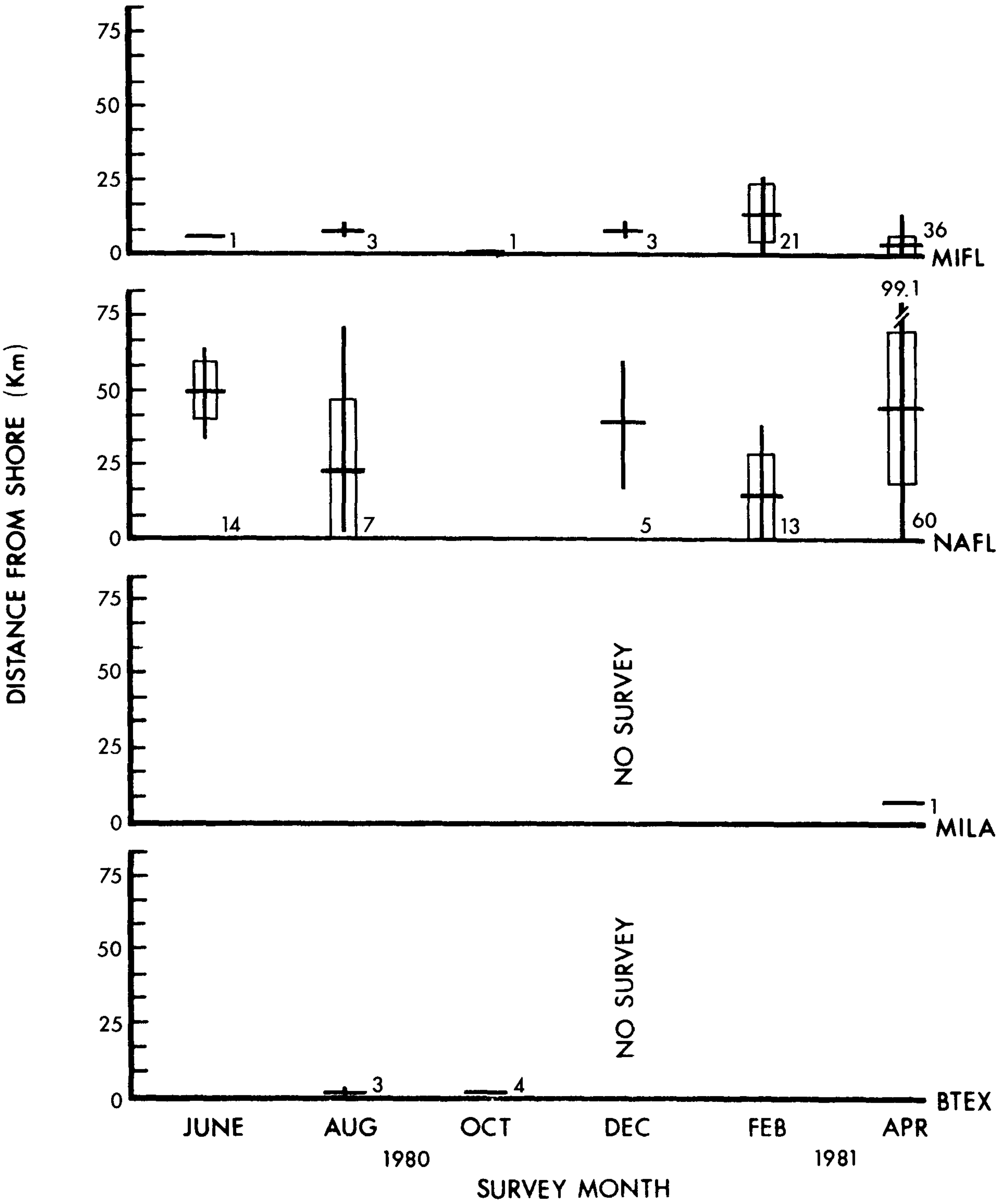


Figure 44. Distance from shore for all sightings of Brown Pelicans by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

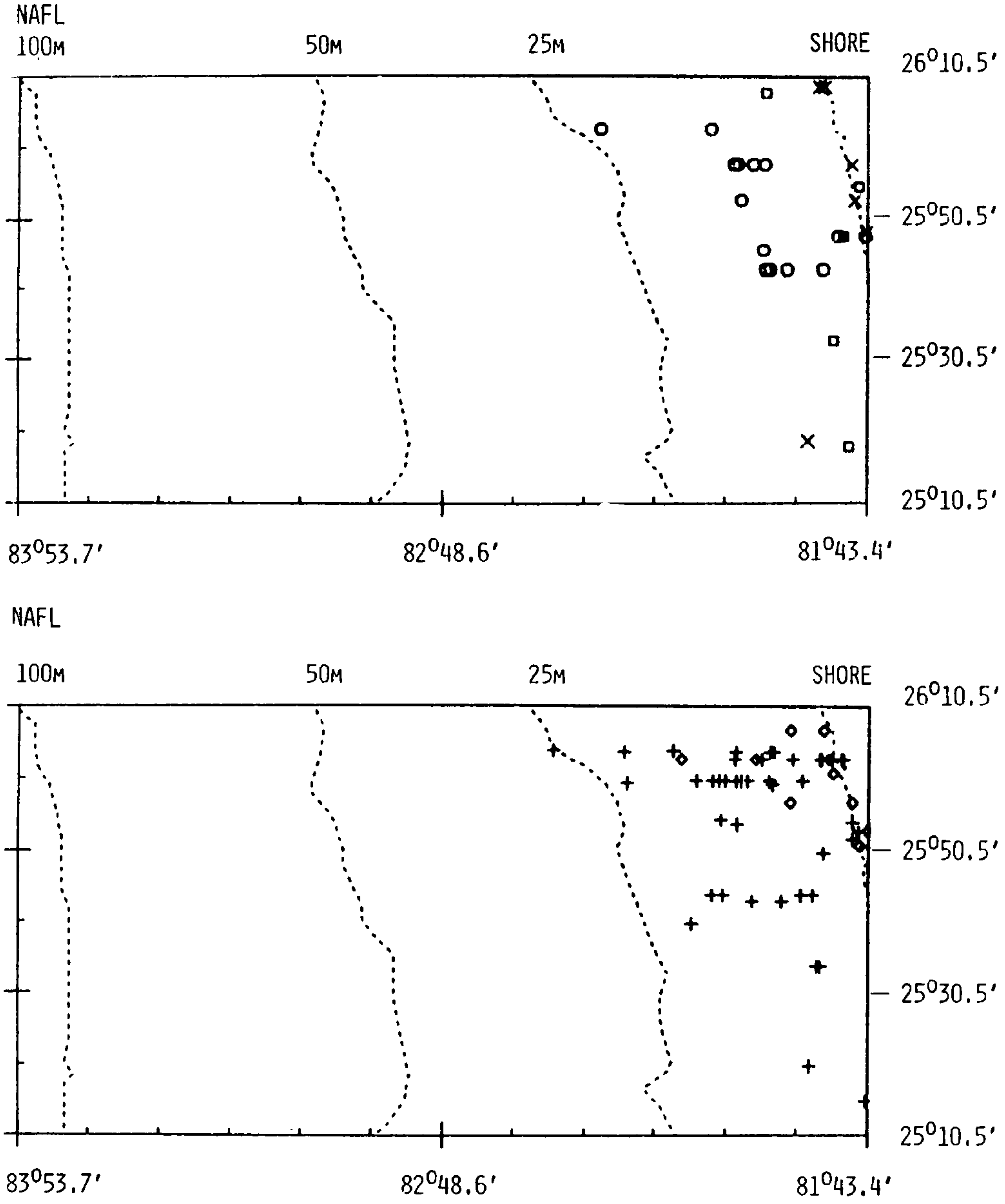


Figure 45. Distribution of all Brown Pelican sightings in the NAFL survey subunit during June (O), August (X), December (□), February (◇), and April (+).

were sighted as much as four times as far from land in NAFL as in other survey subunits. In the MIFL survey subunit, Brown Pelicans ranged 0 to 24 km from shore (Figures 44 and 46). In the BTEX survey subunit, they were distributed from 0 to almost 2 km from land, and in the MILA survey subunit a Brown Pelican was sighted 6.5 km from the coast (Figures 44 and 47). On opportunistic surveys, the distance from shore of Brown Pelican sightings generally was similar to that observed within the survey subunits.

The survey results are in agreement with the literature reports. Brown Pelicans are seldom observed more than 32 km offshore "except to take advantage of especially good fishing conditions" (Williams 1978). However, Schreiber (1978) stated that the Brown Pelican may range 30 to 60 km out to sea. During aerial surveys, Fritts and Reynolds (1981) observed them only within 40 km of land off western Florida.

Brown Pelicans are found mostly in shallow coastal areas (Palmer 1962; Schreiber 1978; Williams 1978). In the Atlantic Ocean, they are distributed from northern South America to North Carolina, including the Gulf of Mexico, according to National Fish and Wildlife Laboratory (NFWL 1980a) and Terres (1980). Presently they are uncommon in Texas and in the northern Gulf of Mexico, but are abundant in peninsular Florida (Schreiber and Risebrough 1972; Oberholser 1974; Schreiber 1978; Williams 1978).

In Louisiana, the only Brown Pelican colonies consist of birds (and their progeny) introduced from Florida to Queen Bess Island and North Island over 200 km east of the MILA survey subunit (Williams 1978). Because breeding Brown Pelicans usually remain within 72 km of the nesting area (Clapp et al. 1982), the single bird sighted in the MILA subunit (29°29.0' N; 92°03.3' W) probably was not associated with the breeding colony at that time. The Brown Pelicans sighted near the Chandeleur Islands were about 20 km from North Island and within range of the breeding colony. In Texas, the breeding colonies are at least 70 km north of the BTEX survey subunit. There are colonies in Florida adjacent to the MIFL and NAFL survey subunits (Clapp et al. 1982). Those colonies in Florida and Texas are therefore within dispersal range of the survey subunits.

Aerial survey data were insufficient to suggest seasonal changes in the range of Brown Pelicans. The literature indicates that they generally move toward the southern parts of their range for the winter (Williams 1978; NFWL 1980a; Clapp et al. 1982), although they "are not strictly migratory" (Bent 1922). In the 1979 surveys of western Florida (Fritts and Reynolds 1981), Brown Pelican distribution was described as relatively close to shore in August, but tended to range farther out to sea in November.

Changes in the distribution of Brown Pelicans in relation to the reproductive season are not clear in the survey data. In the survey area, Brown Pelicans breed mostly on a winter-spring cycle (Schreiber 1980). However, the specific time varies from year to year and colony to colony (Palmer 1962; Anderson and Hickey 1970; NFWL 1980a), thus making it difficult to associate distribution with the breeding season.

Abundance

Density estimates for Brown Pelicans were possible only in the NAFL and MIFL survey subunits (Table 20). Individual densities ranged from 0.12×10^{-1} to 0.22×10^{-1} birds/km^2 in the NAFL survey subunit, and were 0.32×10^{-2} and 0.12×10^{-1} birds/km^2 in

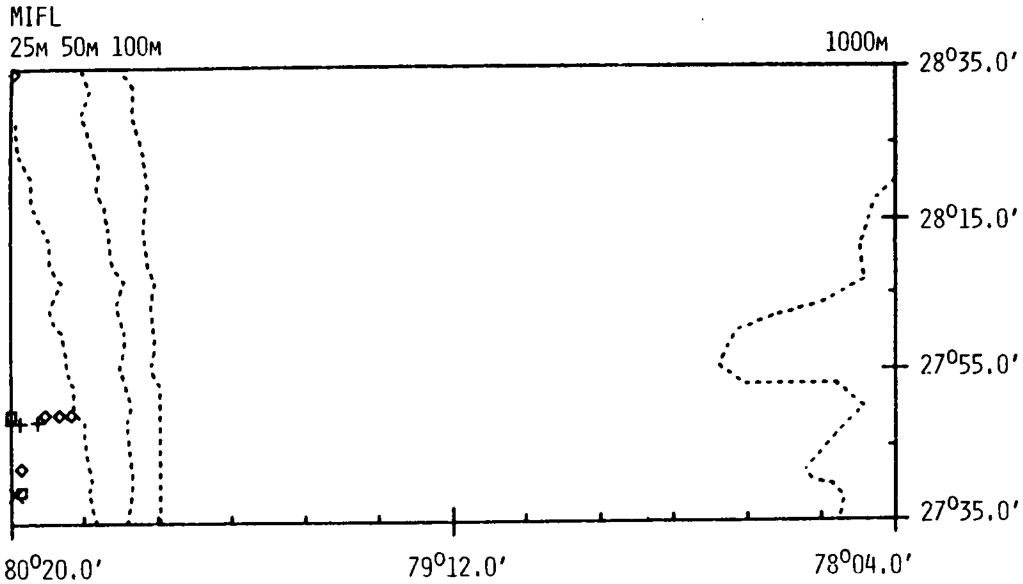


Figure 46. Distribution of all Brown Pelican sightings in the MIFL survey subunit during August (X), December (□), February (◇), and April (+).

the MIFL survey subunit. All Brown Pelicans were sighted within the 25-m isobath, which comprises 27% of the NAFL survey subunit and 5% of the MIFL survey subunit. Based on these percentages, the densities for individuals were recalculated and ranged from 0.44 x 10^{-1} to 0.81 x 10^{-1} birds/km^2 in the NAFL survey subunit and were 0.64 x 10^{-1} and 0.24 birds/km^2 in the MIFL survey subunit.

The largest group sighted consisted of 200 Brown Pelicans in the MIFL survey subunit; NAFL had a maximum group size of 50 Brown Pelicans, and BTEX, 13. The Florida subunits consistently had more and larger flocks of Brown Pelicans than the other survey subunits (Figure 48).

Habitat Use

Brown Pelicans were seen primarily over shallow coastal waters. Water depth at sighting locations ranged from 0 to 25 m (Figure 49). Water depth averages for Brown Pelicans in the NAFL survey subunit are similar to those for the MIFL survey subunit. However, as mentioned earlier, the birds in NAFL ranged over four times the distance from shore as in other survey subunits. In the NAFL survey subunit, Brown Pelicans can go farther offshore and still be over shallow water.

Brown Pelicans were observed over waters with sea surface temperatures ranging seasonally from 19° to 29° C (Figure 50). The literature does not indicate temperature preferences for Brown Pelicans.

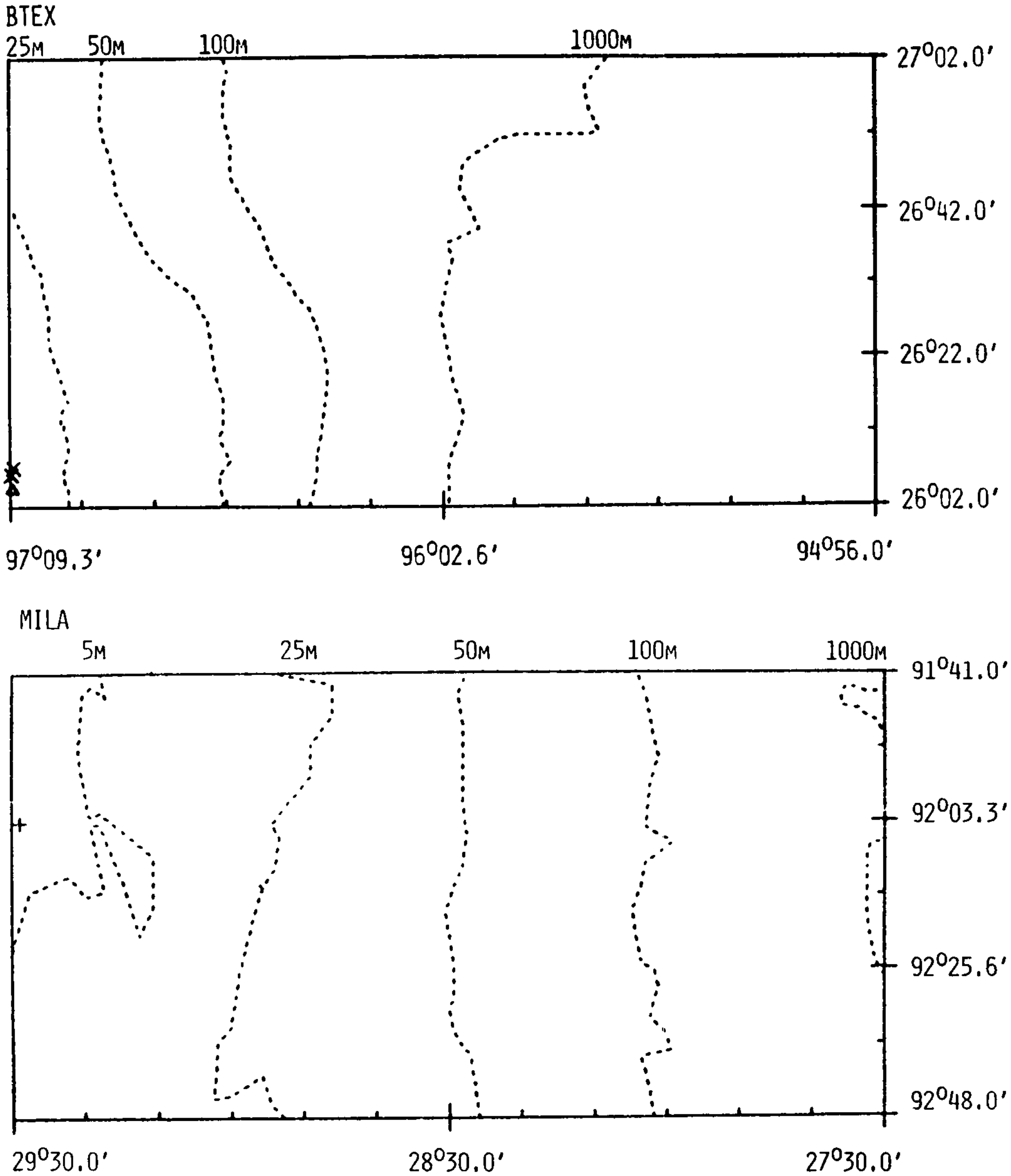


Figure 47. Distribution of all Brown Pelican sightings in the BTEX and MILA survey subunits during August (X), October (△), and April (+).

Table 20. Density and group size estimates for on-line sightings of Brown Pelicans. "All" represents combined months. * = variance too small for calculation.

Survey subunit	Month	No. of sightings	Group density (groups/km^2)	Variance	Mean group size	Standard error	Individual density (birds/km^2)
NAFL	June	12	0.10x10^{-1}	*	1.2	0.1	0.12x10^{-1}
NAFL	February	8	0.35x10^{-2}	*	3.6	1.8	0.13x10^{-1}
NAFL	April	27	0.11x10^{-1}	0.16x10^{-3}	2.1	0.6	0.22x10^{-1}
NAFL	All	51	0.44x10^{-2}	0.20x10^{-5}	2.1	0.4	0.93x10^{-2}
MIFL	February	9	0.88x10^{-2}	*	1.4	0.2	0.12x10^{-1}
MIFL	All	13	0.25x10^{-2}	*	1.3	0.1	0.32x10^{-2}

Associations

Brown Pelicans were observed in association with Double-crested Cormorants, Herring Gulls, Laughing Gulls, Royal Terns, and various unidentified gulls and terns. All of these birds commonly use coastal habitats (Palmer 1962; Oberholser 1974). Occasionally, Brown Pelicans were sighted around fish schools with gulls, terns, or Bottlenose Dolphins. In one sighting in the MIFL subunit, about 200 Brown Pelicans were seen with about 600 gulls, 200 terns, and 1 Loggerhead Turtle, all associated with three fishing boats setting seines around fish schools. Concentrations of animals around fish schools probably represented feeding associations.

Brown Pelicans occasionally were sighted in association with fish schools, which were particularly conspicuous in the NAFL subunit (Table 21). The Brown Pelican's diet consists largely of menhaden, herring, mullet, and sardines (Palmer 1962; Clapp et al. 1982). These are schooling fish that are common inshore (Hoese and Moore 1977), and Brown Pelicans will concentrate where food fish are plentiful (Bent 1922). In South Carolina during the 1950's, a decline of Brown Pelicans coincided with a decrease in menhaden (NFWL 1980a). Brown Pelican populations in California have appeared to oscillate in response to changes in food fish abundance (NFWL 1980a).

Reproduction

The survey results contain no data relating to Brown Pelican reproduction.

Brown Pelicans nest colonially, mostly on offshore islands, and construct nests both on the ground and in bushes or low trees (Palmer 1962; Williams 1978; Clapp et al. 1982). In the southeastern United States, most Brown Pelican colonies contain about 50 to 500 pairs of birds (Clapp et al. 1982). Clutch size is usually three eggs (Palmer 1962), and incubation time is about 4 weeks (Bent 1922). Both parents tend the nest, and the

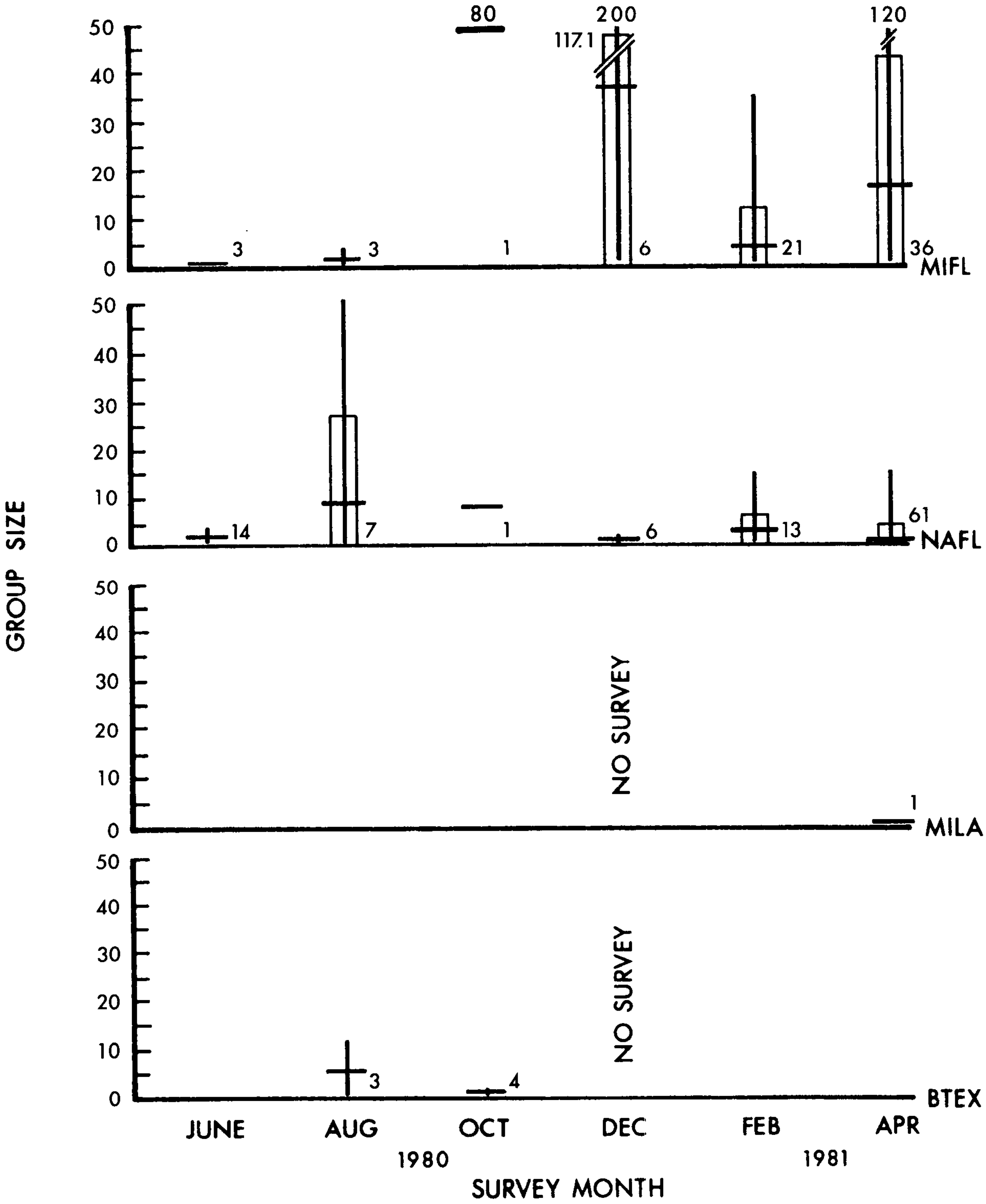


Figure 48. Group size for all sightings of Brown Pelicans by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

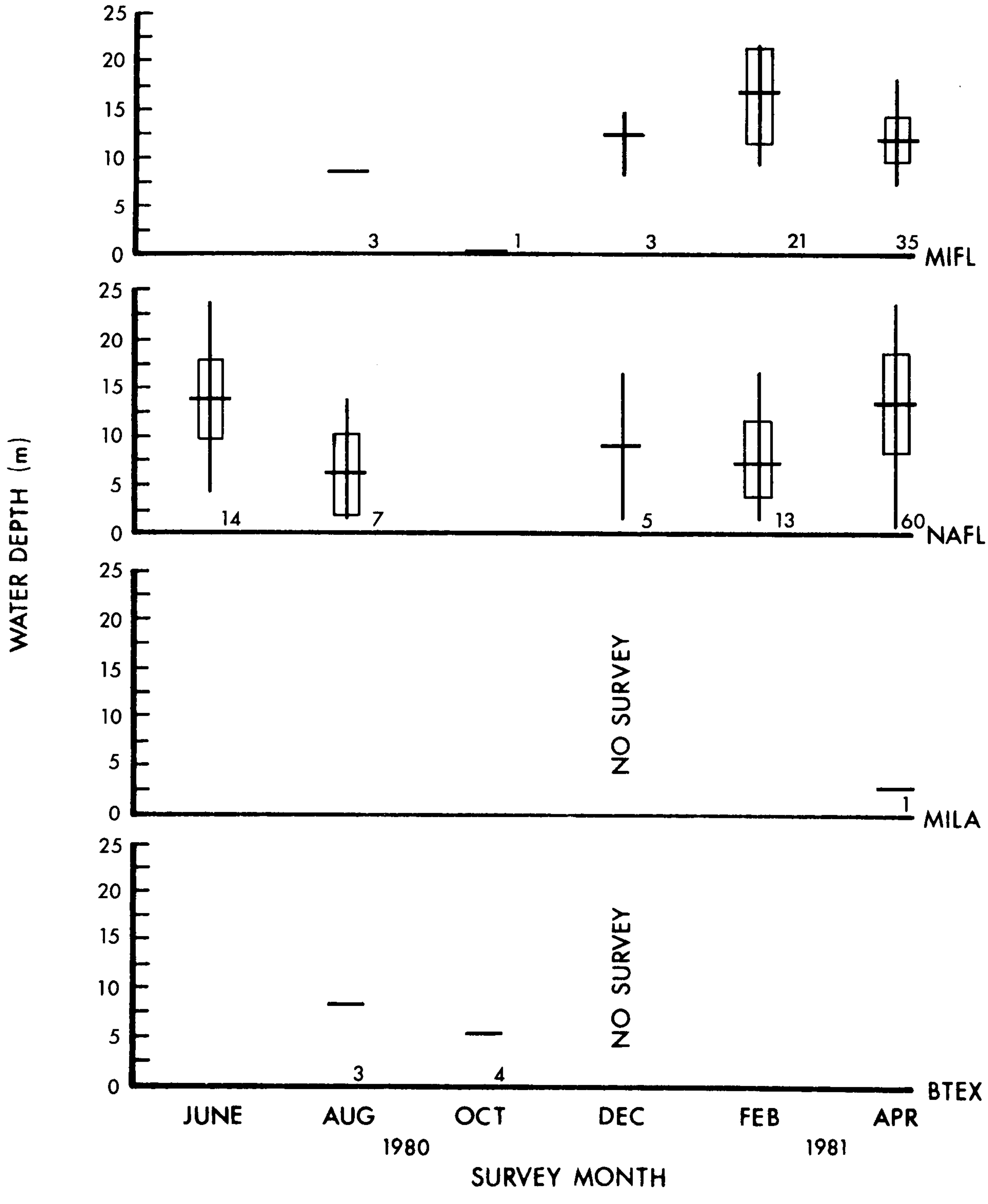


Figure 49. Water depth for all sightings of Brown Pelicans by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

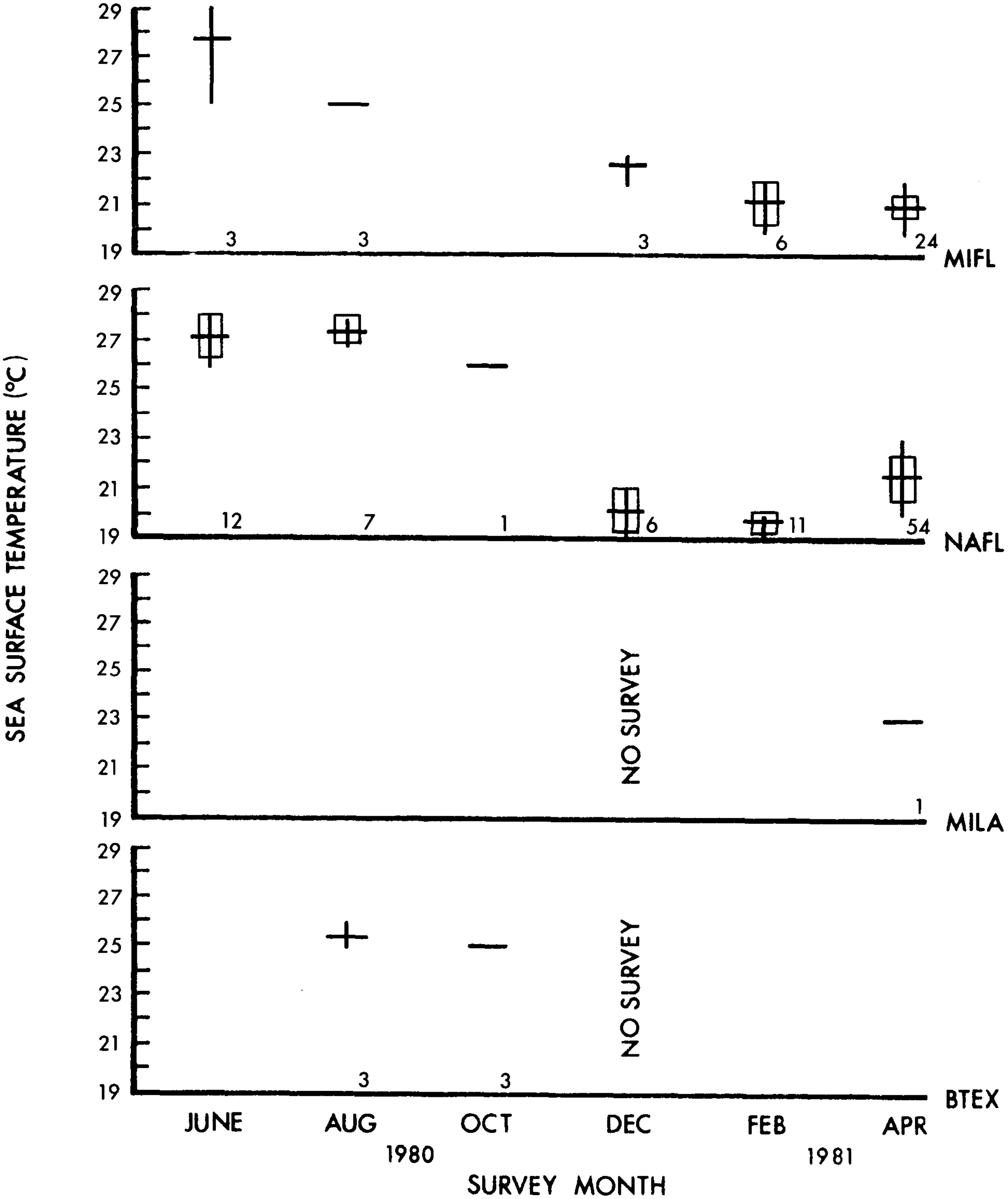


Figure 50. Sea surface temperature for all sightings of Brown Pelicans by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

Table 21. The number of unidentified fish and fish schools (excluding flyingfish) sighted during this study. Dash means no survey.

Month	Survey subunits			
	BTEX	MILA	NAFL	MIFL
June	0	18	118	5
August	19	7	41	4
October	18	22	101	30
December	-	-	24	1
February	6	9	39	9
April	8	7	52	39
TOTAL	51	63	375	88

young are fed by regurgitation (Palmer 1962). The young begin to fly at about the age of nine weeks, but the age of complete independence from the parents is not known (Palmer 1962). Human visitation or other disturbances can disrupt adult nesting behavior, leaving the eggs or young vulnerable to predators (Schreiber and Risebrough 1972; NFWL 1980a; Clapp et al. 1982).

Pesticides and chemical pollutants accumulate in Brown Pelicans after the birds eat contaminated fish (King et al. 1977). Concentration of contaminants has resulted in production of eggs with abnormally thin shells, which are susceptible to crushing by the weight of the bird during incubation. The sensitivity of Brown Pelican reproduction to environmental contaminants has been documented by many sources (e.g., Schreiber and Risebrough 1972; Lowery 1974b; Blus et al. 1975, 1979), and although the problem of pesticides is declining, the need for monitoring continues (Williams 1978).

Behavior

Brown Pelicans sometimes were observed feeding. They feed by plunging from heights of up to 7 to 10 m (Oberholser 1974). Schreiber et al. (1975) believed that a "pelican dives for an individual fish, even if it is in a school". Gulls sometimes attempt to steal fish from Brown Pelicans (Palmer 1962).

Potential Impacts of OCS Development

The detrimental effects of pesticides and other chemical pollutants on Brown Pelican populations (Schreiber and Risebrough 1972; Blus et al. 1975, 1979; King et al.

1977) have led to its endangered status and indicate that this species has great sensitivity to environmental contaminants.

Several of the behaviors of Brown Pelicans make them vulnerable to oiling and to effects related to oil development (Clapp et al. 1982). Oil spills tend to be most common and severe in nearshore areas (Sowls et al. 1980), where Brown Pelican most frequently nest and feed. Plunging for food and sitting on the water would bring pelicans in contact with oil on the water. Brown Pelicans have died in oil spills in California and Florida, and have been found oiled in Texas (Stevenson 1970; Clapp et al. 1982). Oil-related mortality of Brown Pelicans has occurred up to six weeks after an oil spill (King et al. 1979). Brown Pelicans fouled with oil could pass it on to the eggs or chicks and contaminated fish could be regurgitated to the young. In general, sensitivity to disturbance during nesting could lower reproductive success (Clapp et al. 1982). Being an endangered species, Brown Pelicans have not been the subject of experiments to investigate the effects of oil, but the potential impact on this endangered species must be considered in planning the development of OCS resources.

Summary

The majority of Brown Pelican sightings occurred in Florida, with 987 birds seen in the MIFL survey subunit and 243 seen in the NAFL survey subunit. Only 21 Brown Pelicans were seen in the BTEX survey subunit and 1 in the MILA survey subunit. Most (about 56%) Brown Pelicans were seen in April 1981. Brown Pelicans were most common in shallow coastal areas, but they ranged up to 99 km offshore in the NAFL survey subunit where the continental shelf extends well offshore. The Brown Pelican's behavior and habitat use, including use of nearshore waters for feeding and nesting, sensitivity to disturbance while nesting, diving for food, and floating on the water, suggest that this species would be highly vulnerable to oiling and to the effects of OCS development.

MASKED (BLUE-FACED) BOOBY, *Sula dactylatra*

Description

The Masked Booby is a large, long-winged seabird (body length 76 cm to 84 cm; wingspan 160 cm to 170 cm) (Nelson 1978a). Like gannets and other boobies, it has long, pointed wings, a pointed tail, and a sharp conical beak. Adults are white with black primaries, secondaries, and humerals (patches of large feathers on the lower back and tails). The bill is pale, but the bare facial skin is conspicuously blue-black. Juveniles are brown above and predominately white below. A pale patch usually is present on the upper back at the base of the neck. The white of the belly extends onto the upper breast where it ends in an irregular line against the dark brown of the neck. The white adult plumage is attained, initially on the head, during the first 2 years of life.

From the air the Masked Booby resembles a gannet, but can be distinguished by the black secondaries and tail. Often the black is not apparent on gannets and boobies at a distance; under these circumstances gannets look distinctly long-tailed, and masked boobies look almost tailless.

Distribution

Masked Boobies were observed in the BTEX subunit during August, the MILA subunit during August and April, and the MIFL subunit during October (Table 22). No Masked Boobies were identified in the NAFL survey subunit. Four unidentified sulids, that may have been Masked Boobies, were seen during the study.

Eleven Masked Boobies (nine sightings) were seen during this study. Most sightings occurred in the BTEX subunit (Table 22). The summer peak in numbers of Masked Boobies that is reported for the northern Gulf of Mexico (Oberholser 1974; Duncan and Havard 1980; Clapp et al. 1982) was noted only in the BTEX subunit. The MILA survey subunit may be a less favored habitat than the northeastern Gulf of Mexico where Duncan and Havard (1980) found the Masked Booby to be a regular visitor.

Masked Boobies have a pan-tropical distribution, breeding on isolated islands in all tropical oceans. The breeding sites nearest our study area are off Yucatan at Cayos Arcas, Cayos Arenas, and Alacran Reef (Boswall 1978; Paynter 1955), and in the southern Bahamas (Nelson 1978a).

Abundance

No densities estimates were possible on the basis of the small number of sightings.

Habitat Use

In the BTEX subunit during August, Masked Boobies were seen 90 to 224 km from shore ($\bar{x}$ = 134, SD = 55.6, N = 6; Figure 51). Sightings in the MILA and MIFL subunits ranged from 2 to 132 km from shore (Table 22).

Sightings in the BTEX subunit occurred over waters ranging from 200 to 2,500 m in depth ($\bar{x}$ = 1,011 m, SD = 872.6, n = 6). In the MILA and MIFL subunits, sightings occurred over waters that ranged from 1.5 to 75 m in depth (Table 22). The 1979 survey sightings (Fritts and Reynolds 1981) occurred over shallow water that ranged from 8 to 59 m in depth ($\bar{x}$ = 39, SD = 22.4, n = 6; Table 22). Sightings during the 1979 survey were made during the period of maximum northward incursion of IXTOC oil, when floating oil was abundant over the Texas continental shelf. The presence of oil in deeper waters may help explain the occurrence of Masked Boobies in shallow waters.

The April observation in the MILA subunit and the two 1979 survey sightings (Fritts and Reynolds 1981) from South Texas were of boobies flying over turbid, coastal waters. Otherwise, the Masked Boobies observed were over clear, nearshore and offshore waters. Clear, tropical waters are the preferred habitat of Masked Boobies (Nelson 1978a), a preference apparently related to their diet, which primarily consists of flyingfish.

Sightings of Masked Boobies during this study occurred over waters where sea surface temperatures ranged from 24° C during April to 27° C during August (Table 22). All of the sightings during the 1979 survey occurred during August and sea surface temperatures ranged from 27° to 29° C (Table 22).

Table 22. Sighting information on the Masked Booby from the present study and the 1979 survey (Fritts and Reynolds 1981). Dash means no data available. STEX = South Texas subunit and NTEX = North Texas subunit from Fritts and Reynolds (1981).

Survey subunit	Date	No. sighted	Position (Latitude/Longitude)	Distance from shore (km)	Water depth (m)	Sea surface temperature (°C)
THIS STUDY						
MILA	06 Aug. 1980	1	28°11.0'N/91°52.2'W	132	75	27
BTEX	21 Aug. 1980	1	26°47.0'N/96°16.8'W	104	549	26
BTEX	21 Aug. 1980	1	26°47.0'N/96°24.9'W	94	366	26
BTEX	22 Aug. 1980	1	26°03.0'N/95°20.9'W	182	1,550	26
BTEX	22 Aug. 1980	2	26°12.5'N/94°54.9'W	224	2,500	27
BTEX	22 Aug. 1980	1	26°23.0'N/96°03.5'W	109	900	27
BTEX	22 Aug. 1980	1	26°33.1'N/96°21.2'W	90	200	27
MIFL	11 Oct. 1980	2	27°38.0'N/80°10.7'W	19	16	-
MILA	19 Apr. 1981	1	29°31.9'N/92°00.3'W	2	1.5	24
1979 SURVEY						
STEX	20 Aug. 1979	3	26°29.4'N/97°14.0'W	2	13	29
STEX	21 Aug. 1979	2	26°08.0'N/97°09.0'W	2	8	-
NTEX	23 Aug. 1979	1	27°57.5'N/95°49.5'W	72	49	29
NTEX	24 Aug. 1979	1	27°47.2'N/96°12.9'W	64	59	27
NTEX	24 Aug. 1979	3	27°47.4'N/96°20.7'W	57	57	28
NTEX	25 Aug. 1979	3	28°02.4'N/95°47.2'W	65	46	28

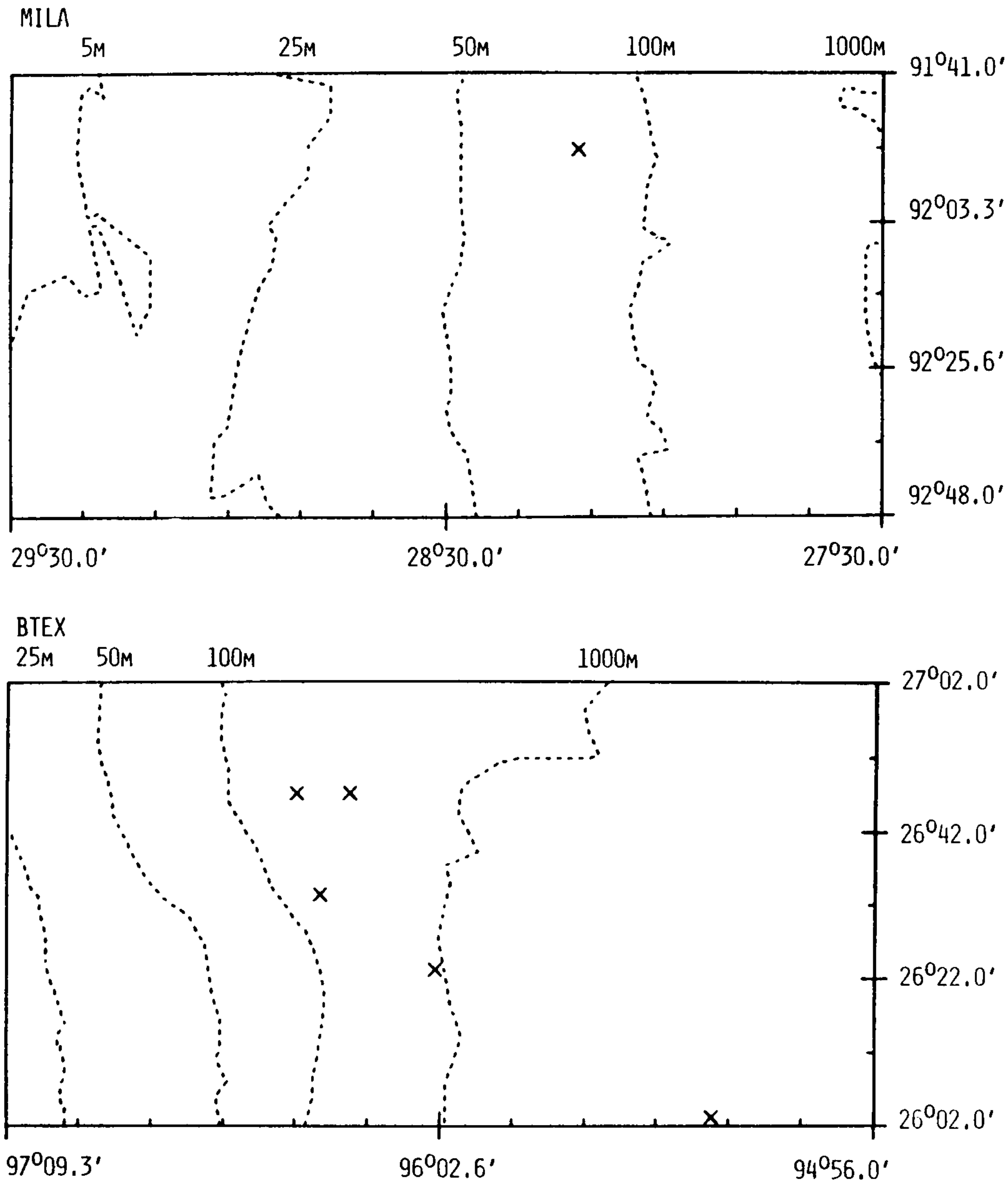


Figure 51. Distribution of all Masked Booby sightings in the MILA and BTEX survey subunits during August (X).

Reproduction

The sightings from this survey include both adults and young birds, but are too few to warrant speculation about differential migration or other age-specific behavior.

Behavior

Four of the Masked Booby observations were in mixed-species feeding flocks with terns and shearwaters. Two boobies were sitting on the water over fish schools; the others were circling above schools. Feeding was not observed. Such participation in aggregations of birds is well known for boobies (Ashmole 1971; Gould 1971; Nelson 1978a).

Potential Impacts of OCS Development

In Texas, the Masked Booby was one of the bird species affected by the IXTOC oil spill (see review by Duncan and Havard 1980). Breeding sites off Yucatan were close to the IXTOC well site, with one colony located within 100 km but the severity of the impact is unknown. Ortego (1978) observed Masked Boobies feeding around an oil production platform 190 km off Cameron, Louisiana, and hypothesized that the platforms enhanced the area as booby habitat by increasing availability of fish and roosting sites.

Summary

Most sightings of Masked Boobies occurred in the BTEX subunit during August. Two sightings occurred in the MILA subunit during August and April, and one in the MIFL subunit during October. Masked Boobies that occur in the study area are believed to breed off Yucatan and in the Bahamas. Masked Boobies reportedly prefer clear, tropical waters. This preference may be related to their diet, which consists primarily of flyingfish. Because they feed by plunge-diving, Masked Boobies are highly susceptible to contamination from oil spills in nearshore and offshore waters.

BROWN BOOBY, Sula leucogaster

Description

Brown Boobies have the long-winged, pointed-tail profile of the other sulids but are distinctly smaller (length 75 cm to 80 cm; wingspan 140 to 150 cm) (Nelson 1978a). They are noticeably slimmer than the gannets and other boobies observed in the study area. Adults are a rich dark brown on their upperparts, neck, breast, and undertail coverts. The underparts show a distinctive brown and white pattern. A narrow brown band follows the leading edge of the underwing. The primaries, secondaries, and primary coverts are brown, but the secondary coverts form a broad white bar on the underwing. The belly is white and is continuous with the white wing lining. Bills and feet are yellow and often are very bright.

The plumage of young birds is similar to that of adults, but much duller with bellies and wing linings pale brown rather than white. The bills and feet are consistently pale, but not always yellow.

From the air, the most recognizable features are the characteristic sulid shape, contrasting upperparts, and the yellow bill.

Distribution

Brown boobies were sighted twice during this study, in the MILA survey subunit in August and on an opportunistic flight near the Dry Tortugas during March. One was seen during the 1979 survey off South Texas (STEX, Table 23) during August (Fritts and Reynolds 1981). Two unidentified sulids that may have been brown boobies were reported. The sightings are summarized in Table 23.

The Brown Booby observed 20 August 1979 was an adult flying in a large aggregation of birds circling over a fish school and a whale shark (Rhincodon typus). The booby observed 7 August 1981 in the MILA subunit also was an adult flying at about 300 m, the altitude of the plane. The five boobies seen on 4 March 1981 were flushed from the Rebecca Shoals light structure during an opportunistic flight near the Dry Tortugas. Rebecca Light is a metal tower with an automated beacon and is a well-known roosting site for seabirds. The tower was visited on 4 March to allow a count of the birds present.

The unidentified sulid observed 11 August 1980 in the MIFL survey subunit was very dark and may have been either a Brown Booby or a juvenile Masked Booby.

An unidentified sulid that may have been a Brown Booby also was sighted on 29 March 1981 during an opportunistic flight off North Carolina.

Brown Boobies were recorded nesting at the Dry Tortugas in 1832 (Howell 1932), but the record is open to question (Clapp et al. 1982). Otherwise, they have not been reported to breed in the southeastern United States. The Brown Booby occurs regularly in low numbers throughout the year in the Florida Keys and especially around Rebecca Light and the Dry Tortugas (Clapp et al. 1982). The Brown Booby is a rare visitor to Louisiana with 12 records available (Duncan and Havard 1980; Clapp et al. 1982). Seven records were reported for Texas by Oberholser (1974) and an additional six are included in Clapp et al. (1982). Brown Boobies nest on suitable oceanic islands throughout the tropics. Colonies are numerous in the Caribbean region; the closest colonies to our study area are on islands north of Yucatan (Paynter 1955), in the southern Bahamas (Nelson 1978a), and off Cuba (Garrido and Montana 1975).

Abundance

The sightings obtained do not alter the previous conception of Brown Booby abundance, which is regular in the Florida Keys and rare elsewhere in the study area.

Habitat Use

Nelson (1978a) described Brown, Masked, and Red-footed Boobies as "blue-water boobies" that preferentially feed in clean, tropical oceans, but noted that Brown Boobies are more likely to visit turbid coastal waters than the other species. The booby seen in south Texas during the 1979 survey (Fritts and Reynolds 1981) was in blue waters beyond the continental shelf. The birds at Rebecca Light were close to clear water over the nearby coral reefs and in the deeper area 15 km to the south. The MILA sighting was in blue-green water offshore of the muddy coastal waters.

Table 23. Sighting information on the Brown Booby and unidentified sulids from the present study and the 1979 survey (Fritt and Reynolds 1981). Dash means no data available. STEX = South Texas subunit from Fritts and Reynolds (1981). OPPO = opportunistic flight.

Survey Subunit	Date	No. of birds sighted	Position (latitude/longitude)	Distance from shore (km)	Water depth (m)	Sea surface temperature (°)
BROWN BOOBIES						
STEX	20 Aug. 1979	1	26°29.0'N/96°13.0'W	100	-	29
MILA	07 Aug. 1980	1	28°35.5'N/92°14.4'W	106	41.0	27
OPPO	04 Mar. 1981	5	24°34.8'N/82°34.9'W	33	8.5	19
UNIDENTIFIED SULIDS						
MIFL	11 Aug. 1980	1	27°39.0'N/78°56.5'W	143	280.0	27
OPPO	27 Mar. 1981	1	34°39.4'N/76°53.9'W	-	8.0	15

Reproduction

Brown Boobies nest on the ground on isolated, rocky, or coralline islands. Normal clutch size is two, but usually only one chick is fledged. The incubation period is about 43 days and the young fledge 95 to 100 days after hatching. For a detailed review of breeding biology, see Nelson (1978a). The sightings in this survey were too few to provide insight into age-specific migration.

Behavior

The observations made in this survey substantiated the reported tendency of Brown Boobies to roost on man-made structures away from shore. Otherwise, they contribute little to the available information about Brown Booby behavior.

Potential Impacts of OCS Development

The regular occurrence of Brown Boobies at Rebecca Light illustrates the attraction that isolated offshore structures may have for these birds. Oil drilling and production platforms in the Gulf of Mexico off southern Florida might therefore attract these birds.

The Brown Booby, like most pelagic birds that plunge, is at least moderately susceptible to oil. An immature Brown Booby found on Ft. Pierce Beach, Florida (a few kilometers south of the MIFL survey subunit) on 19 July 1971 was heavily oiled (Ogden 1971). Although data are lacking, breeding colonies off Yucatan were close to the IXTOC oil spill in Mexico during 1979 and may have been seriously affected by the oil.

Summary

The Brown Booby was seen in the MILA subunit during August and near the Dry Tortugas during March. Brown Boobies are uncommon throughout much of the study area. One sighting of five boobies on a beacon's support structure suggests that Brown Boobies may be attracted to OCS structures. The Brown Booby may be moderately susceptible to the effects of OCS development.

NORTHERN GANNET, *Sula bassanus*

Description

Northern gannets are the largest of all sulids (body length to 102 cm; wingspan to 180 cm) (Cramp et al. 1977, Nelson 1978a). Breeding birds range in weight from 2,400 to 3,610 g (Nelson 1978a). In comparison to other birds, their wings are long, narrow, and pointed. The body is robust, but the pointed tail, long neck, and pointed bill provide a streamlined, fusiform shape. The neck length is proportionally greater than in other sulids, and the wings appear to attach farther back on the body.

Adults are mostly white, with black on the wings (primaries and primary coverts), and usually a bright yellowish wash on the head. Plumage color does not vary appreciably between seasons. Juveniles and birds in their first winter are a dark gray brown with inconspicuous white speckles on the head, neck, and dorsum. The lower breast and belly are pale gray-brown with more white.

Over a period of about 4 years, the dark plumage of the juveniles is gradually replaced by the white adult plumage (Nelson 1978a, 1978b). Although the sequence is variable, the neck and the leading edge of the wings usually become white earlier than the back, tail, and inner wing.

Adults, subadults, and juveniles were recorded separately during this study. From the air, the white bodied adults were very conspicuous but at great distances (e.g., > 800 m) their black wingtips often were not apparent, and they were seen as exceptionally long-bodied white birds, with short, blunt wings. The yellowish wash on the heads of adults was seldom visible from the air. The subadult class included birds showing white areas on the head, neck, and wings, but retaining some of the dark immature feathering. Juveniles were completely dark dorsally.

Gannets often were observed sitting on the water. Adults had a characteristic appearance which was recognizable at great distances, but the darker colored younger birds were difficult to recognize unless they flushed or were viewed from close range. Adults appeared practically all white, and blunt anteriorly; many birds on the water may have had their heads tucked. The wings were folded so that the black wingtips crossed over the base of the tail, giving the impression of a black band separating the tail from the body.

Distribution

Northern Gannets were seen in all survey subunits (Table 24) as well as in Mississippi Sound and North Carolina opportunistic flights. Sightings occurred from December to April in the NAFL and MIFL subunits, but only during February in the BTEX and MILA subunits (Table 24). Gannets occur regularly within the study area from October or November to May (June in the Carolinas) (Clapp et al. 1982). Our sightings occurred within these months and consequently support the seasonal patterns proposed for gannet occurrence in the Gulf of Mexico and the southeastern Atlantic coast.

Northern Gannets occurred in greatest numbers in all survey subunits during February (Table 24). Gannets were most abundant in the MILA subunit, although sightings occurred only in February. In the NAFL and MIFL subunits, sightings occurred from December to April, but in relatively low numbers.

Northern Gannets nest in the eastern North Atlantic from Brittany through Britain to Norway, the Faeroes, and Iceland, and in six colonies in maritime Canada. It is assumed that all gannets wintering off the southeastern United States come from Canadian colonies (Nelson 1978b).

The literature provides little information on the patterns of offshore distribution of gannets. Nelson (1978b) commented that gannets have been seen occasionally in the middle of the North Atlantic. Cramp et al. (1977) indicated that gannets are birds of the offshore continental shelf waters and are infrequent nearshore. Lowery (1974b) mentioned reports of gannets in spring "at various points between the mouth of the Mississippi River and Yucatan". Clapp et al. (1982) reported that gannets were regular but usually well dispersed offshore, and occasionally in high concentrations inshore. Sightings from this study are discrepant with the offshore distribution described in the literature and the subject requires further clarification.

Palmer (1962) considered gannets "rather common" in the eastern Gulf of Mexico but noted that very few records existed for Texas. Oberholser (1974) considered gannets rare in winter on the north and central portions of the Texas coast, and casual on the South Texas coast. Lowery (1974b) reported only about 15 records for Louisiana with most occurrences east of the Mississippi Delta. Clapp et al. (1982) concluded that gannets are more common on the east coast of Florida than in the Gulf of Mexico, and more common in the eastern than in the western Gulf of Mexico. Thus, the relative paucity of gannets in the MIFL and NAFL survey subunits and their abundance in the MILA subunit were unexpected.

Several explanations are possible: (1) gannets may be extending their winter range westward as their population size increases (Nelson 1978b); (2) gannets may have moved farther west than usual during the winter of 1980 and 1981 in response to unknown

Table 24. The number of Northern Gannets sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits							
	BTEX		MILA		NAFL		MIFL	
June	0		0		0		0	
August	0		0		0		0	
October	0		0		0		0	
December	-		-		2	(1)	5	(3)
February	29	(20)	303	(237)	16	(15)	6	(6)
April	0		0		12	(11)	3	(3)
TOTAL	29	(20)	303	(237)	30	(27)	14	(12)

environmental stimuli; (3) the Gulf of Mexico off western Louisiana may be a traditional, but previously unknown wintering area; or (4) human activities in that area, such as shrimp trawling or oil exploration, may have made the region more attractive to gannets.

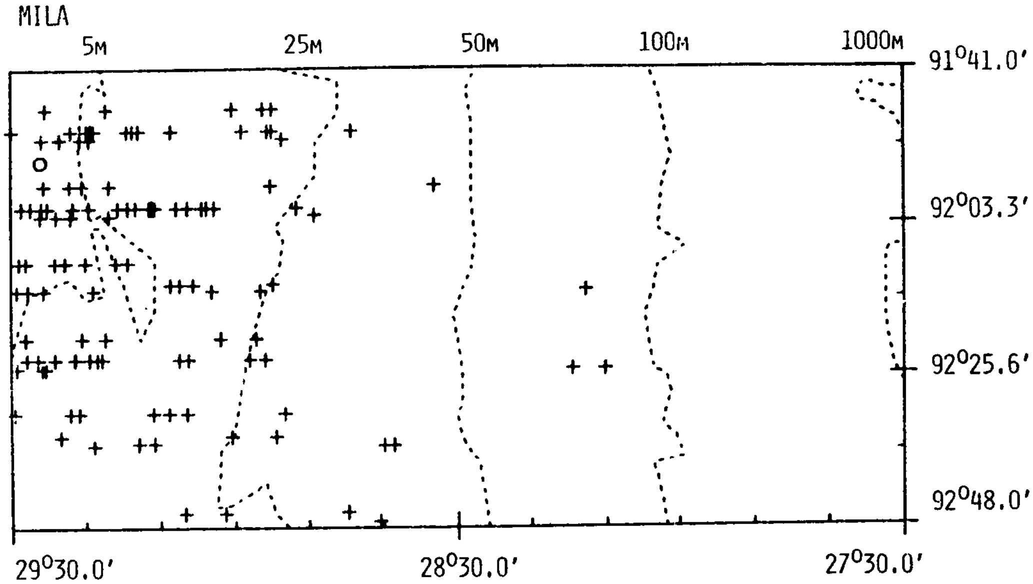
Abundance

Density estimates were calculated for Northern Gannets only during February in the BTEX, MILA, and NAFL subunits and ranged from 0.50 x 10^{-2} birds/km^2 in the BTEX and NAFL subunits to 0.96 x 10^{-1} birds/km^2 in the MILA subunit. Gannets occurred primarily in the inshore 111 km of the survey subunits (Figures 52 through 54). When density estimates are adjusted to reflect the limited distribution of gannets in the subunit (density/percent of subunit utilized), values ranged from 0.1 x 10^{-1} birds/km^2 in the BTEX and NAFL subunits to 0.19 birds/km^2 in the MILA subunit.

Habitat Use

Gannets were seen to 153 km from shore, but most sightings were in nearshore waters (Figures 52 through 54). Monthly mean distances from shore ranged from 33 km in the MILA subunit to 58 km in the NAFL subunit (both during February).

Northern Gannets were usually seen over shallow coastal waters with depths ranging from 1 to 50 m (Figures 52 through 54). Occasionally, sightings occurred over waters up to 746 m deep. In the MILA survey subunit, where most sightings occurred, the water was quite turbid, varying in color from blue-green 80 km from shore, to pale brown in the shallows near the beach. These muddy inshore and nearshore waters were preferred by the gannets. Cramp et al. (1977) called the gannet an inhabitant of the



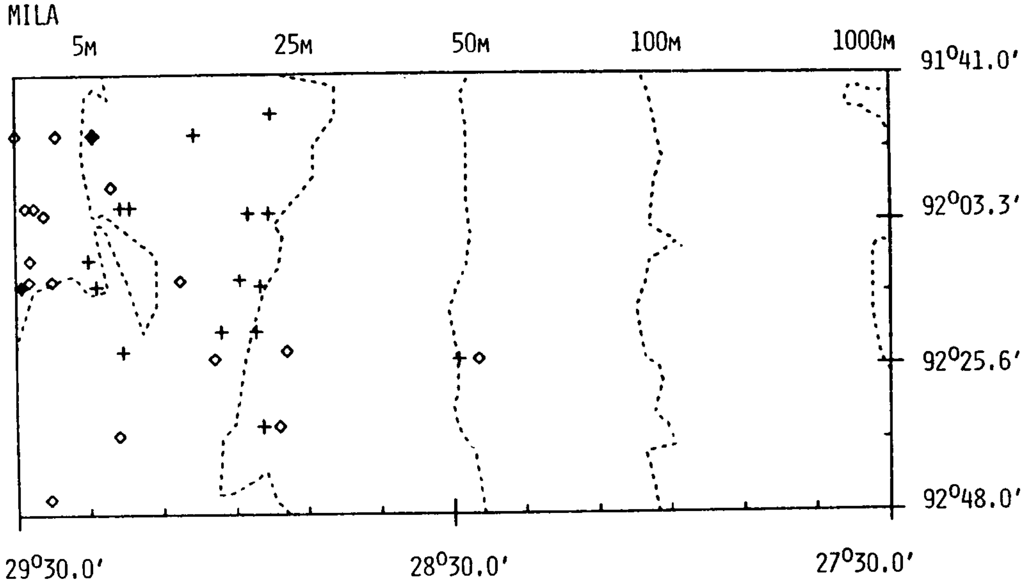


Figure 52. Distribution of all Northern Gannet sightings in the MILA survey subunit during February (Adults = +) and April (Adults = O) above, and during February (Subadults = + , Juveniles = ◇) below.

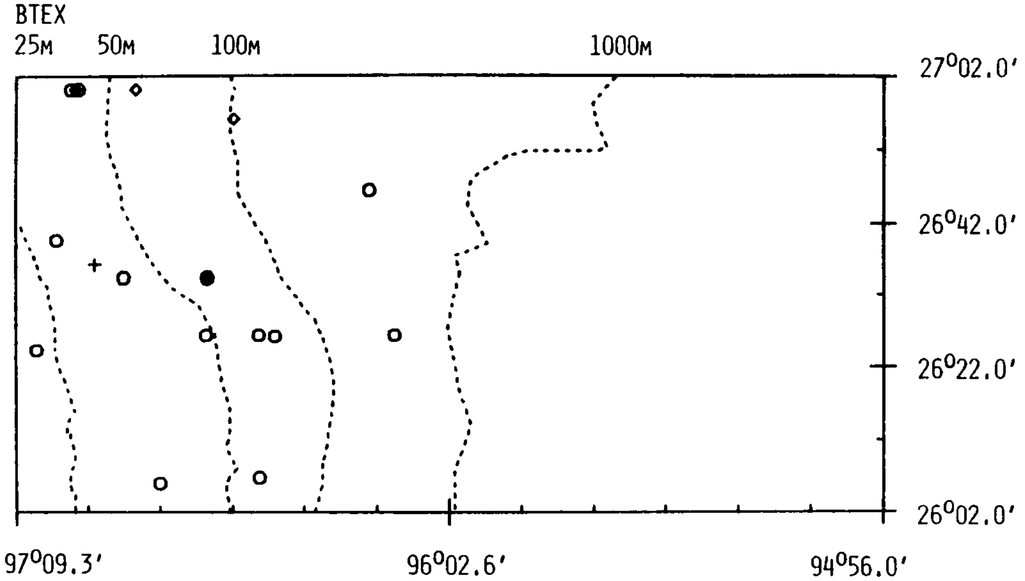


Figure 53. Distribution of all Northern Gannet sightings in the BTEX survey subunit during February (Adults = O, Subadults = +, Juveniles = ◇).

continental shelf which "comes inshore freely only in pursuit of schools of fish or in unusual weather conditions".

Northern Gannets were seen over water where surface temperatures ranged from 13° C during February in the MILA subunit to 24° C during December in the MIFL subunit. Gannets were not found in the warmest waters surveyed in December, February, and April. Because the warmest waters consistently were offshore, temperature effects cannot be separated from the effects of depth and distance from shore.

Associations

Northern Gannets usually were found alone or in small (two to five individuals), monospecific groups, even though they tended to occur in areas of high bird density in the MILA survey subunit. One adult was observed apparently being chased by a Herring Gull, but no other interactions of gannets with other birds were recorded. The lack of flocking and lack of interaction with other birds is at variance with the gannet literature. Nelson (1978b) called gannets communal feeders, stating that the white plumage of adults evolved as a positive attractant to aid in feeding on fish schools. Nelson (1978a, 1978b) also reported gannets gathering in large flocks to feed on the offal and discarded fishes from trawlers. Although shrimp trawlers were common in the inshore and nearshore waters of the MILA subunit and often were followed by numerous gulls and terns, the gannets present in the area were not sighted in these flocks. The lack of associations and observed feeding behavior may be explained in part if gannets feed during periods of the day before aerial surveys were conducted (i.e., dusk or dawn).

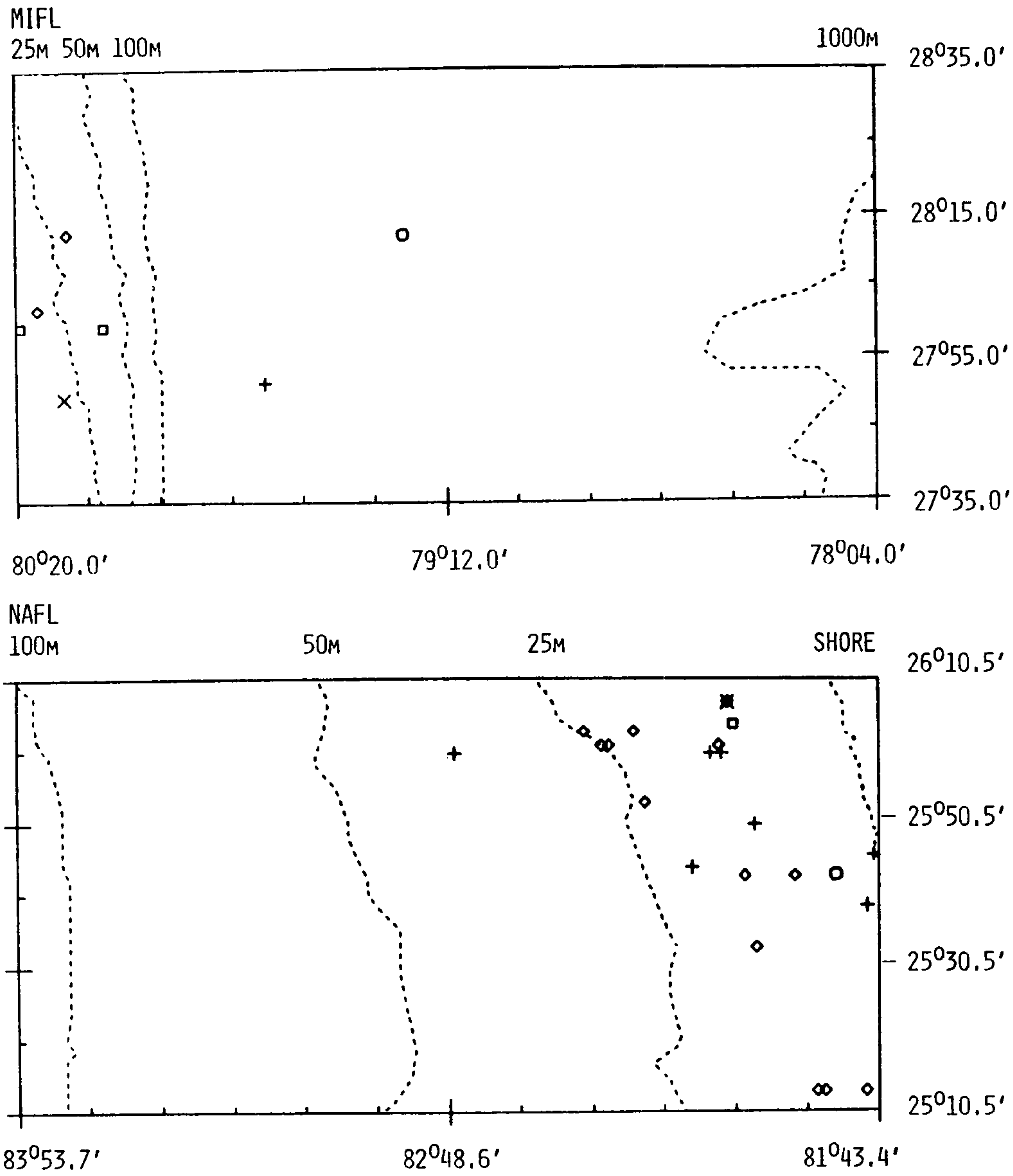


Figure 54. Distribution of all Northern Gannet sightings in the MIFL survey subunit (above) during December (Adults = □), February (Adults = ◇ , Subadults = X, Juveniles = O), and April (Adults = +), and in the NAFL survey subunit (below) during February (Adults = ◇ , Subadults = X), and April (Adults = +, Subadults = □ , Juveniles = O).

Reproduction

Gannets observed in this study were classified as juveniles (less than 1 year old), subadults (1 to 4 years old but not yet in adult plumage), and adults. Most of the observations from survey subunits were of adults (80%). Subadults and juveniles each constituted about 10% of all gannets sighted. Sightings in the BTEX subunit included a higher ratio of juveniles (35%) than did other subunits.

Adults gannets, because of their white plumage, are more conspicuous and more likely to be sighted during aerial surveys. Sightings of adults in the MILA subunit during February occurred a mean distance of 206 m from the transect line. Means for sightings of subadults and juveniles were 152 m and 134 m from the line, respectively. Because adults can be seen at greater distances from the transect line, ratios of adults to subadults and juveniles may be unrealistic. However, density estimates comparing adults, subadults, and juveniles compensated for varying conspicuousness of the age classes. Results were similar to ratios obtained from previous comparisons; adults constituted about 75% of the sightings, subadults about 15%, and juveniles about 10%.

The observed age structure, with a predominance of adults, is typical of oceanic birds with low fecundity, delayed maturation, high adult survival rates, and lower juvenile survival rates (Nelson 1978b). The age structure of the birds observed is surprising, because young gannets are thought to conduct longer migrations than adults (e.g., Lowery 1950, 1974b; Cramp et al. 1977; Clapp et al. 1982; Nelson 1978a), and are believed to predominate the Southeastern United States (Duncan and Havard 1980). Adults may have been farther south than is typical in response to unusual weather or other environmental conditions, but few data are available to support this hypothesis.

Behavior

Most of the gannets seen in this survey were either flying or were sitting on the water. A few birds were seen foraging. Gannets feed on fish schools by aerial plunging. They have been known to dive on fish from as high as 27 m above the water's surface (Nelson 1978b). The gannet may hit the water at more than 100 km/h. Unaided dives may penetrate about 3.5 m below the surface. By swimming with the wings and feet, gannets may extend their dives to depths of 12 to 15 m (Nelson 1978b). The mechanism of prey capture is poorly known. The concussion of the bird impacting the water may stun prey near the surface before it is grasped; deeper prey may be grasped in the bill directly (Nelson 1978b). Gannets also feed from the water's surface by scooping prey in the bill or diving from the surface (Nelson 1978b).

Potential Impacts of OCS Development

Okeefe (1978) reported that 11% of the oiled birds found on the Irish coast were gannets, and they comprised 1.8% of the oiled seabirds found along British coasts from the winter of 1966 and 1967 to 1973 and 1974 (Croxall 1977). Several incidents involving oiled gannets have been reported in the study area. Chamberlain and Chamberlain (1952) reported 27 oiled gannets on a North Carolina beach in February 1952. One oiled gannet each has been reported from Louisiana, Georgia, and Texas. (Thompkins 1944; James 1970; Webster 1976).

The concentration of gannets off western Louisiana, in the area of OCS development in the northern Gulf of Mexico, raises the possibility that development enhances the area as a gannet habitat. However, direct evidence of such enhancement was not found. Reef-dwelling fish are known to concentrate around the legs of platforms, and gannets seem to be an opportunistic piscivores (Nelson 1978b). Northern Gannets, unlike gulls and terns, were not seen perching on the drilling rigs and production platforms common in the area.

Summary

Northern Gannets were seen in all subunits during February and also in the NAFL and MIFL subunits during December and April. Most gannets were seen in the MILA subunit. Sightings were usually of single birds flying low over or sitting on the water. Gannets feed by aerial plunging and surface diving for fish. Impacts of OCS development are potentially great during winter months when gannets are most abundant in the northern Gulf of Mexico.

DOUBLE-CRESTED CORMORANT, Phalacrocorax auritus

Sightings of cormorants may have included the Great Cormorant (Phalacrocora carbo) and the Olivaceous Cormorant (Phalacrocorax olivaceus). From an aircraft, these birds cannot be distinguished from the Double-crested Cormorant. However, in the U.S., the Great Cormorant typically is found north of Maryland and rarely enters the study area (Palmer 1962). The Olivaceous Cormorant may be found in the study area in Louisiana and Texas, but prefers fresh- and brackish-water habitats (Palmer 1962). Therefore, cormorants sighted during the surveys were assumed to be Double-crested Cormorants.

Description

The Double-crested Cormorant is a large aquatic bird (up to about 92 cm long and wingspan to about 135 cm) (Palmer 1962) with a long tail, snakelike neck, and slender, pointed bill. Adults are black with yellow-orange throat pouches. During the breeding season, recurved crest feathers grow behind the eyes. The sexes are similar in appearance. Immature birds tend to be fuscous in color with a pale breast and dull yellow throat pouch. Adult plummage is acquired after about 2 years (Palmer 1962). Cormorants often swim with the body nearly submerged and with the head held erect and the bill pointed upward. They may be observed diving from the surface of the water. Cormorants perch in an upright posture, often with the wings outspread.

A cormorant can be identified from an aircraft by its large size, long neck and tail, and black coloration. The swimming and perching habits also are useful identification cues. The throat pouch and crest feathers of the Double-crested Cormorant usually are not visible from the air.

Distribution

Cormorants were sighted in all survey subunits. Over 69% of all cormorants (219 birds) sighted during scheduled surveys were in the NAFL survey subunit (Table 25). About 29% of the cormorants (92 individuals) were seen in the MILA subunit. Slightly

Table 25. The number of Double-crested Cormorants sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits			
	BTEX	MILA	NAFL	MIFL
June	0	0	5 (2)	0
August	0	0	0	0
October	0	0	0	0
December	-	-	178 (4)	0
February	2 (1)	91 (3)	20 (13)	1 (1)
April	2 (1)	1 (1)	16 (13)	1 (1)
TOTAL	4 (2)	92 (4)	219 (32)	2 (2)

more than 1% (four cormorants) were encountered in the BTEX subunit, and less than 1% (two animals) in the MIFL survey subunit. Eight cormorants were sighted during opportunistic surveys near Mississippi Sound. They were observed as single birds and in flocks of up to 75 in the MILA subunit, and up to 150 to 200 in the NAFL subunit. Large flocks are typical because cormorants tend to be gregarious (Palmer 1962).

The lack of sightings in the MIFL subunit is noteworthy because over 20,000 breeding Double-crested Cormorants are estimated to nest in the state (Clapp et al. 1982). Double-crested Cormorants are uncommon to rare in Louisiana and Texas in the summer and fall, but are common in both states during the winter and early spring (Lowery 1974b; Oberholser 1974). In the winter, Double-crested Cormorants may be more abundant along the coast of South Texas than anywhere else in the southeastern U.S. (Clapp et al. 1982). The relative dearth of cormorant sightings compared with the reported abundance in the literature is most likely a result of the cormorant's preference for nearshore, inshore, and inland areas. The majority of cormorants seen were in the NAFL subunit, the only subunit which overlaps land. Most surveys, therefore, included little prime habitat for Double-crested Cormorants, except the nearshore areas of NAFL.

Double-crested Cormorants are distributed from Canada to northern Mexico, and range throughout the study area (Palmer 1962). Many of the birds migrate to northern parts of their range to breed, but breeding also occurs on both coasts of Florida (Clapp et al. 1982). Double-crested Cormorants formerly bred in Louisiana and Texas (Lowery 1974b; Oberholser 1974), but currently nesting is rare to nonexistent in those states (Clapp et al. 1982).

The survey results are supported by information from the literature. In the 1979 survey (Fritts and Reynolds 1981), cormorants were sighted in both Texas and West Florida. Cormorants frequent coastal areas and inland waters, and usually forage within 16 km of the roost or colony (Palmer 1962). Almost 95% of the cormorant sightings (35 observations) in this study occurred within 16 km of land.

Cormorants were sighted in all subunits in February and April 1981. In the NAFL survey subunit, they were seen also in June and December 1980. About 56% of all cormorants (178 individuals) were sighted in December 1980, and 36% (114 animals) in February 1981 (Table 25). Only 6% (20 cormorants) were encountered in April 1981, and about 2% (5 birds) in June 1980.

The great abundance (92%) of cormorants sighted during the winter months is probably a result of seasonal migrations into the study area (Palmer 1962).

Many Double-crested Cormorants are migratory, flying to the southern parts of the range in the fall and returning north in the spring (Palmer 1962). However, some birds remain as year-round residents in the vicinity of each survey subunit (Oberholser 1974; Clapp et al. 1982). The absence of cormorant sightings during the summer in all subunits except NAFL suggests that most birds migrate from the area.

Abundance

A density estimate for Double-crested Cormorants was possible only in the NAFL subunit for combined survey months. Calculations resulted in a group density of 0.29 x 10^{-2} birds/km^2 (n = 10; variance = not computed). Using an average group size of 1.9 (SE = 0.4), the individual density was determined to be 0.55 x 10^{-2} birds/km^2 in the NAFL subunit. However, all sightings of cormorants were well within the 25-m bathymetric line, which comprises 27% of the NAFL subunit. Based on the percentage of the subunit where cormorants were sighted, the individual density was recalculated to be 0.20 x 10^{-1} birds/km^2.

Migratory movements of cormorants are associated mainly with the availability of food fish (Palmer 1962). The large numbers of cormorants in the NAFL survey subunit may be related to the greater abundance of fish schools sighted there (Table 21).

Habitat Use

They were observed the greatest distance from land in the MILA subunit, where they ranged from 0 to 29 km offshore ($\bar{x}$ = 9 km, n = 4; Figures 55 and 56). In the NAFL survey subunit, cormorants were seen from 0 to 20 km out to sea ($\bar{x}$ = 7 km, SD = 4.5, n = 29; Figures 55 and 57). They were sighted in the MIFL subunit at 2 and 13 km from land and in the BTEX subunit at 0 and 6 km offshore (Figures 55 and 56).

The greatest range of water depths at cormorant sighting locations was 0 to 22 m in the NAFL subunit ($\bar{x}$ = 7 m; SD = 4.2; n = 29; Figure 58). Cormorants were seen over shallower waters in the other subunits. Water depths at sighting locations were 0 to 6 m in the MILA subunit ($\bar{x}$ = 2 m; n =4), 13 and 15 m in the MIFL subunit, and 0 and 17 m in the BTEX subunit. Double-crested Cormorants are thought to prefer water less than 10 m deep for feeding, but may catch prey in water as deep as 22 m (Palmer 1962).

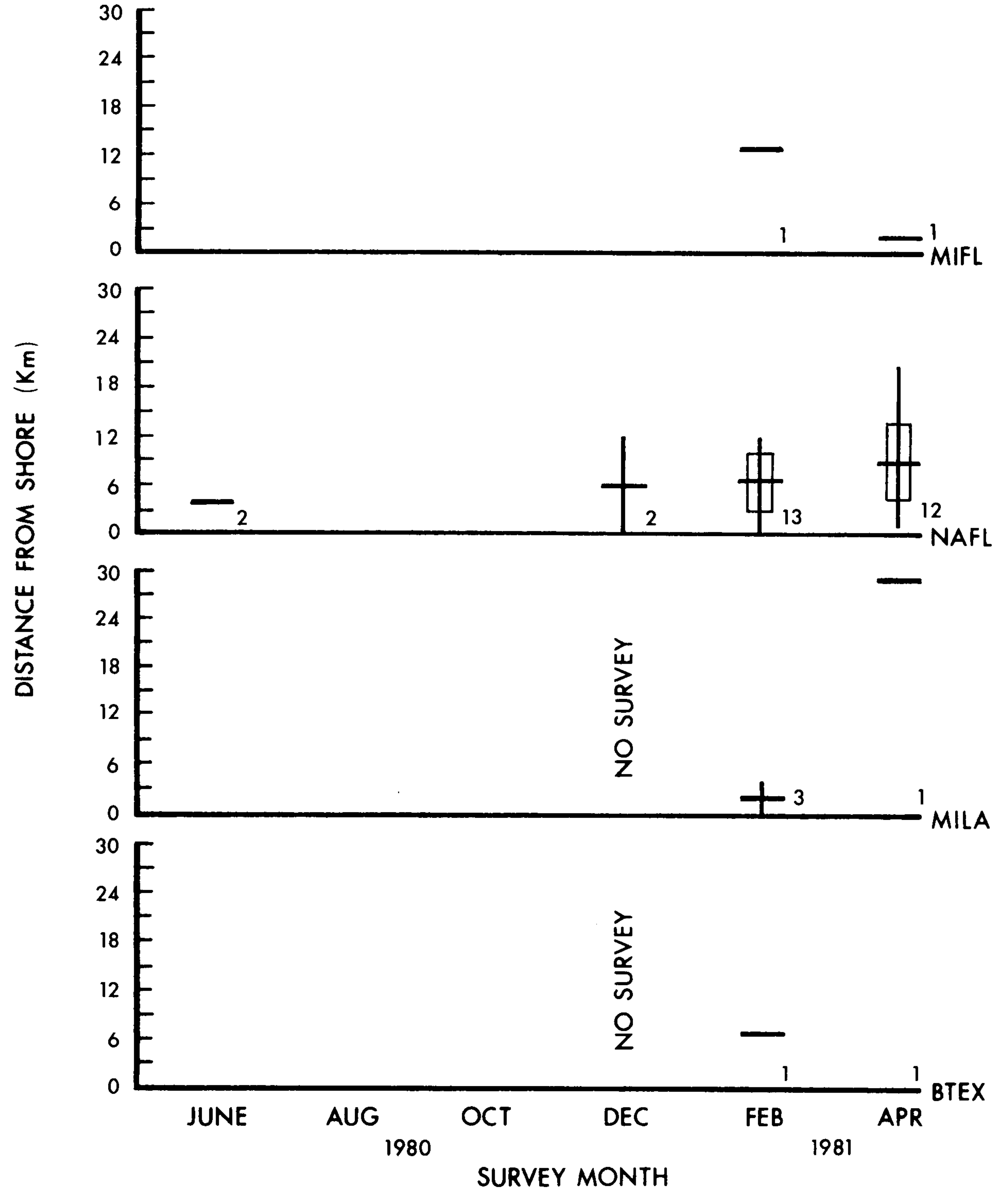


Figure 55. Distance from shore for all sightings of Double-crested Cormorants by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

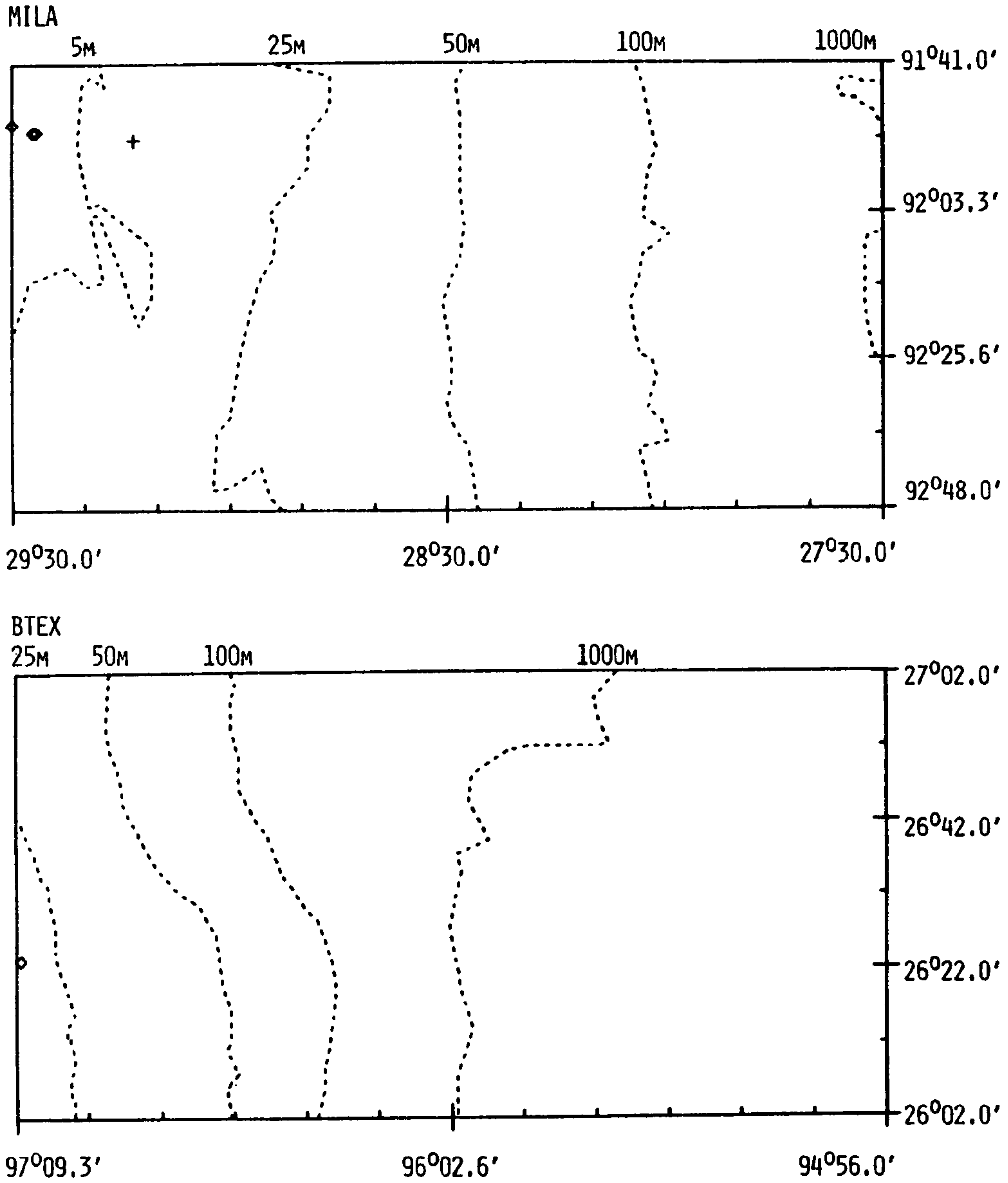


Figure 56. Distribution of all Double-crested Cormorant sightings in the MILA and BTEX survey subunits during February (◇) and April (+).

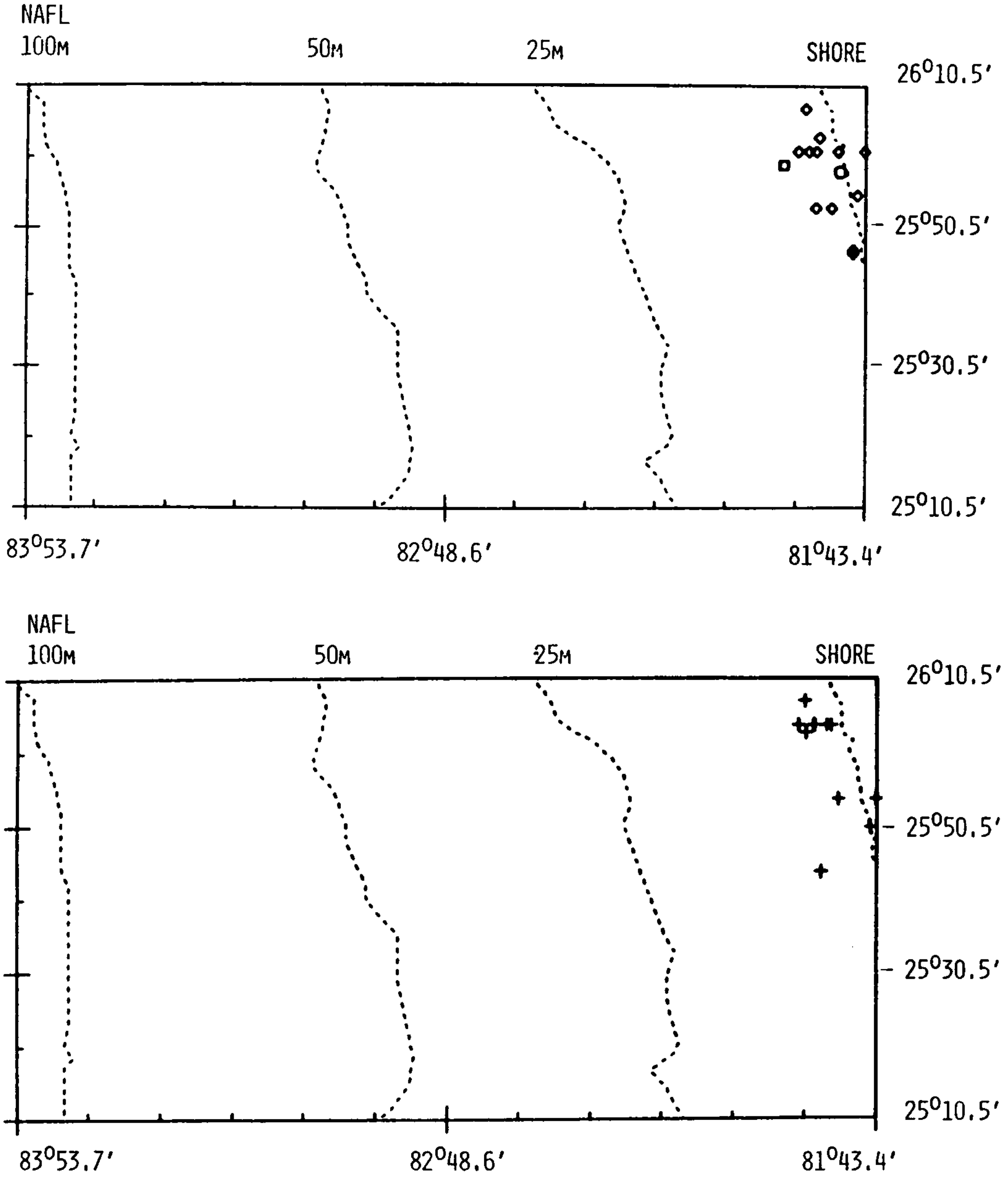


Figure 57. Distribution of all Double-crested Cormorant sightings in the NAFL survey subunit during June (O), December (□), February (◇), and April (+).

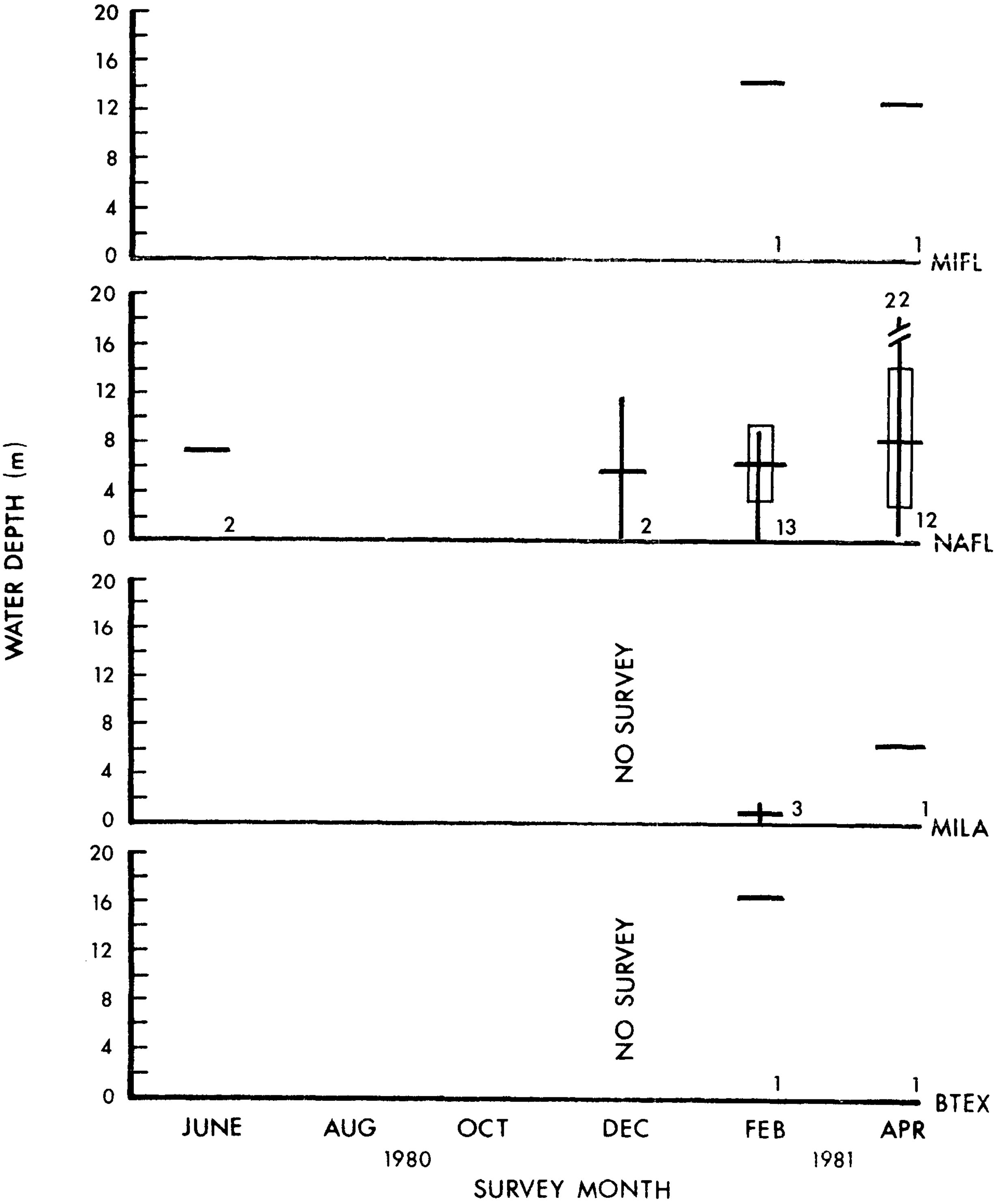


Figure 58. Water depth for all sightings of Double-crested Cormorants by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

Sea surface temperatures at sighting locations for cormorants ranged from 13° to 27° C (Figure 59). Because of the wide range of temperatures observed at sighting locations, cormorants do not appear to be selecting habitat on the basis of sea surface temperatures.

Associations

In the MILA survey subunit, a flock of about 75 cormorants was sighted together with about 500 unidentified pale terns on a sandbar. In the NAFL subunit, cormorants were observed on a sandbar with Brown Pelicans. All of these birds utilize similar coastal habitats (Palmer 1962; Oberholser 1974).

Reproduction

Cormorants breed in the summer in colonies and build nests on the ground or in elevated sites such as trees or cliffs (Clapp et al. 1982). Clutch size is usually three to four eggs, and incubation lasts 24 to 29 days (Palmer 1962). The nest is tended by both sexes, and the young are fed by regurgitation until they fledge at about 8 weeks (Bent 1922). Nesting birds are susceptible to disturbance by humans (Ellison and Cleary 1978).

Behavior

Cormorants were observed flying and sitting on the water, on a marker bouy, and on sandbars. They were seen diving from the surface of the water, apparently to avoid the aircraft.

Cormorants feed mostly on fish by diving from the surface and occasionally feed together in flocks (Palmer 1962). A cormorant's feathers are not completely waterproof, and after leaving the water, the bird will often hold the wings outstretched to dry (Palmer 1962).

Potential Impacts of OCS Development

The preference of cormorants for coastal areas, and their habits of swimming at the surface and diving for food, make them especially susceptible to oil from OCS development. Double-crested Cormorants became fouled with oil and died after oil pollution incidents in west Florida, Virginia, and California (Sims 1970; Stevenson 1970; Holmes and Cronshaw 1977; Roland et al. 1977). Cormorants may suffer severely from local petroleum spills, but large impacts on populations are not likely because of the cormorant's wide distribution along the coast and relatively high reproductive rate (Bourne 1976).

Summary

A total of 219 cormorants was recorded in the NAFL survey subunit, 92 in the MILA subunit, 4 in the BTEX subunit, and 2 in the MIFL subunit. They were seen during February and April 1981 in all survey subunits, and also during June and December 1980 in the NAFL subunit. The larger numbers observed during December and February probably were winter migrants from the north. The preference of cormorants for shallow coastal waters makes them susceptible to contact with oil spills.

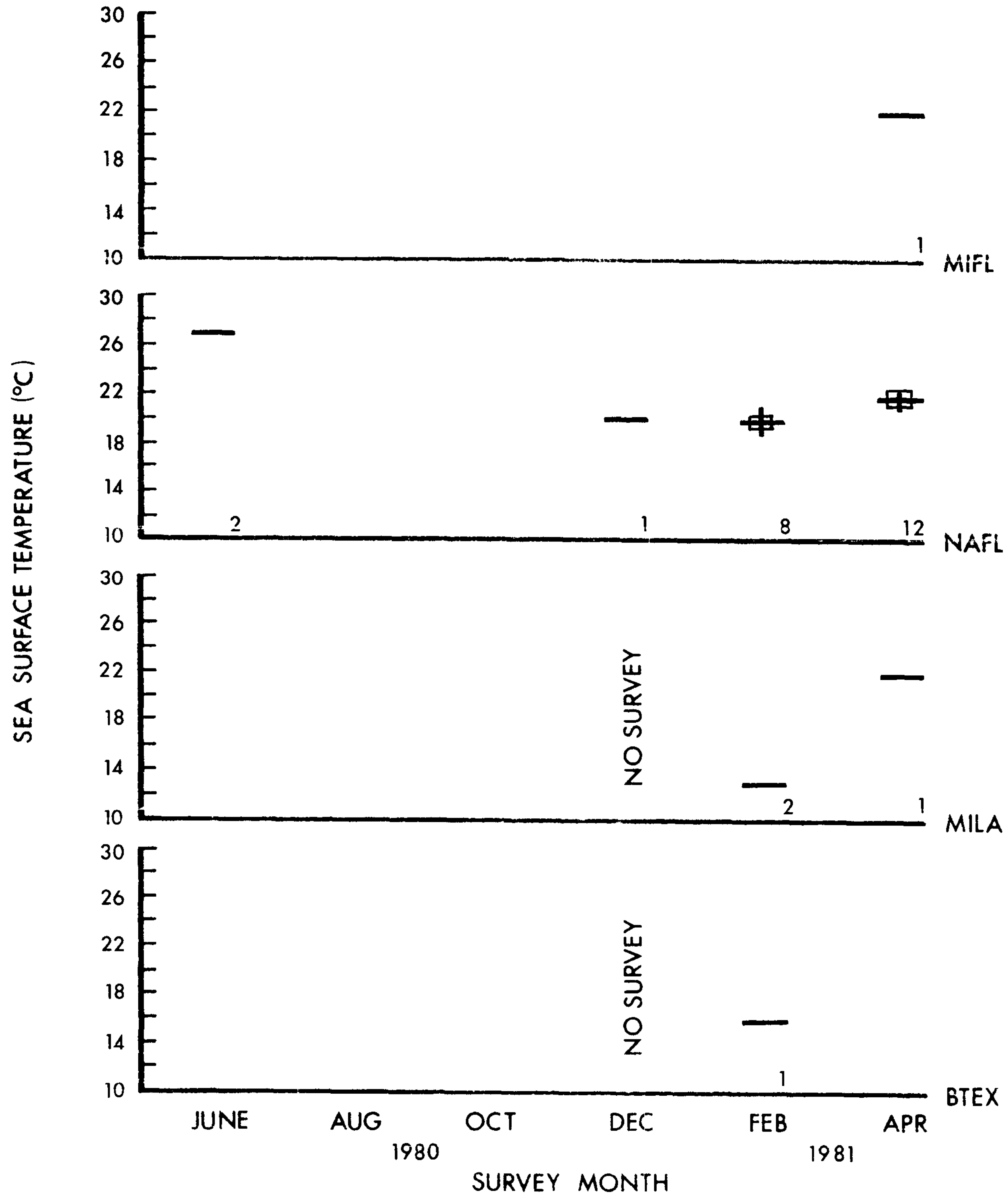


Figure 59. Sea surface temperature for all sightings of Double-crested Cormorants by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

MAGNIFICENT FRIGATEBIRD, *Fregata magnificens*

All frigatebirds observed were considered *Fregata magnificens*, since no records of other frigatebirds exist for the study area (Palmer 1962; Terres 1980). It is doubtful that characters necessary for distinguishing species could be seen from the air.

Description

The Magnificent Frigatebird is a large, dark seabird (body length 95 to 110 cm; wingspan 214 to 245 cm) (Cramp et al. 1977) with long, angular, and pointed wings, a long, gray, hook-tipped bill, and a long, deeply forked tail. The adult male is all black with iridescent feathers on the head, upper wings, and back. During the breeding season the male may be seen with an inflatable orange-red gular pouch. The adult female is dark brownish black except for a white chest and pale bands formed by lesser upper wings coverts. The adult female is larger and heavier than the adult male (Harrington et al. 1972). The subadult plumage is similar to adult female plumage except the subadult has a white head and more white in the abdominal region. Subadult plumage may last up to four years (Palmer 1962; Cramp et al. 1972).

Most characters are distinguishable from an aircraft and often allow determination of age-class and sex of adults. Generally, sightings were of single animals soaring or gliding high above the water and often higher than the airplane. During surveys flown at 91 m, observers may have missed some frigatebirds which were above the aircraft. Surveys flown at 228 m were better suited for censusing frigatebirds.

Distribution

Magnificent Frigatebirds were seen in the BTEX (October), NAFL (June to February), and MIFL (June to December) survey subunits (Table 26). During opportunistic surveys, sightings occurred adjacent to the Dry Tortugas, Florida (December to April), off western Florida (October and April), and east of the Mississippi Delta, Louisiana (October).

During aerial surveys, 1 frigatebird was seen in the BTEX survey subunit, 96 birds were seen in NAFL survey subunit, and 13 birds were seen in the MIFL survey subunit (Table 26). No frigatebirds were seen in the MILA survey subunit. This distribution might be explained in part by the proximity of the NAFL survey subunit to the breeding colony at the Marquesas Keys (Figure 60), and the proximity of the MIFL survey subunit to breeding colonies in the Bahama Islands (Palmer 1962) and the colony at Marquesas Keys.

Frigatebirds were most abundant in survey subunits during October (Table 26). The NAFL survey subunit had the greatest number of sightings during August and October. This abundance may reflect the dispersal of fledglings from the breeding colony at the Marquesas Keys. Unfortunately, the fledging period for the Marquesas Keys breeding colony has not been determined (Robertson 1978; Clapp et al. 1982) and therefore cannot be correlated to periods of peak abundance.

Magnificent Frigatebirds are found along the tropical and subtropical coasts of North America and South America with outlying populations in the Galapagos Islands off Ecuador and the Cape Verde Islands off Senegal (see Clapp et al. 1982). Breeding

Table 26. The number of Magnificent Frigatebirds sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits			
	BTEX	MILA	NAFL	MIFL
June	0	0	8 (6)	1 (1)
August	0	0	34 (34)	1 (1)
October	1 (1)	0	46 (36)	9 (9)
December	-	-	5 (5)	2 (2)
February	0	0	3 (2)	0
April	0	0	0	0
TOTAL	1 (1)	0	96 (83)	13 (13)

colonies have been reported for many locations including the Gulf of Mexico, Caribbean Sea, Atlantic coast of North and South America, and Pacific coast of Central and South America (Palmer 1962). The only breeding colony known for the United States is located on the Marquesas Keys between Key West, Florida and the Dry Tortugas, Florida (Ogden 1969; Figure 60). A possible nesting was reporting on Ship Island, Aransas County, Texas, on 6 June 1931 (Oberholser 1974). Frigatebirds remain in the area of the breeding colony during nonbreeding periods, but their range from the breeding colony is not known (Cramp et al. 1977). Nonbreeding roosts are known for the entire coast of the Gulf of Mexico. Within the study area, roosts are most frequent along the Florida coast (Clapp et al. 1982). The largest reported roost in the study area is on the Chandeleur Islands, Louisiana (Lowery 1974b). The large numbers of birds sighted on the Chandeleurs (5,000 to 10,000) suggest that birds from foreign breeding colonies must use Gulf coast roosts, since relatively small numbers breed at the Marquesas Keys colony (Clapp et al. 1982).

Along the Florida west coast, frigatebirds are common from March to November (Harrington et al. 1972). On the Louisiana coast, they are present from March to December (Lowery 1974b). Sightings of frigatebirds during this study correspond with these dates except for those animals seen during December and February near the Dry Tortugas and the Marquesas Keys breeding colony.

Abundance

Density estimates for Magnificent Frigatebirds were calculated only for the NAFL subunit. During August and October, when frigatebirds were most abundant, estimates were 0.015 birds/km^2 and 0.016 birds/km^2, respectively. During August and October, frigatebirds were seen largely in the inshore half of the NAFL survey subunit. Adjusting

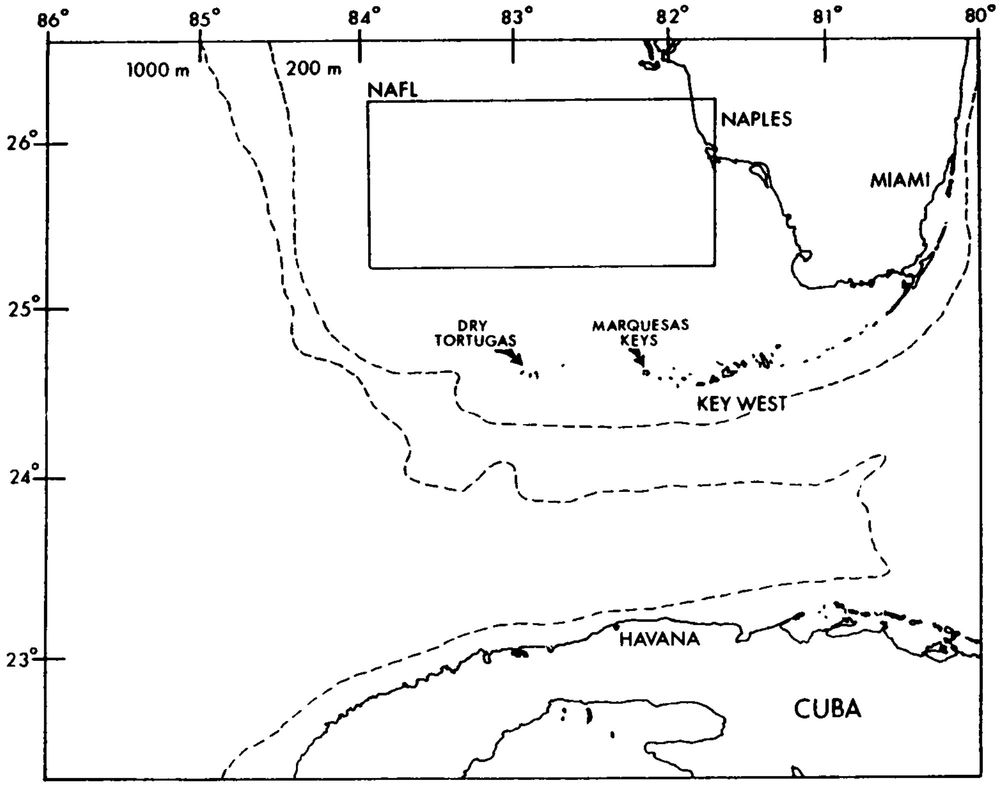


Figure 60. The proximity of the NAFL survey subunit to the breeding colony Magnificent Frigatebirds on Marquesas Keys.

the calculated estimates to reflect the limited range of frigatebirds in the inshore half of the subunits (density/.50 subunit) results in densities of 0.030/km^2 and 0.032/km^2 for August and October, respectively.

Habitat Use

Frigatebirds are thought to feed near the coast, and generally stay within sight of land (Palmer 1962). During aerial surveys birds were up to 165 km from shore (Figure 61), but the majority were distributed in the inshore half of the NAFL subunit (Figure 62). They may forage well offshore, explaining records of birds sighted far from land (Cramp et al. 1977; Clapp et al. 1982).

Frigatebirds were most abundant and occurred farthest from shore in the NAFL survey subunit (Figures 61 and 62). The NAFL survey subunit has a broad, shallow continental shelf and supports a diverse fauna. The large number of fish schools sighted in the NAFL subunit (Table 21), which is an indication of the high productivity of this area, should be a strong attraction to frigatebirds. Frigatebirds eat flyingfish, mullet,(*Mugil* spp.), Atlantic Herring (*Clupea harengus*), menhaden (*Brevoortia* spp.)

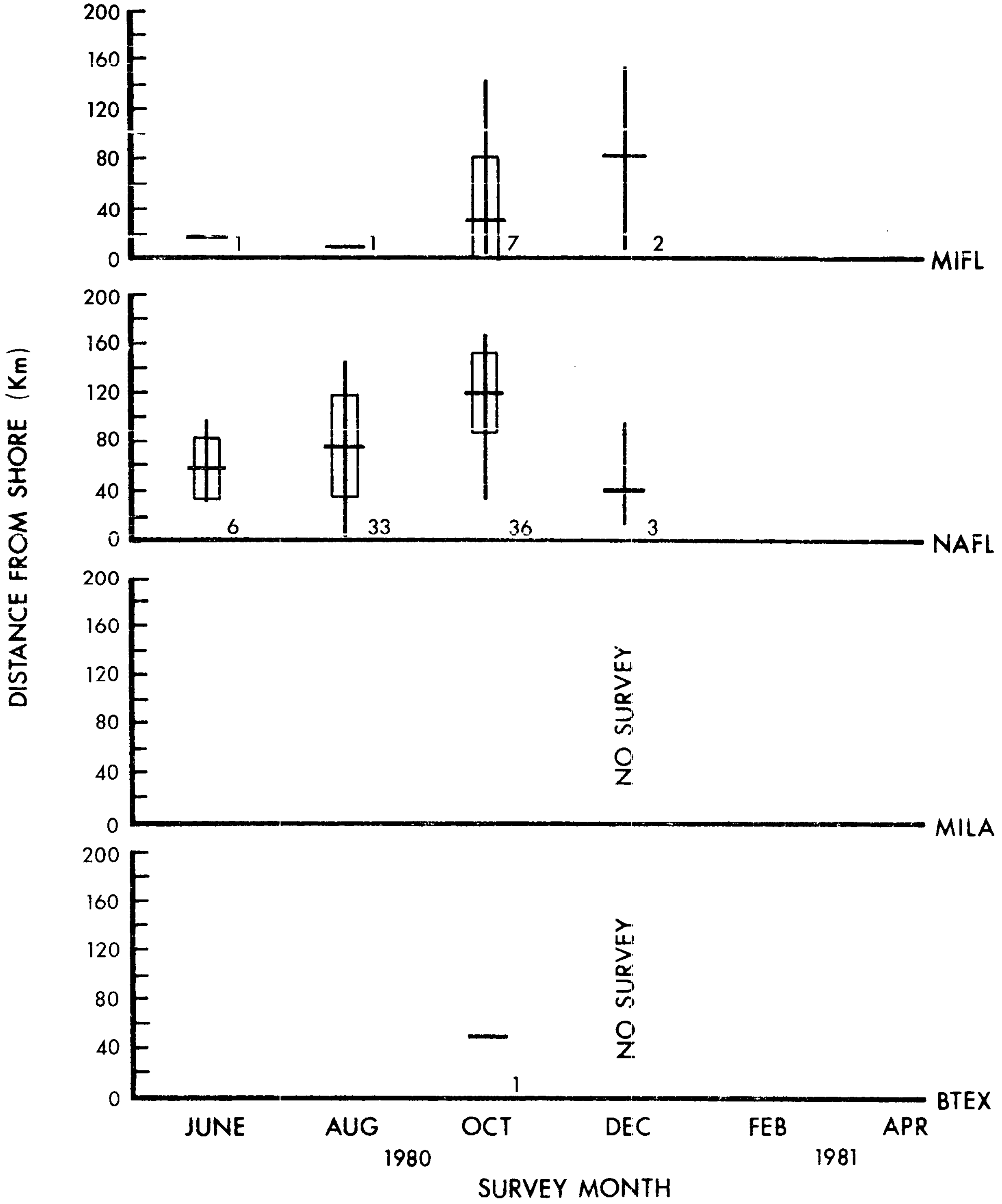


Figure 61. Distance from shore for all sightings of Magnificent Frigatebirds by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

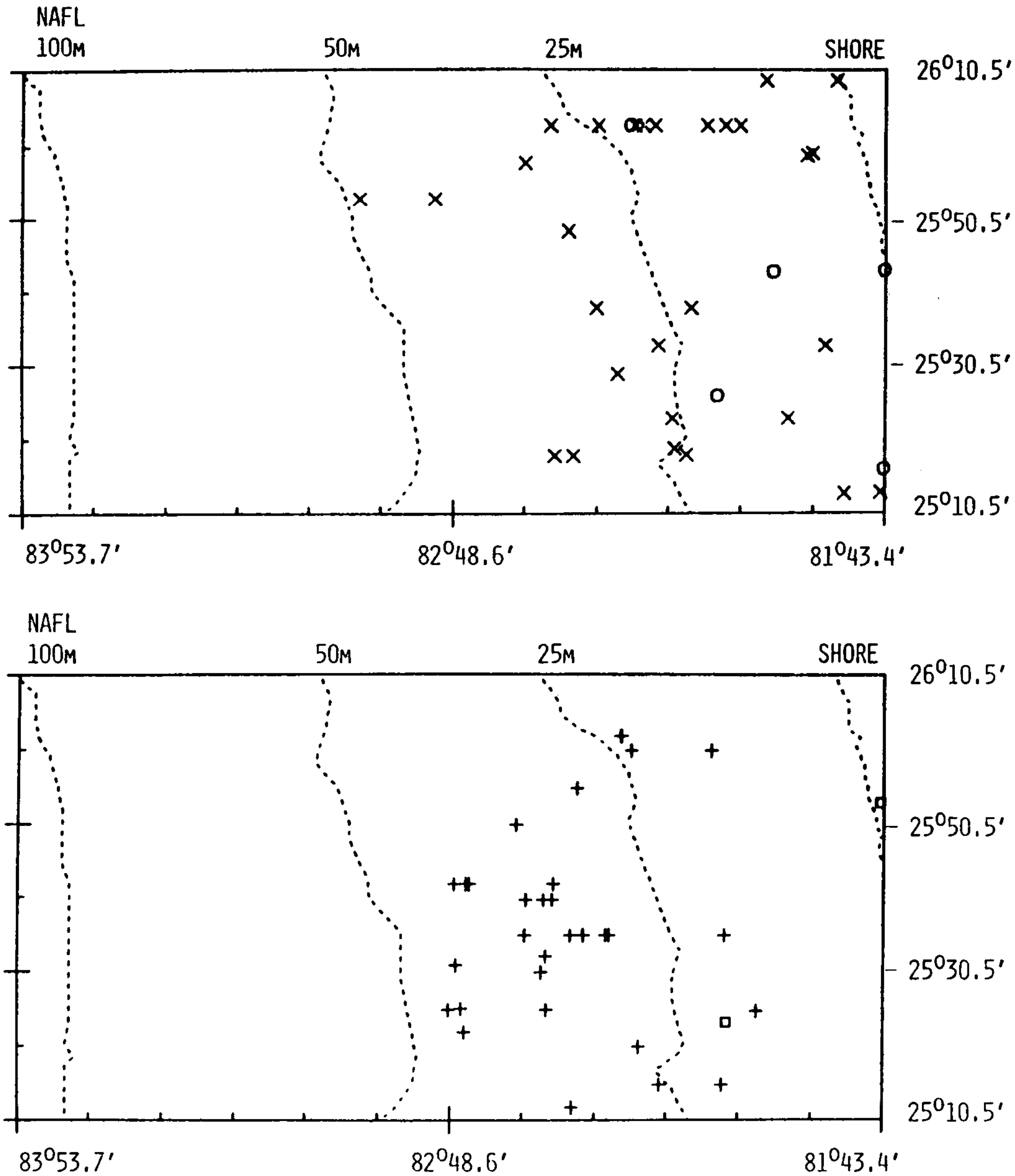


Figure 62. Distribution of all Magnificent Frigatebird sightings in the NAFL survey subunit during June (O), August (X), October (+), and December (□).

Pinfish (*Lagodon rhomboides*), Hardhead Catfish (*Arius felis*), and Weakfish (*Cynoscion regalis*) (Murphy 1936; Palmer 1962; Cramp et al. 1977). Most of these fish occur in the Gulf of Mexico (Hoese and Moore 1977), and are probably present in the NAFL subunit.

Reproduction

The breeding biology of Magnificent Frigatebirds is not well known. Breeding activity (courting, nest building, egg laying) has been reported during most months of the year at different colonies in the Gulf of Mexico and Caribbean Sea (Palmer 1962); and data for the Marquesas Keys' breeding colony are fragmentary (Robertson 1978). One egg is laid; incubation is estimated at about 50 days; fledging takes about 166 days; and the female feeds the young for 16 to 20 weeks after they fledge (Diamond 1972, 1973). This prolonged breeding activity suggests that female Magnificent Frigatebirds do not breed every year (Diamond 1972).

Behavior

Behavioral observations were limited, but the birds were typically seen soaring high above the water, a behavior associated with foraging (Harrington et al. 1972). One frigatebird was seen chasing jaeger. We could not determine if this was an attempt to rob the jaeger. Kleptoparasitism by frigatebirds is well-documented (Bent 1922; Palmer 1962; Cramp et al. 1977). Magnificent Frigatebirds feed from the air by seizing prey from the surface of the water (Palmer 1962; Clapp et al. 1982).

Potential Impacts of OCS Development

Clapp et al. (1982) found no records of oiling for Magnificent Frigatebirds and considered them one of the sea birds least susceptible to direct effects of oiling. Frigatebirds may avoid plumage oiling since they usually seize prey at the surface and rarely wet more than the head (Palmer 1962; Cramp et al. 1977; Clapp et al. 1982). Oil or chemical spills in waters within frigatebird foraging areas could indirectly affect this bird by causing changes in the abundance and distribution of food species. It is also possible that frigatebirds could ingest oil-coated prey. Human disturbance, such as aircraft noise and boat traffic (associated with offshore and coastal oil operations) near the Marquesas Keys breeding colony, pose a potential threat (Robertson 1978). Such activities could cause panic flights by breeders and result in nest failure. Bent (1922) noted that panic flights often caused eggs and nestlings to be dislodged from the nest and abandoned, or adults to become entangled and injured in mangrove on which they commonly nest.

Summary

Magnificent Frigatebirds were most common in the NAFL and MIFL survey subunits, which are adjacent to the Marquesas Keys breeding colony. The largest numbers were seen in the NAFL survey subunit during August and October. Frigatebirds were seen up to 165 km offshore. Frigatebirds are probably not likely to be affected by OCS development activities, unless the latter conflict with breeding at the Marquesas Keys colony.

HERONS, SUBORDER ARDEAE

During aerial surveys eight species of herons and their allies (Families Ardeidae, Threskiornithidae, and Ciconiidae) were seen. Species identified included the Great Blue Heron (*Ardea herodias*), Little Blue Heron (*Egretta caerulea*), Cattle Egret (*Bubulcus ibis*), Reddish Egret (*Egretta rufescens*), Snowy Egret (*Egretta thula*), America Bittern (*Botarus lentiginosus*), Wood Stork (*Mycteria americana*), and Roseate Spoonbill (*Ajaia ajaja*). Not all herons and egrets were identified, and species other than those mentioned may have been sighted.

The most abundant species recorded was the Snowy Egret, of which 103 were seen on 13 occasions. Sightings of this species occurred in all except the MIFL survey subunit. Most (85%) of the sightings occurred in April, and 6 of the 7 April sightings (85%) for which direction of movement was recorded showed a general movement northward.

The second most abundant species was the Cattle Egret. It was observed in all survey subunits during June, and additionally in the MILA survey subunit during August. A total of 29 Cattle Egrets were seen on eight occasions. Sightings occurred from 19 to 242 km from shore ($\bar{x} = 99$, SD = 87.8, n = 6), and most were probably of migratory birds.

The Roseate Spoonbill was only seen in the BTEX survey subunit during August, February, and April. All five sightings (40 birds) occurred close to shore and may have been related to nesting colonies located in Laguna Madre, adjacent to the BTEX survey subunit.

The Reddish Egret was seen twice (5 birds): once in the BTEX survey subunit during June, and once in the MILA subunit during April. These sightings occurred 120 and 80 km from shore, respectively, and probably represented migrating birds.

Two sightings (two birds) of the Great Blue Herons were seen in the NAFL survey subunit, one in February and one in April. Both sightings occurred close to shore. A single Wood Stork was seen over the shore in the NAFL survey subunit during February. The only American Bittern recorded was seen during October in the MIFL survey subunit. It was seen 57 km from shore, and probably represented a migrating bird.

Unidentified white egrets (Great Egrets, Snowy Egrets, Cattle Egrets, white-phase Reddish Egrets, or immature Little Blue Herons) were seen on 61 occasions (397 birds). Sightings occurred in all survey subunits and in all survey periods except December. Unidentified dark herons (Great Blue Herons, adult Little Blue Herons, Louisiana Herons, or dark-phase Reddish Egrets) occurred in the BTEX, MILA, and NAFL survey subunits during June, October, and April. A total of 115 dark herons (9 sightings) were seen.

The species identified during aerial surveys generally breed from Central and South America and the West Indies north to Newfoundland (Palmer 1962; Hancock and Elliot 1978). The Reddish Egret, Wood Stork, and Roseate Spoonbill generally do not breed as far north as other species seen during aerial surveys (Palmer 1962; Hancock and Elliot 1978). Species breeding in the southern portions of their ranges tend to be sedentary, while those breeding in northern portions of their ranges migrate south in the fall after post-breeding dispersal from nesting colonies (Hancock and Elliot 1978). Migration to breeding sites occurs in the spring (Hancock and Elliot 1978).

Sightings from aerial surveys corresponded with existing knowledge. Peak numbers of sightings occurred during April (Table 27). Birds in these sightings were often headed in a northerly direction, possibly towards their nesting grounds (Table 27). The sightings during the late summer and fall (August and October) may represent post-nesting dispersal. The birds sighted during the late summer and fall were less consistent in direction of flight than those sighted during the spring (Table 27).

SURF SCOTER, Melanitta perspicillata

During aerial surveys, a single Surf Scoter was seen on 5 February 1981 in the BTEX survey subunit. It was 28 km from shore where the water was 38 m deep and the sea surface temperature was 17° C.

The Surf Scoter breeds primarily near lakes and ponds in the tundra regions of northwestern Canada and western Alaska (AOU 1957; Oberholser 1974). It winters from the eastern Aleutians to Baja California on the Pacific Coast and from the Bay of Fundy to North Carolina on the Atlantic Coast (AOU 1957; Oberholser 1974). It rarely reaches Florida (AOU 1957; Oberholser 1974); in Texas it is rarely and irregularly seen between mid-October and mid-May (Oberholser 1974).

PHALAROPES, FAMILY SCOLOPACIDAE

Three species of phalaropes occur within the study area: The Red Phalarope (Phalaropus fulicaria), Wilson's Phalarope (Phalaropus tricolor), and the Red-necked Phalarope (Phalaropus lobatus). Due to the small size and similar winter plumage of these species, accurate identification from the air was difficult.

During aerial surveys 188 unidentified phalaropes (32 sightings) were seen. Most (145 phalaropes in 25 sightings) were seen during opportunistic surveys over Onslow Bay, North Carolina, during late March. A group of 13 phalaropes occurred during an opportunistic survey in February east of the Mississippi Delta. In the MIFL survey subunit, 20 phalaropes (three sightings) were seen during early April. During late April, 10 phalaropes (three sightings) were seen in the BTEX survey subunit. Phalaropes identified from the air were in nonbreeding, winter plumage. Most sightings were of birds sitting on the water. Sightings were frequently near water mass boundaries and lines of sargassum.

The breeding ranges of Red-necked and Red Phalaropes are largely the Arctic and Subartic regions of North America, Eurasia, Greenland, and Icleand (Bent 1927; Godfrey 1966), with Red Phalaropes breeding slightly farther north (Murphy 1936). Wilson's Phalarope breeds in southern Canada and the northern United States from the Pacific Ocean to the Great Lakes region (Bent 1927; Godfrey 1966). All three species winter in tropical and subtropical waters south of the Equator (Godfrey 1966; Clapp et al. in prep.). Wilson's Phalarope may also winter in similar regions north of the Equator (AOU 1957). Red-necked and Red Phalaropes are commonly seen at sea during migration, while Wilson's Phalaropes tend to occur in coastal and inland areas (Bent 1927; Murphy 1936; Clapp et al. in prep.).

Table 27. The direction of movement of Herons and their allies. Dash means no data.

Direction of movement	Number of sightings				
	June	August	October	February	April
North	-	1	-	-	11
Northeast	-	1	1	-	12
East	-	4	1	-	1
Southeast	2	1	1	-	-
South	-	-	1	-	3
Southwest	-	-	1	-	-
West	-	-	1	1	4
Northwest	1	-	-	-	3

Red and Red-necked Phalaropes are commonly seen in large numbers and in mixed-species flocks at sea (Bent 1927; Murphy 1936). They swim on the surface of the water (Murphy 1936), and they commonly aggregate at windrows of sargassum and at water mass boundaries (Bent 1927; Murphy 1936; Brown 1981). Phalaropes reportedly pick copepods, which are concentrated at water mass boundaries, from near-surface waters (Brown 1981).

JAEGERS, Stercorarius spp.

Includes: Pomarine Jaeger, Stercorarius pomarinus
Parasitic Jaeger, Stercorarius parasiticus
Long-tailed Jaeger, Stercorarius longicaudus

All three species of jaegers have been reported from the study area. Because individual species are difficult to accurately distinguish from an aircraft, they are discussed together.

Description

The Pomarine Jaeger is the largest of the three species (53 to 56 cm long; wingspan about 122 cm). It occurs in both light and dark phases. In the light phase, the top of the head is black, and the sides of the head and collar are straw colored. The head and breast are white; the flanks and undertail coverts are dusky. Underwing and upperparts are dusky brown. The base of the primaries is white with whitish shafts. A dusky brown band extends across the breast. The bill is brown with a black, hooked tip. The legs are black. The most distinctive characteristic of the Pomarine Jaeger is the dark wedge-shaped tail, which in full adult plumage has two central tail feathers that extend approximately 5 cm beyond the others and are rounded and vertically twisted. In the dark phase, the underparts are as dark as the upperparts.

The Parasitic Jaeger is a medium-sized bird (43 to 51 cm in length; wingspan 102 cm). It is more slender than the Pomarine Jaeger, but has a similar plumage pattern in both light and dark phases. The top of the head is not black, but brown like the back and upperwings. The sides of the head and the neck are yellow. Parasitic Jaegers also have white at the base of the primaries. In the adult plumage, the wedge-shaped tail has two pointed central tail feathers that extend about 7 cm beyond the others.

The Long-tailed Jaeger is the smallest jaeger (53 to 58 cm long including 15 to 20 cm of extended tail feathers; wingspan 76 cm). It apparently does not have a dark phase. The top of the head is brownish-black, and the remainder of the upperparts are grayish brown with black primaries. The side of the head and neck are yellow, like the Parasitic Jaeger. The breast and underbody are white with dusky flanks. There is very little white at the base of the primaries. The underwings are grayish brown. The bill is brown with a black, hooked tip, and the legs are bluish gray. In adult plumage, two greatly elongated, narrow, and pointed central tail feathers (or streamers) are distinctive.

Immatures of all three species lack the distinctive central tail feathers. The young of the Pomarine and Parasitic Jaegers are practically indistinguishable at sea. The young Long-tailed Jaeger is more grayish brown than the other two.

From the air, jaegers are generally identified by their gull-like shape, dark-brown coloration, distinctive tail shape, and especially by the white at the base of the primaries (Godfrey 1966; Tuck and Heinzel 1978).

Distribution

Eight Jaegers were seen in all four survey subunits. In the MIFL subunit, one was seen during August and two during October. In the NAFL survey subunit, one was observed during February and another during April (Figure 63). One was seen during February in the MILA survey subunit, and two were observed during April in the BTEX survey (Figure 64).

The breeding range of all three species of jaegers is Holarctic. Within North America, the Pomaine Jaeger breeds from northern Alaska to Banks Island, northern MacKenzie, Southhampton Island, northern Quebec, and Baffin Island (Clapp et al. in prep.). The Parasitic Jaeger breeds in North America from the Bering Sea to Labrador; north to Point Barron and northern Ellesmere Island; and south to the Aleutian Islands, Kodiak, southern MacKensie, northern Ontario, and northern Quebec (AOU 1957; Godfrey 1966). In North America, the Long-tailed Jaeger breeds across northern Alaska and Canada to Nunicak Island, Mt. McKinley National Park, northern Yukon Territory, northern Quebec, and Southhampton Island (Clapp et al. in prep.). Breeding probably occurs from May to August. Recorded dates for egg-laying by the Pomarine Jaeger are concentrated in mid-June (Maher 1974).

All three species migrate along the Atlantic and Pacific coasts, as well as through the interior of the U.S. and Canada (AOU 1957; Godfrey 1966; Clapp et al. in prep.). Most Pomarine Jaegers winter in tropical waters north of the equator although some do cross to the Southern Hemisphere (Wynne-Edwards 1935; Vaurie 1965). They winter along

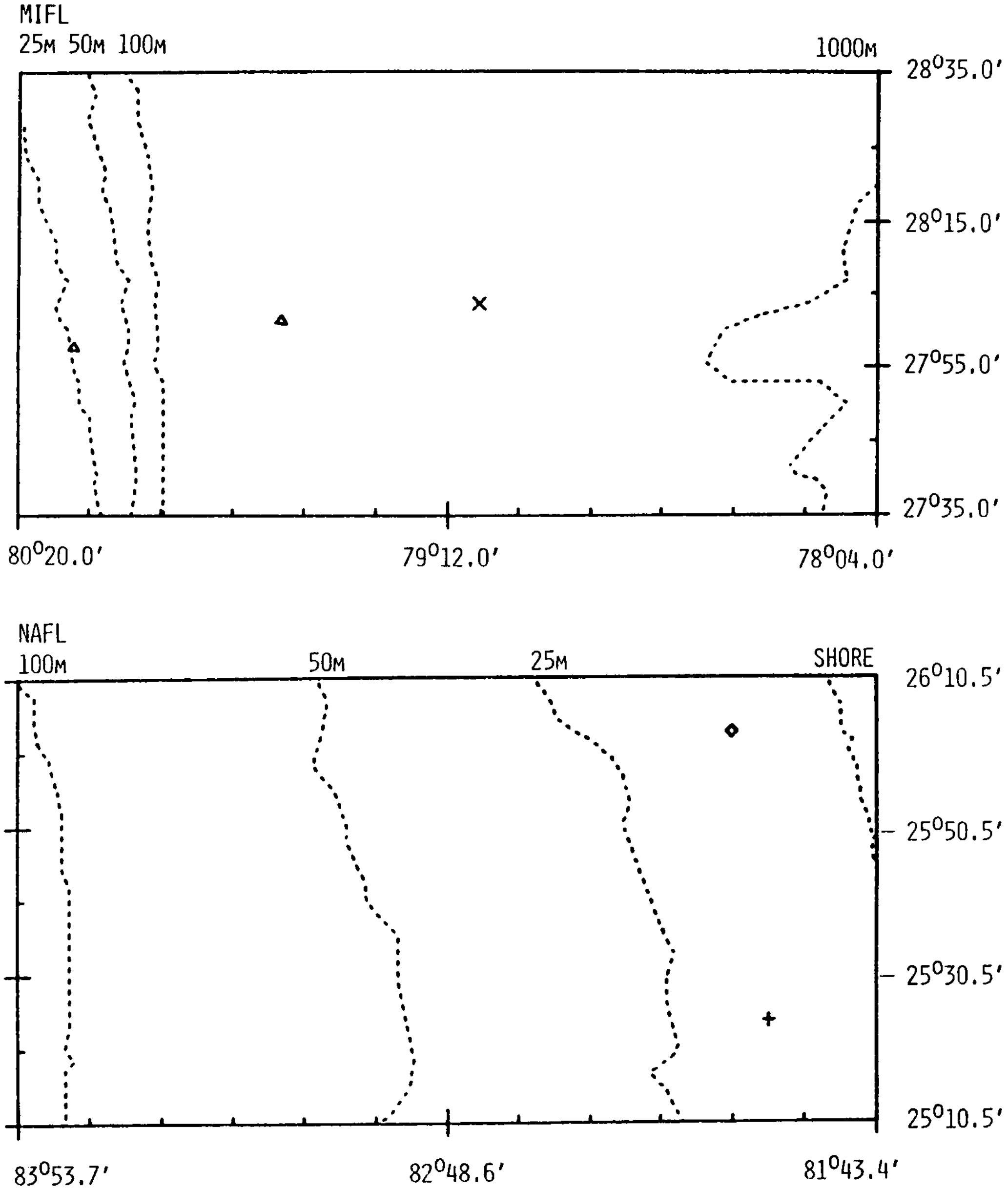


Figure 63. Distribution of all jaeger sightings in the MIFL and NAFL survey subunits during August (X), October (△), February (◇), and April (+).

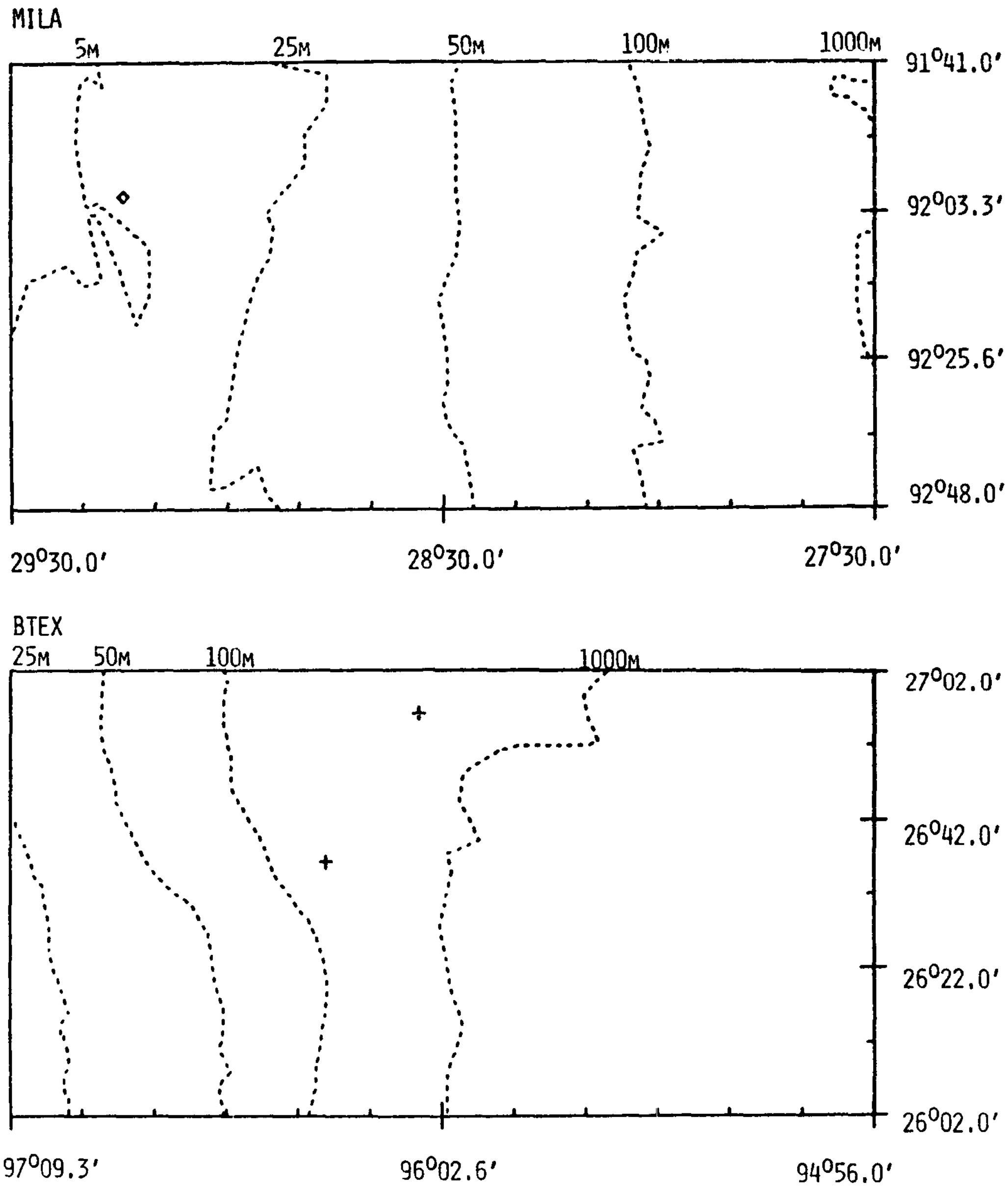


Figure 64. Distribution of all jaeger sightings in the MILA and BTEX survey subunits during February (◇) and April (+).

the continental shelf, but are rarely seen close to shore. The Parasitic Jaeger also occurs throughout continental shelf waters, yet tends to occur closer to shore than the other jaegers. Long-tailed Jaegers migrate well out at sea and winter in tropical Atlantic and Pacific waters (Clapp et al. in prep.).

Abundance

Since Long-tailed Jaegers tend to remain well offshore (Clapp et al. in prep.) and the adults' tails are so distinctive, those seen during this survey were probably Pomarine or Parasitic Jaegers. Off the east coast of Florida, Pomarine Jaegers are most common during fall migrations and are more common than Parasitic Jaegers. In the Gulf of Mexico, Pomarine Jaegers seem to be more common in the western Gulf and Parasitic Jaegers are most common near Alabama (Duncan and Havard 1980). Duncan and Havard (1980) reported many unidentified jaegers off Florida. Williams (1965) summarized records from the Gulf of Mexico: 85 Parasitic Jaegers, 43 Pomarine Jaegers, and 6 Long-tailed Jaegers.

Habitat Use

Pomarine and Parasitic Jaegers eat carrion and prey on small birds and mammals, but feed extensively by kleptoparasitism (robbing food from other birds). Their habitat use is therefore primarily determined by the food habits and habitat use of the birds they parasitize. The Parasitic Jaeger is reported to be a more opportunistic feeder than the Pomarine Jaeger. Not much is known of the feeding habits of the Long-tailed Jaegers at sea, but they have been seen feeding on baitfish as well as kleptoparastizing other birds.Within the entire study area, jaegers ranged 27 to 142 km from shore (Table 28).

Reproduction

The breeding biology of the three jaeger species is very similar (Maher 1974). They lay one or two eggs in unlined nests, usually on mounds in the open tundra. Both parents incubate the eggs. During the breeding season, the birds feed on small rodents, berries, insects, and small birds (Clapp et al. in prep.). They do not renest following loss of the first clutch (Maher 1974). Incubation lasts for 24 to 26 days.

Behavior

Jaegers were seen flying alone or in the vicinity of other birds. One jaeger was chased by a Magnificent Frigatebird. The birds were flying in tight circles and it was not possible to tell if food was involved. Both birds practice kleptoparasitism.

Potential Impacts of OCS Development

Jaegers spend the nonbreeding season at sea and roost on the water; therefore, they are susceptible to oiling. Clapp et al. (in prep.) reported three instances of oiled Pomarine Jaegers, and although none of the other jaegers are known to have been found oiled, they are all susceptible to oiling when roosting on the water. Jaegers are predatory in habits and occasionally scavenge; therefore, they could ingest oil by opportunistically consuming other animals killed by oil. Long-tailed Jaegers are relatively rare in the study area.

Table 28. Sighting information on unidentified jaegers. OPPO - opportunistic flight.

Survey subunit	Date	No. of birds	Position (Latitude/Longitude)	Distance from shore (km)	Water depth (m)	Sea surface temperature (° C)
BTEX	25 Apr. 1981	1	26°36.0'N/96°20.8'W	95	190	22
BTEX	25 Apr. 1981	1	26°56.0'N/96°06.4'W	124	686	23
MILA	19 Feb. 1981	1	29°14.4'N/92°01.0'W	34	7	17
NAFL	06 Mar. 1981	1	26°03.5'N/82°05.2'W	27	13	20
NAFL	03 Apr. 1981	1	25°24.5'N/81°59.5'W	84	17	21
MIFL	11 Aug. 1980	1	28°35.0'N/79°07.0'W	142	786	27
MIFL	11 Oct. 1980	1	27°57.5'N/80°11.0'W	37	28	25
MIFL	13 Oct. 1980	2	28°01.1'N/79°38.3'W	91	465	27
OPPO	14 Dec. 1980	1	25°00.4'N/84°33.0'W	250	210	24

Summary

Eight jaegers were observed in all the survey subunits. They were seen during August and October in the MIFL subunit, April and March in NAFL, February in MILA, and April in BTEX. Pomarine and Parasitic Jaegers were the jaegers most likely seen. Jaegers are kleptoparasitic, but also may feed opportunistically on small living prey. They may be vulnerable to floating oil when they roost on the water and may prey on oiled birds.

GREAT BLACK-BACKED GULL, *Larus marinus*

The Great Black-backed Gull is the largest gull likely to be found in the study area. One immature Great Black-backed Gull was seen during an opportunistic flight off Onslow Bay, North Carolina in April. During boat trips out of Oregon Inlet, North Carolina, adults and immatures were seen (but not counted) sitting inshore on pilings and flying over the protected waters of the inlet or over open water near the shore.

The Great Black-backed Gull is primarily a coastal bird and in the northwest Atlantic Ocean ranges from Labrador to North Carolina (Godfrey 1966; Parnell and Soots 1975). It is an opportunistic feeder. It eats fish and other marine organisms, carrion, and often robs other birds of food (Bent 1921). The Great Black-backed Gull has been known to prey on storm petrels, ducks, and the eggs of other birds (Bent 1921; Cobb 1957; Parslow 1965). It feeds on the surface of the water or plunges from the air for food (Cross 1953).

Coon et al. (1979) found No. 2 fuel oil to have adverse effects on hatchability of Great Black-backed Gull eggs. This species has been known to successfully clean oil from its feathers. However, in at least one instance, this cleaning resulted in "bad health and a distressed condition", and the oiled bird did not attempt to breed that year (Corkhill et al. 1973). The Great Black-backed Gull roosts on beaches and on the water at night, and has been fouled by oil slicks while roosting on the water at night (Clapp et al. in prep.).

HERRING GULL, Larus argentatus

Larus argentatus smithsonianus occurs in the study area (AOU 1957).

Description

The Herring Gull is a medium to large bird with pointed wings and a square tail (body length 56 to 61 cm; wingspan 132 cm) (Tuck and Heinzel 1978). It is the largest gull that regularly occurs throughout the study area. In adult breeding plumage the head, neck, rump, and tail are white. The back and upperwings are gray. The wings have a white trailing edge and black tips that are interrupted with white spots. The underparts are white. The bill is yellow with a subterminal red spot on the mandible. The legs and feet are pinkish. Adult winter plumage is similar to breeding plumage except that the head and neck are flecked with brown.

In immature, first winter plumage, the body is largely brown with whitish flecks. The primaries, secondaries, and retrices are dark brown. The head, neck, and rump are lighter brown than the back and upperwings. The underparts are brown. The bill is dark brown to black. The legs and feet are pinkish brown. The second winter plumage is paler than the first winter plumage: the head and neck are white with brown flecks; the back is gray mottled with brown; the rump is white; and the tail is brown. The upperwings are gray-brown with dark brown to blackish primaries. The underparts are largely white. The bill is flesh colored with a dark tip, and the legs and feet are pinkish.

The flight of the Herring Gull is direct and characterized by strong, regular wingbeats. The Herring Gull can utilize the wind and glide for long periods with little effort (Baudinette and Schmidt-Nielsen 1974).

From the air, the gull body shape and coloration were useful identification cues. The Herring Gull could be confused with the Ring-billed Gull (see Ring-billed Gull species account for details). The larger size and somewhat slower wingbeats of the Herring Gull were distinctive when compared with those of other gull species.

Distribution

The Herring Gull was seen in all survey subunits during February and April (Table 29). It also was seen in the MILA subunit during October, and the NAFL subunit during December. During on-line surveys, 1,829 Herring Gulls (574 sightings) were seen. All sightings within survey subunits, including sightings that were not part of a scheduled survey and those that occurred while away from the survey line, totaled 732 (3,640 birds). Sightings were most numerous in the MILA survey subunit. Throughout the study area, the largest number of sightings occurred during February (Table 29). Sightings in

Table 29. The number of Herring Gulls sighted on-line during this study. The number in parenthesis represents the number of sightings. Dash means no survey. * = no on-line survey.

Month	Survey subunits							
	BTEX		MILA		NAFL		MIFL	
June	0		0		0		0	
August	0		0		0		0	
October	0		46	(12)	0		0	
December	-		-		65	(25)	*	
February	184	(51)	950	(250)	121	(93)	136	(47)
April	9	(7)	308	(79)	7	(7)	3	(3)
TOTAL	193	(58)	1304	(341)	193	(125)	139	(50)

the BTEX, NAFL, and MIFL survey subunits were most common over coastal waters, while sightings in the MILA survey subunit during February and April were more evenly dispersed throughout the subunit (Figures 65 through 68).

Sightings during aerial surveys were consistent with existing knowledge. The relative abundance of Herring Gulls within the survey subunits suggests that numbers may be greatest in the northern limits of the Gulf of Mexico. This suggests that the Mississippi Valley may be a major migration route for Herring Gulls. The greater range of distribution within the MILA survey subunit might be explained in part by localized concentrations of food or increased competition resulting in larger numbers of Herring Gulls and other bird species moving farther from shore to forage for food.

Outside North America, the Herring Gull breeds across northern Eurasia from Norway to the Bering Sea. Breeding also occurs in Iceland, Greenland, the Azores, Madeira, and the Canary Islands in the Atlantic Ocean (AOU 1957). The Herring Gull breeds in northern North America from Alaska to Newfoundland and Nova Scotia. The breeding range extends south through the central Canadian provinces to the Great Lakes states (Bent 1922; Godfrey 1966; Clapp et al. in prep.). Breeding occurs throughout the New England states and along the Atlantic coast to North Carolina (Kadlec and Drury 1968; Parnell and Soots 1975; Clapp et al. in prep.).

During winter months, the Herring Gull remains as far north as there is open water (Clapp et al. in prep.). It also migrates along the Pacific coast to El Salvador, along the Atlantic coast to the southeastern United States, and down the Mississippi Valley to the coasts of the Gulf of Mexico (Clapp et al. in prep.). This species occasionally occurs in

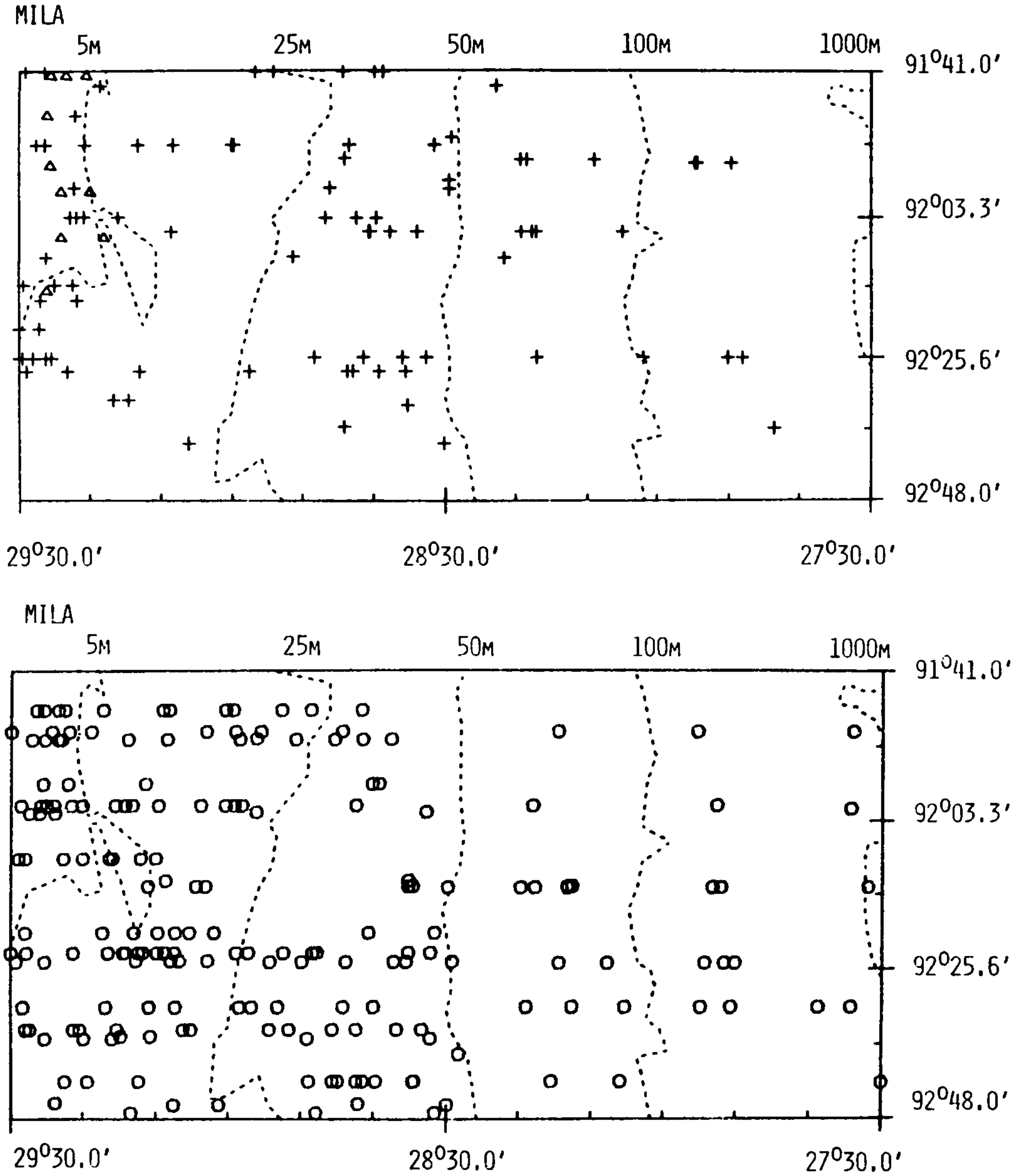


Figure 65. Distribution of all Herring Gull sightings in the MILA survey subunit during October (△), February (O), and April (+).

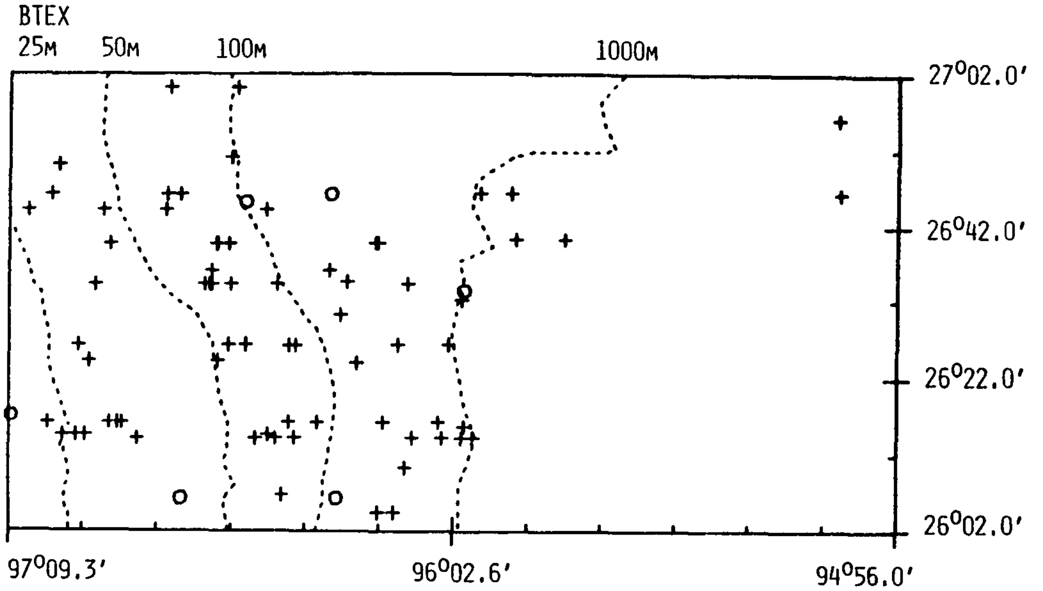


Figure 66. Distribution of all Herring Gull sightings in the BTEX survey subunit during February (+) and April (O).

Panama and Bermuda, and in the West Indies from the Bahamas to Barbados (Cooke 1940; AOU 1957).

Atlantic coast colonies probably provide a majority of the gulls wintering in the Carolinas and Georgia, while Great Lakes colonies may contribute the majority of birds wintering in the Gulf of Mexico (Clapp et al. in prep.). October sightings in the MILA survey subunit (Table 29) may be of Herring Gulls that were migrating directly south along the Mississippi Valley from the Great Lakes colonies and thus arriving earlier than birds taking longer indirect routes along the Atlantic coast (Clapp et al. in prep.).

Abundance

Density estimates for Herring Gulls were calculated for survey subunits and months with adequate data and ranged from 0.19 x 10^{-1} birds/km^2 to 1.75 birds/km^2 (Table 30). Densities were adjusted (density/percentage of the subunit utilized) to reflect the percentage of the subunit used by the species. The greatest adjusted densities occurred in the MILA subunit during October and February (1.28 birds/km^2 and 1.75 birds/km^2, respectively). In the BTEX, MILA, and MIFL subunits, highest adjusted densities occurred during February; densities dropped to relatively low levels in subsequent periods. In the NAFL subunit, the highest adjusted density occurred during December and the lowest occurred in February (0.17 birds/km^2 and 0.11 birds/km^2, respectively). Lower densities may have occurred in the NAFL subunit due to its southernmost location. Early declines in the NAFL densities suggest that Herring Gulls in the southern portions of their winter range begin migration to the north earlier than do Herring Gulls

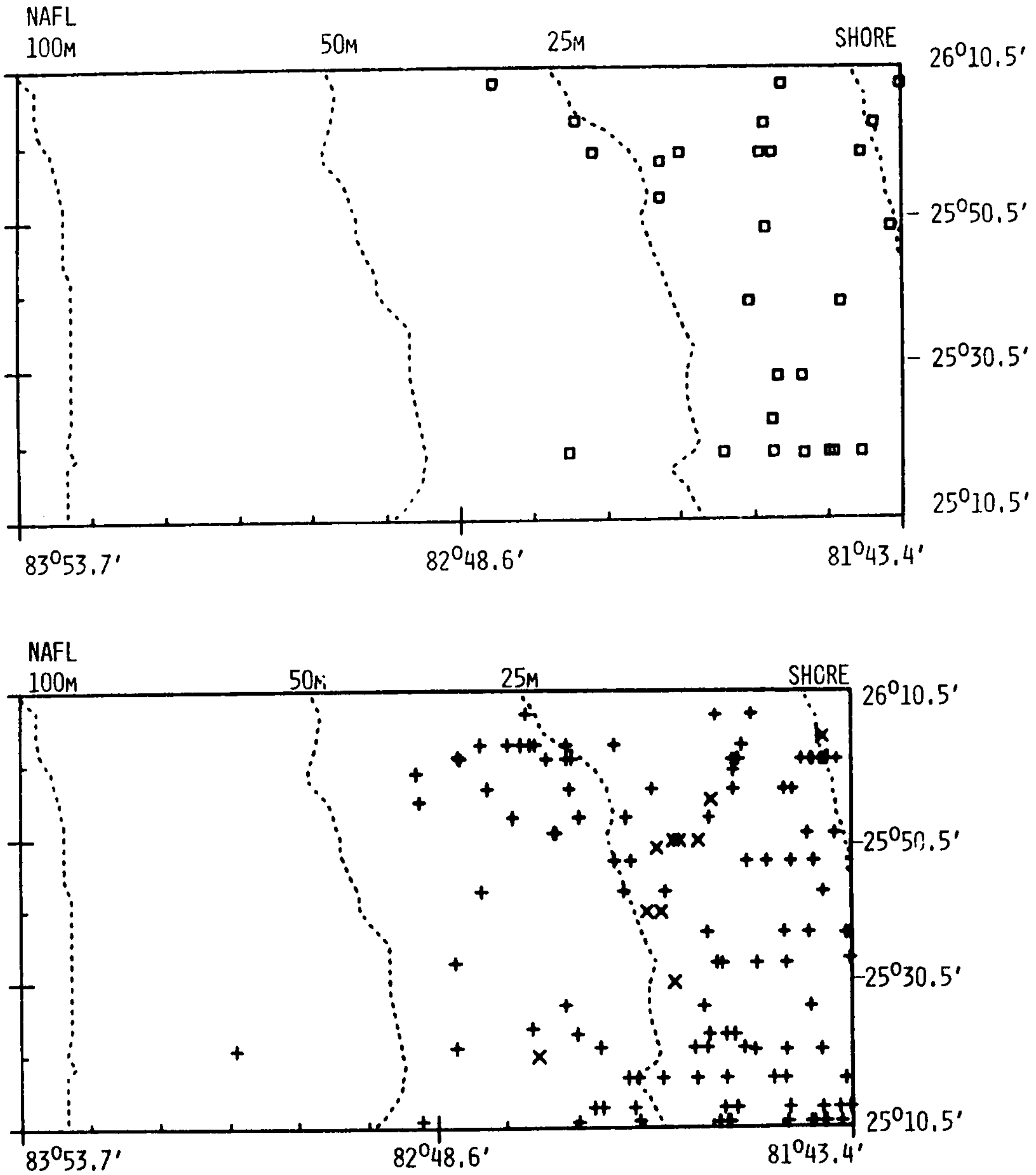


Figure 67. Distribution of all Herring Gull sightings in the NAFL survey subunit during December (□), February (+), and April (X).

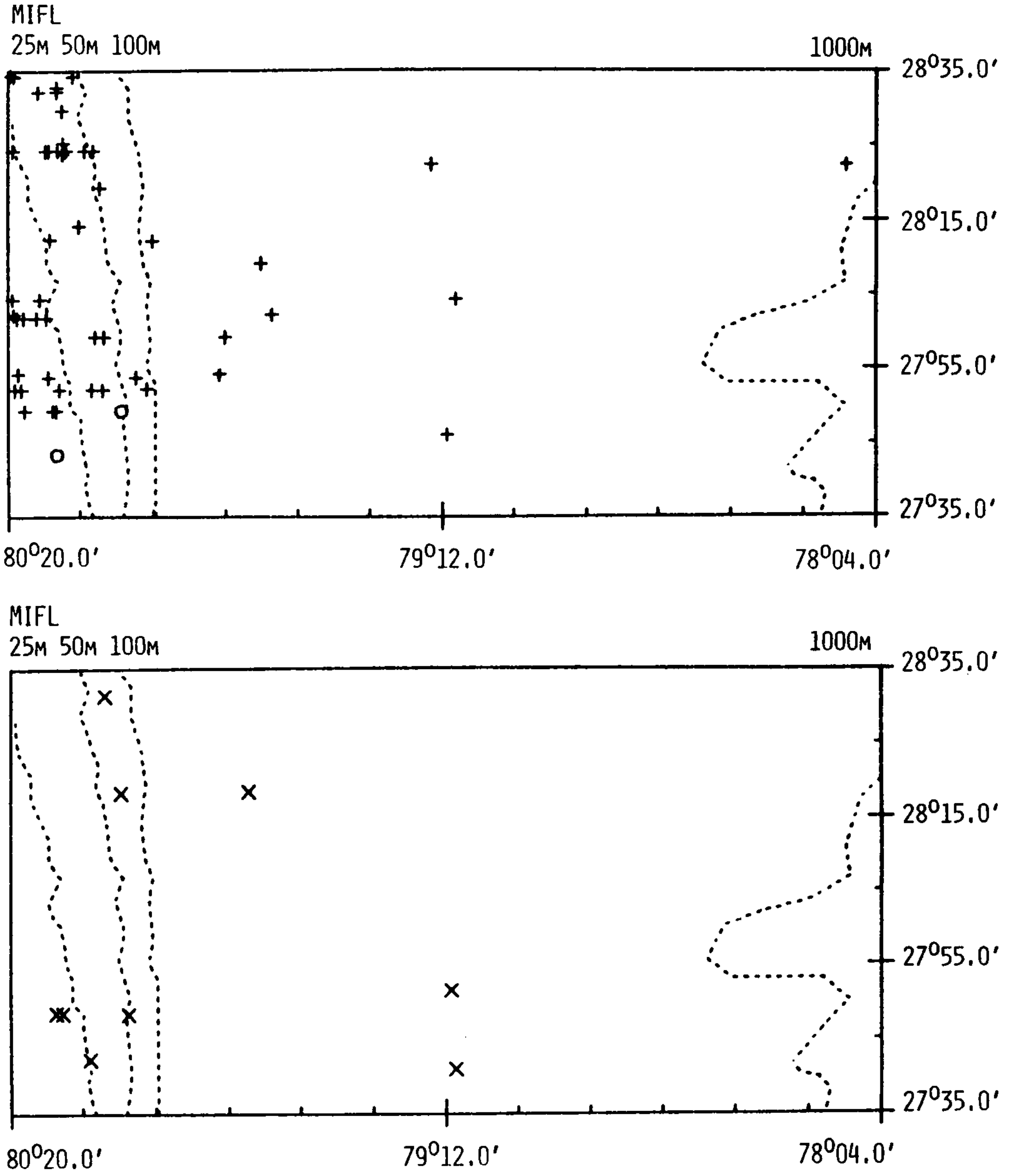


Figure 68. Distribution of all Herring Gull sightings in the MIFL survey subunit during December (O), February (+), and April (X).

Table 30. Density and group size estimates for on-line sightings of Herring Gulls. "All" represents combined months. * = variance too small for calculation.

Survey subunit	Month	No. of sightings	Group density (groups/km^2)	Variance	Mean group size	Standard error	Individual density (birds/km^2)
BTEX	February	45	0.17	$0.11 x 10^{-1}$	3.9	1.1	0.66
BTEX	April	7	$0.27 x 10^{-1}$	*	1.3	0.2	$0.35 x 10^{-1}$
BTEX	All	52	$0.35 x 10^{-1}$	$0.29 x 10^{-3}$	3.5	0.9	0.12
MILA	October	10	$0.14 x 10^{-1}$	*	4.4	1.1	$0.64 x 10^{-1}$
MILA	February	217	0.43	$0.47 x 10^{-1}$	4.1	1.2	1.75
MILA	April	59	$0.38 x 10^{-1}$	$0.24 x 10^{-4}$	3.9	1.6	0.15
MILA	All	286	$0.85 x 10^{-1}$	$0.12 x 10^{-2}$	4.1	1.0	0.35
NAFL	December	23	$0.18 x 10^{-1}$	$0.50 x 10^{-4}$	2.7	1.7	$0.47 x 10^{-1}$
NAFL	February	76	$0.53 x 10^{-1}$	$0.38 x 10^{-3}$	1.3	0.1	$0.67 x 10^{-1}$
NAFL	All	104	$0.12 x 10^{-1}$	$0.15 x 10^{-4}$	1.6	0.4	$0.19 x 10^{-1}$
MIFL	February	43	$0.35 x 10^{-1}$	$0.35 x 10^{-2}$	3.0	1.6	0.11
MIFl	All	45	$0.14 x 10^{-1}$	$0.18 x 10^{-3}$	2.9	1.5	$0.41 x 10^{-1}$

that winter in more northerly portions of the study area. Conspicuous decreases in the densities of Herring Gulls between February and April in the BTEX and MILA subunits suggest that the majority of Herring Gulls began migration to the north at some time between the two survey periods.

The Herring Gull is common to abundant from mid-September or mid-November through April along the coasts throughout the study area (Sprunt 1954; Lowery 1974b; Oberholser 1974; Clapp et al. in prep.). From mid-May to September, Herring Gulls are rare within the study area except in North Carolina (Sprunt 1954; Lowery 1974b; Clapp et al. in prep.).

Herring Gull numbers in North America have been increasing since the early 1900's (Kadlec and Drury 1968; Parnell and Soots 1975; Burger 1977; Clapp et al. in prep.). The increase has been attributed to garbage dumps, which provide a consistent food supply for Herring Gulls (Drury and Smith 1968; Oberholser 1974). The Herring Gull's flexibility in nest site selection also has allowed the increase in numbers (Burger 1977). The breeding range has recently expanded south to North Carolina (Parnell and Soots 1975), and may be continuing to expand southward along the Atlantic coast (Clapp et al. in prep.).

Habitat Use

In the MILA subunit during October, sightings occurred relatively close to shore ($\bar{x}$ = 16 km, Figures 65 and 69). During other months in the MILA subunit, sightings ranged 3 to 227 km from shore with mean distances from shore of 69 and 66 km for February and April, respectively (Figure 69). During February, the distance of sighting locations from shore in the MILA subunit was significantly more variable than in all other subunits. In BTEX, NAFL, and MIFL subunits, sightings were concentrated largely within the inshore half of the survey subunits, although sightings farther from shore occasionally occurred (Figures 65 to 68). The mean distance from shore during February in MIFL was significantly lower than in all other survey subunits (Newman-Keuls test).

Herring Gulls have been reported up to 926 km from shore in the northeastern Pacific Ocean, where they may remain over pelagic waters for extended periods (Sanger 1973). These gulls may have adapted to their offshore existence by following ships and feeding on garbage thrown overboard (Sanger 1973). Herring Gulls in the MILA survey subunit potentially exploit garbage from offshore structures and operations in a similar manner.

The Herring Gull was sighted over waters of depths to 1,628 m (BTEX, February), which suggests that this species' range is not limited by the depth of the water over which it occurs. Sightings occurred where sea surface temperatures ranged from 12° C during February to 25° C during December and February.

Associations

In 66 of the 732 sightings (9%), Herring Gulls (42.7% of the birds observed) were associated with other animals, boats, and oceanic features (Table 31). The most common association (7.1% of all sightings) was with other bird species including the Ring-billed Gull, Laughing Gull, Bonaparte's Gull, Royal Tern, Common-group Tern, Sooty Tern, and Northern Gannet (Table 31). These associations were frequently focused on fish schools or fishing boats (Table 31), and probably represent feeding situations. Bottlenose Dolphins were occasionally included with the fish-bird aggregations. On eight occasions, Herring Gulls were associated with coastal and nearshore structures. Unidentified gulls (605 birds) were associated with OCS structures on 11 occasions. In all cases, other bird species also were present. The association between Herring Gulls and oil rigs warrants further investigation to determine if gulls use such structures as roosts and if so, the significance of such behavior. On one occasion, a Herring Gull was seen resting on the carapace of a basking Loggerhead Turtle.

Group sizes of Herring Gulls in associations ranged from 1 to 250 individuals with a mean group size of 23.5 (SD = 50.5). Group sizes for all sightings within survey subunits ranged from 1 to 500 individuals with mean group sizes that ranged from 1.0 (SD = 0, n = 11) to 6.1 (SD = 23.4, n = 79). Group sizes within associations probably tended to be larger because birds were concentrated by attractants such as food resources or roosting sites.

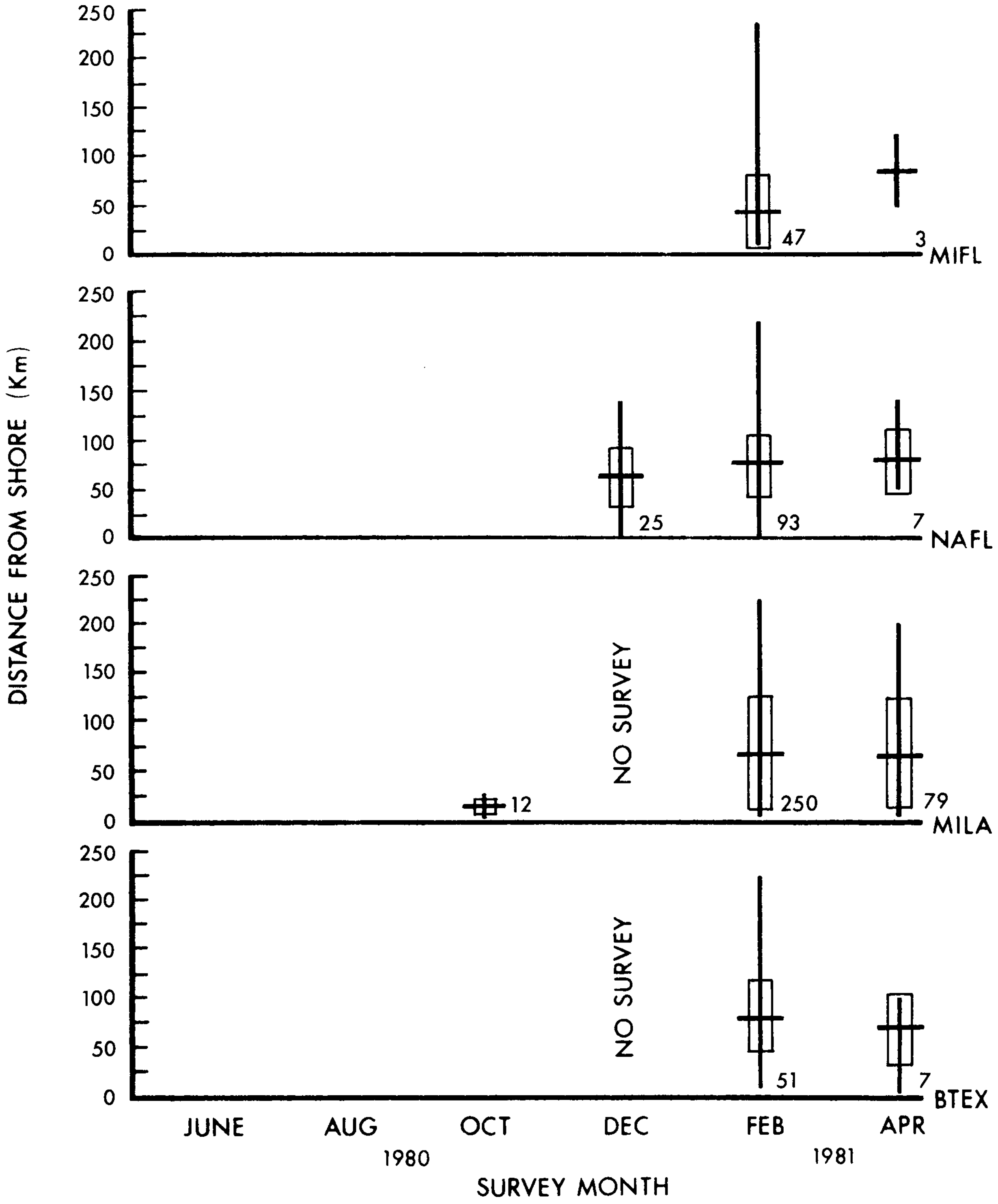


Figure 69. Distance from shore for on-line sightings of Herring Gulls by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

Table 31. Number of sightings and percentages of associations of Herring Gulls. Some sightings were of associations including two or more animal groups, thus subtotals are not cumulative.

Herring Gull associations	No. of sightings	Percentage of all sightings	No. of Herring Gulls	Percentage of Herring Gulls
All	66	9.0	1,554	42.7
With Bottlenose Dolphin	8	1.1	182	5
With other birds including other gull species, terns, and gannets	52	7.1	1,535	42.2
With Loggerhead Turtles	1	1.0	1	1.0
With unidentified fish and fish schools	10	1.4	108	3.0
With fishing boats, sport boats, and ships	24	3.3	855	23.5
With OCS structures	8	1.1	50	1.4
With water mass boundaries and sargassum	8	1.1	19	1.0

Reproduction

The Herring Gull nests in colonies, often with other bird species, near rivers, lakes, and seas (Bent 1922; Clapp et al. in prep.). Nests usually are located in open areas on sand, gravel, rocks, and grassy fields (Bent 1922; Clapp et al. in prep.). The nest has a shallow cup and is constructed of grasses, weeds, mosses, and seaweeds (Bent 1922; Godfrey 1966; Burger 1977). Three eggs are usually laid between May and June, occasionally as late as August (Bent 1922; Erwin 1971; Terres 1980). Fledging occurs 42 to 49 days after hatching (Terres 1980). Herring Gulls retain subadult plumage until they are about 46 months old, although birds in third-winter plumage closely resemble those in adult winter plumage (Dwight 1925). Herring Gulls will often renest, if initial clutches are lost (Clapp et al. in prep.).

Behavior

The Herring Gull is a highly opportunistic feeder (Clapp et al. in prep.). It generally feeds on animal matter ranging from invertebrates to small mammals, carrion, and garbage, but will also take berries, fruits, and grasses (Clapp et al. in prep.). In the study area, the Herring Gull is commonly seen along sandy beaches and tidal mud flats where it feeds on fish, marine invertebrates, and carrion (Sprunt 1954). It also occurs in large flocks feeding at garbage dumps and near fishing boats (Bent 1922; Oberholser 1974; Clapp et al. in prep.). When feeding over water, it usually picks food from the surface, rarely wetting its feathers. However, it can plunge into the water for food in a tern-like manner (Bent 1922; Oberholser 1974). Herring Gulls also parasitize other birds for food (Bent 1922; Morrison 1978).

During aerial surveys, the Herring Gull was occasionally seen resting on the water. The Herring Gull is a rapid and buoyant swimmer, but generally does not travel far in this fashion (Bent 1922).

Potential Impacts of OCS Development

Herring Gulls have been victims of oil spills along the eastern North Atlantic coast (Gorski et al. 1977, cited by Clapp et al. in prep.; Lloyd et al. 1974). Herring Gulls could be oiled while roosting on the water overnight (Bourne 1976). Oil transported to eggs reduces hatching success in gulls (White et al. 1979). Herring Gull chicks that have ingested sublethal amounts of oil have a lower chance of survival during stressful situations (Miller et al. 1978). Although petroleum could cause considerable damage to individuals of this species on a local level, OCS development probably would not represent a major threat to this species due to its widespread distribution and abundance (Bourne 1976; Clapp et al. in prep.).

Summary

The Herring Gull was observed throughout the study area, with largest numbers occurring in the MILA survey subunit. It was seen from October to April; greatest numbers occurred in February. It was distributed throughout the MILA survey subunit but had a more coastal distribution in other survey subunits. It was frequently associated with other bird species, fishing boats, and fish. The Herring Gull was frequently seen in large flocks and occasionally seen resting on the water. The overall effects of OCS development on the species do not represent a major impact, although local populations may be greatly affected.

RING-BILLED GULL, *Larus delawarensis*

Description

Of the three most common gulls in the study area, Ring-billed Gulls are intermediate in size (body length 47 cm; wingspan 122 cm) (Tuck and Heinzel 1978) between the larger Herring Gull, *Larus argentatus*, and the smaller Laughing Gull, *Larus atricilla*. The Ring-billed Gull has a square tail and pointed wings. In adult plumage the head, neck, rump, and tail are white. The back and upperwings are light gray. The wings have a white trailing edge. The wingtips are black with subterminal white spots on the outermost primaries. The underparts are white. The bill is yellow with a dark ring near the tip. The legs and feet are yellow.

First-year immature birds have brown flecks on the white of the head, neck, and rump. The tail is white with a well-defined, dark, subterminal band. The coloration of the back, which is gray mottled with brown, becomes darker brown-gray on the upperwings to dark brown on the outer primaries. The underparts are white flecked with brown. The bill is flesh-colored with a dark brown tip. The legs and feet are pinkish to flesh-colored. Second year immature plumage is similar to the first year immature plumage, but is predominantly gray. Adult plumage is attained in the third year (Godfrey 1966).

Flight is direct and is characterizied by strong, regular wingbeats. Ring-billed Gulls are capable of hovering.

From the air, the gull body shape and flight patterns were useful identification cues. However, the Ring-billed Gull was difficult to distinguish from other species of gulls. In adult plumage, Ring-billed Gulls and Herring Gulls have white heads, necks, rumps, and tails. Both species have pale gray backs and upperwings with black tips on the wings. From the air, the ring on the bill and other subtle differences were not distinguishable. The only character that could be used to distinguish the two species was size. Size estimation was not always reliable, during sightings in which only one of the species was seen.

In subadult plumage, the Ring-billed Gull could be confused with immature Herring Gulls and Laughing Gulls. All three species have pale heads flecked with brown. The back and upperwings are brownish gray, although the Laughing Gull's may be darker. All three species have basically white tails with terminal or subterminal dark bands. Because differences between species were often subtle, many gulls were recorded as unidentified gulls.

Distribution

Ring-billed Gulls were seen in the BTEX and MILA survey subunits during October and February (Figures 70 and 71). They occurred in the NAFL survey subunit during December and were not seen in the MIFL survey subunit. During on-line aerial surveys 227 Ring-billed Gulls were seen in 116 sightings. The largest number of sightings occurred in the NAFL survey subunit during December, although more birds were seen in fewer sightings in the MILA subunit during October (Tables 32 and 33). Low numbers were seen in the BTEX subunit during October and February and in the MILA subunit during February. About 92% of all Ring-billed Gull sightings occurred within 111 km of the shoreward boundaries of the survey subunits. During October, Ring-billed Gulls were more common close to shore in the BTEX and MILA survey subunits than during February (Figures 70 and 71).

Ring-billed Gulls are probably less pelagic than other gulls wintering in the southeastern United States and may be restricted to land and waters close to shore (Clapp et al. in prep.). Data from this study indicate that during winter the Ring-billed Gull is less common offshore than the Herring Gull and the Laughing Gull. Ring-billed Gulls are probably more abundant inland than sightings during this study suggest. An inland distribution would explain the discrepancy between the relatively low number of

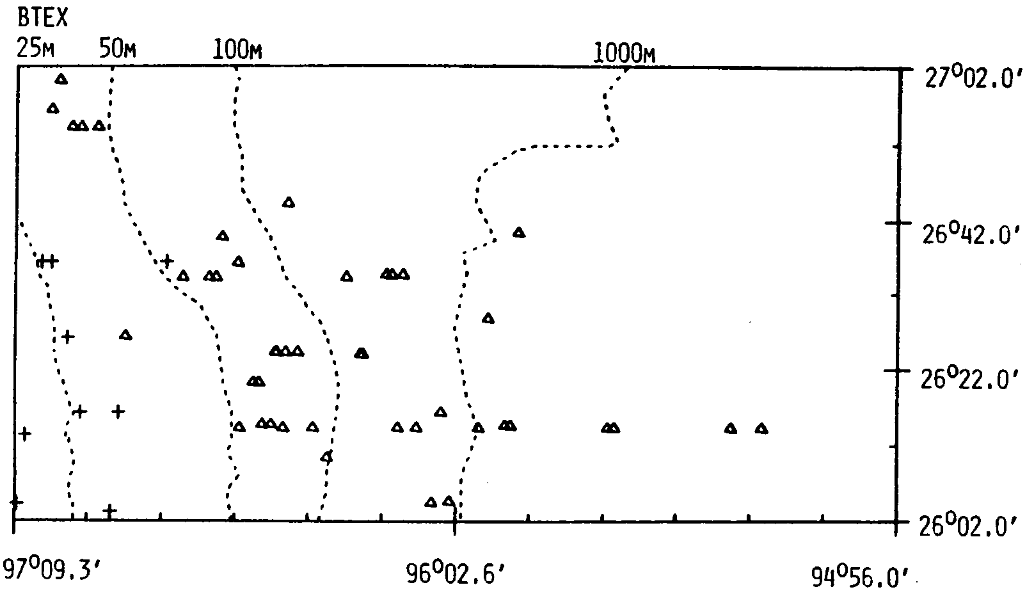


Figure 70. Distribution of all Ring-billed Gull sightings in the BTEX survey subunit during October (△) and February (+).

sightings that occurred during this study and the common to abundant status reported in the literature.

Ring-billed Gulls breed in the northern United States from California to New York including Oregon, Washington, Idaho, Colorado, the Dakotas, and the Great Lakes states (Bent 1922; Godfrey 1966; Clapp et al. in prep.). Breeding sites in Canada are located in the central plains provinces of Alberta, Saskatchewan, and Manitoba; adjacent to the Great Lakes in Ontario and Quebec; and on the Atlantic Coast of Newfoundland and Labrador (Bent 1922; Godfrey 1966; Clapp et al. in prep.). This species' winter range extends south along the Pacific Coast to Mexico, and the Atlantic Coast of North America to Florida and the Gulf of Mexico, occasionally reaching Central and South America (Clapp et al. in prep.). Birds wintering in the western Gulf of Mexico probably migrate southward along the Mississippi Valley from colonies in the central United States and Canada (Clapp et al. in prep.). Birds wintering on the Atlantic Coast and in the eastern Gulf of Mexico probably are from the Great Lakes colonies (Southern 1967; Clapp et al. in prep.). Ring-billed Gulls concentrate around garbage dumps, port cities, sewage outfalls, lawns, and plowed fields (Clapp et al. in prep.). Ring-billed gulls are common inland and along the coast during the winter (Oberholser 1974; Clapp et al. in prep.).

Abundance

Density estimates for the Ring-billed Gull calculated for subunits and months with adequate data ranged from 0.014 birds/km^2 to 0.17 birds/km^2, but this species was not sighted throughout any subunit during any month (Table 32). When adjusted to reflect the

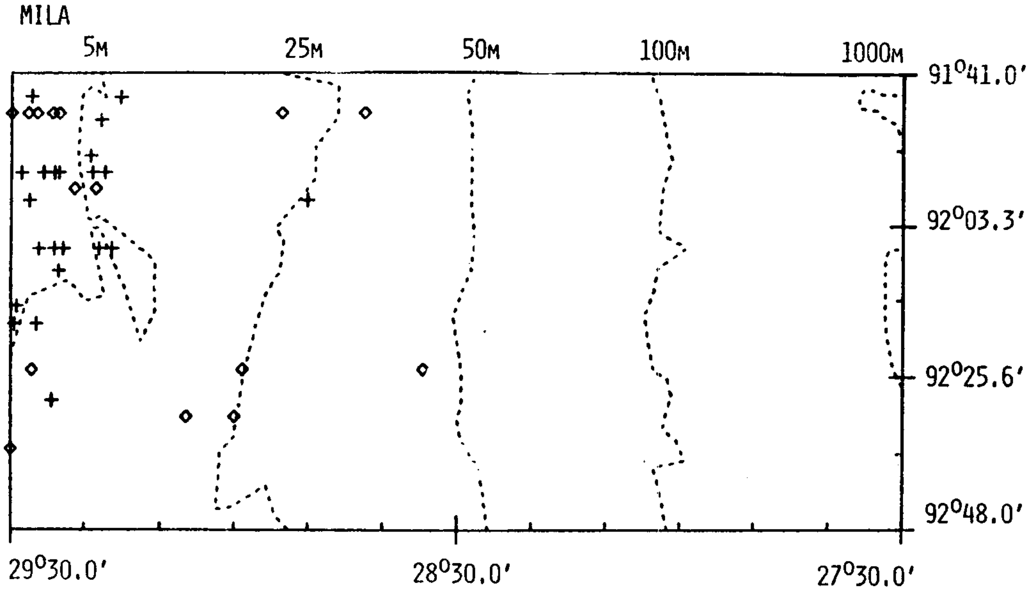


Figure 71. Distribution of all Ring-billed Gull sightings in the MILA survey subunit during October (+) and February (◇).

limited distribution of Ring-billed Gulls within subunits (e.g., calculated density/percentage of area used) monthly density estimates ranged from 0.026 birds/km^2 to 1.76 birds/km^2 in the MILA subunit during February and October, respectively. The results of density calculations and adjusted calculations indicate higher concentrations of Ring-billed Gulls occurred during October in the MILA subunit and during December in the NAFL subunit. The surveys with highest calculated densities correspond to periods when Ring-billed Gulls would be migrating into the study area. Density estimations during February in the BTEX and MILA subunits are lower and suggest that either numbers in the study area were decreased or the Ring-billed Gulls in the study area were more dispersed than in October and December. The lower density estimates during February may reflect the absence of gulls that had already migrated north.

The Ring-billed Gull is common to abundant during the winter in the study area (Lowery 1974b; Oberholser 1974; Clapp et al. in prep.), and is considered the most numerous wintering gull in Florida (see review by Clapp et al. in prep.). Oberholser (1974) noted increases in the numbers of Ring-billed Gulls seen in Texas between 1950 and 1970.

The lack of sightings during aerial surveys in the MIFL survey subunit may be explained in part by the inland and coastal distribution of this species. Most of the western border of the MIFL subunit is more than 10 km from shore. We noted Ring-billed Gulls from land-based observations in eastern Florida during the winter of 1980-81. The difficulty of gull identification also may have contributed to the lack of Ring-billed Gull

Table 32. Density and group size estimates for on-line sightings of Ring-billed Gulls. "All" represent combined months. * = variance too small for calculation.

Survey subunit	Month	No. of sightings	Group density (groups/km^2)	Variance	Mean group size	Standard error	Individual density (birds/km^2)
BTEX	February	19	$0.41\text{x}10^{-1}$	*	1.8	0.5	$0.73\text{x}10^{-1}$
BTEX	All	20	$0.76\text{x}10^{-2}$	$0.32\text{x}10^{-6}$	1.8	0.5	$0.14\text{x}10^{-1}$
MILA	October	31	$0.26\text{x}10^{-1}$	$0.14\text{x}10^{-3}$	3.4	1.0	$0.88\text{x}10^{-1}$
MILA	February	14	$0.70\text{x}10^{-2}$	*	1.9	0.6	$0.13\text{x}10^{-1}$
MILA	All	45	$0.67\text{x}10^{-2}$	$0.64\text{x}10^{-3}$	3.0	0.7	$0.20\text{x}10^{-1}$
NAFL	December	38	0.14	$0.13\text{x}10^{-1}$	1.2	0.1	0.17

sightings. Unidentified gull sightings occurred from October to April in the MIFL survey subunit.

Habitat Use

On-line sightings during October in the BTEX subunit for Ring-billed Gulls usually occurred close to shore, with a mean distance from shore of 24 km (SD = 14.4, n = 7). During February, on-line sightings occurred farther offshore with a mean distance from shore of 75 km (SD = 37.2, n = 18). Although not as distinctive, this pattern was also present in the MILA survey subunit.

Ring-billed Gulls were seen from the shore out to waters 1,326 m deep (in the BTEX subunit during February). Although most sightings (84%) occurred in waters less than 100 m deep, distance from shore appears to be more important than water depth in determining the distribution of Ring-billed Gulls (Table 34). This species was sighted over waters with surface temperatures that ranged from 12° C during February to 25° C during October.

Associations

Frequently Ring-billed Gulls were associated with other birds and shrimp boats. All associations included other bird species and totaled 11% of all sightings (56% of all Ring-billed Gulls). Ring-billed Gulls were seen with Herring Gulls, Laughing Gulls, Royal Terns, members of the Common-group Terns, and Sooty Terns. Shrimp boats were included in 4% of all sightings (17% of all Ring-billed Gulls).

Aggregations probably result in response to a locally abundant food source. Ring-billed Gulls frequently search for food in the company of other gull species by following

Table 33. The number of Ring-billed Gulls sighted on-line during this study. The number in parenthesis represents the number of sightings. Dash means no survey. * = no on-line survey.

Month	Survey subunits			
	BTEX	MILA	NAFL	MIFL
June	0	0	0	0
August	0	0	0	0
October	8 (7)	105 (31)	0	0
December	-	-	54 (45)	*
February	32 (19)	28 (15)	0	0
April	0	0	0	0
TOTAL	40 (25)	133 (46)	54 (45)	0

coastal ships (Bent 1922). The Ring-billed Gull was associated with a cetacean, the Bottlenose Dolphin (Tursiops truncatus), on one occasion.

Reproduction

The Ring-billed Gull nests in colonies and often with other species (Bent 1922; Godfrey 1966). Nests are located along the upper beach or among rocks (Bent 1922) on islands and peninsulas surrounded by freshwater or saltwater (Baird 1976, cited by Clapp et al. in prep.). The nest is usually on the ground, and usually constructed of grass, twigs, and leaves (Bent 1922; Godfrey 1966; Terres 1980). This species usually lays three eggs between early May and mid-June (Bent 1922; Terres 1980; Clapp et al. in prep.). The incubation period varies from 21 days (Bent 1922; Terres 1980) to about 27 days (Godfrey 1966; Vermeer 1970; Baird 1976, cited by Clapp et al. in prep.). The fledging period ranges from 34 to 41 days (Vermeer 1970). Ring-billed Gulls will renest if the nest is lost early in the breeding season (Clapp et al. in prep.). Immature plumage is retained until the third year, although some individuals may become reproductively active before developing adult plumage (Ryder 1975).

Behavior

During the breeding season, Ring-billed Gulls feed largely on insects, small fish, plant material, garbage, small rodents, eggs of other species, and worms (Bent 1922; Godfrey 1966; Jarvis and Southern 1976; Clapp et al. in prep.). During the winter, they feed on fish, marine invertebrates, insects, carrion, and garbage (Bent 1922; Clapp et al. in prep.). They scavenge along beaches, mud flats, and sand bars (Bent 1922; Clapp et al.

Table 34. The number of Ring-billed Gull sightings in relation to water depth and distance from shore.

Water depth (m)	Distance from shore (km)			
	0 to 55.5	55.6 to 111	111.1 to 165.5	165.6 to 222
0 to 5	19	0	0	0
5.1 to 25	37	8	0	0
25.1 to 50	12	17	0	0
50.1 to 100	5	12	1	0
100.1 to 1,000	0	12	0	0
1,000.1 +	0	0	7	2

in prep.). Over water, they catch food by plunging from the air or dipping for food at the surface (Bent 1922).

The Ring-billed Gull is a highly gregarious species on the breeding grounds and throughout its winter range (Bent 1922). During this study, flocks of up to 2,600 birds, including this species, other gulls, and terns were seen.

The Ring-billed Gull swims readily and is graceful and buoyant on the water (Bent 1922). Ring-billed Gulls roost on exposed sand bars and islands, but probably do not sleep on the water (Clapp et al. in prep.). During this study, Ring-billed Gulls were only seen occasionally on the water.

Potential Impacts of OCS Development

The Ring-billed Gull, due to its seasonal occurrence in the study area and the low numbers seen over coastal waters, may be relatively unsusceptible to the effects of OCS activities in the study area. Structures erected for OCS operations in coastal waters may provide overnight roosting locations for Ring-billed Gulls and other species. During this study, gulls were often seen perching on offshore structures. The frequency of this behavior and its significance warrants further study.

Summary

Ring-billed Gulls were seen in the BTEX, MILA, and NAFL survey subunits. Sightings occurred from October to February. Most sightings occurred in the NAFL subunit, but a larger number of birds aggregated in the larger groups seen in the MILA subunit. Relatively few Ring-billed Gulls were seen during this study. Ring-billed Gulls were reported to be more common on the basis of land-based counts; therefore, these gulls may occur in greater numbers inland. Identification of this gull from an aircraft is difficult. Ring-billed Gulls were frequently seen in flocks with other gull and tern species, often associated with shrimp boats. The Ring-billed Gull is relatively unsusceptible to the effects of OCS development.

LAUGHING GULL, Larus atricilla

Description

The Laughing Gull (body length 38 to 43 cm; wingspan 107 cm) is smaller than the Ring-billed Gull and larger than Bonaparte's Gull (Terres 1980). The adult Laughing Gull has a white body and tail. The mantle is dark gray and blends into the solid black outer five primaries. The entire trailing edge of the wings has a white border. In summer, the adult Laughing Gull has a black head. The dark eyes are encircled by white lids, and the bill is blood red. In winter, the head of the adult is white with a few dusky feathers. The bill is black in winter. Young (first winter) birds have a pale grayish brown mantle with much darker primaries and secondaries. Only the secondaries close to the body are tipped white. The tail is gray with a broad black subterminal band. The breast is brown. The rump and remainder of underparts are white. Second winter birds lose some brown and develop more gray color on the mantle. The breast and part of the head become white. The bill is black (Tuck and Heinzel 1978).

In the summer the black head, the dark mantle, and the lack of white within the black of the wingtips is characteristic of adult Laughing Gulls. In winter the latter two characteristics and size of the gull are diagnostic of Laughing Gulls when seen from the air. Young Laughing Gulls were more difficult to distinguish from young Ring-billed Gulls. However, the larger amount of dark coloration in the tail and the darker mantle of the Laughing Gull distinguishes the two species as adults.

Distribution

Laughing Gulls were observed in all survey subunits. Considering only on-line data, most Laughing Gulls (more than 3,200 birds) were seen in the MILA survey subunit. About 500 Laughing Gulls were seen on-line in the BTEX survey subunit, about 200 were seen on-line in the NAFL survey subunit, and about 44 were seen on-line in the MIFL survey subunit. The reason for the greater number of Laughing Gulls in the MILA survey subunit is unclear, but may, in part, be attributed to higher primary productivity in this area (USDOI 1976). The coast of Louisiana is used extensively by Laughing Gulls for nesting (Clapp et al. in prep.), indicating the area is suitable for supporting year round residence of large numbers of the gulls.

The Laughing Gull breeds from Nova Scotia along the Atlantic and Gulf coasts to Texas. In the Pacific, it breeds along the northwestern coast in Sinaloa and Sonora, Mexico (AOU 1957). It also breeds locally in the West Indies to Venezuela (Oberholser 1974). The Laughing Gull winters from North Carolina along the Atlantic and Gulf coasts to the mouth of the Amazon in Brazil. In the Pacific, it winters from southern Mexico to Lima, Peru (Clapp et al. in prep.).

The Laughing Gull is present year round within the study area. Major breeding colonies within the survey area are scattered along the Gulf of Mexico and in the Carolinas (Figure 72). Within the BTEX and MILA survey subunits, Laughing Gulls were

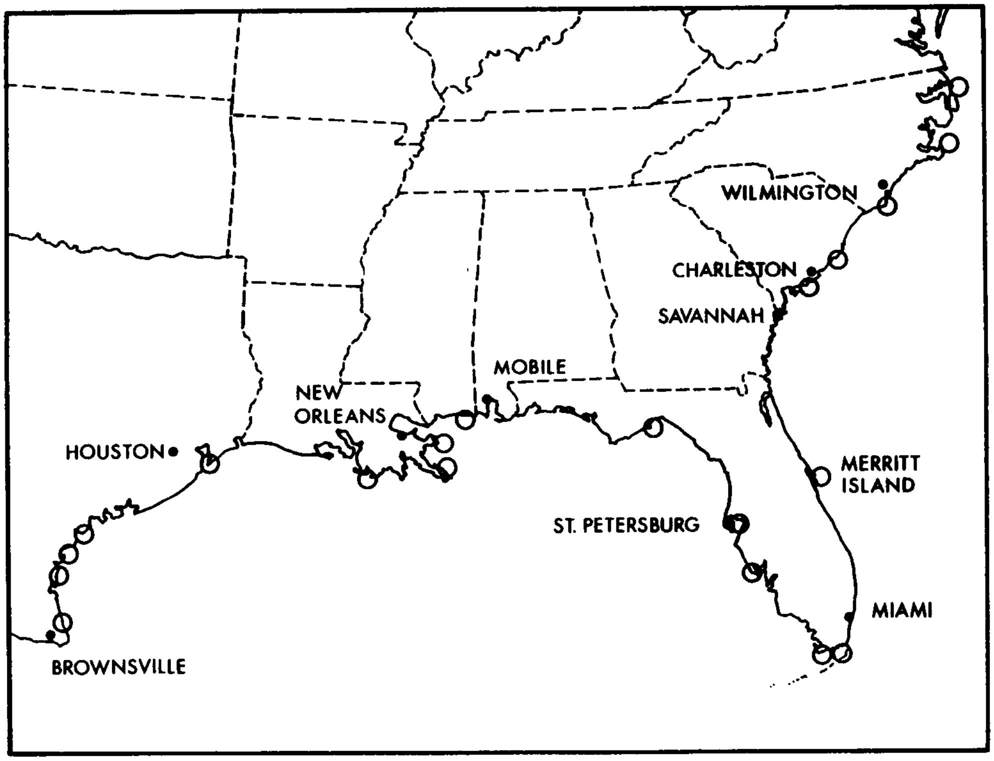


Figure 72. Major Laughing Gull nesting areas in the study area.

observed during June, August, October, February, and April (Figures 73 through 76). Within the NAFL subunit, they were seen during August, October, December, February, and April (Figure 77). Within the MIFL subunit, Laughing Gulls were observed during October, February, and April (Figure 78).

Abundance

Density estimates for Laughing Gulls were possible for all four survey subunits (Table 35). In the BTEX survey subunit, individual densities ranged from 0.16 x 10^{-1} birds/km^2 in August to 0.51 birds/km^2 in October. In the MILA survey subunit, individual densities were higher, ranging from 0.74 birds/km^2 in February to 2.34 birds/km^2 in August. In the NAFL subunit, the data were sufficient to calculate a density estimate (0.52 birds/km^2) only for December. The pooled data for NAFL resulted in a much lower estimate of 0.91 x 10^{-1} birds/km^2. Data were also insufficient in the MIFL subunit to calculate a density estimate for each month. The April individual density was 0.16 x 10^{-1} birds/km^2 and the overall individual density estimate (from pooled data) was 0.58 x 10^{-2} birds/km^2. However, these esimates are not entirely realistic since the distribution of Laughing Gulls was restricted during some months. An adjustment can be made in the density estimates. For example, in the MILA subunit, only 29% of the subunit contained Laughing Gulls. The adjusted density therefore is 8.1 birds/km^2 (density/percentage of the subunit utilized). Not all density estimates can be adjusted, but those that can result

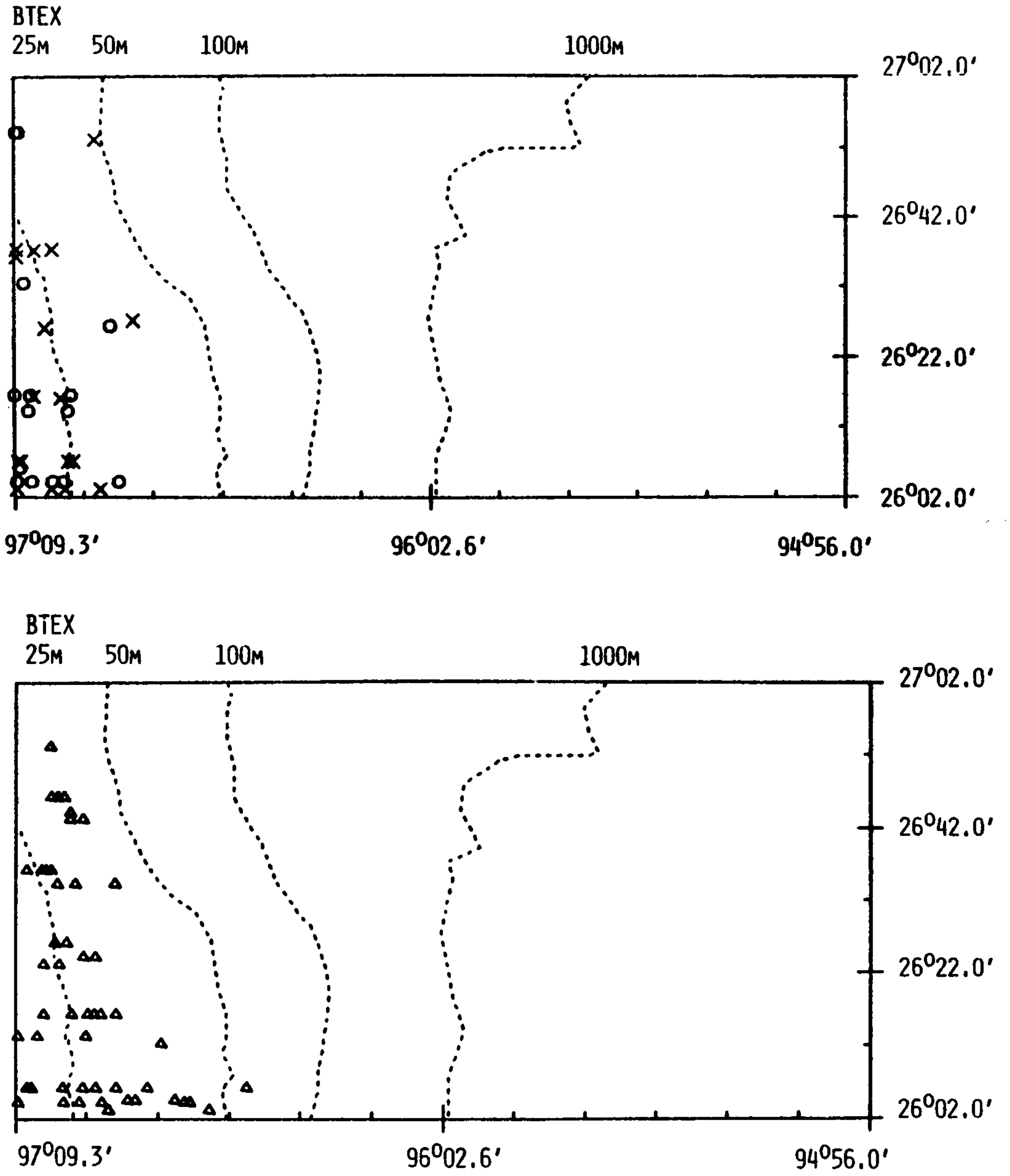


Figure 73. Distribution of all Laughing Gull sightings in the BTEX survey subunit during June (O), August (X), and October (△).

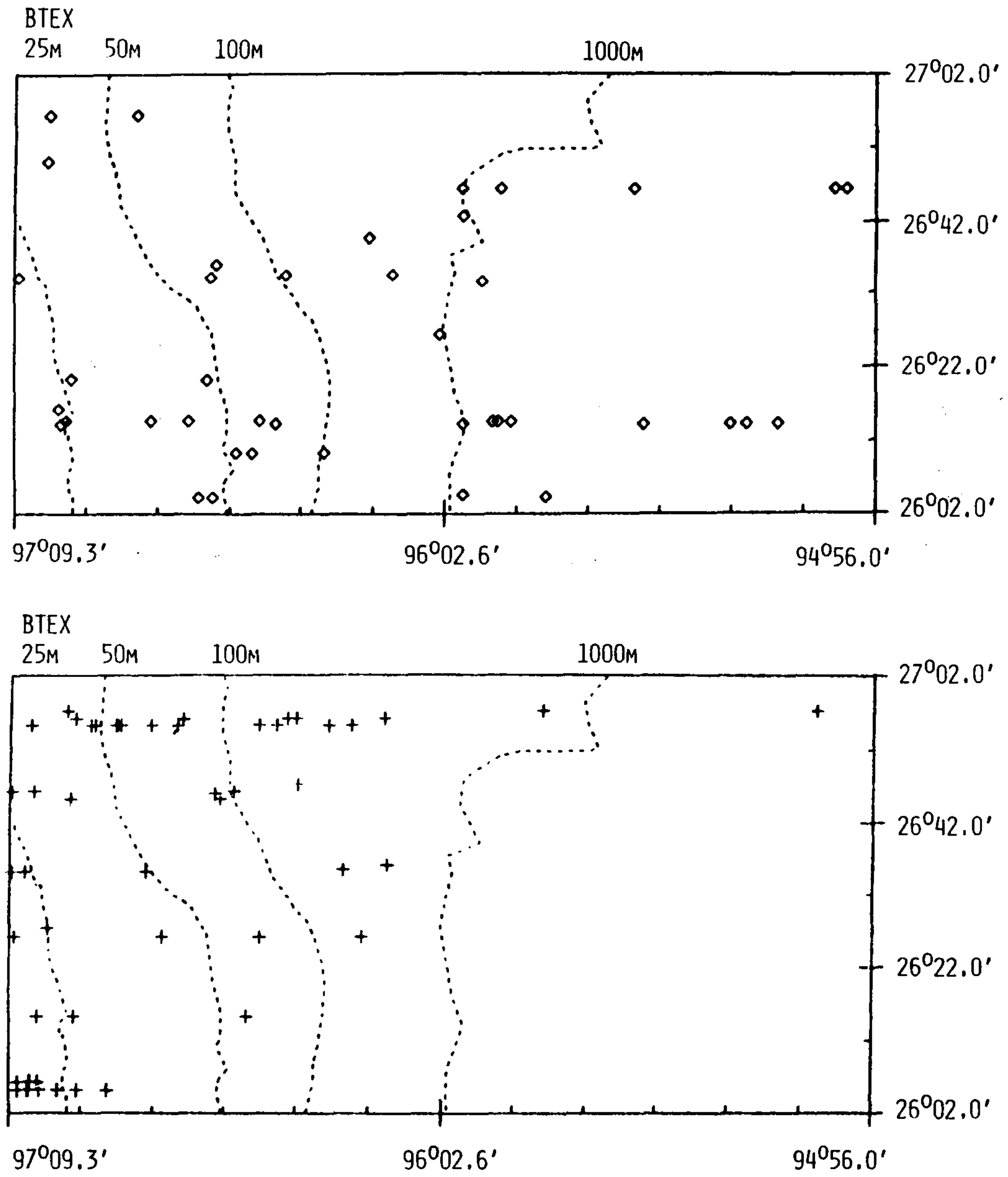


Figure 74. Distribution of all Laughing Gull sightings in the BTEX survey subunit during February (◇) and April (+).

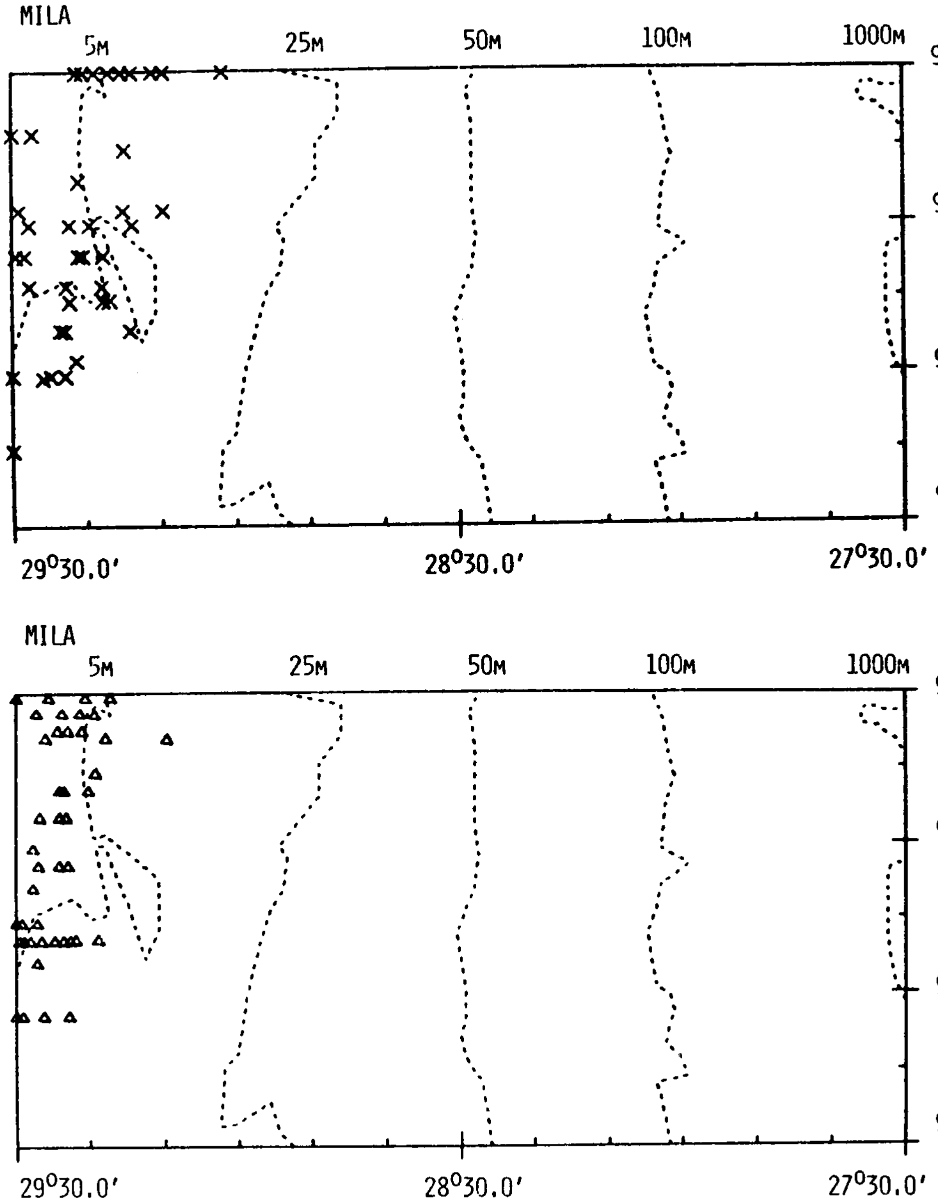
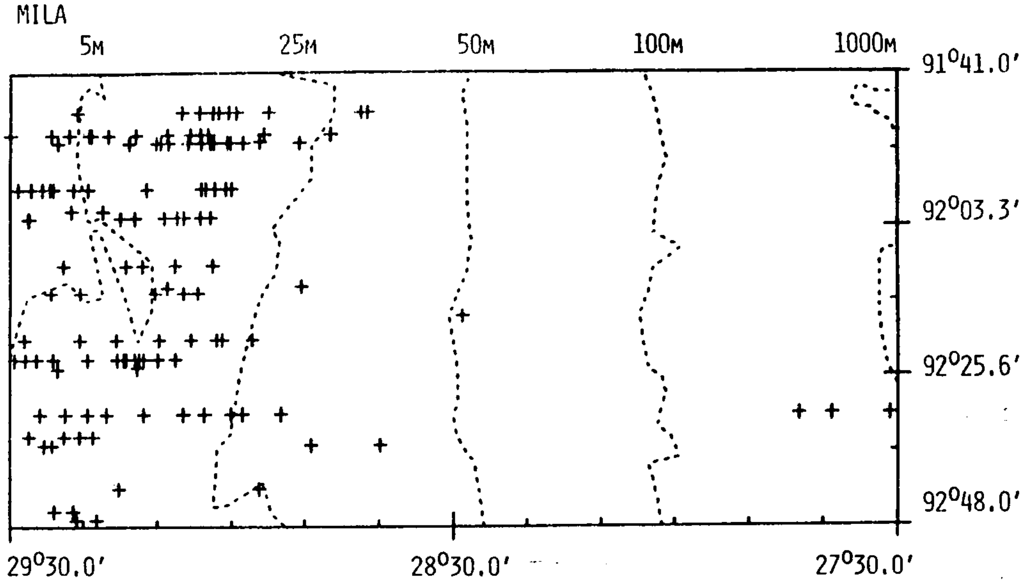


Figure 75. Distribution of all Laughing Gull sightings in the MILA survey subunit during August (X) and October (△).



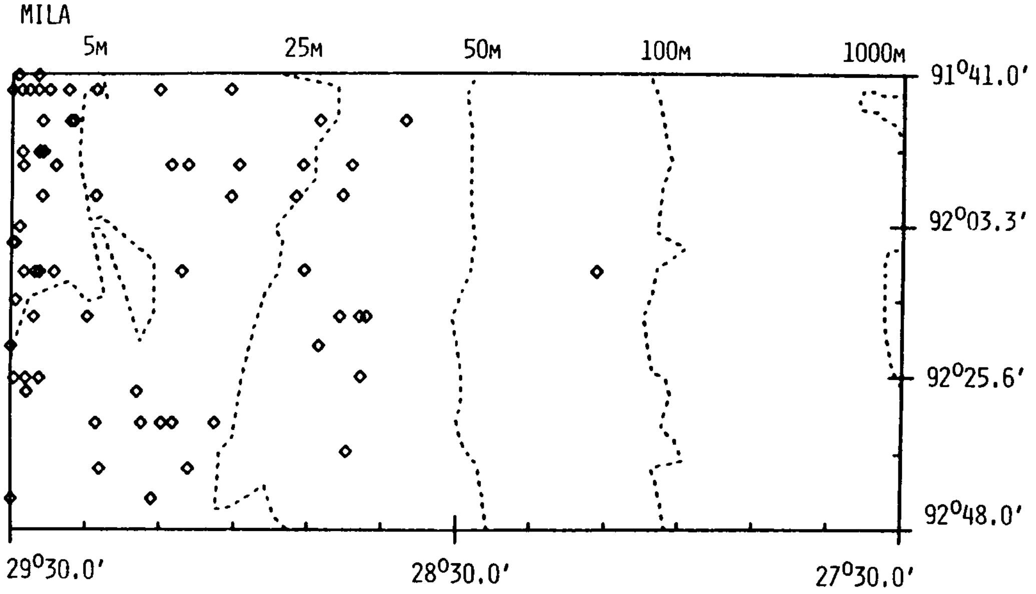


Figure 76. Distribution of all Laughing Gull sightings in the MILA survey subunit during February (+) and April (◇).

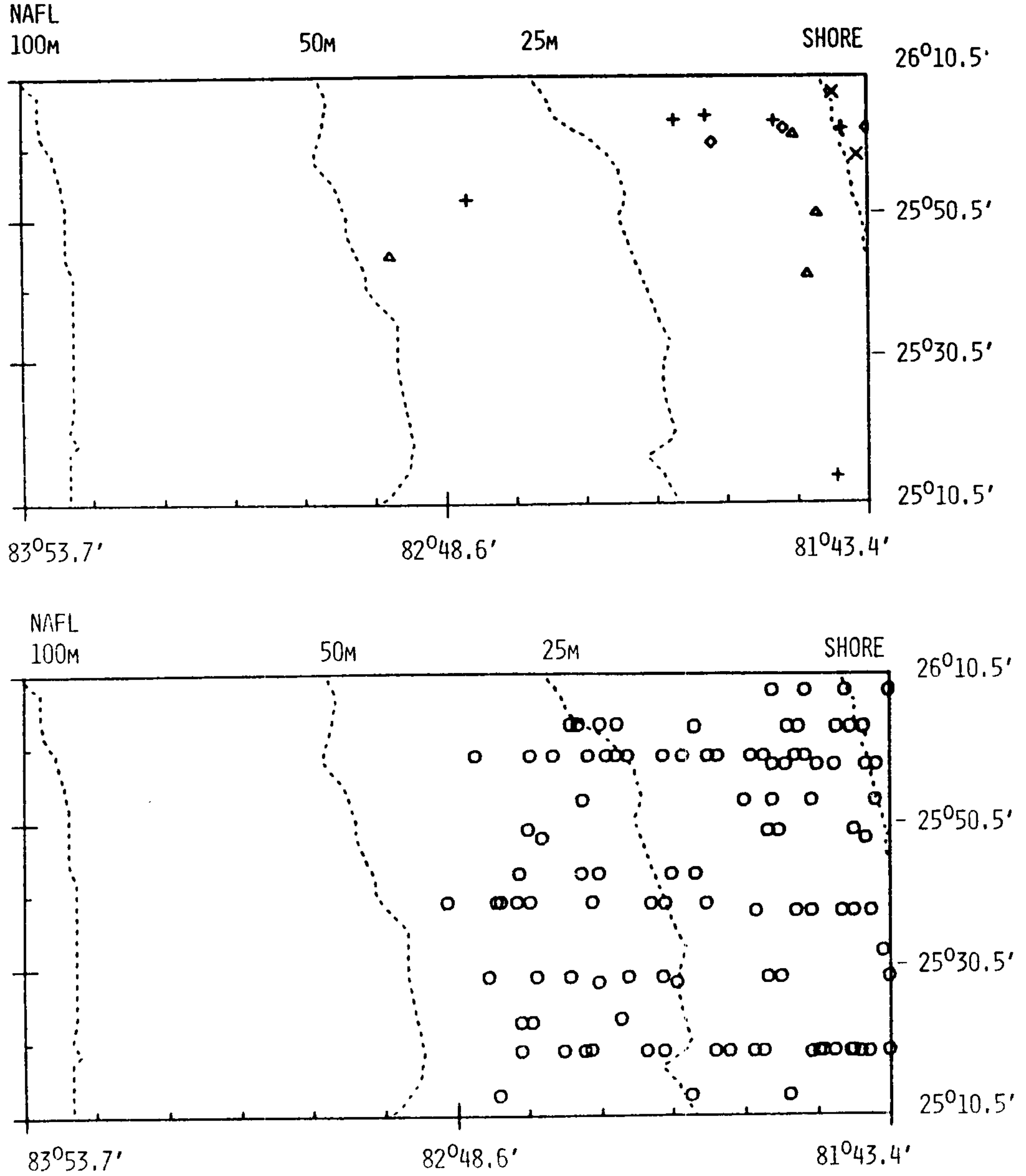


Figure 77. Distribution of all Laughing Gull sightings in the NAFL survey subunit during August (X), October (△), December (O), February (◇), and April (+).

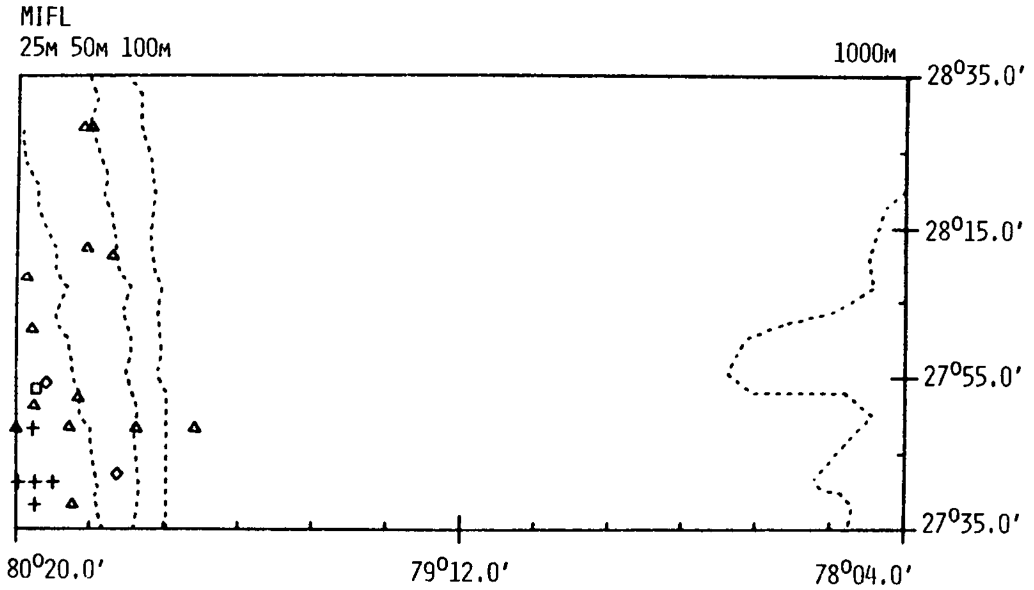


Figure 78. Distribution of all Laughing Gull sightings in the MIFL survey subunit during October (+), December (□), February (◇), and April (△).

in at least a tripling of the original density estimate. Adjusted densities reflect density within areas used by Laughing Gulls.

Group sizes ranged from 1 to 800 Laughing Gulls with monthly averages ranging from 1.25 (NAFL) to 24.1 (MILA) (Figures 79 and 80). In the MIFL survey subunit, average group sizes over all months was 2 to 2.7 birds/group (range 1 to 15 birds/group). In the NAFL survey subunit, average group size over all months was 1.25 to 2.5 birds/groups (range 1 to 30 birds/group). In the MILA survey subunit, average group size varied from 2.9 to 24.1 birds/group (range 1 to 800 birds/group). In the BTEX survey subunit, average group size varied from 2.2 to 19.6 birds/group (range 1 to 800 birds/group). Large groups, 100 Laughing Gulls or more, often represented feeding flocks associated with other birds, shrimp trawlers, etc (see associations). The largest group (800 gulls) was sighted during October in both MILA and BTEX where the Laughing Gulls were concentrated nearshore. Such aggregations could indicate concentrations of food.

Habitat Use

The greatest average distance from shore in MIFL was 26 km, while the greatest average distances from shore in MILA, NAFL, and BTEX was 43.4, 76.9, and 96.9 km, respectively (Figure 81). Although some sightings occurred as far offshore as 234 km, most of the sightings occurred within 111 km of the coast.

Within the MIFL survey subunit, the average distance from shore of Laughing Gulls was greater in February and April than in October (Figure 81). In the NAFL survey

Table 35. Density and group size estimates for on-line sightings of Laughing Gulls. "All" represent combined months. * = variance too small for calculations.

Survey subunit	Month	No. of sightings	Group density (groups/km^2)	Variance	Mean group size	Standard error	Individual density (birds/km^2)
BTEX	June	18	$0.29x10^{-1}$	*	2.8	1.1	$0.82x10^{-1}$
BTEX	August	19	$0.82x10^{-2}$	*	2.0	0.4	$0.16x10^{-1}$
BTEX	October	51	0.15	$0.47x10^{-2}$	3.5	1.1	0.51
BTEX	February	18	$0.20x10^{-1}$	*	8.2	4.2	0.17
BTEX	April	42	0.14	$0.24x10^{-2}$	2.2	0.7	0.31
BTEX	All	148	$0.64x10^{-1}$	$0.35x10^{-3}$	3.4	0.7	0.22
MILA	August	58	0.27	$0.50x10^{-2}$	8.7	2.9	2.34
MILA	October	61	0.19	$0.38x10^{-2}$	5.5	2.1	1.05
MILA	February	148	0.34	$0.41x10^{-2}$	2.2	0.7	0.74
MILA	April	61	$0.88x10^{-1}$	$0.53x10^{-2}$	21.9	10.4	1.92
MILA	All	328	0.16	$0.25x10^{-2}$	7.6	2.1	1.22
NAFL	December	116	0.27	$0.20x10^{-2}$	1.9	0.3	0.52
NAFL	All	123	$0.50x10^{-1}$	$0.17x10^{-3}$	1.8	0.3	$0.91x10^{-1}$
MIFL	April	6	$0.50x10^{-2}$	*	3.3	2.3	$0.16x10^{-1}$
MIFL	All	11	$0.22x10^{-2}$	*	2.6	1.3	$0.58x10^{-2}$

subunit, average sighting distance was farthest from shore in December, followed by April and October respectively. In the MILA survey subunit, the mean distances from shore for all 4 months were significantly different (Newman-Keuls test). Laughing Gulls were closest to shore in October and farthest from shore in February. In the BTEX survey subunit, sightings averaged closest to shore in June and farthest from shore in February. Average distances from shore during June, August, and October were not significantly different, but April and February were significantly greater than in the other months (Newman-Keuls test).

The literature presents no information on the seasonal distribution of the Laughing Gull away from shore. The distribution seen in the study area may be influenced by the breeding cycle, oceanographic features, and food sources. Breeding colonies may draw Laughing Gulls away from the MIFL and NAFL survey subunits in June and August. The spread of gulls farther from shore in winter may reflect dispersal at the end of the breeding season.

In October when the breeding season is well over, Laughing Gulls remain close to shore in MILA and BTEX, perhaps reflecting food sources concentrated in this area. Other gulls, such as Herring and Ring-billed Gulls, move into the study area in winter. Increased competition for food sources could force the Laughing Gulls gradually farther

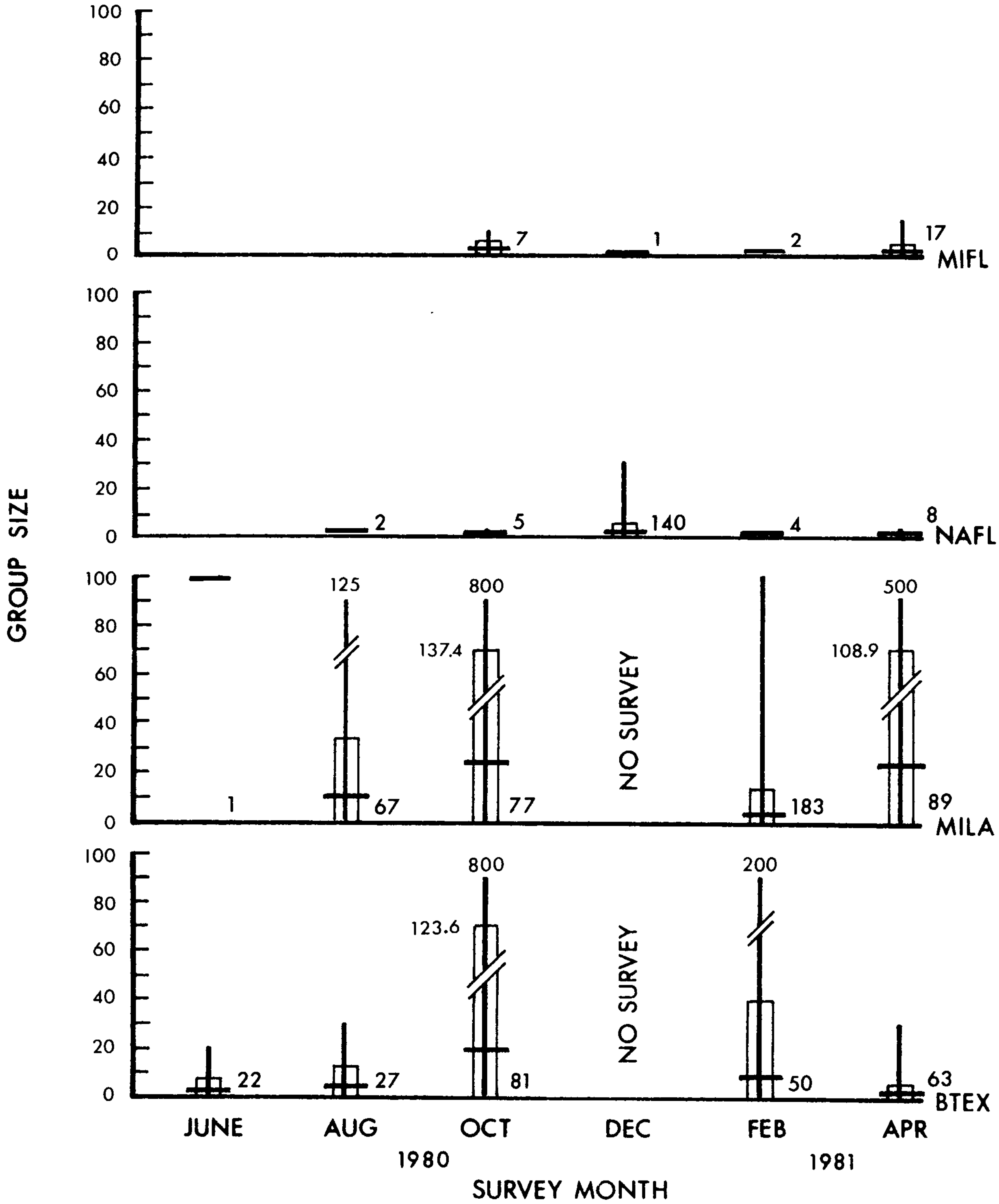


Figure 79. Group size for all sightings of Laughing Gulls by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

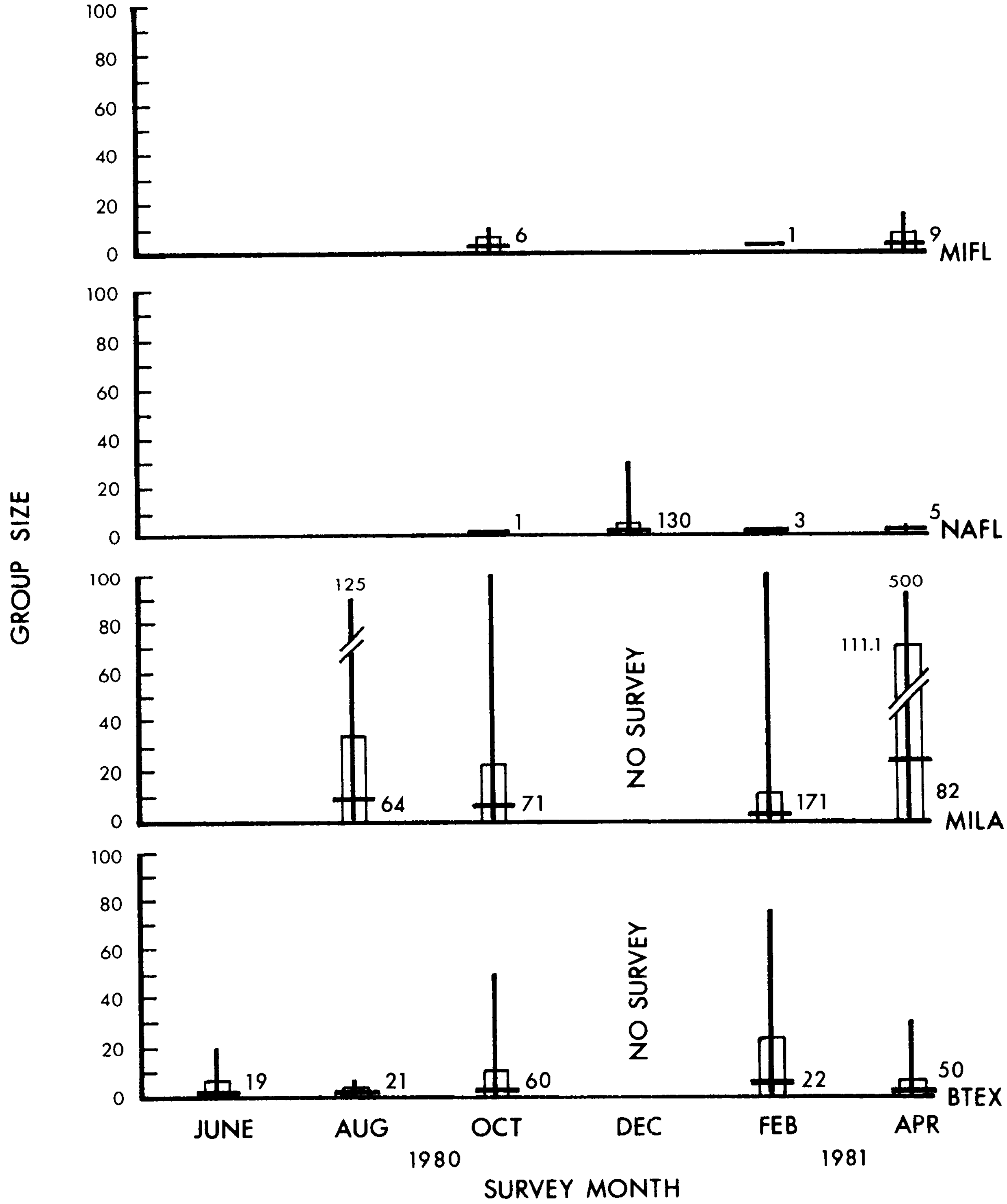


Figure 80. Group size for on-line sightings of Laughing Gulls by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

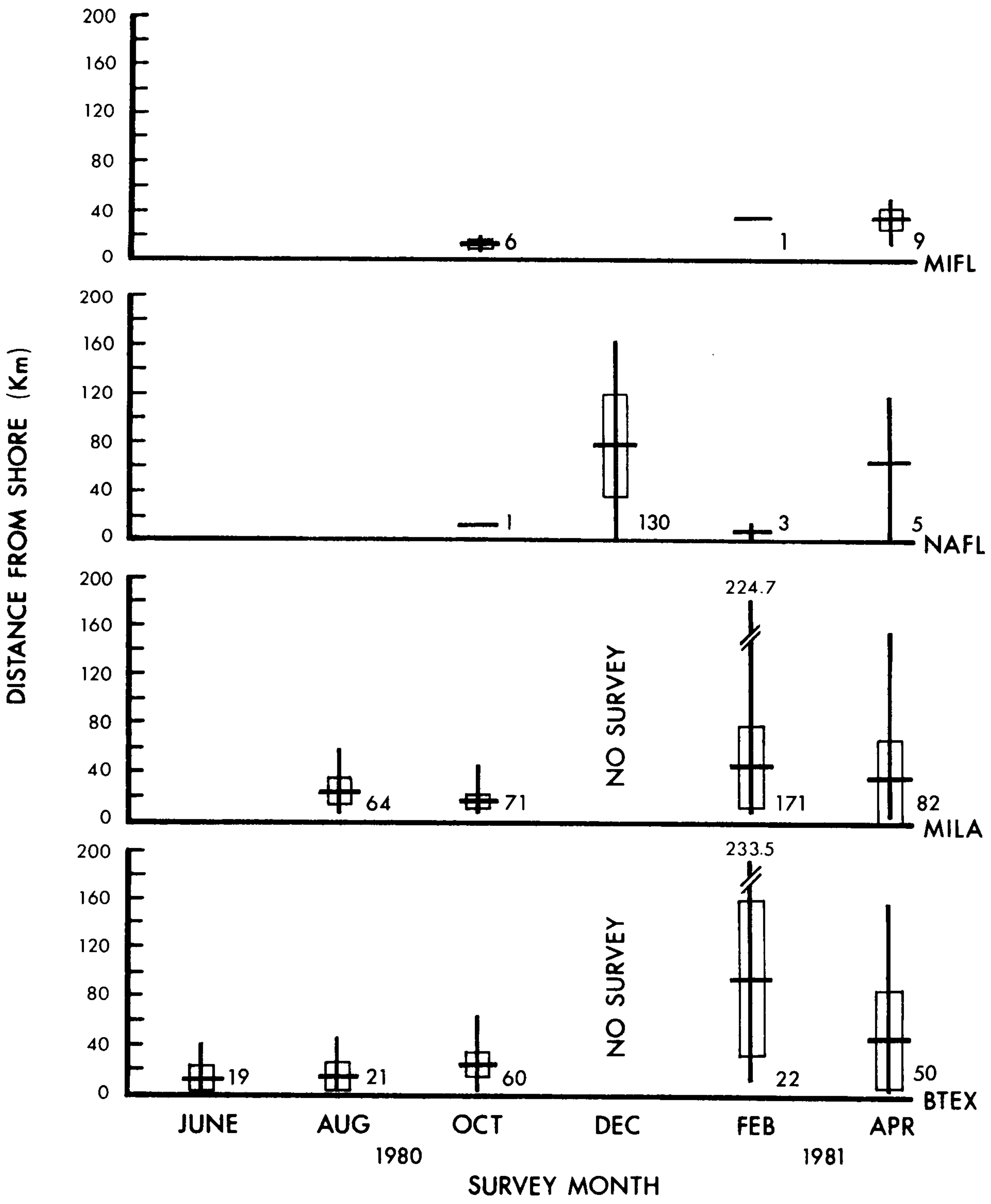


Figure 81. Distance from shore for on-line sightings of Laughing gulls by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

from shore. The distribution of Laughing Gulls might also be influenced by the distribution of fishing boats, primarily shrimp trawlers in the area. In the MIFL survey subunit, the abundance of Laughing Gulls is fairly low throughout the year, perhaps reflecting limited food sources; but data are lacking.

Laughing Gull sightings occurred where water depths ranged from 0 to 1,664 m. Average water depths ranged from 3 to 548 m (Figure 82). Since the Laughing Gull is a surface feeder, depth is important to its distribution only as it relates to food sources. Even though depths at which the Laughing Gull occurs ranged widely, most were shallow and within 111 km of shore.

Sea surface temperatures where Laughing Gulls were sighted ranged from 12° C during February to 31° C during August (Figure 83). Sea surface temperatures would probably only affect Laughing Gulls through the distribution of their food sources.

Associations

The Laughing Gull was seen in association with 14 species of mammals, birds, and fishes including the Royal Tern, Herring Gull, White-tailed Tropicbird, Northern Gannet, Brown Pelican, Audubon's Shearwater, Bottlenose Dolphin, and Whale Shark. The Royal Tern was the species most often seen associated with Laughing Gulls (21% of all sightings of Laughing Gulls). The Herring Gull was seen in association with Laughing Gulls less often (19% of all sightings). The most striking examples of association were those involving shrimp trawlers, Bottlenose Dolphins, and numerous species of gulls and terns. Large numbers of Laughing Gulls and other birds were also occasionally associated with fish schools. As the season progressed from summer to winter, the Laughing Gull was noted less frequently with Royal Terns and more often with winter inhabitants such as Herring and Ring-billed Gulls (Table 36). Similar food preferences of the gulls could be the reason for the change in associations.

Reproduction

No reproductive data were obtained during the aerial surveys. The Gulf states contain major breeding grounds for the Laughing Gull (Figure 72). The Laughing Gull nests from April through July (Oberholser 1974). It nests in colonies, on coastal islands, in saltwater marshes, and along beaches. The large nest is built on the ground or on tufts of grass or reeds (Terres 1980). Three to four eggs are usually laid (Bent 1921; Sprunt 1954). Incubation takes about 20 days (Terres 1980). The mean age at fledging, in a study by Schrieber and Schrieber (1980), was 42.5 days.

Behavior

The food of the Laughing Gull varies from eggs and small fish taken from the water's surface during flight to offal and garbage from fishing boats. The species scavenges in garbage dumps as well as along the beach. The Laughing gull also robs other birds of food. After feeding at sea, the species settles on the water in large rafts to rest (Bent 1921; Palmer 1962).

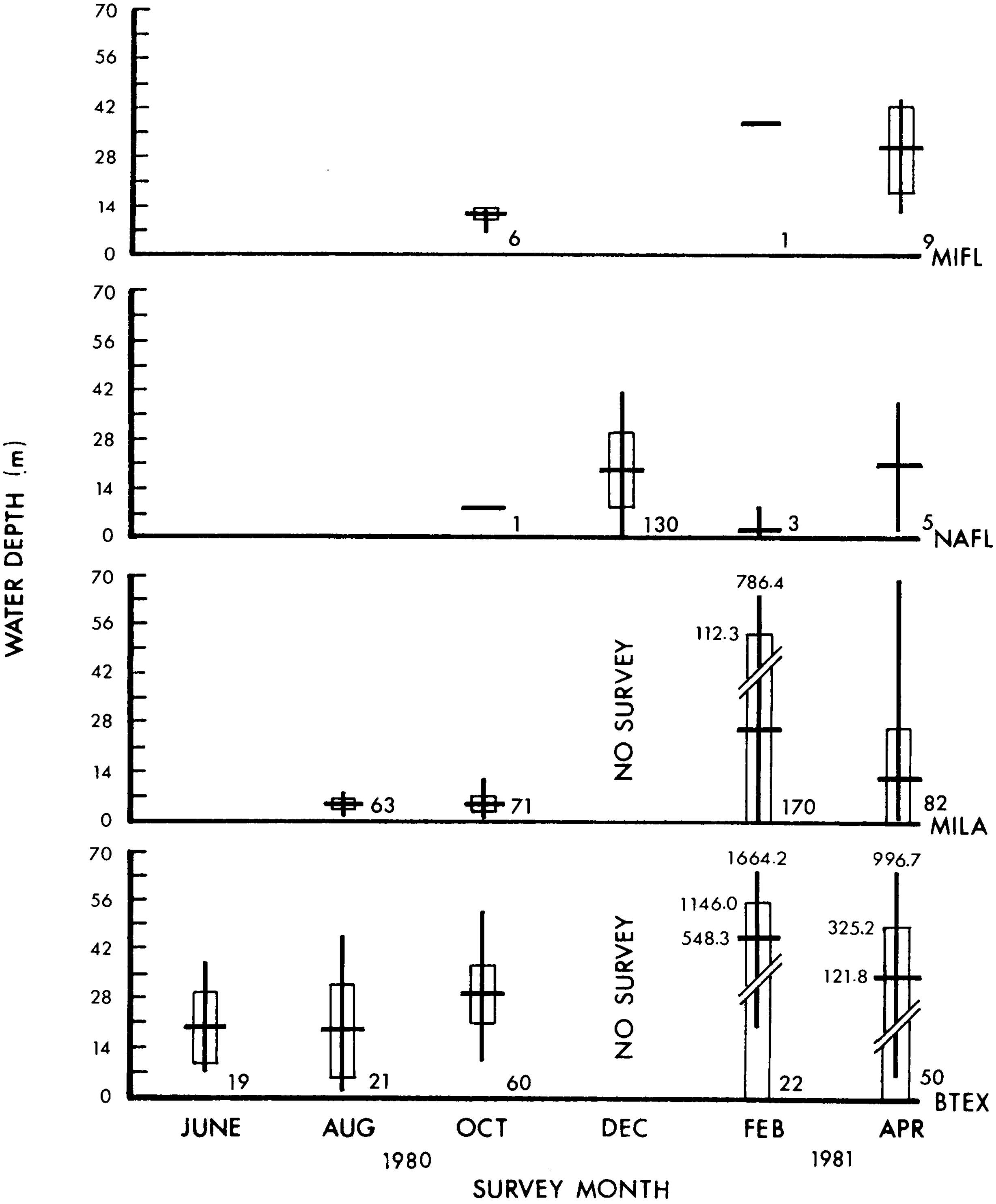


Figure 82. Water depth for on-line sightings of Laughing Gulls by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box),range (vertical bar), and number of sightings (numbers on x-axis).

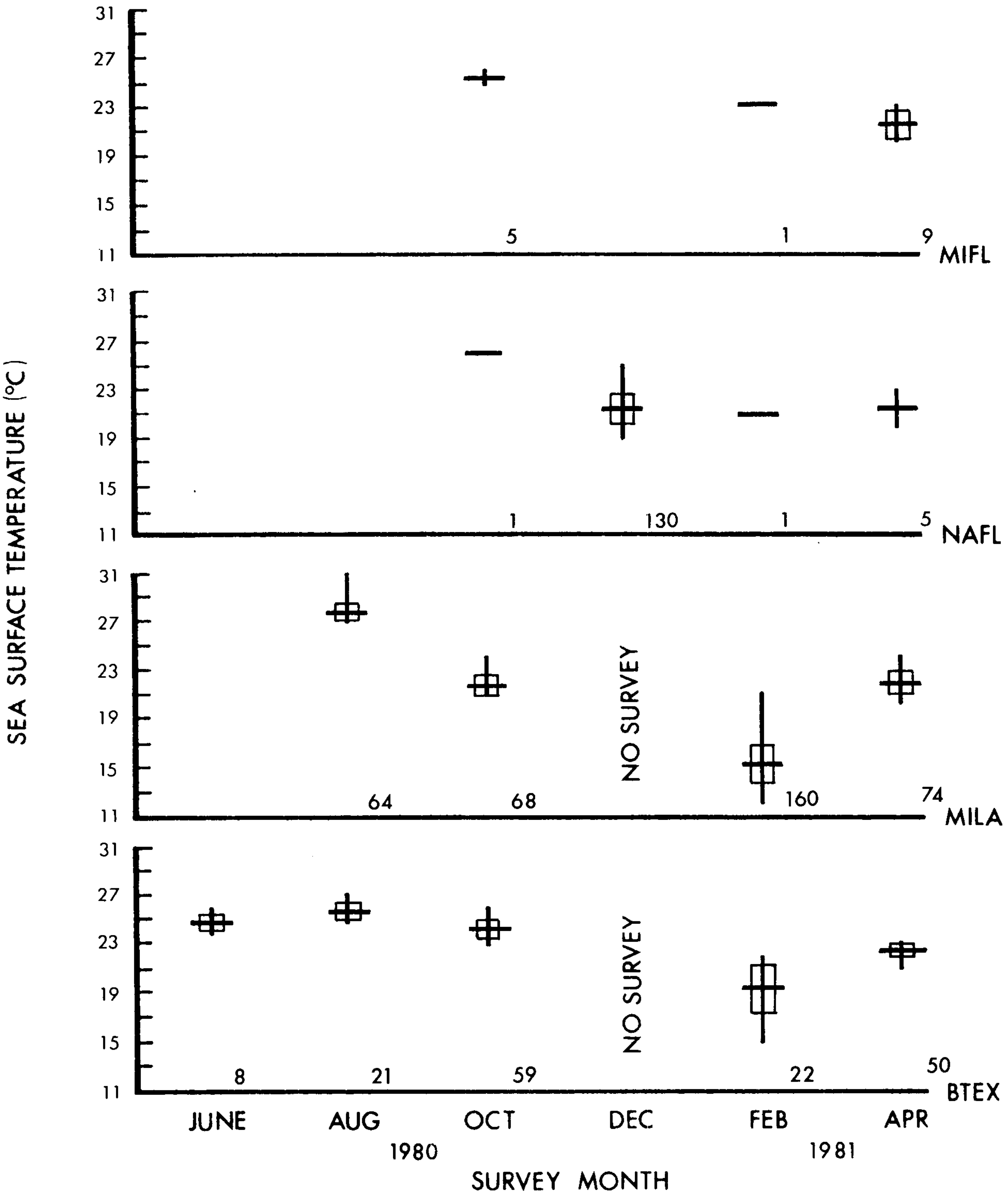


Figure 83. Sea surface temperature for on-line sightings of Laughing Gulls by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

Table 36. Percentage of Laughing Gull associations with terns and other gulls throughout the study for all survey subunits.

Month	Associations with terns (%)	Associations with gulls (%)	Associations with terns and gulls (%)
June	100	0	0
August	100	0	0
October	62	8	31
December	42	58	0
February	5	80	15
April	20	60	20

Potential Impacts of OCS Development

Since the Laughing Gull is very common in the study area and is often found resting on the water, it is likely to encounter oil pollution. Several studies (King and Lefever 1979; White et al. 1979) have reported that oil decreases hatchability of Laughing Gull eggs and reduces the bird's ability to withstand stress.

Summary

The Laughing Gull is a permanent resident in the study area and was seen in all four survey subunits. It was more abundant in the MILA survey subunit than in the other subunits. It was more abundant in BTEX than in NAFL and it was least abundant in MIFL. In the MILA and BTEX subunits, the Laughing Gull was observed in all survey periods. In the NAFL and MIFL subunits, the Laughing Gull was not seen during June; nor was it seen during August in MIFL. This absence can be attributed to the long distance of breeding colonies from these survey subunits. In the winter months, the Laughing Gull ranged farther from shore, perhaps due either to competitive pressures from other gulls or seasonal movements of prey. The Laughing Gull was often found in association with other gulls and terns feeding at trawling shrimp boats. Bottlenose Dolphins were also seen in this feeding situation.

The Laughing Gull is vulnerable to oil slicks since it feeds and rests on the water. It also scavenges along beaches where it may be contaminated by oil washed up on shore. The large numbers of Laughing Gulls in the study area increase the probability that the species will contact oil from OCS activities, but the population is less vulnerable than those of less abundant and less widespread species.

FRANKLIN'S GULL, Larus pipixcan

Description

Franklin's Gull is a medium-sized bird (34 to 36 cm long; wingspan about 89 cm), smaller than the Laughing Gull and larger than Bonaparte's Gull (Tuck and Heinzel 1978). In summer, adults have a black head with a white line above and below the eye. The underparts and tail are white. The upperparts are gray, but lighter than in the Laughing Gull. The first five primaries are black with white tips. The remaining primaries and secondaries are gray tipped with white. The most distinguishing characteristics of this species in flight is the white area that separates the black primaries from the gray upperwing coverts on each wing. The bill is dark red and legs are reddish brown. In the winter, the adult bird loses the black hood, which is replaced by a dusky black coloration on the crown and sides. The immature bird has a white forehead. The crown and sides of the head are dusky, the upperparts are grayish brown, and the wingtips are white. The tail is gray with a broad subterminal black band that does not always extend to the outer two tail feathers. The bill and legs are brown.

From the air, the adult Franklin's Gull is most easily confused with the adult Laughing Gull. The white patch in the wings, which separates the black on the primaries from the gray mantle is most diagnostic. In young birds, the white on the forehead and breast distinguishes Franklin's Gull from the duskier Laughing Gull.

Distribution and Abundance

A total of 52 Franklin's Gulls were seen on 12 occasions during April in the BTEX subunit (Table 37; Figure 84). The largest flocks were seen over land (10 birds) or over the beach (20 birds). Most birds over water occurred singly (seven separate birds) or in small flocks of up to six birds (three flocks). Since migration occurs during April in Texas (Oberholser 1974), birds were probably on their way north when observed.

Franklin's Gull breeds from the prairie provinces of Canada south to Oregon, Utah, Montana, South Dakota, and Iowa (Godfrey 1966). The main winter range of the Franklin's Gull is on the west coast of South America from northern Peru to southern Chile (Bent 1921). It also winters in smaller numbers along coastal Louisiana and Texas. Dates of occurrence for Franklin's Gull in Louisiana extend from September to May (Lowery 1974b). In Texas, Franklin's Gull winters from January through March, and leaves on its migration to breeding grounds from April to June (Oberholser 1974).

Habitat Use

The species was observed several miles inland and as far as 100 km offshore (Figure 84; Table 37). Sea surface temperatures in April ranged from 22° to 23° C where Franklin's Gulls were seen.

Franklin's Gulls breed in inland marshes or sloughs, and feed in marshes and open, cultivated fields. Franklin's Gull feeds largely on insects during the breeding season. Not much is known of the food habits of this species during migration and winter, but Clapp et al. (in prep.) suggested it is more an opportunistic feeder during this time. Almost 50% of all Franklin's Gulls observed during the survey were over water. They

Table 37. Sighting information on Franklin's Gull from BTEX during April. Dash means no data available.

Date	No. of birds	Position (Latitude/Longitude)	Distance from shore (km)	Water depth (m)	Sea surface temperature (° C)
25 Apr. 1981	1	26°54.5'N/97°09.3'W	20	29	22
25 Apr. 1981	6	26°54.5'N/97°09.3'W	20	29	22
25 Apr. 1981	1	26°56.0'N/96°46.7'W	56	71	22
25 Apr. 1981	1	26°36.0'N/96°20.8'W	95	190	22
25 Apr. 1981	1	26°26.0'N/96°45.4'W	55	44	22
26 Apr. 1981	5	26°57.0'N/96°48.7'W	53	64	22
27 Apr. 1981	10	-	-	-	-
28 Apr. 1981	1	26°15.0'N/96°24.3'W	77	82	23
28 Apr. 1981	4	26°55.0'N/97°93.0'W	20	29	22
28 Apr. 1981	1	26°55.0'N/96°52.6'W	46	57	22
28 Apr. 1981	1	26°55.0'N/96°20.2'W	101	384	23
29 Apr. 1981	20	26°19.2'N/97°11.8'W	-	3	-

were sighted at various times of the day, and many were seen far offshore. They could have been feeding on marine organisms.

Associations

One flock of six Franklin's Gulls was observed in association with a shrimp boat, terns, and dolphins. The animals were probably attracted by the organisms churned up by the shrimp boat's trawls. In another sighting, one Franklin's Gull was flying with a Laughing Gull.

Reproduction

Franklin's Gulls nest in marshes in shallow water with semi-open emergent vegetation. Usually, three eggs are laid (Godfrey 1966). Franklin's Gulls rarely breed successfully before the third year of age. Eggs are incubated 18 to 24 days (Bent 1921; Burger 1974), and young are fledged at 23 to 33 days (Clapp et al. in prep.).

Potential Impacts of OCS Development

Franklin's Gull occurs seasonally within the study area, and during that time is vulnerable to oil spills when it feeds and sits on the water (Wierenga 1976, cited by Clapp et al. in prep.).

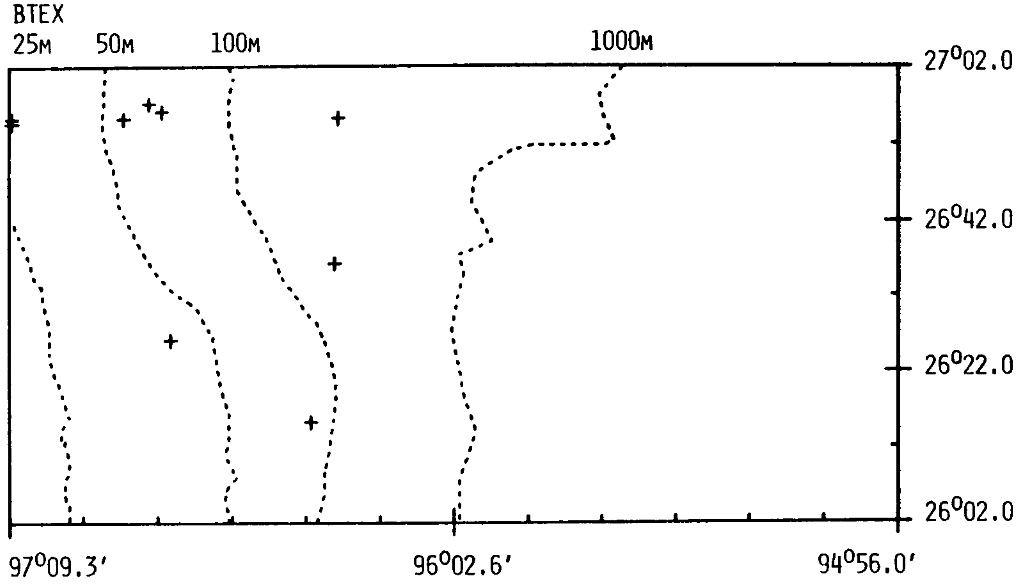


Figure 84. Distribution of all Franklin's Gull sightings in the BTEX survey subunit during April (+).

Summary

Fifty-two Franklin's Gulls were seen during April in the BTEX survey subunit. They occurred over land and ranged to about 100 km offshore. Some were with terns and dolphins around a fishing boat. During April the Franklin's Gulls, wintering in South America, begin migrating north to the breeding grounds in Canada, which explain their presence along the Texas coast in April. The Franklin's Gull is only vulnerable to oil contamination within the study area during the limited time it spends migrating over the Gulf of Mexico.

BONAPARTE'S GULL, Larus philadelphia

Description

Bonaparte's Gull is a small seabird (body length 32 cm; wingspan 82 cm) (Tuck and Heinzel 1978) with pointed wings and a square tail. The bill is black and slender. In adult breeding plumage, the head is black with a broken, white eye-ring. The back and upper wings are silver-gray, although the outer primaries are white with black tips. The neck, rump, and tail are white. The feet and legs are pink. During nonbreeding periods, the head is white with a dark spot posterior to the eye.

In immature plumage, the head is like that of the nonbreeding adults. The trailing edge of the wing and a bar formed by secondary coverts are grayish brown, and there is more black on the white, outer primaries than in adults. The tail has a subterminal black band. The feet and legs are not as brightly colored as in breeding birds.

Flight is direct and characterized by somewhat buoyant, regular wingbeats. This gull also is capable of a hovering flight resembling that of a hovering tern.

From the air, the Bonaparte's Gull resembles a tern more than a gull. The silver-gray back and wings fade to almost white, making the white on the outer primaries inconspicuous. Most birds seen were in nonbreeding plumage and had white heads. The shape of the tail was distinctive from that of terns. The small size of this gull and its buoyant flight helped distinguish it from other gulls.

Distribution

Bonaparte's Gull was seen in largest numbers along the northern coast of the Gulf of Mexico. In the MILA subunit, 210 birds (60 sightings) were seen during February and one bird was sighted during April. Three birds (two sightings) were seen in the NAFL subunit during April, and two birds (two sightings) were seen in the MIFL subunit during February. No sightings occurred in the BTEX subunit. During opportunistic surveys, 6,199 birds were seen east of the Mississippi Delta during February and March ($\bar{x} = 172$ birds, SD = 844.1, n = 36; range 1 to 5,000), and 71 birds (21 sightings) were seen off Onslow Bay, North Carolina, in March.

Bonaparte's Gull breeds in the coniferous belt of western and central Canada and Alaska (Godfrey 1966). From August to September, birds from western portions of the breeding range migrate south along the Pacific to California and western Mexico (Clapp et al. in prep.). Birds from central North America migrate to the Great Lakes region, and then to the Atlantic or Gulf coast. These birds arrive in the study area during December or January and remain until May (Clapp et al. in prep.).

Within its winter range in the southeastern United States, Bonaparte's Gull feeds over freshwater lakes, estuaries, and the nearshore waters of the Gulf of Mexico and Atlantic Ocean, but may stay offshore for extended periods (Clapp et al. in prep.). Data from aerial surveys indicate that they commonly occur over coastal waters of the northern Gulf of Mexico, and that few sightings occur offshore (Figure 85).

Abundance

Density estimates for Bonaparte's Gull were calculated only for the MILA subunit during February. An estimate of 0.076 birds/km^2 was obtained. Bonaparte's Gulls occurred in the inshore 40% of the subunit. If the calculation is adjusted to reflect this gull's limited distribution (density/.40), the density becomes 0.19 birds/km^2.

Bonaparte's Gull is reported to be more common in Florida along the coast of the panhandle than off the peninsular coasts (Sprunt 1954). The species is considered occasionally common off Texas and along the northern coast of the Gulf of Mexico (Lowery 1974b; Oberholser 1974; Clapp et al. in prep.). The period of peak numbers ranges from October to May (Lowery 1974b; Oberholser 1974; Clapp et al. in prep.). The observations made during this study are concordant with previous knowlege of Bonaparte's Gull.

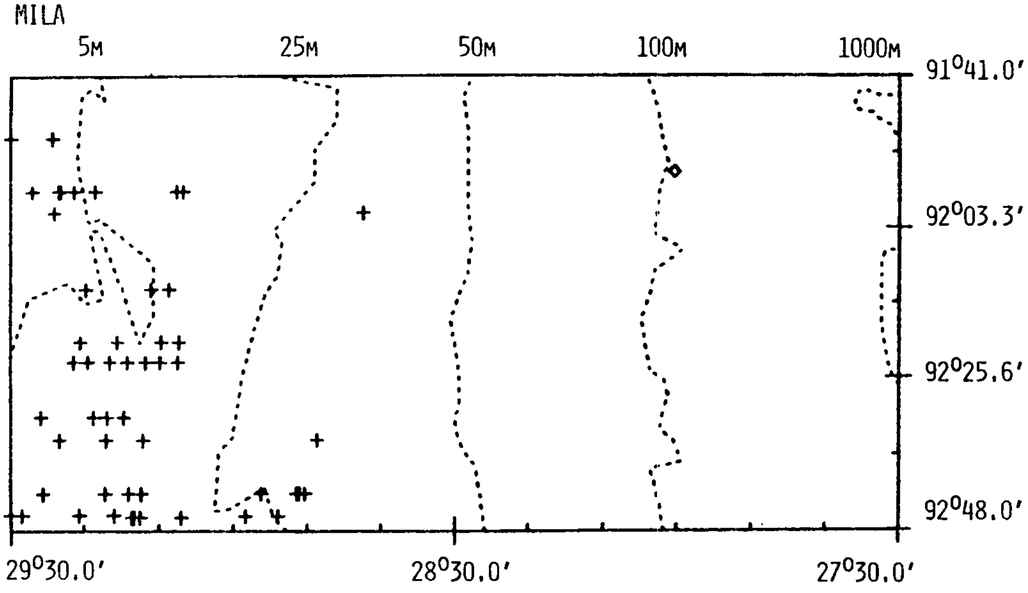


Figure 85. Distribution of all Bonaparte's Gull sightings in the MILA survey subunit during February (+) and April (◇).

Habitat Use

In the MILA subunit, sightings occurred from 5 km from shore ($\bar{x} = 37$; SD = 22.3; n = 60) during February to 169 km from shore (single sighting) during April (Figure 85).

Sightings occurred over the beach and over waters up to 2,423 m deep. Sightings over waters with depths greater than 100 m constituted only 3% of all sightings, while 78% of sightings were over waters 25 m deep or less. Data from this study suggests that Bonaparte's Gulls are commonly found over shallow coastal waters, where this species has been known to feed (Sprunt 1954; Clapp et al. in prep.). Our aerial survey data conflict with Lowery's (1974b) belief that the species is more pelagic than other gulls.

Bonaparte's Gull was seen over waters with surface temperatures ranging from 12° C in April off the Mississippi Delta to 24° C in February in the MIFL subunit.

Associations

Bonaparte's Gull was frequently associated with water mass boundaries. Of all sightings of Bonaparte's Gulls, about 4% were flying or sitting on the water near water mass boundaries, but these sightings included the largest groups seen (93% of all Bonaparte's Gulls). Bonaparte's Gulls were only occasionally seen following shrimp boats with other gulls and terns.

Reproduction

Unlike other gulls, Bonaparte's Gull usually does not nest in colonies, although it may nest in small groups (Twomey 1934; Terres 1980; Clapp et al. in prep.). Nests are platforms of twigs, moss, and lichens from 4 to 20 ft (1.2 to 6.0 m) high in spruce trees and are usually near small muskeg ponds (Twomey 1934; Terres 1980). This gull usually lays three eggs between late May and mid-July (Clapp et al. in prep.). Incubation is about 24 days (Jehl and Hussell 1966). Age at fledging is not known. Immature plumage is retained until the second autumn (Bent 1922; Godfrey 1966), and birds may breed before developing adult plumage (Clapp et al. in prep.).

Behavior

During this study, Bonaparte's Gull frequently was seen sitting on and hovering above the water. This species feeds by aerial plunging for small fish (Clapp et al. in prep.), and by fluttering near the water's surface to pick up food (Oberholser 1974). A sighting of a large flock of Bonaparte's Gulls (5,000 birds) during an opportunistic survey in February was of special interest, because it was associated with a water mass boundary located east of the Mississippi Delta. The gulls were evenly spaced and sitting on the water along a 7.5-km section of the boundary. The boundary was detected by changes in sea surface temperatures and water color as well as by visible accumulations of sargassum and trash. A second large flock (1,000 birds) was associated with a water mass boundary east of the Mississippi Delta during an opportunistic survey in March. These were the only sightings of such large flocks of Bonaparte's Gulls. Most sightings were of small flocks; monthly means from survey subunits ranged from 1.0 to 3.5 birds/flock (SD = 11.4).

Potential Impacts of OCS Development

Bonaparte's Gull, due to its seasonal inland distribution, is less vulnerable to oil and gas effects than other gulls. It is seasonally vulnerable while wintering along the coasts of the Gulf of Mexico and Atlantic Ocean. This gull's habits of plunging into the water for food and resting on the water's surface in large flocks, and its largely coastal distribution make it a potential victim of coastal oil and chemical spills. The ability of Bonaparte's Gull to avoid oil is not known.

Summary

Bonaparte's Gull was seen during February and April, and in the MILA, NAFL, and MIFL subunits. Largest numbers were seen during February in the MILA subunit and during opportunistic surveys east of the Mississippi Delta. They were not identified in the BTEX subunit. They usually were seen over coastal waters. Large numbers of this species were seen sitting on the water along water mass boundaries. Impacts of OCS development are unknown, but Bonaparte's Gulls are potentially vulnerable in the winter.

BLACK-LEGGED KITTIWAKE, Rissa tridactyla

One Black-legged Kittiwake was observed on 4 March 1981 at 24°25.2' N, 83°12.5' W. This location is 25 km southwest of Loggerhead Key, Dry Tortugas. The kittiwake was circling with a flock of 15 Sooty Terns over a school of 10 to 12 Devil Rays (probably Mobula hypostoma). This group was on the northern boundary of the Florida Current.

Black-legged Kittiwakes breed on cliff faces on arctic and subarctic islands and coasts. Apparently, most kittiwakes remain at sea in cold, north temperate regions, but small numbers disperse south to southern California in the Pacific and to the Gulf of Mexico (Oberholser 1974; Lowery 1974b).

GULL-BILLED TERN, (Sterna nilotica)

Description

The Gull-billed Tern is a medium-sized pale tern (body length 35 cm; wingspan 86 cm) (Watson 1966). It has white underparts and tail, and pale gray wings and back. The bill is heavy and black, and the head is adorned with a black cap. It is similar in body size to a Sandwich Tern, but it is more compact with a shorter neck and tail and broader, less pointed wings.

From the air the wings appear whiter, especially at the wingtips, than those of the other pale terns in the study area. When viewed from above, the wings are also broader and more like those of gulls.

Distribution and Abundance

One Gull-billed Tern was sighted near the beach in the MILA survey subunit on 14 June 1980. Gull-billed Terns also were observed from the survey aircraft at Lakefront Airport, New Orleans, Louisiana, and from the ground at Laguna Atascosa National Wildlife Refuge and along the shores of Laguna Madre in South Texas.

Gull-billed Terns are primarily inhabitants of brackish and freshwater marshes (Bent 1921), so the absence of offshore sightings is not surprising. Gull-billed Terns nest in coastal and inland marshes from Laguna Atascosa in South Texas around the Gulf through Louisiana and Alabama to the Tampa Bay area, Florida, and sporadically up the Atlantic coast to Long Island, New York (Clapp et al. in prep.). The Gull-billed Tern is migratory and possibly passes over OCS areas on its way to wintering areas in Central and South America. In the survey subunits, Gull-billed Tern density probably is near zero for most of the year. Density may be appreciable during migration.

Habitat Use

Gull-billed Terns inhabit marshes in coastal and inland areas. They are not found in pelagic waters (Erwin 1978).

Reproduction

The Gull-billed Tern nests either in coastal marshes or on dry sand flats above the high tide mark (Bent 1921). The nest is usually a simple depression in the sand (Lowery 1974b) but these birds also utilize vegetation gathered from nearby areas (Bent 1921). The Gull-billed Tern generally lays two or three eggs per clutch.

Behavior

The Gull-billed Tern is primarily insectivorous and hawks insects on the wing (Oberholser 1974). It also feeds on small fish, crabs, and shrimp near the edges of bays and lagoons (Oberholser 1974). It rarely, if ever, dives or swims, and does not get its feathers wet while feeding.

Potential Impacts of OCS Development

Gull-billed Terns might be affected in two ways by OCS development. First, onshore support facilities such as tank farms, refineries, and dredged harbors may destroy nesting and feeding habitat. Second, oil spilled at sea can be transported by high seas or storm surges onto salt marsh vegetation, thus temporarily reducing available habitat and posing a threat of direct oiling.

Summary

A single Gull-billed Tern was seen in the MILA subunit. Other sightings occurred over land or inland waters in Louisiana and Texas. Gull-billed Terns usually inhabit brackish and freshwater marshes, explaining the low number seen during this study. Gull-billed Terns may be affected by OCS development, onshore support activities, or oil spills in coastal habitats.

COMMON-GROUP TERN

Includes: Forster's Tern, *Sterna forsteri*
Common Tern, *Sterna hirundo*
Arctic Tern, *Sterna paradisaea*
Roseate Tern, *Sterna dougallii*

These species were too similar in appearance to distinguish. Most Common-group Terns in the survey area were probably Common and Forster's Terns.

Description

All the Common-group Terns are small (32 to 42 cm length; wingspan 50 to 62 cm), gray-winged birds with white bodies and black caps. Arctic and Common Terns have white tails with dark gray margins, Forster's Tern has a pale gray tail with white margins, and the Roseate Tern has a completely white tail. The tails of Roseate and Forster's Terns are longer than those of Arctic and Common Terns. The wings of Common and Arctic Terns are a darker shade of gray than those of Forster's and Roseate Terns. When breeding, these terns differ in bill color, but nonbreeding birds all tend to have dark bills. In winter, Common and Roseate Terns develop white foreheads, while in nonbreeding Forster's Terns the cap is reduced to a mark behind each ear.

From the air, Common-group Terns appear white. They are distinguished from other pale terns primarily by shape, size, and wingbeat. Common-group Terns have small heads and very short necks so that the wings appear to be set far forward on the body. This shape distinguishes them from the larger and longer-necked Royal and Sandwich

Terns. Bonaparte's Gulls are similar in shape, size, and color, but can be distinguished by the broader tail and, at close range, by the white outer primaries.

Distribution

Common-group Terns were seen in all subunits but were most prevalent in the MILA survey subunit (143 sightings; 664 birds) and in the NAFL survey subunit (89 sightings; 441 birds; Table 38). Fewer birds were sighted in the MIFL survey subunit (13 sightings; 225 birds) and they were uncommon in the BTEX survey subunit (14 sightings; 22 birds).

Large numbers of Common-group Terns (789 birds) were sighted during October in the MIFL, NAFL, and MILA subunits, but the hightest monthly total (427 birds) occurred in the MILA subunit during February (Table 38). The birds apparently migrate into the subunits by October. They stay only briefly in the MIFL subunit and are virtually gone by December. In the NAFL subunit, the October population high (336 birds) was diminished by December (84 birds), and only one bird was sighted during February. In the MILA subunit high numbers were counted during October and February, but the December abundance is uncertain because of a lack of surveys.

In the BTEX (Figure 86) and MILA (Figure 87) subunits, Common-group Terns were seen during all surveys. They were observed in the NAFL subunit during all months except June and August (Figure 88). While in the MIFL subunit, they were only seen during June and August (Figure 89).

During an opportunistic flight south of the NAFL survey subunit in December, a major concentration of Common-group Terns was found (Figure 90). This may be a previously unrecognized major wintering area, and more information on the specific identity of these birds is needed.

Forster's Terns breed only in North America from the Gulf of Mexico to the prairie pothole marshes. Most of the world's population winters in and around the Gulf of Mexico, although some winter on the Pacific coast of Mexico and California (Clapp et al. in prep.).

Common Terns are much more widespread, with breeding colonies in prairie marshes in temperate areas of North America, across Eurasia, and in a few locations in Africa. In Canada, Common Terns breed from southern Mackenzie and northern Alberta, south and east through the prairie provinces to the Great Lakes region, and east to the maritime provinces (Godfrey 1966). In the United States, they breed across the northern tier of plains states from Montana to Minnesota, around the Great Lakes, along the Atlantic coast from New England to North Carolina, and irregularly on the Gulf Coast (AOU 1957; Clapp et al. in prep.). They migrate through the study areas, especially off the Atlantic coast.

Roseate Terns breed in small numbers in the Florida Keys as well as in the West Indies, Western Europe, South Africa, the Indian Ocean, India, Southeast Asia, and the Indo Pacific. Throughout this range, colonies tend to be relatively small and scattered. In much of the range, populations of Roseate Terns are declining in numbers (Nisbet 1980), and the species is being considered for endangered or threatened status in the United States.

Table 38. The number of Common-group Terns sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits							
	BTEX		MILA		NAFL		MIFL	
June	2	(2)	4	(2)	0		0	
August	4	(1)	2	(2)	0		0	
October	3	(3)	230	(41)	336	(58)	223	(11)
December	-		-		84	(24)	1	(1)
February	1	(1)	427	(97)	1	(1)	1	(1)
April	12	(7)	1	(1)	20	(6)	0	
TOTAL	22	(14)	664	(143)	441	(89)	225	(13)

Arctic Terns have a Holarctic breeding range on tundra and subarctic coastline extending south to Massachusetts and France in the Atlantic.

The four species of Common-group Terns tend to migrate at different distances from shore. The best available information comes from boat surveys off North Carolina (Lee and Booth 1979) and the east coast of Florida. Forster's Terns are common during migrations and in winter along Florida beaches (Sprunt 1954). Common Terns are rare inshore in Florida, but migrate in numbers 15 to 30 km from shore. Roseate Terns from the colonies in the northeastern United States apparently migrate far offshore from New England and New York directly to the eastern Caribbean (Nisbet 1980). The migration route of Roseate Terns to and from the Florida Keys is unknown. Arctic Terns apparently migrate using the mid-Atlantic and are very rare within 200 km of shore (Kale 1977; Lee and Booth 1979).

Abundance

Common-group Tern densities were calculated for the MILA subunit during October and February, and for the NAFL subunits during October and December (Table 39). Densities ranged as high as 0.99 birds/km^2 in the MILA subunit during February, but these calculations are misleading because Common-group Terns were only sighted in about 30% of the MILA subunit and in about 50% of the NAFL subunit. If densities are adjusted for amount of habitat used (e.g., density/0.30 or 0.50), results are increased. Adjusted densities range as high as 3.3 birds/km^2 in the MILA subunit during February, and 1.3 birds/km^2 in the NAFL subunit during October. It should be noted, however, that Bonaparte's Gulls were first encountered during February in the MILA subunit, but were not distinguished from Common-group Terns until the second day of surveys. Therefore,

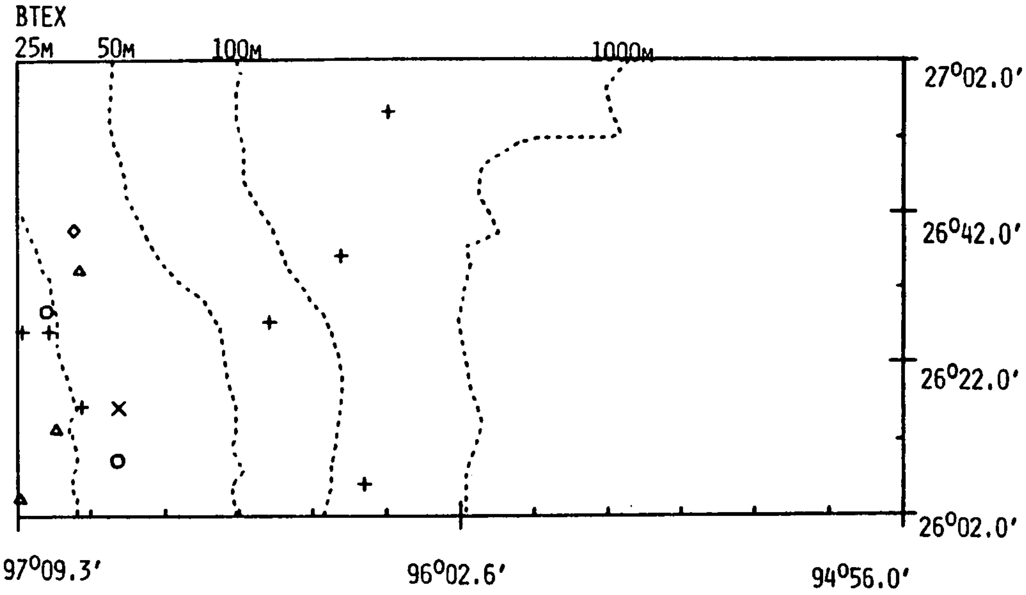


Figure 86. Distribution of all Common-group Tern sightings in the BTEX survey subunit during June (O), August (X), October (△), February (◇), and April (+).

the February counts and density calculations may be overestimates of the numbers of Common-group Terns present.

The sightings of Common-group Terns observed south of the NAFL survey subunit, near the Dry Tortugas (Figure 90) may represent a major wintering concentration. Because the birds were discovered during an opportunistic survey, densities were not calculated; but significant numbers (39 groups; 360 birds) were observed in only 36 minutes of flying. Common-group Terns have not previously been reported to concentrate in this area.

Group sizes ranged from 1 to 200, and monthly means ranged from 1 to 20 birds/group (Figure 91). Mean group sizes were largest during the October surveys and mean group size in the MIFL subunit during October was almost four times as large as any other monthly mean.

Habitat Use

In the BTEX, MILA, and MIFL survey subunits, Common-group Terns generally remained within 30 km of shore and monthly mean distances from shore varied from 7 to 74 km (Figure 92). In the NAFL survey subunit monthly mean distance from shore ranged from 79 to 115 km. In the NAFL subunit during October, 13 of 48 sightings (61%) were inside the 25-m contour, whereas during December, 14 of 17 sightings (82%) were between the 25 and 50-m contour. Similar distribution shifts were not noted in other subunits, and an explanation for the shift is not available.

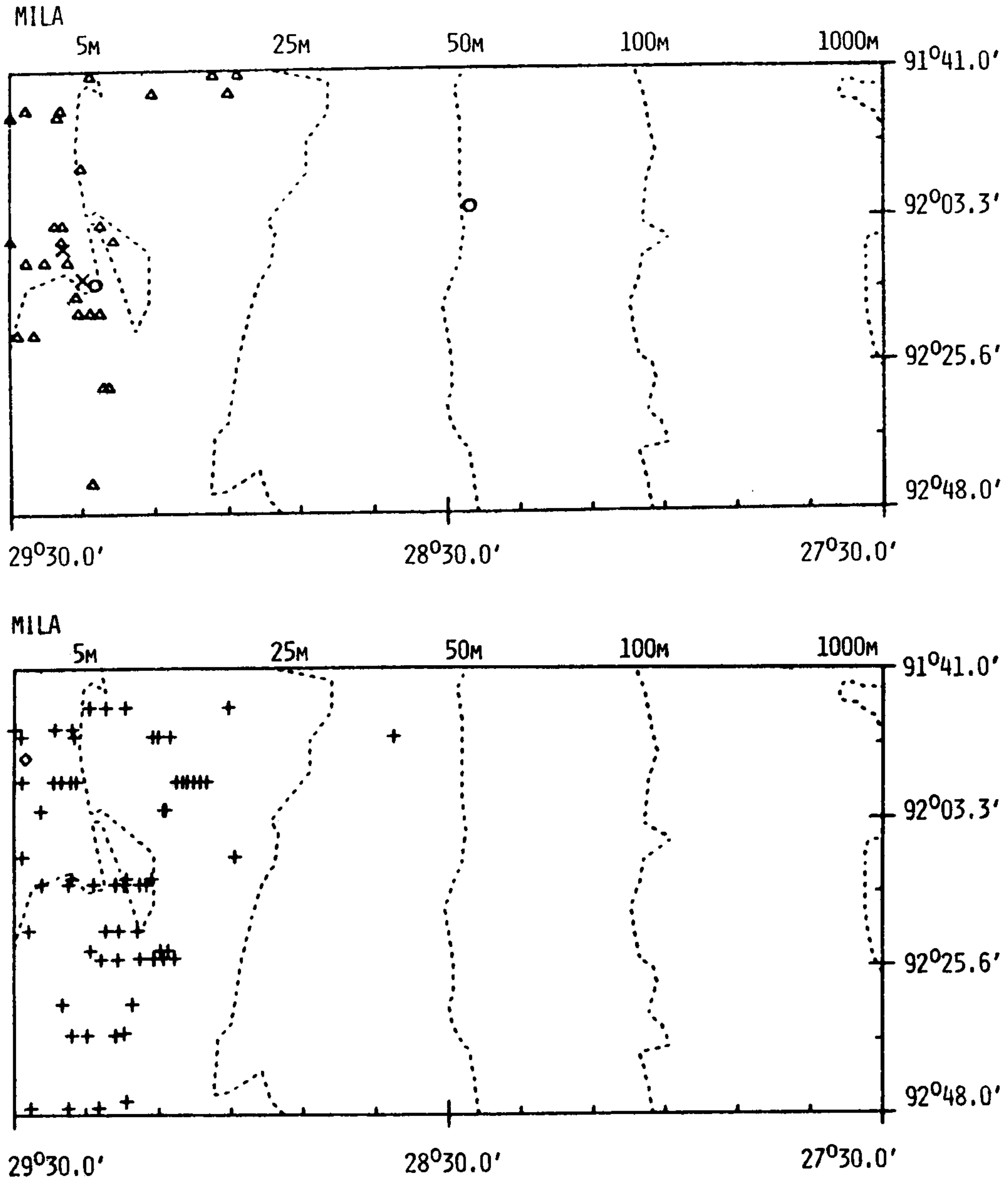


Figure 87. Distribution of all Common-group Tern sightings in the MILA survey subunit during June (O), August (X), October (△), February (+), and April (◇).

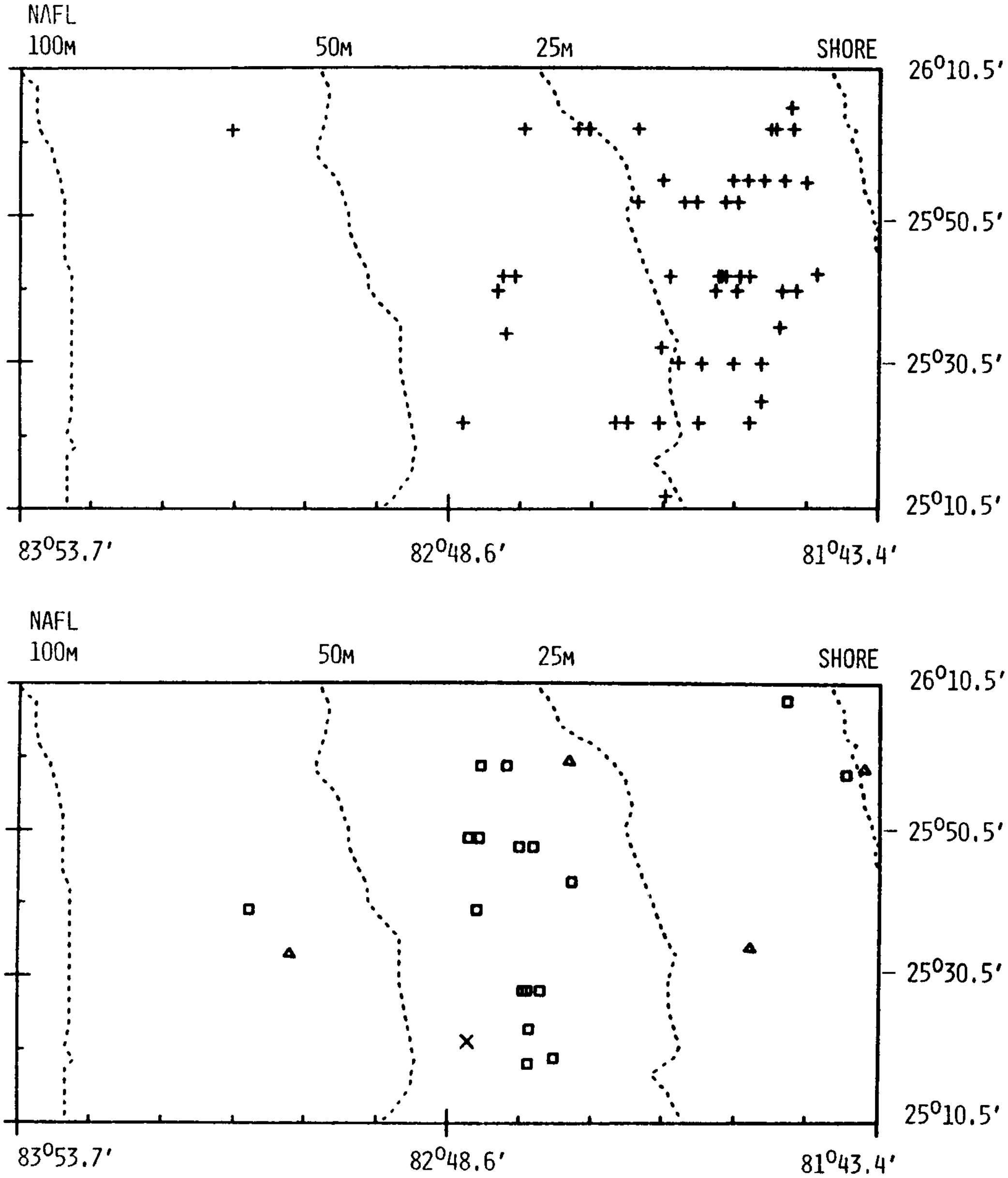


Figure 88. Distribution of all Common-group Tern sightings in the NAFL survey subunit during October (+), December (□), February (X), and April (△).

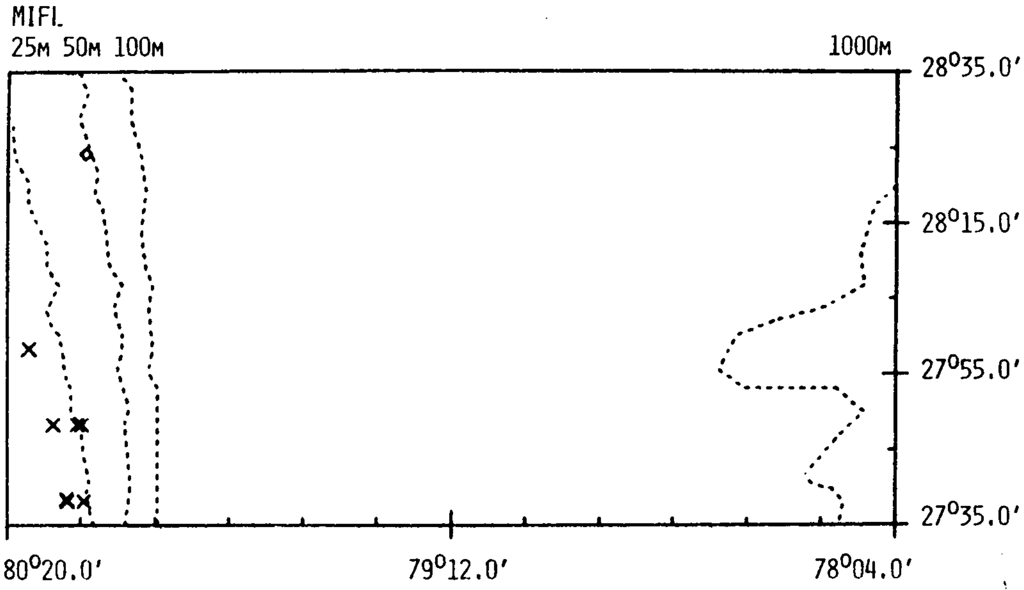


Figure 89. Distribution of all Common-group Tern sightings in the MIFL survey subunit during October (X) and February ( ).

Water depth at sighting locations ranged from 1 to 604 m (Figure 93). Monthly averages were usually about 20 to 30 m in depth in the MIFL, NAFL, and BTEX subunits. Common-group Terns in the MILA subunit were generally over shallower water with monthly averages generally less than 10 m. The mean depth at sighting locations (176 m) for April in the BTEX subunit was exceptional. The birds seen during these surveys might have been migrants following an offshore route across the northern Gulf of Mexico (also see Royal Tern species account).

Surface water temperatures at Common-group Tern sighting locations ranged from 12° to 28° C. Most of the birds were sighted in inshore areas during the coldest months.

Associations

Common-group Terns were observed in association with other vertebrates on 32 occasions. Royal Terns (21 sightings), schooling fishes (10 sightings), and Black Terns (7 sightings) were most frequently associated with the Common-group Terns. Thirteen other species of birds were occasionally observed with Common-group Terns. Twelve of the sightings were of Common-group Terns in multispecies feeding flocks. One Common-group Tern was perched on the carapace of a Loggerhead turtle. Bottlenose Dolphins (once) and unidentified dolphins (twice) were the only marine mammals sighted near Common-group Terns.

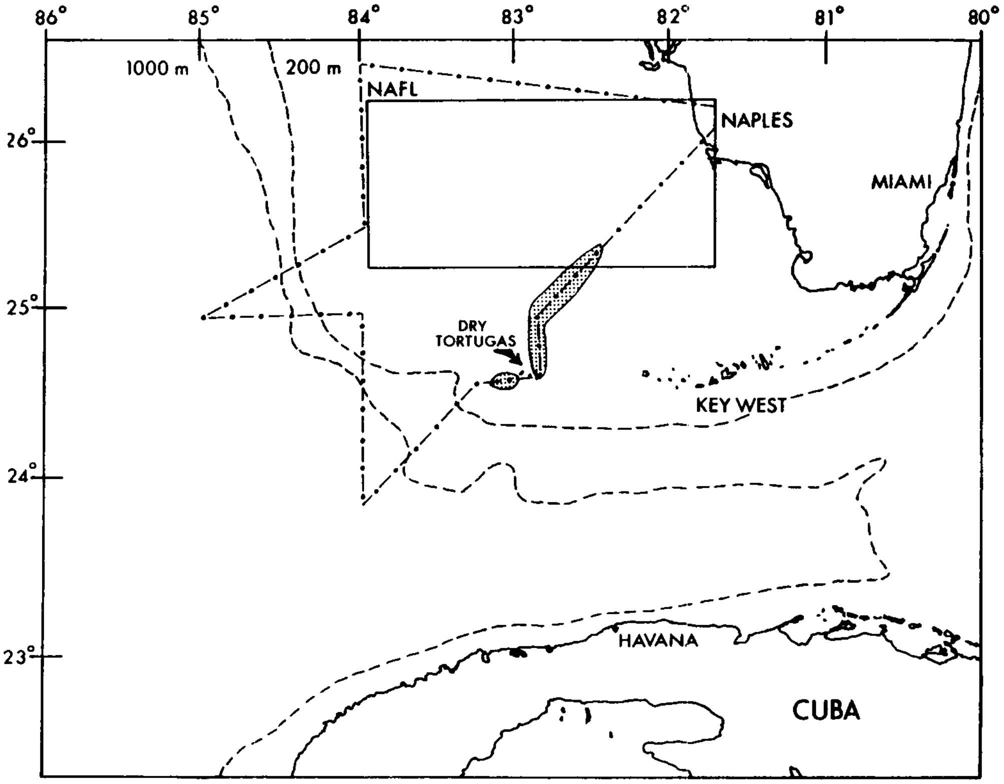


Figure 90. Sightings of Common-group Terns (stippled area) on an opportunistic flight (•–•–•) south and west of the NAFL survey subunit. The sightings (360 birds in 39 groups) may be part of a previously unrecognized concentration of Common-group Terns off southwestern Florida.

Reproduction

This study did not provide information on reproduction of Common-group Terns. Common, Forster's, and Arctic Terns nest in colonies on freshwater and salt marshes, although Common Terns also nest on more open, sandy subtrates. Roseate Terns usually nest on rocky or rubble-strewn areas, often within Common Tern colonies (Erwin 1978; Nisbet 1980).

Behavior

Most of the Common-group Terns observed were flying, many in flocks with other seabirds. Two were seen perched, one on a float and one on a Loggerhead Turtle. None were sighted swimming. The low numbers of perching and swimming terns observed may reflect the difficulty of identifying these birds from the aircraft when they are not in flight. Common-group Terns feed mainly by plunging for fish and aquatic invertebrates.

Table 39. Density and group size estimate for on-line sightings of Common-group Terns. "All" represents combined months.

Survey subunit	Month	No. of sightings	Group density (groups/km^2)	Variance	Mean group size	Standard error	Individual density (birds/km^2)
MILA	October	29	0.79×10^{-1}	0.44×10^{-2}	6.2	2.2	0.49
MILA	February	75	0.20	0.91×10^{-2}	4.9	2.7	0.99
MILA	All	106	0.28×10^{-1}	0.61×10^{-5}	5.2	2.0	0.15
NAFL	October	39	0.88×10^{-1}	0.11×10^{-1}	7.3	3.9	0.64
NAFL	December	23	0.11	0.61×10^{-2}	3.6	1.0	0.40
NAFL	All	66	0.28×10^{-1}	0.61×10^{-2}	5.6	2.3	0.15

In contrast to Royal and Sandwich Terns, Common-group Terns often hover before plunging. Hovering was noted on several occasions.

Potential Impacts of OCS Development

Several impacts on Common-group Terns have been documented or hypothesized. About 1% of the breeding Common Terns in two nesting sites in New York were spotted with tar (Duffy 1977; Gochfeld 1979, cited by Clapp et al. in prep.). This may be an underestimate of the numbers affected if seriously oiled birds fail to return to nesting colonies. Common Tern nesting habitat (estuarine marshes) may be subject to disturbance or destruction around OCS staging areas. Forster's Terns might also be subject to impact from oil spills because most of the world's population winters in the study area. In general, OCS related activities would affect Common-group Terns most during the fall and winter when the birds are concentrated in the study area.

Summary

Common-group Terns represent a grouping of Forster's Terns, Common Terns, Arctic Terns, and Roseate Terns, which usually cannot be differentiated when seen from an aircraft. Common-group Terns were seen in all subunits during October and February. Concentrations (> 200 birds) were present in all but the BTEX subunit during October, and were only occasionally observed after October in the MIFL subunit, after December in the NAFL subunit, and after April in the MILA subunit. A previously unrecognized concentration (39 groups; 360 birds) of Common-group Terns was recorded south of the NAFL subunit. Densities adjusted for habitat use ranged from 3.3 birds/km^2 in the MILA subunit during February to 1.3 birds/km^2 in the NAFL subunit during October. The birds generally were sighted within 30 km of shore except in the NAFL subunit where monthly averages were 79 to 115 km from shore. Known effects of OCS development include observations of tar on Common Terns at nesting colonies in New

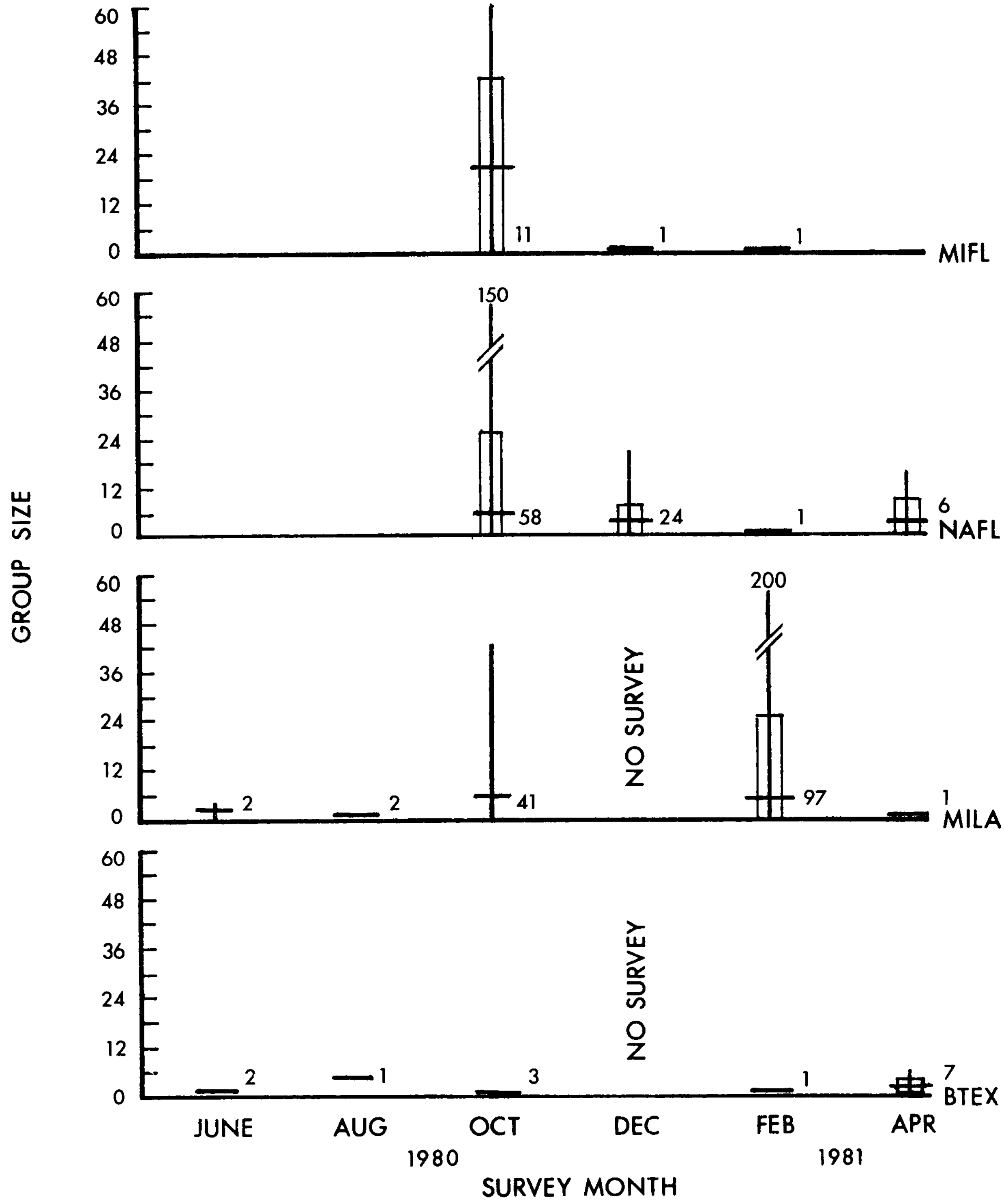


Figure 91. Group size for all sightings of Common-group Terns by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

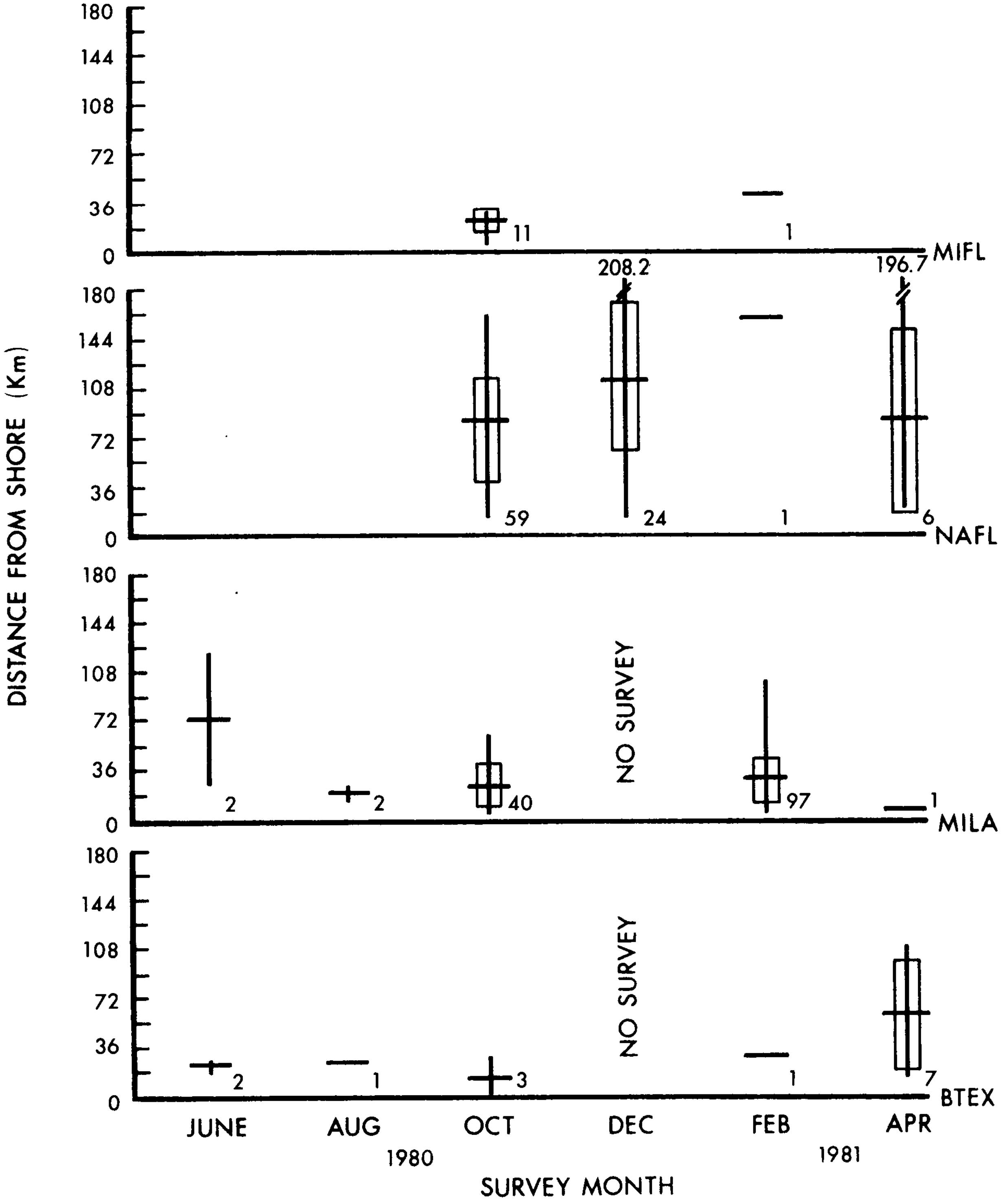


Figure 92. Distance from shore for all sightings of Common-group Terns by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

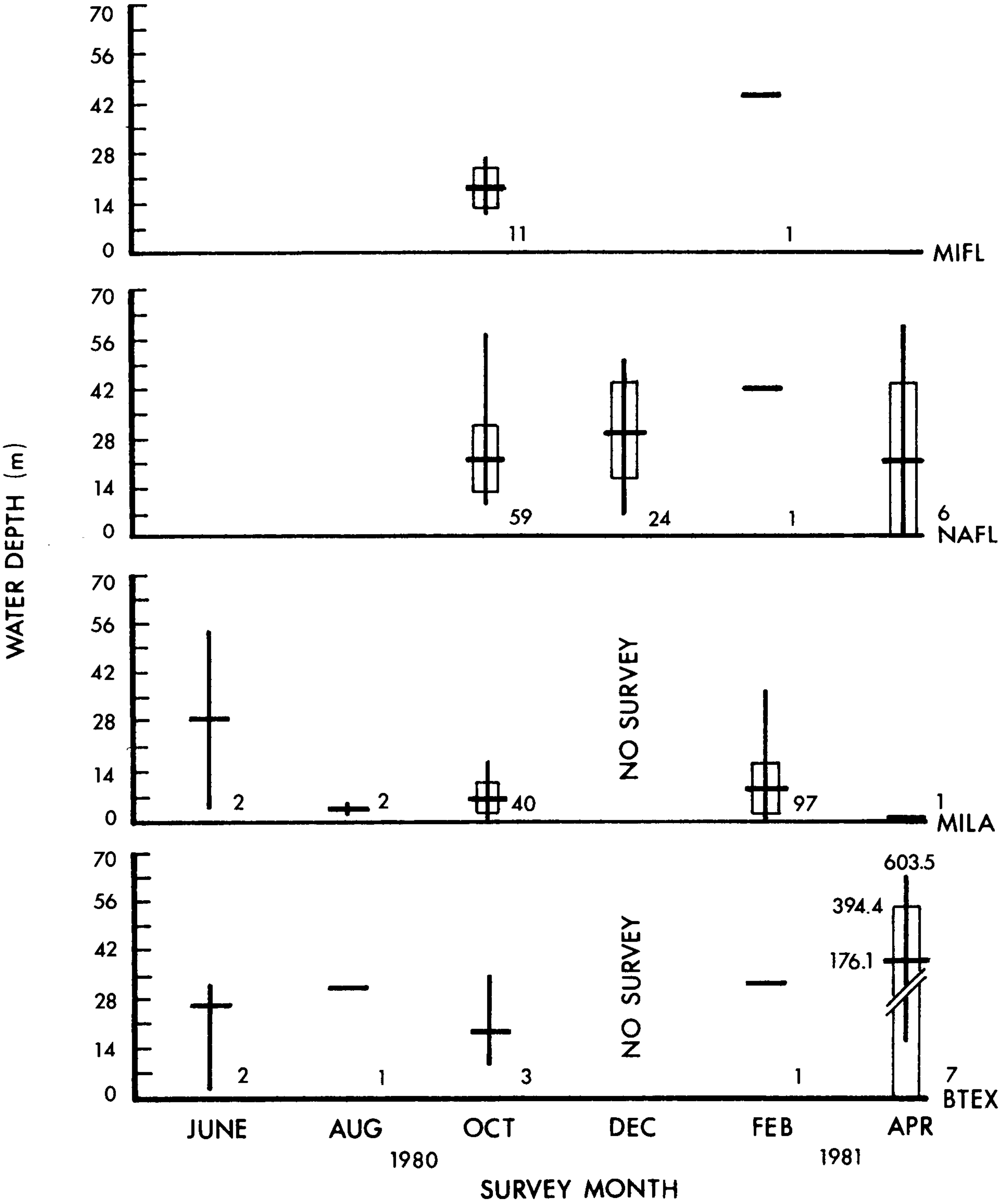


Figure 93. Water depth for all sightings of Common-group Terns by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

York. Much of the world's population of Forster's Tern winters in the study area, creating the potential for serious impact in the event of a catastrophic oil spill.

SOOTY TERN, Sterna fuscata

Description

The Sooty Tern is a dark-backed tern with white underparts (body length 38 cm; wingspan 86 cm) (Watson 1966). The crown, nape, back, and the upper surfaces of the wings and tail are uniformly brownish black. The forehead, cheeks, underparts, and outer tail feathers are white, although the belly may have a pale gray wash.

From the air, the Sooty Tern can be distinguished from the other two dark-backed terns (Bridled Tern and Black Tern) by the larger size, deeper wingbeat, more direct flight, and by the uniform blackish appearance of the upperparts. The white underparts and wing linings are surprisingly apparent from above.

Distribution

Sooty Terns were seen in all survey subunits. They were most common in the MIFL during April and in NAFL during April, and in April, June, and August (Figures 94 through 96; Table 40). They were observed in much lower numbers in BTEX (three sightings) and in MILA (two sightings). Sightings occurred during June, August, February, and April, but not during October or December.

The one major colony of Sooty Terns in the southeastern United States is on the Dry Tortugas. The NAFL subunit lies 40 km to the north of this colony, so the sightings in this subunit probably represent birds foraging from the colony. Opportunistic flights on 4 March and 9 April 1981, examined the distribution of feeding Sooty Terns around the Dry Tortugas colony (Figure 97). On 4 March, Sooty Tern sightings were concentrated in and along the northern boundary of the Florida Current to the south/southeast and to the southwest of the Dry Tortugas (bearings 170° and 235° from Bush Key). On 9 April, observations of Sooty Terns were more widespread, occurring south and southeast of the colony (bearing 155° to 200°), and to the northwest (bearing 280° to 310°). In addition, Sooty Terns in the scheduled February and April surveys in NAFL were concentrated to the north of the Dry Tortugas (bearing 335° to 05°). The colony experienced almost complete reproductive failure in 1981, so it may be unsafe to assume that feeding areas and food supplies were typical. Sooty Terns sighted in the MIFL subunit probably come from the Bahamas, where a number of Sooty Tern colonies are located (AOU 1957). The Sooty Tern's habit of ranging far offshore is well known (Murphy 1936; Ashmole 1968; Brown 1975). The Sooty Tern has a pan-tropical oceanic distribution, breeding on tropical islands in the Caribbean Sea, Atlantic Ocean, Indian Ocean, and across the Pacific Ocean from Micronesia to Hawaii (Murphy 1936; AOU 1957).

Abundance

Density estimates of Sooty Terns were calculated for the MIFL and NAFL subunits (Table 41). In the MIFL subunit, density was estimated to be 0.079 birds/km^2 during April and 0.022 birds/km^2 overall. In the NAFL subunit, density estimates ranged from 0.5×10^{-2} birds/km^2 during August to 0.23 birds/km^2 during April (Table 41). The overall

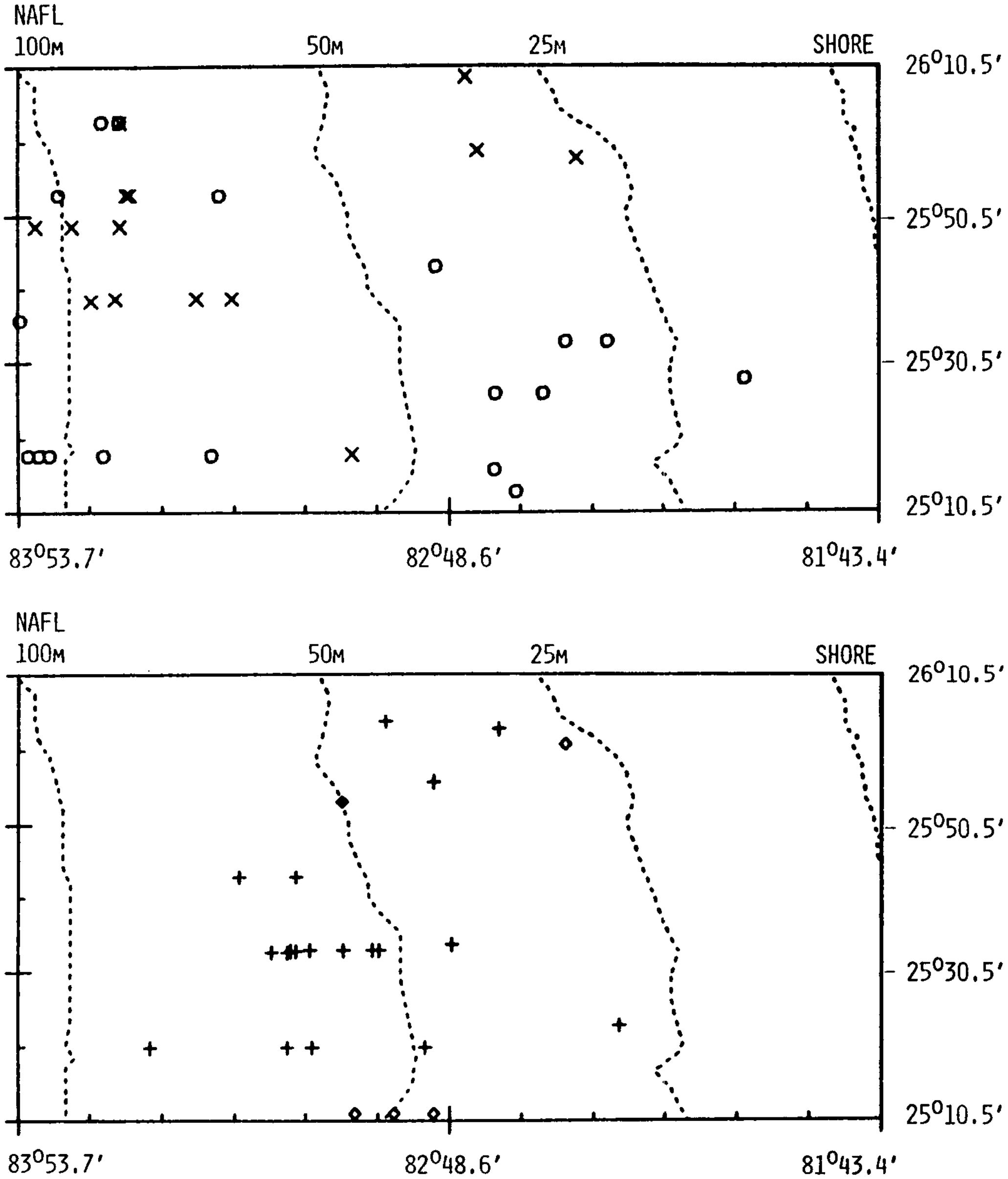


Figure 94. Distribution of all Sooty Tern sightings in the NAFL survey subunit during June (O), August (X), February (◇), and April (+).

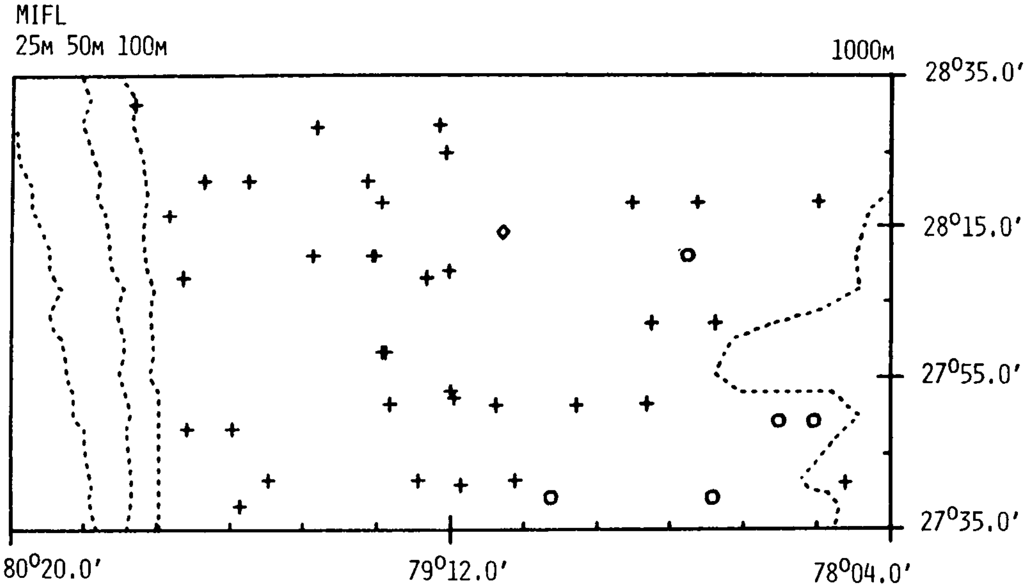


Figure 95. Distribution of all Sooty Tern sightings in the MIFL survey subunit during August (O), February (◇), and April (+).

density in the NAFL subunit was greater than that of the MIFL subunit (Table 41) and may be explained in part by the proximity of the NAFL subunit to the Dry Tortugas breeding colony.

Group sizes were larger in the subunits and during the months with more sightings (Tables 40 and 41). The larger groups observed during months with most frequent sightings (e.g., in MIFL and NAFL during April) probably were feeding flocks. Sooty Terns normally search for food alone or in small groups. When a fish school is located by one or more terns, the birds' feeding behavior attracts other terns within sight of the feeding situation. In fact, the direct flight of birds moving toward the incipient feeding flock may stimulate other more distant birds to follow and join the flock (Gould 1971). Thus, the largest flocks may form in regions where the density of searching birds is highest.

Habitat Use

Sooty Terns were found far offshore (Figures 94 through 98). For the NAFL and MIFL subunits, the monthly mean distances from shore all are greater than 115 km.

Sooty Terns showed a distinctly pelagic distribution. In the MIFL subunit, they occurred only over waters with depths of 130 m or more ($\bar{x}$ = 661, range = 132 to 1,042 m). In the NAFL subunit, which is entirely on the continental shelf, depths ranged from 20 to 119 m ($\bar{x}$ = 61 m), but all sightings were 70 km or more from shore. At these depths and distances from shore, the water in NAFL was blue and extremely clear. Although

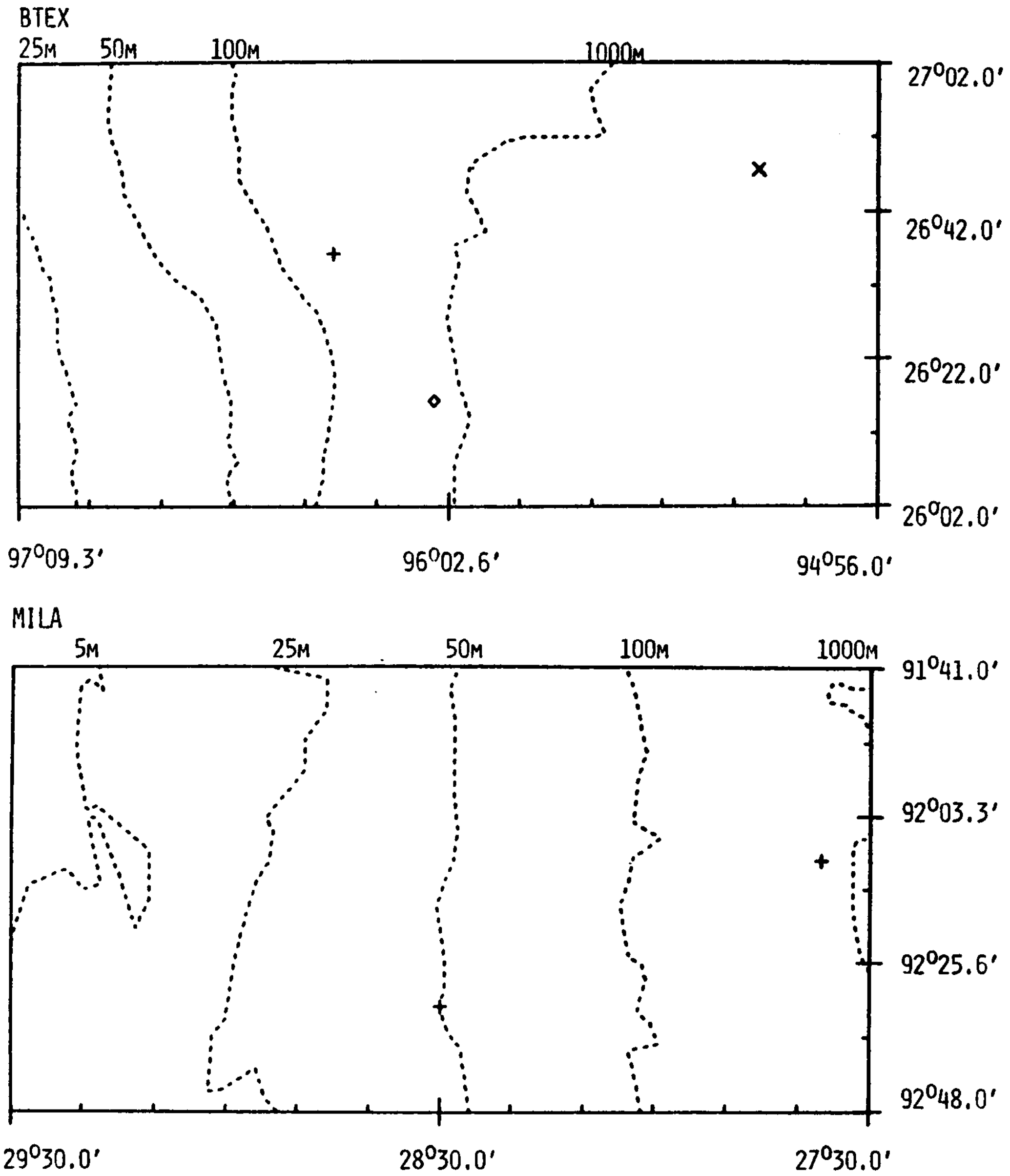


Figure 96. Distribution of all Sooty Tern sightings in the BTEX and MILA survey subunits during August (X), February (◇), and April (+).

Table 40. The number of Sooty Terns sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits			
	BTEX	MILA	NAFL	MIFL
June	0	0	37 (16)	0
August	2 (1)	0	30 (15)	28 (5)
October	0	0	0	0
December	-	-	0	0
February	1 (1)	0	18 (5)	1 (1)
April	1 (1)	2 (2)	139 (29)	220 (40)
TOTAL	4 (3)	2 (2)	224 (65)	249 (46)

they feed on schooling baitfishes (Gould 1971), the Sooty Terns seen in the NAFL subunit were not near the nearshore baitfish concentrations present in the subunit at depths of 10 to 50 m.

Sooty Terns were observed over waters with sea surface temperatures ranging from 20° C (NAFL in February) to 28° C (NAFL in August). In each month, they were concentrated in the warmest water available. This is not surprising, as the warmest water was away from shore.

During an opportunistic flight off the Dry Tortugas on 4 March 1981, Sooty Terns were found concentrated along the northern boundary of the Florida Current. On that flight 26 of 29 Sooty Tern observations were within 1 km of the current boundary. In MIFL, all Sooty Tern sightings were over the Gulf Stream or east (offshore) of the Gulf Stream. In April, the terns were as frequent over the Gulf Stream as they were to the east of it; but in August and February, the sightings were to the east of the main current.

Associations

Of all of the Sooty Terns seen during this study including off-line sightings (145 sightings, 539 individuals) 17% of all sightings (37% of individuals) were associated with other vertebrates. Sooty Terns were observed flying above cetaceans 9 times, over fish schools 10 times, with other birds 5 times, and over a Loggerhead Turtle once. The cetaceans included Striped Dolphins twice, unidentified dolphins three times, and Spinner Dolphins, Spotted Dolphins, Risso's Dolphins, and an unidentified whale each once. The fish schools consisted of large predatory fish feeding at the surface (one school was

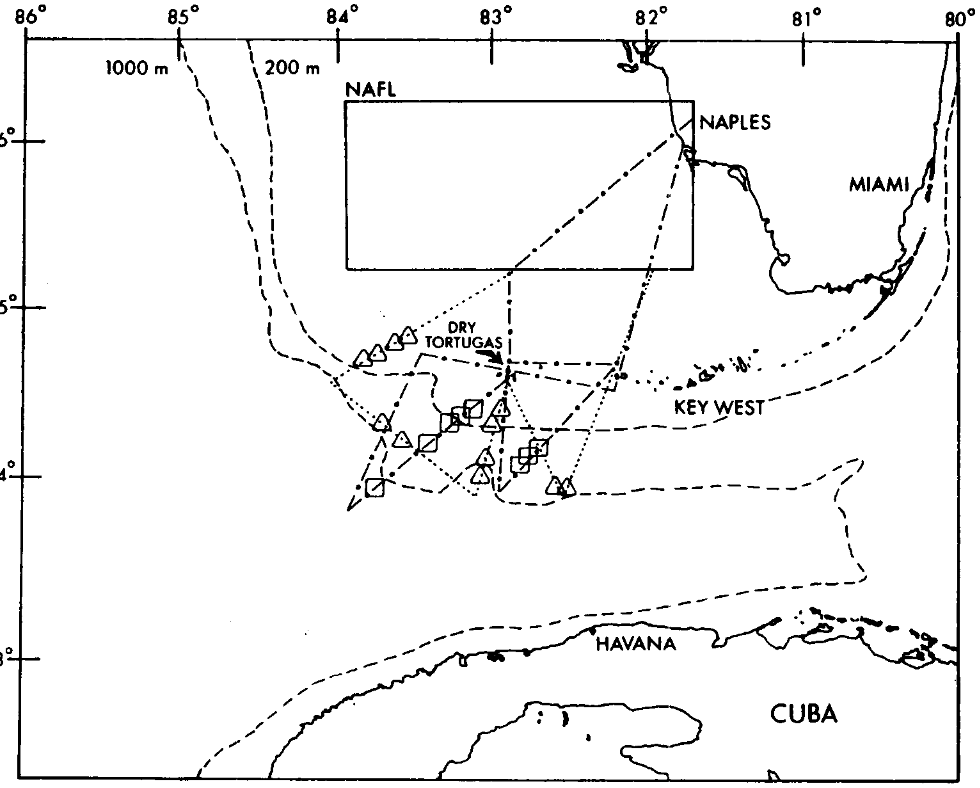


Figure 97. Sooty Tern sightings during opportunistic flights near the Dry Tortugas in March (□) and April (△). Flight paths for March (• – •) and April (• • •) are indicated.

identified as tuna). One association included a Whale Shark with three fish schools. Sooty Terns in the Pacific are well known for their tendency to feed in flocks while circling above schools of feeding dolphins and tuna (Gould 1971). In fact, the feeding birds often are the first clues to tuna seiners that the fish are present (Pryor and Kang 1980).

Reproduction

Sooty Terns nest on the ground, on bare sand, or under vegetation on isolated marine islands (Bent 1921; Ashmole 1968). The normal clutch size is one. The young are fed and attended by the parents after fledging and probably after leaving the colony (Feane 1975). Fledgling Sooty Terns have a distinctive dark-bellied plumage but were not observed in the survey.

In the study area, Sooty Terns breed in several small colonies on the Texas and Louisiana coasts, but total numbers are only about 20 pairs per state (Portnoy 1977; Blacklock et al. 1978). The one Florida colony on the Dry Tortugas numbers about 100,000 birds, and is one of the most important colonies in the Atlantic Ocean.

Table 41. Density and group size estimates for on-line sightings of Sooty Terns. "All" represent combined months. * = variance too small for calculations.

Survey subunit	Month	No. of sightings	Group density (groups/km^2)	Variance	Mean group size	Standard error	Individual density (birds/km^2)
NAFL	June	10	0.50×10^{-1}	*	3.0	1.9	0.15
NAFL	August	10	0.44×10^{-2}	*	1.1	0.1	0.50×10^{-2}
NAFL	April	18	0.38×10^{-1}	*	6.1	2.2	0.23
NAFL	All	38	0.23×10^{-1}	$.47 \times 10^{-3}$	4.0	1.2	0.93×10^{-1}
MIFL	April	20	0.13×10^{-1}	$.41 \times 10^{-5}$	6.0	3.7	0.79×10^{-1}
MIFL	All	23	0.38×10^{-2}	$.32 \times 10^{-5}$	5.9	3.2	0.22×10^{-1}

Behavior

Sooty Terns usually were observed flying, although three times they were flushed from floating boards. They often flew at altitudes of 20 to 40 m above the water. The terns seen in association with fish schools and bird flocks were probably feeding, although actual prey capture was not noted.

Sooty Terns feed by swooping to pick fish from the surface, and by capturing small flyingfish in the air. Their habit of feeding over dolphins and large fish is apparently a result of these animals chasing large numbers of flyingfish into the air (Gould 1971).

Potential Impacts of OCS Development

Sooty Terns are unable to waterproof their feathers (Johnston 1979). They neither sit on the water nor plunge into it during feeding (Murphy 1936). When bathing or cooling, they splash the breast briefly against the water (Bent 1921). Therefore, Sooty Terns should not be highly impacted by floating oil. However, Sooty Terns with small spots of tar on their wings, tails, or underparts are common in the Dry Tortugas colony. These small spots apparently are not harmful, but in 1980 distressed adult birds with larger tar balls were present in the colony. On hot days Sooty Tern chicks may be susceptible to contamination from oil on the beach. The larger chicks walk down to the edge of the water, apparently for purposes of thermoregulation. In the process, they could become fouled with petroleum contaminants.

The Dry Tortugas colony is among the most important colonies in the Atlantic and is located only 40 km south of proposed lease areas off Naples. These lease areas may, in fact, be important feeding areas for Sooty Terns. Development of OCS areas could affect Sooty Terns by direct oiling and by affecting the food chain. Adverse effects on

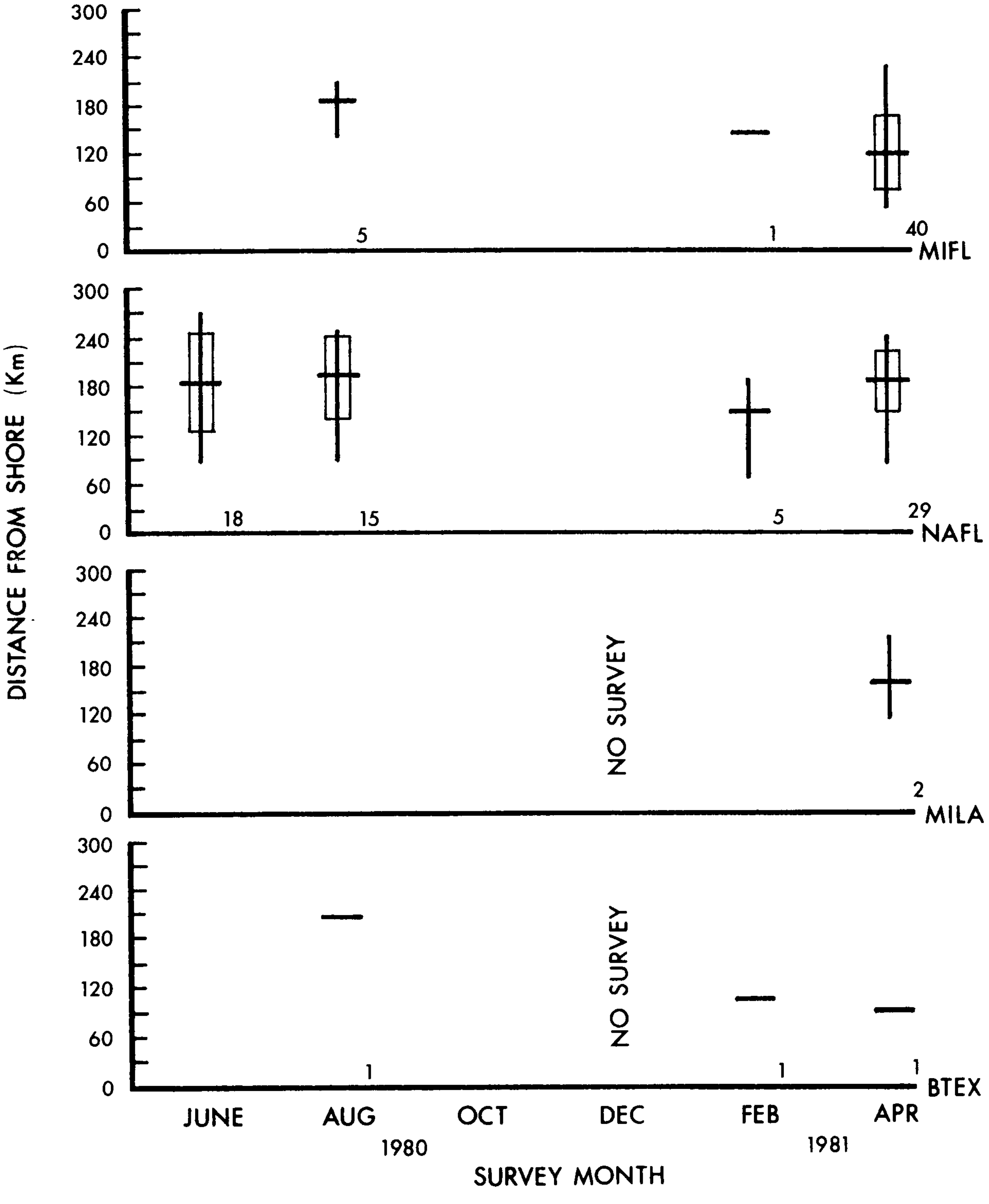


Figure 98. Distance from shore for all sightings of Sooty Terns by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

populations of flyingfish or on the large predatory fish and dolphins that chase flyingfish into the air could reduce the food availabile to the terns.

Summary

Although seen in all survey subunits, Sooty Terns were most common in the NAFL and MIFL subunits. Sooty Terns were seen in all months except October and December. The abundance of Sooty Terns in the NAFL and MIFL subunits is probably related to the proximity of breeding colonies in the Dry Tortugas and Bahama Islands. The Sooty Tern has a pelagic distribution and was occasionally associated with major currents. Sooty Terns feed at the surface, rarely getting their feathers wet in the process. Varying degrees of oiling have been observed on Sooty Terns, but the impact oil has on this species is unknown.

BRIDLED TERN, Sterna anaethetus

Description

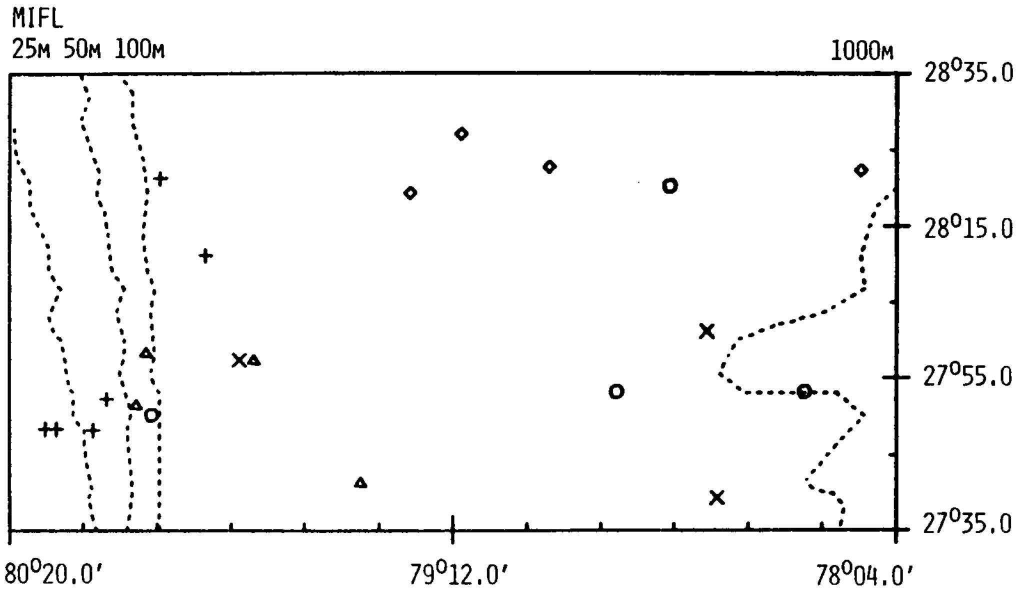
The Bridled Tern (body length 35 cm; wingspan 76 cm) (Watson 1966) is one of four dark-backed pelagic terns occurring in the study area. Adult Bridled Terns have white foreheads, black caps, pale collars, gray-brown backs, blackish wingtips, and brown tails with white outer margins. Underparts are white, often with a pale-gray wash posteriorly. Young birds are paler and grayer with streaked caps and obscurely scalloped backs.

From the air, Bridled Terns may be confused with Sooty Terns or with Black Terns (a fourth dark tern, the Brown Noddy, is distinctive). The Bridled Tern may be distinguished from the Sooty Tern by (1) the pale collar, (2) the upper back distinctly paler than the wings, (3) the tail distinctly paler than the wings and lower back, (4) the shallower wingbeat, and (5) the smaller size. The Bridled Tern is larger than the Black Tern and has darker and more pointed wings.

Distribution

Including off-line sightings, Bridled Terns were seen 45 times in the survey, in all survey subunits and during all survey months except December (Figures 99 and 100). Two-thirds of the sightings were made in the MIFL subunit. Eight (18%) sightings were in BTEX, seven (16%) in NAFL, and only one (2%) in MILA. One sighting was made between the BTEX and MILA subunits. Seventeen (39%) of the sightings occurred in April, while June had seven (16%). August, October, and February each had five sightings (11%).

These observations fit fairly well into the patterns of distribution described recently for the study area (Lee and Booth 1979; Duncan and Havard 1980; Clapp et al. in prep.), but also provide significant new information. This survey produced seven sightings from BTEX, whereas previously only seven occurrences existed for the entire state of Texas (Clapp et al. in prep.). The Texas records from this study average 100 km from shore, beyond the normal range of the party fishing boats producing the previous offshore records.



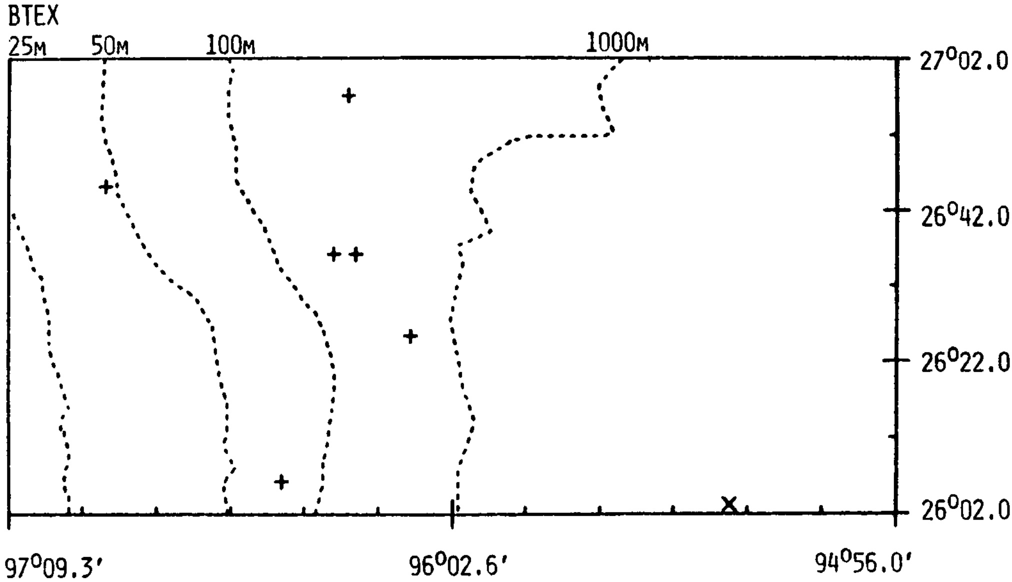


Figure 99. Distribution of all Bridled Tern sightings in the MIFL and BTEX survey subunits during June (O), August (X), October (△), February (◇), and April (+).

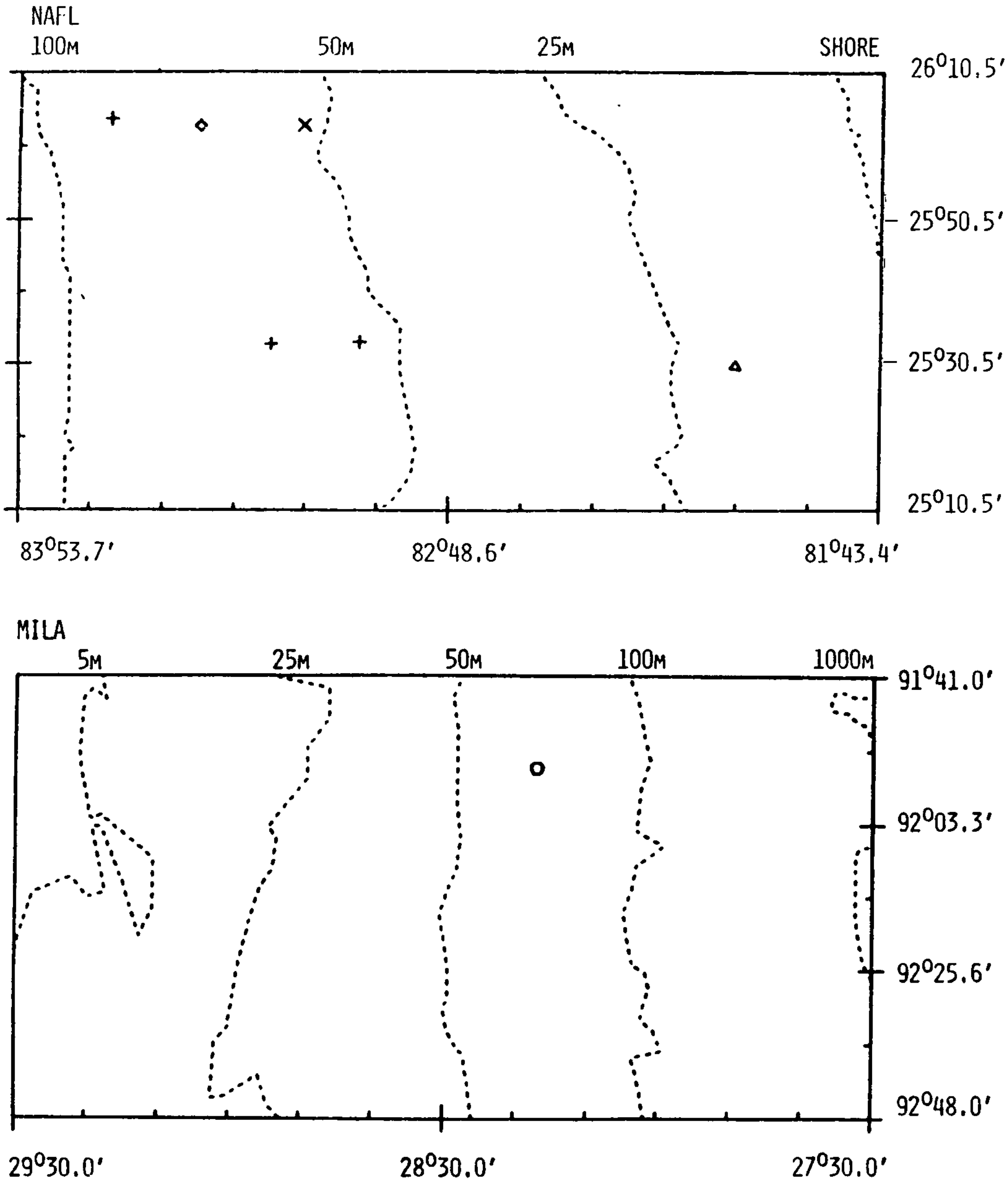


Figure 100. Distribution of all Bridled Tern sightings in the NAFL and MILA survey subunits during June (O), August (X), October (△), February (◇), and April (+).

Table 42. The number of Bridled Terns sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits			
	BTEX	MILA	NAFL	MIFL
June	0	1 (1)	0	9 (6)
August	7 (1)	0	3 (1)	5 (3)
October	0	0	1 (1)	4 (4)
December	-	-	0	0
February	0	0	1 (1)	9 (4)
April	7 (6)	0	4 (4)	9 (7)
TOTAL	14 (7)	1 (1)	9 (7)	36 (24)

Abundance

Bridled Tern density could be estimated only for the MIFL survey subunit, by combining data for all months. A density estimate of 0.58×10^{-2} birds/km^2 was obtained. This estimate may be unrealistically low as Bridled Terns were inconspicuous from the survey aircraft. Boat-based observations suggest that higher densities may be more normal. Fifteen of the sightings (38%) were of two to four birds, while the rest were of individuals.

At sea, Bridled Terns normally are seen in pairs or in larger groups and seldom as single birds. The high frequency of sightings of single Bridled Terns (62%) in this study is probably related to observation from an aircraft. In the pairs and groups of Bridled Terns observed from boats, individuals often were separated by several hundred meters. Thus, it is likely that many of the "single" Bridled Terns had unobserved companions nearby.

Habitat Use

Bridled Terns were seen 16 to 235 km from shore ($\bar{x} = 119$, $n = 39$). They averaged much farther from shore (170 km) in the NAFL subunit, where the continental shelf is broad, than in the MIFL (109 km), or BTEX (101 km) subunits. However, the full range of distance from shore occurred at MIFL.

With the exception of April, most Bridled Terns observed in the MIFL subunit were beyond the Florida-Hatteras slope (Figure 101; average depth during all months except

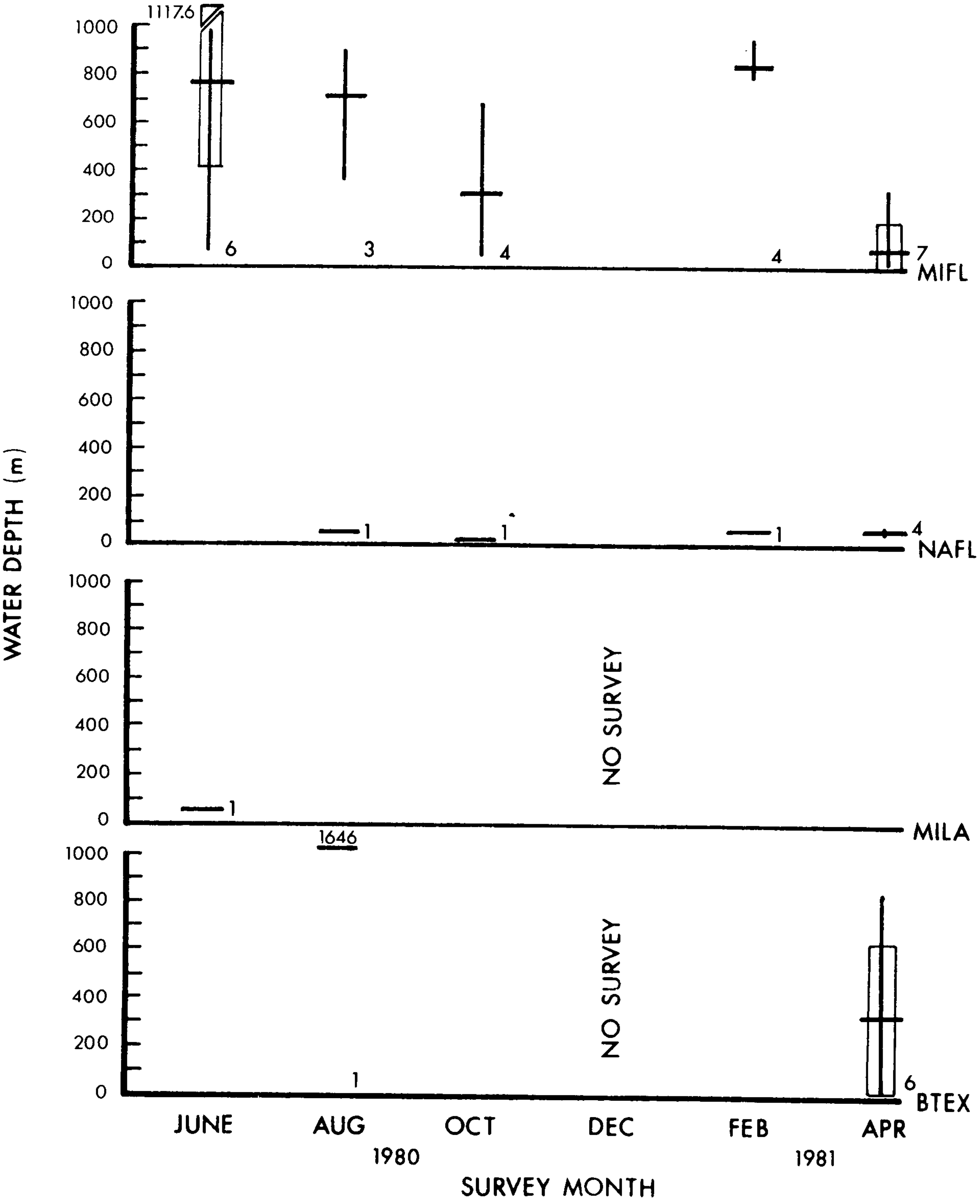


Figure 101. Water depth for all sightings of Bridled Terns by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

April = 668 m, n = 17). April's sightings were concentrated inshore of and along the western boundary of the Gulf Stream (mean depth = 85 m). The average depth of the seven sightings from the NAFL subunit was 55 m. This lower average depth is not surprising, because the entire NAFL survey subunit is on the continental shelf with waters shallower than 250 m. The seven Texas observations were over water averaging 528 m deep (47 to 1,646 m), and the sighting in the MILA subunit was over water 63 m deep.

Surface seawater temperatures are available for 36 of the Bridled Tern sightings. These range from 21° to 27° C ($\bar{x}$ = 24° C). The only prominent relationship between Bridled Tern distribution and currents involves the western boundary of the Gulf Stream. In April, the Bridled Tern sightings were clustered along and just inshore of this boundary. Lee and Booth (1979) commented that most of their Bridled Tern records off North Carolina were associated with the boundary of the Gulf Stream.

Associations

Bridled Terns were occasionally associated with other vertebrates. Four Bridled Terns were observed in February circling a school of large tuna splashing at the surface. Bridled Terns were seen near marine mammals (while the aircraft was circling the mammals) on five occasions. The mammals involved were Striped Dolphins (on two occasions), Spotted Dolphins, Short-finned Pilot Whales, and an unidentified dolphin. Twice, Bridled Terns were observed in mixed-species feeding flocks with other seabirds. More than half of the Bridled Tern sightings were over or near lines of sargassum. Duncan and Havard (1980) reported that off Alabama, Bridled Terns "are always associated with sargassum weed".

In April, Bridled Terns in the MIFL subunit were concentrated along and inshore of the Gulf Stream's western boundary. At the same time, Sooty Terns were present within the subunit in the greatest numbers seen in any survey subunit. Sooty Terns were seen over the Gulf Stream and to the east (Figure 95) a distribution complementary to that of Bridled Terns. This distributional pattern could result from competitive interaction or from different habitat preferences, but sufficient information is unavailable to support either hypothesis. During the same month, Bridled and Sooty Terns were observed together in feeding flocks in the BTEX subunit and in the northwestern Gulf of Mexico.

Reproduction

Bridled Terns nest in small colonies on tropical and subtropical oceanic islands (Bent 1921). The colonies nearest the study area are on islets off Cuba (Garrido and Montana 1975) and the Bahamas (Bent 1921; AOU 1957) including Cay Sal Bank (National Museum of Natural History Specimens). The regular summer sightings off MIFL may represent nonbreeding birds, or birds foraging from colonies in the northern Bahamas.

Behavior

Bridled Terns were observed five times sitting on boards and other floating objects, but dark terns perched on objects generally could not be identified from the air unless they flushed. Some of the unidentified dark terns seen on debris may therefore have been Bridled Terns.

Bridled Terns were not observed feeding, although those recorded circling over tuna and within mixed-species feeding flocks probably were foraging.

Potential Impacts of OCS Development

Bridled Terns seldom sit on the surface of the ocean, preferring instead to roost on floating logs, net floats, and other flotsam. Such debris is often fouled with oil and could bring Bridled Terns into contact with oil. This oil may adhere to their feet and eventually could be injested during preening, or may contact the eggs during incubation, causing embryonic death (White et al. 1979). Because they feed by swooping or hovering and picking food items from the water's surface, they should rarely come in direct contact with floating oil.

Summary

Bridled Terns were seen in all subunits, but most sightings occurred in the MIFL subunit. Bridled Terns were seen in all survey months except December, with most sightings occurring in April. Sightings occurred over nearshore and offshore waters. Bridled Terns were only occasionally associated with sargassum windrows and marine vertebrates including fish, birds, and cetaceans. Bridled Terns usually perch on floating objects rather than alight on the water. Oil on such objects can be transmitted to the bird and also be carried to nesting sites adjacent to the study area.

LEAST TERN, Sterna antillarum

Although the California subspecies of Least Tern, Sterna antillarum browni, is endangered, the Least Terns in the study area are not considered endangered or threatened.

Description

The Least Tern is the smallest of the North American terns (body length 21.5 to 24 cm; wingspan 51 cm) (Terres 1980). It has white underparts and tail, and gray wings with black outer primaries. The cap is black, but the forehead is white. The bill is yellow with a black tip.

From the air, Least Terns could be recognized by their very small size, pale color, and short tail.

Distribution

Least Terns were observed only during two months in two survey subunits. Single sightings occurred in the NAFL survey subunit during December and April , and seven sightings occurred in the BTEX subunit during April (Figure 102). The December sighting is unusual, as Least Terns rarely winter in the study area.

The scarcity of Least Tern sightings is not surprising because this species prefers inshore habitats (Erwin 1978), and the survey subunits include very little of this habitat. Least Terns breed on the Atlantic coast from southern Maine to the Florida Keys, and on the coasts of all states bordering the Gulf of Mexico. They also breed along rivers in the

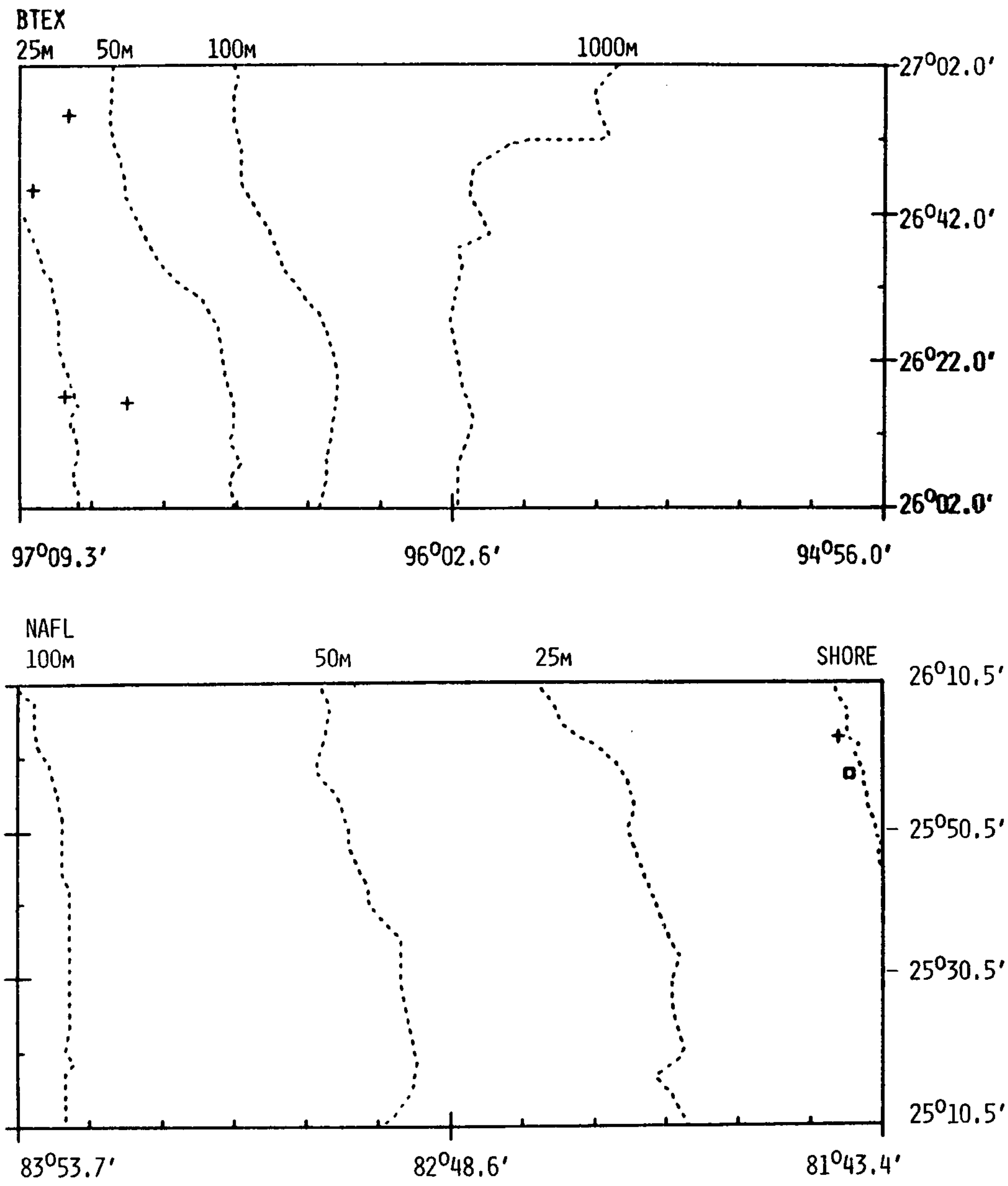


Figure 102. Distribution of all Least Tern sightings in the BTEX and NAFL survey subunits during December (□) and April (+).

interior of the United States from Nebraska and Ohio south to New Mexico and the Gulf of Mexico (AOU 1957). Elsewhere, Least Terns breed in a few colonies on the Pacific coast from San Francisco Bay to Chiapas, Mexico (AOU 1957; Clapp et al. in prep.), on islands off Venezuela, and in much of Europe and northwestern Asia, Iraq, India, and Sri Lanka. In the western Pacific, Least Terns breed from Manchuria and Japan to Australia. They also breed along rivers in several areas of Africa north of the Equator (AOU 1957).

Abundance

The nine Least Tern sightings are too few for calculation of density. Two sightings in the BTEX subunit were of two birds each. All other sightings were of single birds.

Portnoy (1977) reported 14,300 Least Terns for coastal Alabama, Mississippi, and Louisiana. Blacklock et al. (1978) reported that about 8,600 nested on the Texas coast in 1973 but by 1976 numbers had declined to 760.

Habitat Use

The two sightings in the NAFL subunit were 2 and 6 km from shore. The sightings in BTEX averaged 20 km from shore (ranging from 7 to 31).

Both observations in the NAFL subunit were over water 2 m deep. The seven sightings from BTEX were over water averaging 27 m deep (ranging from 6 to 39 m).

Least Terns often feed in marshes, rivers, and lakes, but in coastal areas they usually feed in shallow water within 50 m of the beaches. The sightings in the BTEX survey subunit during April, out to 31 km from shore and over water to 39 m deep, may have been of migrating birds, since April is the normal period of spring migration (see the Royal Tern and Common-group Tern accounts for evidence of tern migration in the BTEX subunit during April).

The sightings from the BTEX subunit were over water with surface temperatures of 22° C. The December sighting from the NAFL subunit was over 21° C water, and the April sighting was over 23° C water.

Associations

Two Least Terns were observed over a single unidentified dolphin. One Least Tern was flying along a windrow of sargassum.

Reproduction

Least Terns usually nest in small colonies on bare or sparsely vegetated sand and shell substrates. Twenty-eight of 39 colonies censused by Portnoy (1977) contained fewer than 100 breeding pairs. They nest on barrier beaches, spoil islands (Portnoy 1977), and a variety of sites where vegetation has been removed by human activities. In recent years the roofs of shopping malls and other buildings have been used as nesting sites.

Behavior

The Least Tern feeds on small fish and crustaceans by surface skimming, and hovering and plunging (Watson 1966; Terres 1980). Least Terns are thought to be less gregarious than other tern species (Bent 1921).

Potential Impacts of OCS Development

Because Least Terns feed extensively in canals, bays, salt marshes, estuaries, and other enclosed aquatic habitats, they may be exposed to oil somewhat less frequently than are Royal, Sandwich, and other coastal terns.

Onshore facilities related to OCS development may displace Least Tern colonies. However, Least Terns are likely to make use of areas modified by OCS activities. Roofs of warehouses, unvegetated shell levees, and areas of shell or sand fill around onshore facilities could provide nesting sites, provided levels of human activity are not too high.

Summary

Least Terns were sighted nine times, twice in the NAFL survey subunit and seven times in the BTEX survey subunit. All sightings were within 32 km of shore, and over water less than 40 m deep. Least Terns appear to be less vulnerable to oiling than other coastal terns. Onshore facilities related to OCS development may provide nesting habitat for Least Terns.

ROYAL TERN, Sterna maxima

The Royal Tern and Caspian Tern Sterna caspia are similar in appearance and are not readily distinguishable from above. Caspian Terns were not identified in this study. Caspian Terns are widespread in the study area, but much less common than Royal Terns, and usually are restricted to inland, estuarine, and inshore habitats not studied in detail during this investigation. It is unlikely that many of the birds identified as Royal Terns were Caspian Terns.

Description

The Royal Tern is a large (body length 48 cm; wingspan 110 cm) (Watson 1966), pale tern with broad, but pointed, wings and a shallowly forked tail. It has a black crest (in the breeding season, a black cap) and an orange bill. Young Royal Terns can be distinguished from adults by differences in wingtip patterns. However, these differences usually were not discernable from the air.

When seen from the air, the Royal Tern is distinguished from other pale terns by its larger size and several differences in shape. The wings appear broader, especially at the base, and the body appears more robust. Royal and Sandwich Terns have longer necks and shorter tails than the other pale terns; thus, their wings appear to be set midway between head and tail. Royal Terns are distinguished from Sandwich Terns by their broader wings and more robust bodies (the differences in bill color and head patterns are seldom apparent from the air).

Distribution

The Royal Tern was the animal species most frequently observed during the surveys. It was also the most widespread with sightings in all months and all areas (Figures 103 through 113; Table 43). Royal Terns were seen most frequently in MIFL and NAFL subunits during October and in MILA and BTEX subunits during August (Table 43). The MILA and BTEX subunits are near major breeding colonies, so the August peaks may be the result of post-breeding dispersal of adults and young from the colonies. The October peaks in the Florida subunits may represent migration of birds from colonies to the north (the Carolinas and Louisiana) into the Caribbean. In the NAFL subunit during October and the BTEX subunit during April, Royal Terns were significantly farther offshore than in the other surveys. This also suggests migration may have been occurring.

In western North America, Royal Terns breed from Southern California to the Pacific coast of Mexico (including Baja California, and the Tres Marias Islands) (AOU 1957). In eastern North America, they breed from Maryland to Florida, around the coast of the Gulf of Mexico, and throughout the Caribbean Sea. A much smaller population breeds in Mauritania on the northwest coast of Africa (AOU 1957).

The Shell Key National Wildlife Refuge in the MILA subunit has a Royal Tern colony (Portnoy 1977). Other colonies are located along the Louisiana and Texas coasts (Blacklock et al. 1978) near the MILA and BTEX subunits. The NAFL and MIFL subunits are isolated from large colonies, although a very small colony exists at Merritt Island. Some southward migration occurs, but Royal Terns are present throughout the winter in most of the breeding ranges. North Carolina, which has large breeding colonies, has relatively few wintering birds (Clapp et al. in prep.).

Buckley and Buckley (1972) noted that breeding Royal Terns in North Carolina and Virginia regularly feed 20 to 30 km from the colonies, but that they tend to feed close to shore. The birds in these surveys were found much farther offshore than was considered normal for their population by Buckley and Buckley (1972).

Abundance

Sufficient sample sizes for monthly density calculations were obtained in all survey subunits except the MIFL subunit (Table 44). Densities ranged from 0.64×10^{-2} birds/km^2 in the BTEX subunit during February to 1.43 birds/km^2 in the MILA subunit during August (Table 44). When monthly densities were adjusted to reflect the portion of each subunit utilized by Royal Terns during that month (density/percent of subunit utilized), densities ranged from 0.36×10^{-1} birds/km^2 in the BTEX subunit during February to 5.72 birds/km^2 in the MILA subunit during August. Densities were greatest in the MILA and NAFL subunits, where the continental shelf is broad. Densities were highest during October in all subunits except the MILA subunit, where densities were greatest in August.

Mean group sizes ranged from 1.0 to 8.8 (Figure 114). No significant differences in group size between survey subunits or survey months were detected.

The Royal Tern population of the eastern United States numbered about 120,000 to 150,000 breeding adults in the mid-1970's. Of these, about 33,000 to 36,000 nested in North Carolina, and 29,000 to 34,000 nested in South Carolina (Clapp et al. in prep.).

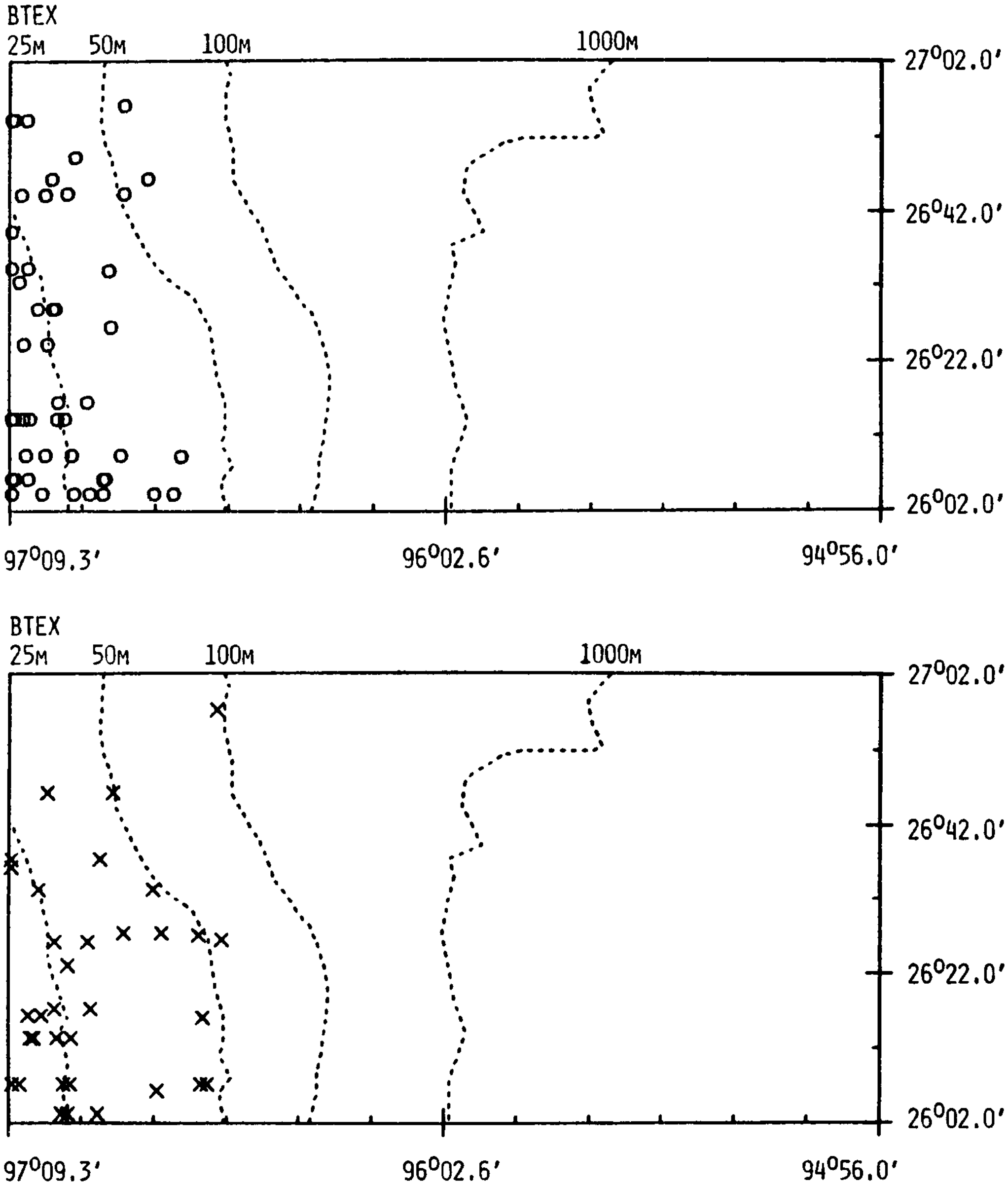


Figure 103. Distribution of all Royal Tern sightings in the BTEX survey subunit during June (O) and August (X).

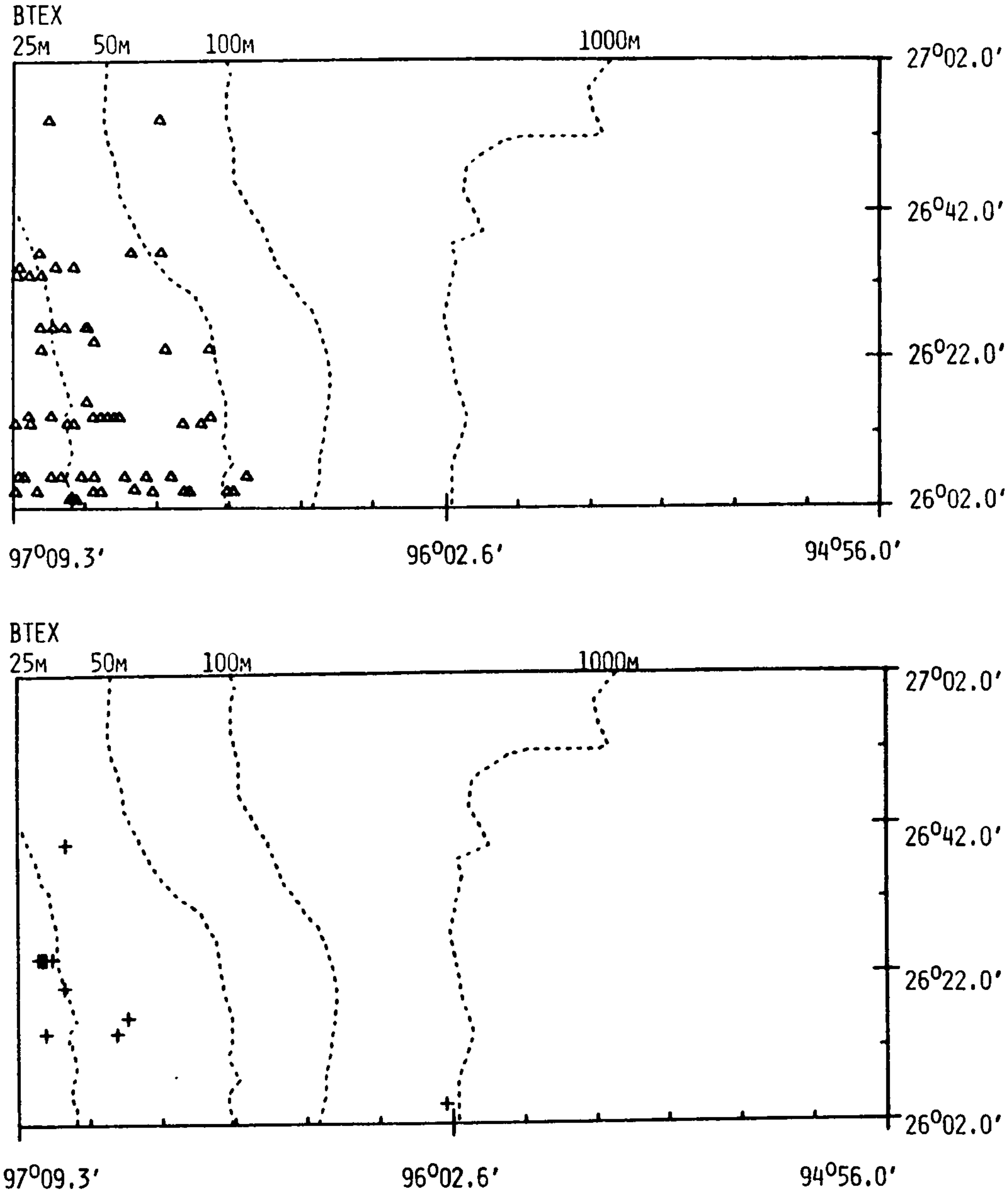
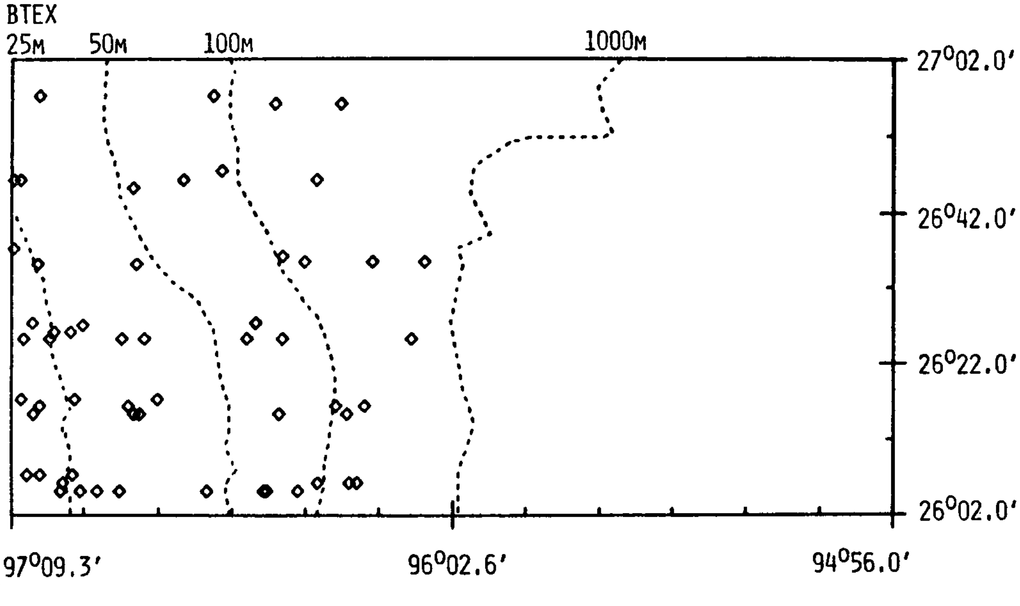


Figure 104. Distribution of all Royal Tern sightings in the BTEX survey subunit during October (△) and February (+).



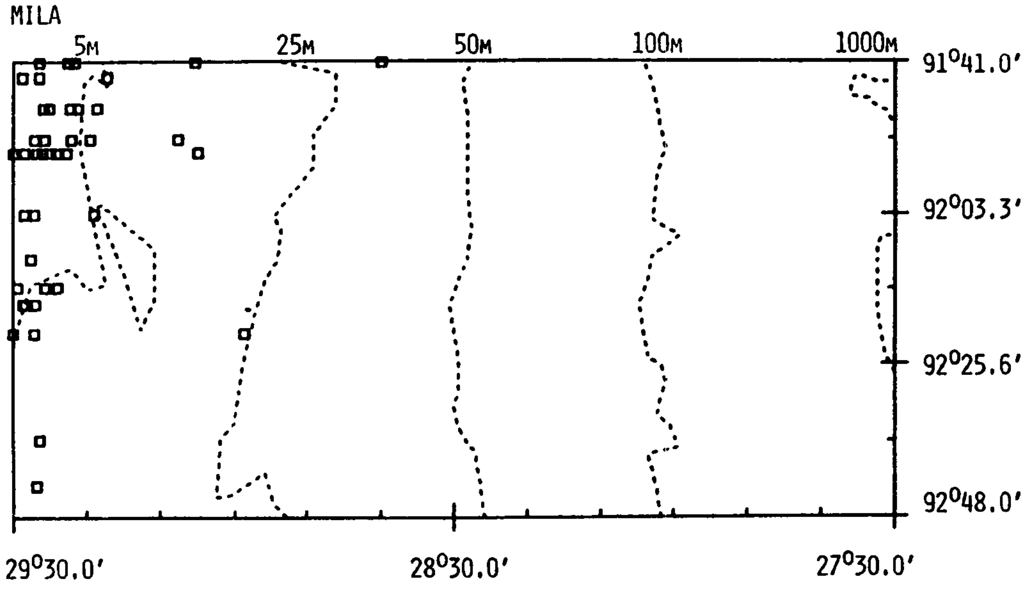


Figure 105. Distribution of all Royal Tern sightings in the BTEX survey subunit (above) during April (◇) and in the MILA survey subunit (below) during April (□).

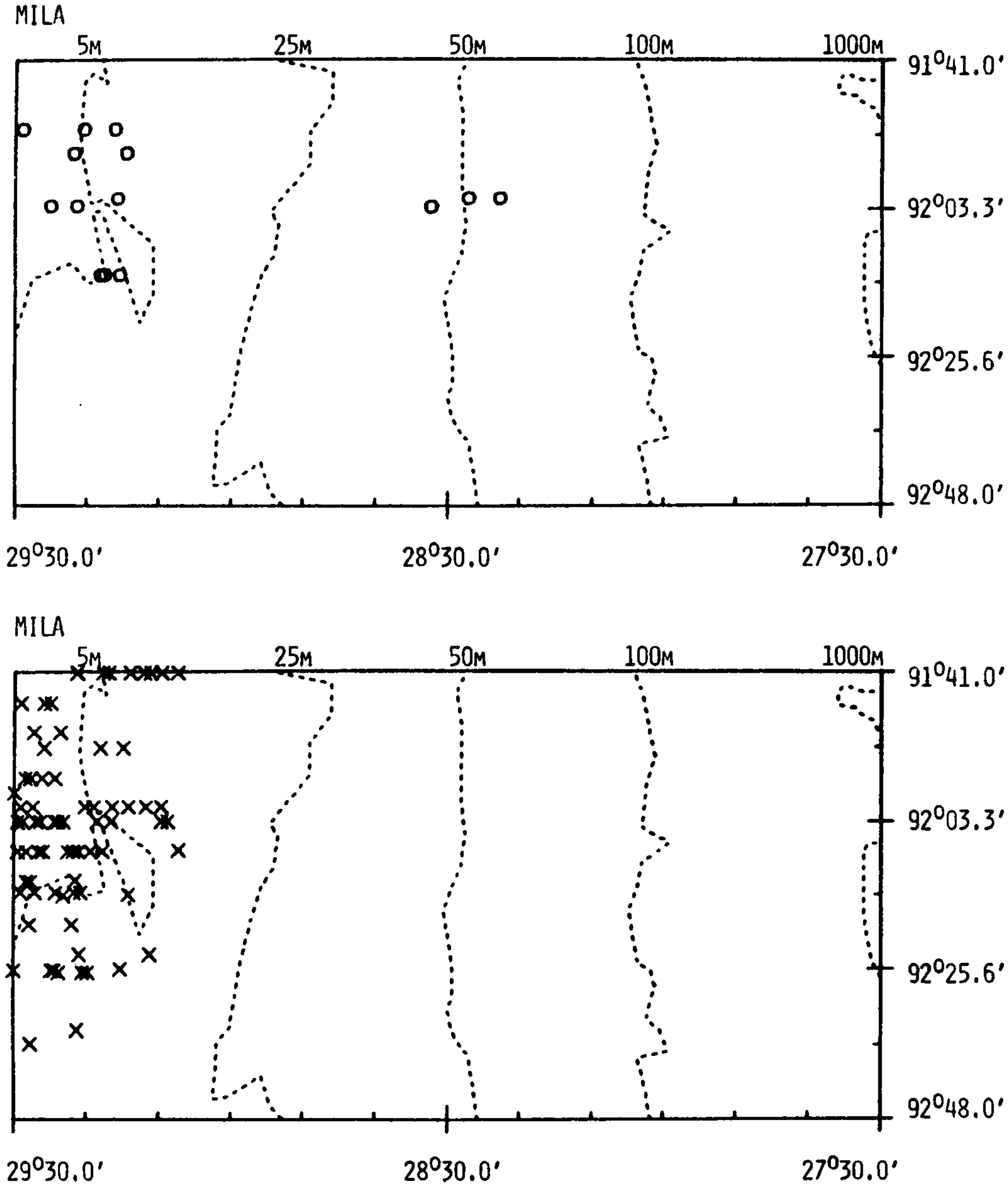


Figure 106. Distribution of all Royal Tern sightings in the MILA survey subunit during June (O) and August (X).

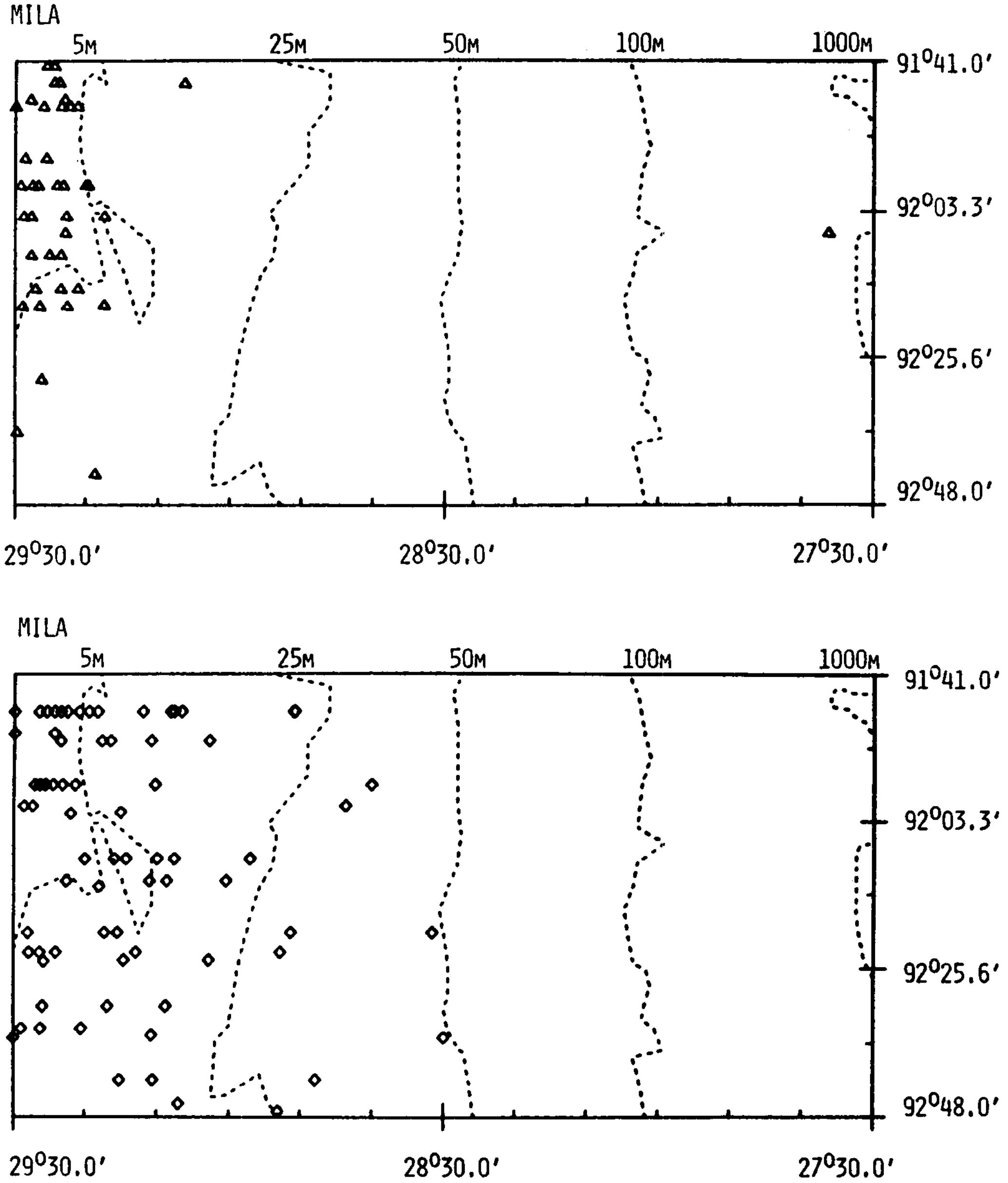


Figure 107. Distribution of all Royal Tern sightings in the MILA survey subunit during October (△) and February (◇).

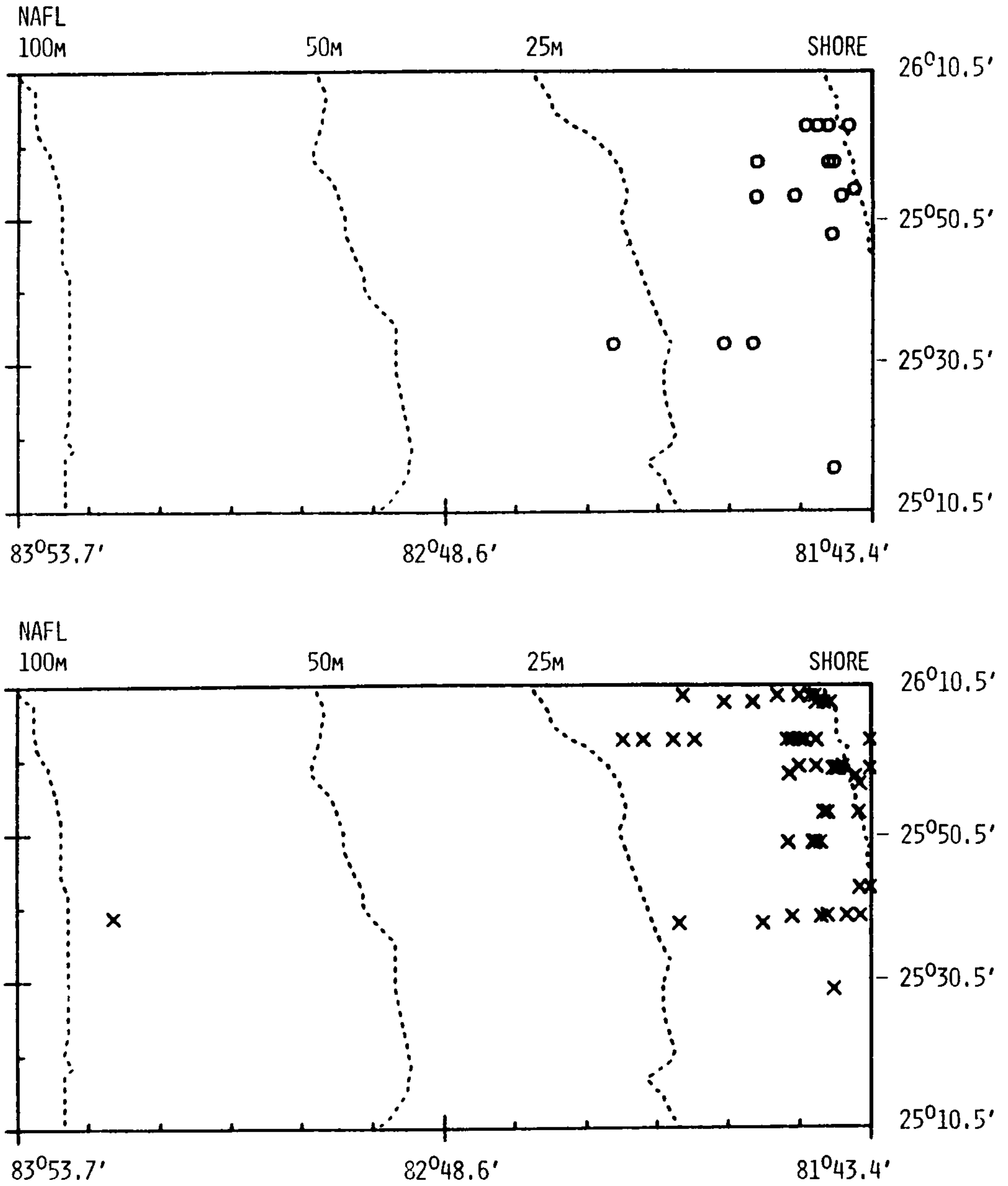


Figure 108. Distribution of all Royal Tern sightings in the NAFL survey subunit during June (O) and August (X).

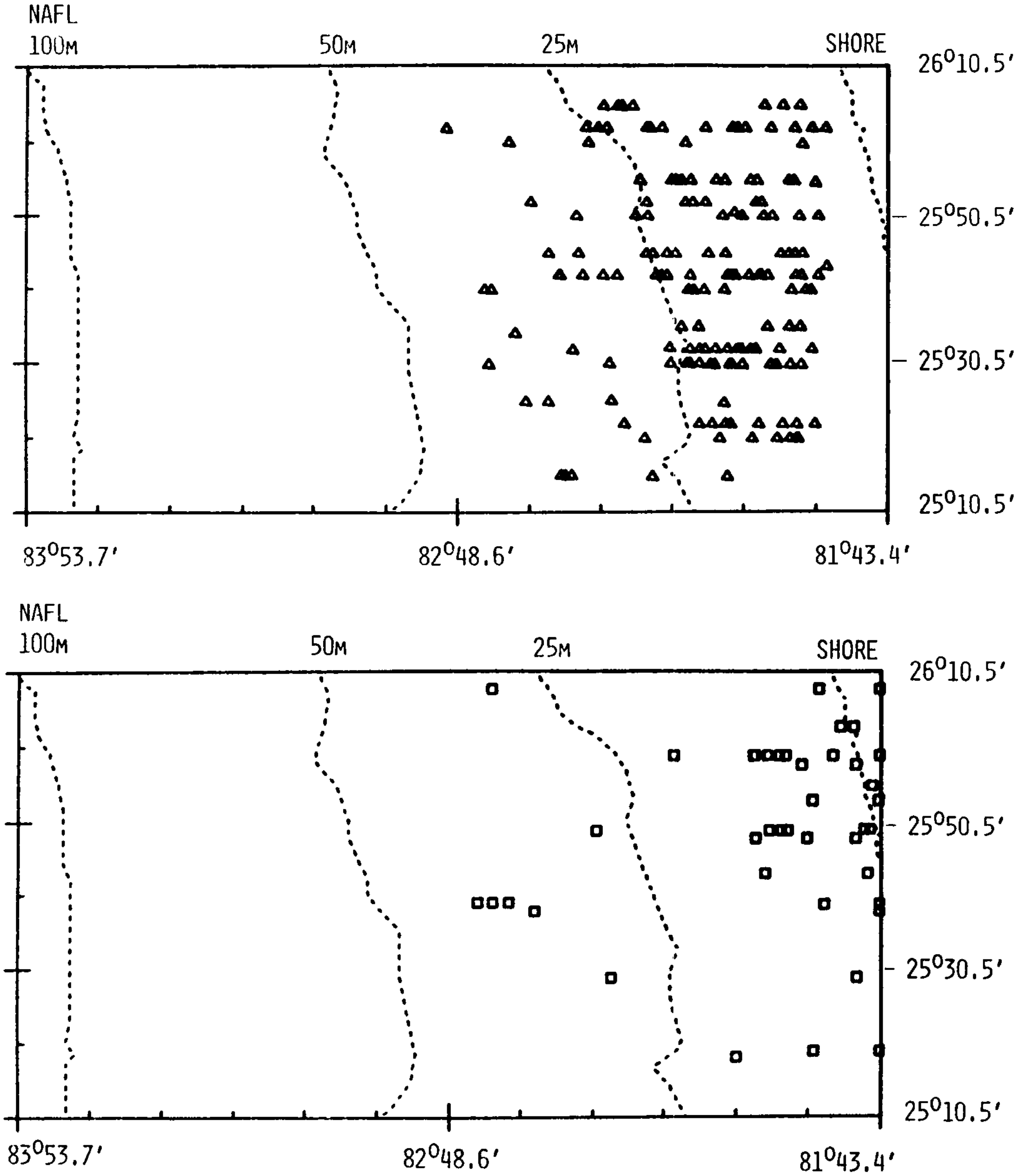


Figure 109. Distribution of all Royal Tern sightings in the NAFL survey subunit during October (△) and December (□).

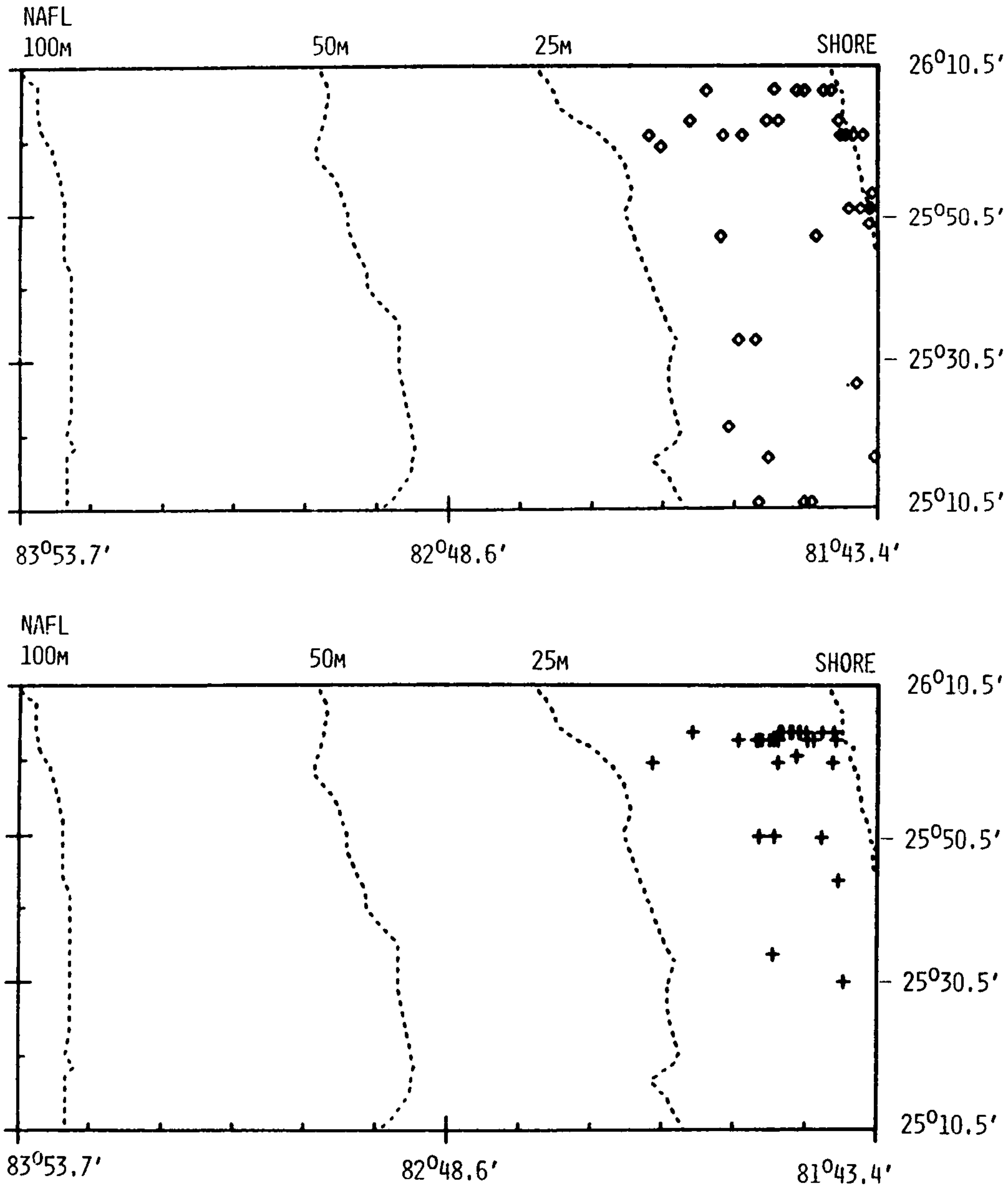


Figure 110. Distribution of all Royal Tern sightings in the NAFL survey subunit during February (◇) and April (+).

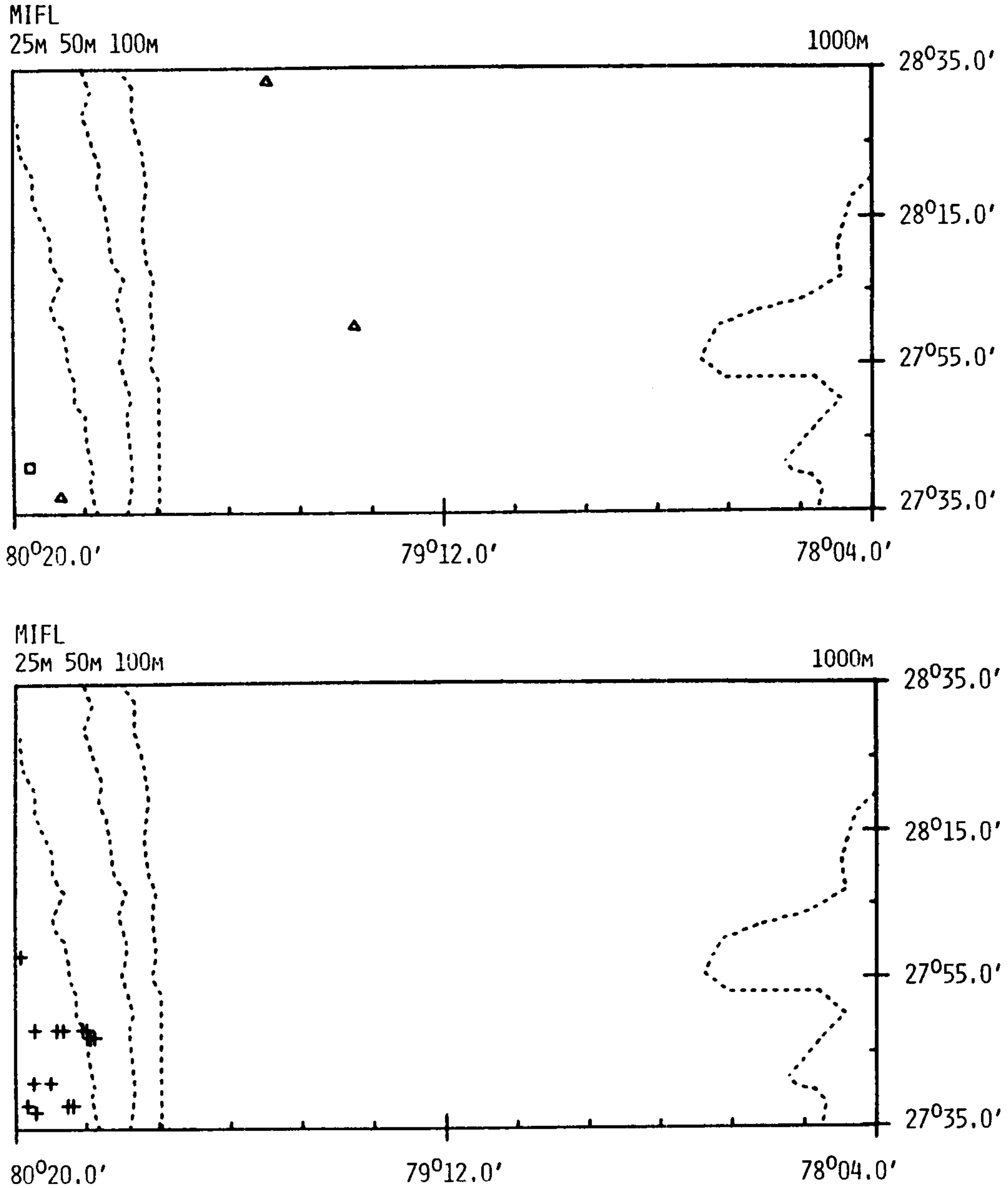


Figure 111. Distribution of all Royal Tern sightings in the MIFL survey subunit during June (△), August (□), and October (+).

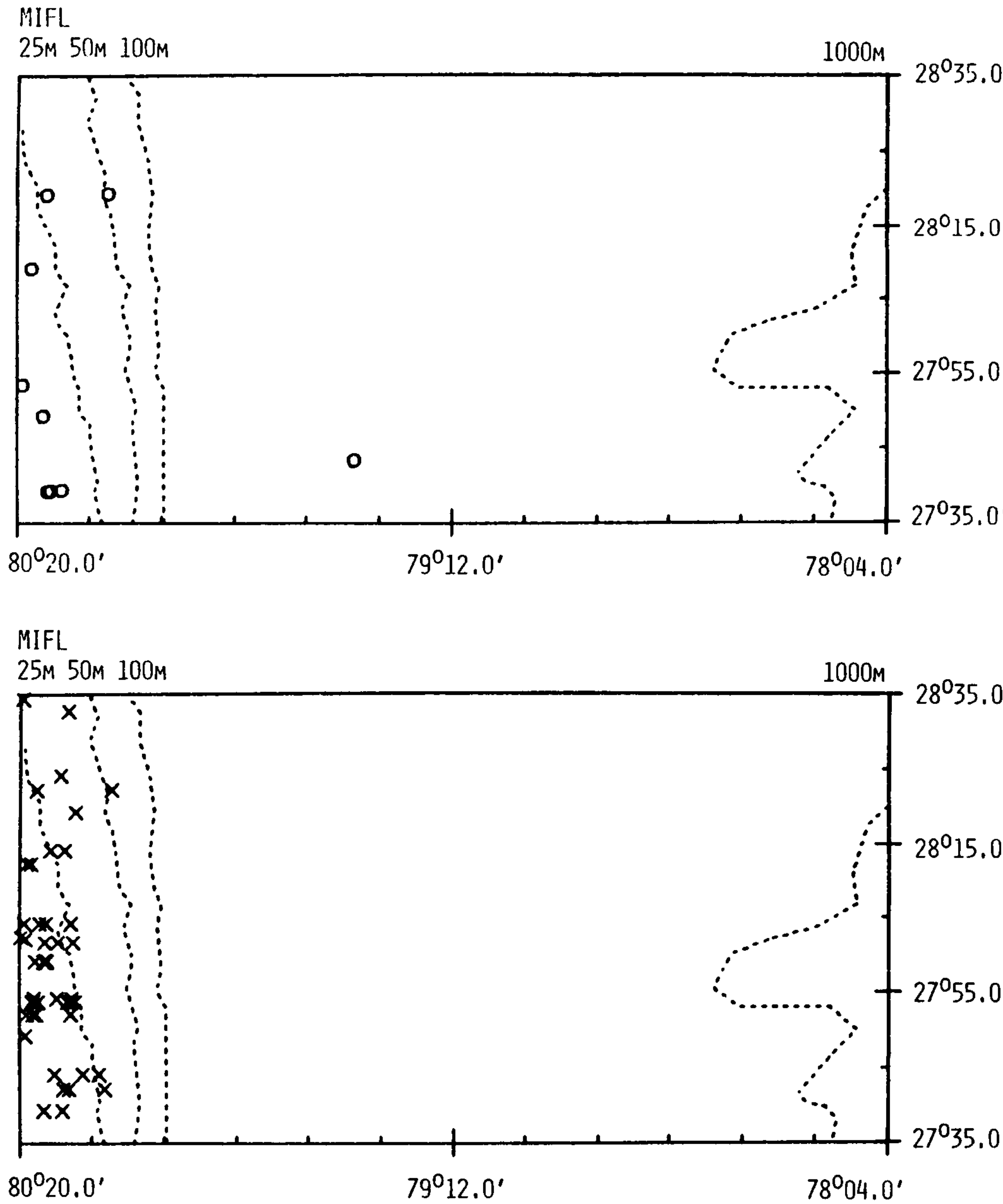


Figure 112. Distribution of all Royal Tern sightings in the MIFL survey subunit during December (O) and February (X).

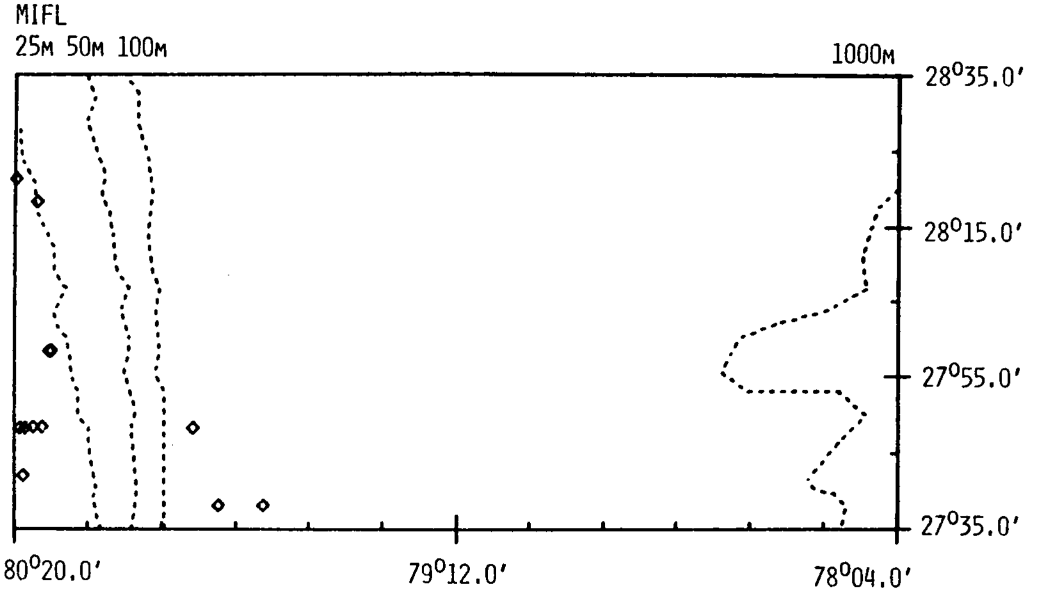


Figure 113. Distribution of all Royal Tern sightings in the MIFL survey subunit during April (◇).

About 14,000 nested in Florida (Clapp et al. in prep.), 21,000 in Louisiana (Portnoy 1977), and 24,000 in Texas (Blacklock et al. 1978).

Habitat Use

The patterns of distribution from shore are complex. Mean distances from shore varied from 9 km in the MIFL subunit during August to 74 km in the NAFL subunit during October (Figure 115). Royal Tern observations averaged significantly farther from shore in the NAFL subunit during October than in any other survey months (for all comparisons, $p < 0.05$). In the BTEX survey subunit, they averaged significantly farther from shore during April than in the other months (for all comparisons, $p < 0.05$) and in the MILA subunit, the June observations were farther from shore than the October observations ($p < 0.05$). Data from the MIFL subunit were excluded from analysis of variance for distance from shore, water depth and temperature, and group size due to small sample sizes. Observations in the MIFL subunit averaged 9 to 40 km from shore.

Royal Terns occurred over waters 1 to 841 m deep (Figure 116). In the BTEX survey subunit during April, Royal Tern sightings were over significantly deeper water than in all other surveys. However, the sightings in the MIFL subunit during June and August were also over deep water.

Royal Terns occurred where sea surface temperatures varied from 12° to 28° C. (Figure 117). Apparently, Royal Terns were not selecting particular water temperatures, but were occupying habitats chosen for other reasons (e.g., depth, food availability).

Table 43. The number of Royal Terns sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits			
	BTEX	MILA	NAFL	MIFL
June	204 (85)	152 (23)	21 (19)	21 (15)
August	348 (40)	763 (93)	187 (78)	7 (2)
October	158 (79)	286 (68)	1,922 (267)	293 (29)
December	-	-	73 (47)	18 (15)
February	11 (11)	143 (102)	52 (47)	94 (59)
April	120 (80)	294 (64)	39 (39)	197 (34)
TOTAL	841 (295)	1638 (350)	2294 (497)	630 (154)

Associations

Royal Terns were seen feeding in flocks. The flocks frequently contained Laughing Gulls and, less frequently, Herring Gulls, various other terns, shearwaters, jaegers, boobies, and frigatebirds. These flocks tended to be over schools of baitfish or behind trawlers. Flocks of Royal Terns were most frequently encountered over baitfish in the NAFL subunit where fish schools were conspicuous (Figures 118 through 120). In August and October (Figures 118 and 119) the distribution of Royal Terns coincided with that of fish schools (the plots are of Royal Terns and of unidentified fish, most of which are schooling fish). In June, December, February, and April, Royal Terns still were associated with fish schools, but the schools extended farther from shore than the terns.

In the MILA subunit, Royal Terns often flocked behind trawlers. Bottlenose Dolphins were also present near some of the trawlers. The dolphins and birds were probably feeding on fish stirred up by the trawlers.

Reproduction

Royal Terns breed in large dense colonies (Buckley and Buckley 1972; Erwin 1977, 1978) on coastal sand and shell islands. One or two eggs (rarely three to four) are laid from April to June in the study area. The incubation period lasts about 20 to 22 days, and fledging occurs from 28 to 35 days after hatching (Fisher and Lockley 1954). The Royal Tern produces a single brood per year (Kale et al. 1965, cited by Terres 1980). Royal Terns typically feed their young for several months after fledging. This behavior

Table 44. Density and group size estimates for on-line sightings of Royal Terns. "All" represent combined months. * = variance too small for computation.

Survey subunit	Month	No. of sightings	Group density (groups/km^2)	Variance	Mean group size	Standard error	Individual density (birds/km^2)
BTEX	June	61	$0.53x10^{-1}$	$0.11x10^{-2}$	2.7	1.0	0.14
BTEX	August	26	$0.67x10^{-2}$	$0.29x10^{-4}$	6.3	3.8	$0.41x10^{-1}$
BTEX	October	47	0.11	$0.64x10^{-2}$	1.7	0.2	0.19
BTEX	February	6	$0.64x10^{-2}$	*	1.0	0.0	$0.64x10^{-2}$
BTEX	April	49	$0.41x10^{-1}$	$0.76x10^{-3}$	1.4	0.3	$0.58x10^{-1}$
BTEX	All	189	$0.64x10^{-1}$	$0.38x10^{-3}$	2.6	0.6	0.17
MILA	June	13	$0.24x10^{-1}$	*	3.2	1.4	$0.76x10^{-1}$
MILA	August	61	0.25	$0.44x10^{-2}$	5.7	2.6	1.43
MILA	October	52	$0.38x10^{-1}$	$0.25x10^{-3}$	4.7	1.3	0.18
MILA	February	88	$0.96x10^{-1}$	$0.38x10^{-4}$	1.2	0.1	0.12
MILA	April	48	$0.26x10^{-1}$	$0.58x10^{-4}$	4.3	2.3	0.11
MILA	All	262	$0.82x10^{-1}$	$0.50x10^{-4}$	3.6	0.8	0.29
NAFL	June	13	$0.11x10^{-1}$	*	1.0	0.0	$0.11x10^{-1}$
NAFL	August	62	$0.38x10^{-1}$	$0.28x10^{-3}$	1.2	0.1	$0.47x10^{-1}$
NAFL	October	194	0.16	$0.41x10^{-2}$	6.8	1.8	1.07
NAFL	December	39	$0.79x10^{-1}$	$0.50x10^{-3}$	1.5	0.3	0.12
NAFL	February	25	$0.14x10^{-1}$	$0.58x10^{-2}$	1.0	0.04	$0.14x10^{-1}$
NAFL	April	15	$0.15x10^{-1}$	*	1.0	0.0	$0.15x10^{-1}$
NAFL	All	348	$0.85x10^{-1}$	$0.44x10^{-3}$	4.3	1.0	0.37
MIFL	All	62	$0.11x10^{-1}$	$0.85x10^{-3}$	1.3	0.1	$0.14x10^{-1}$

was observed from the beach near Naples, Florida, although it was not seen from the survey aircraft.

Behavior

Most observations of Royal Terns were of flying birds, but a few were sitting on the water. In the MILA subunit, Royal Terns commonly roosted on pilings and production platforms. Royal Terns feed by aerial plunging, and plunging was observed on numerous occasions.

Potential Impacts of OCS Development

Royal Terns plunge into the water, occasionally sit on the water, and occur over inshore and nearshore waters, so they may be more susceptible to oiling than the more pelagic species, such as Sooty and Bridled Terns. Birds roosting on beaches

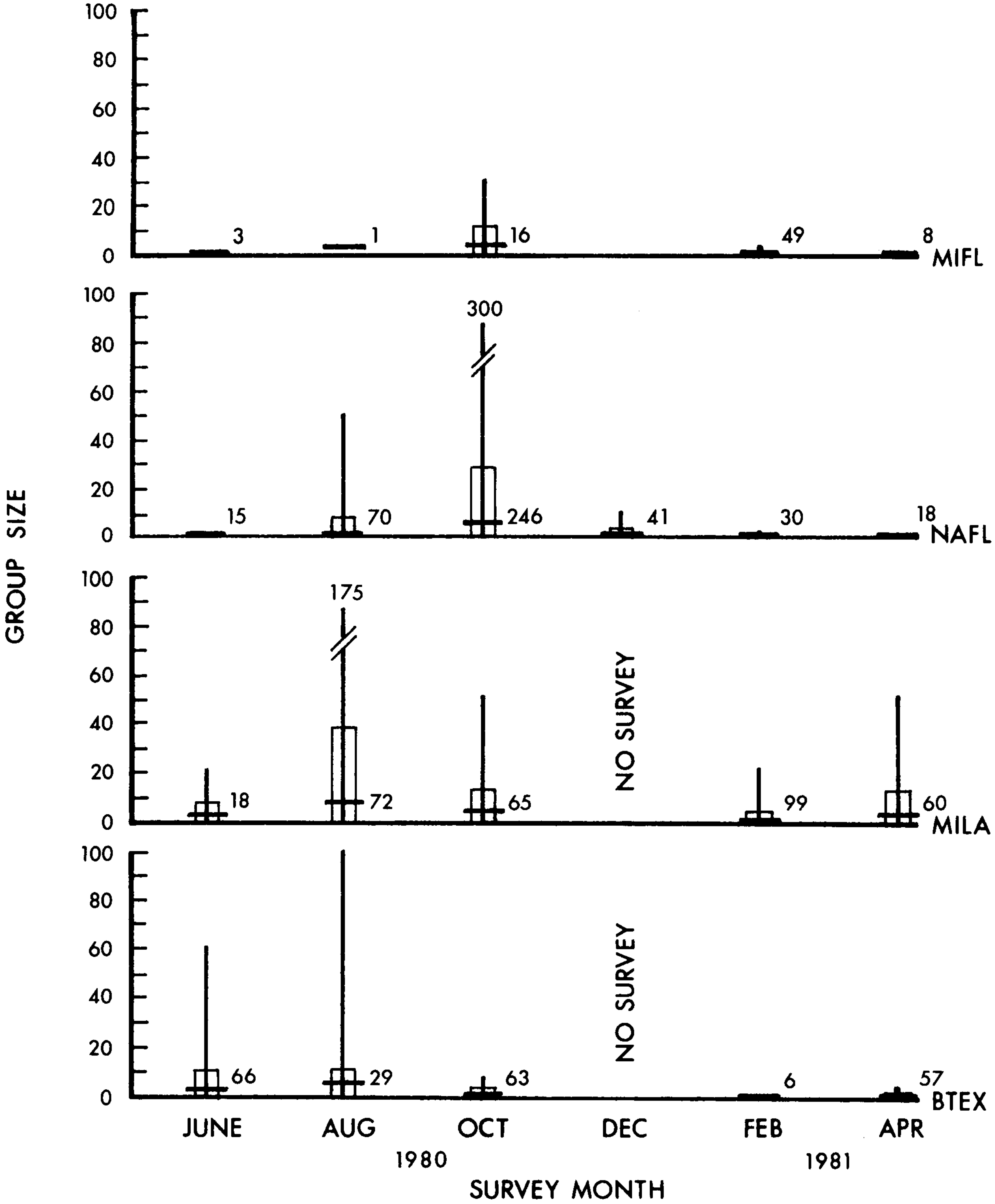


Figure 114. Group size for all sightings of Royal Tern by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

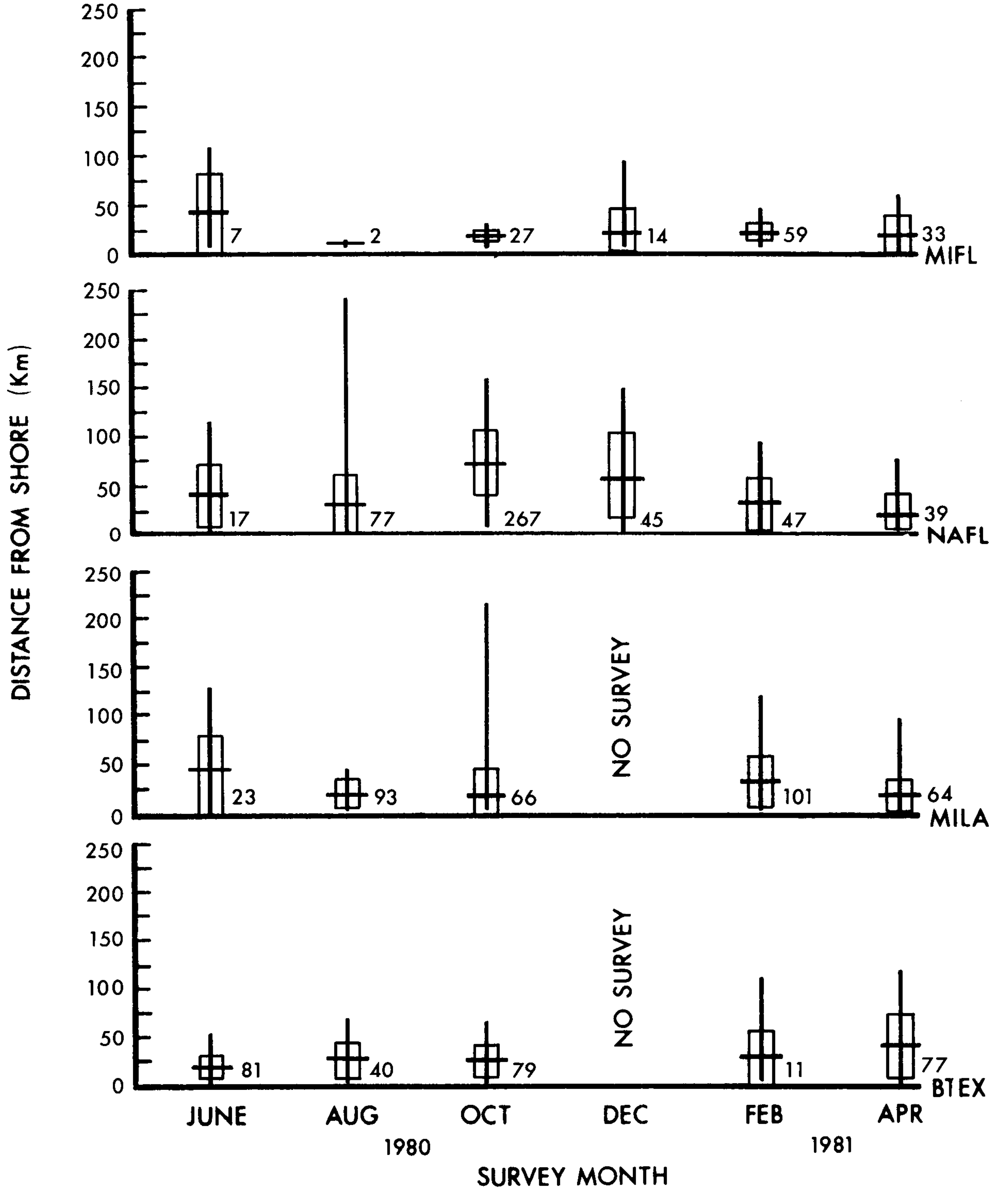


Figure 115. Distance from shore for all sightings of Royal Tern by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

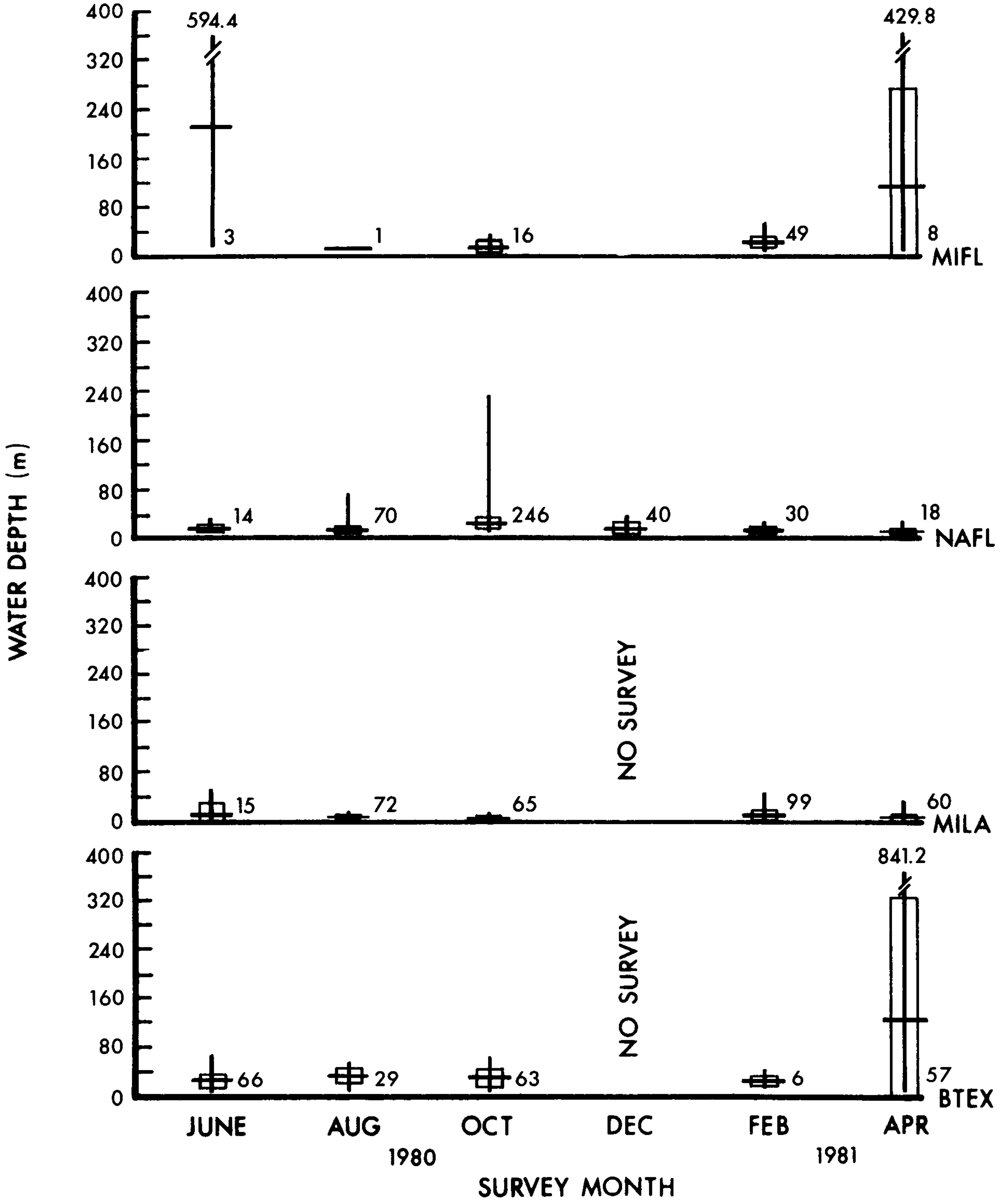


Figure 116. Water depth for all sightings of Royal Terns by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

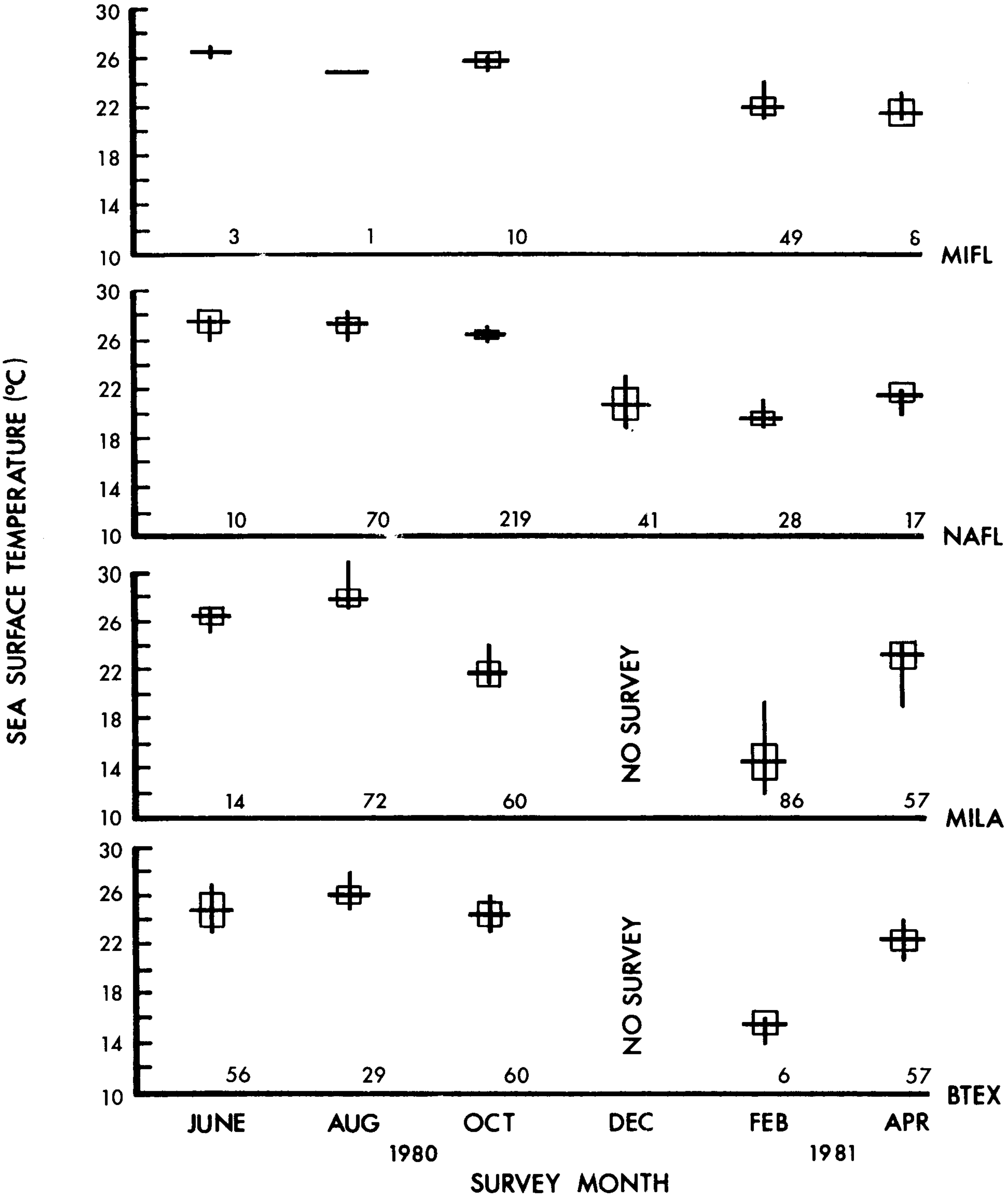
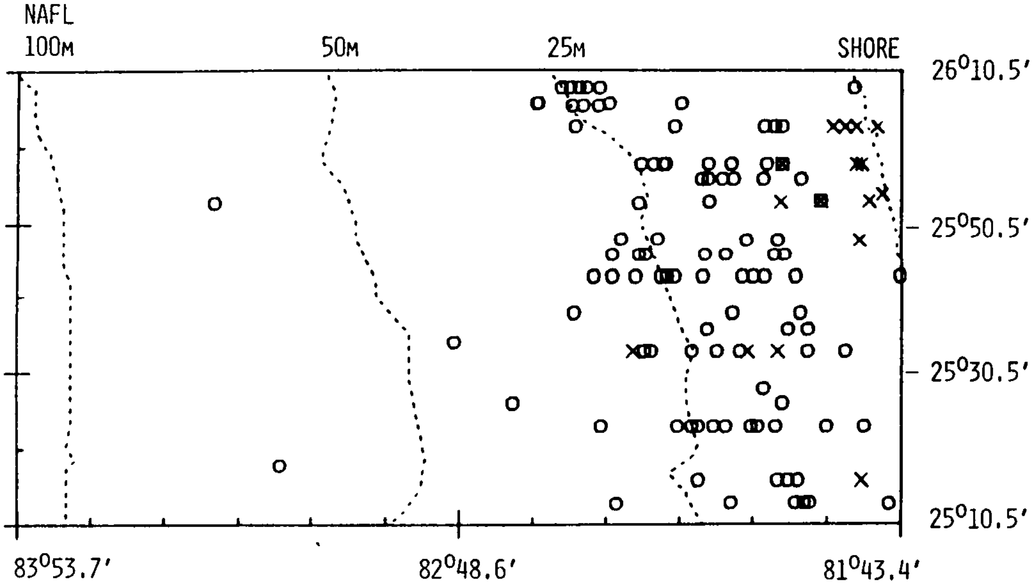


Figure 117. Sea surface temperature for all sightings of Royal Terns by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).



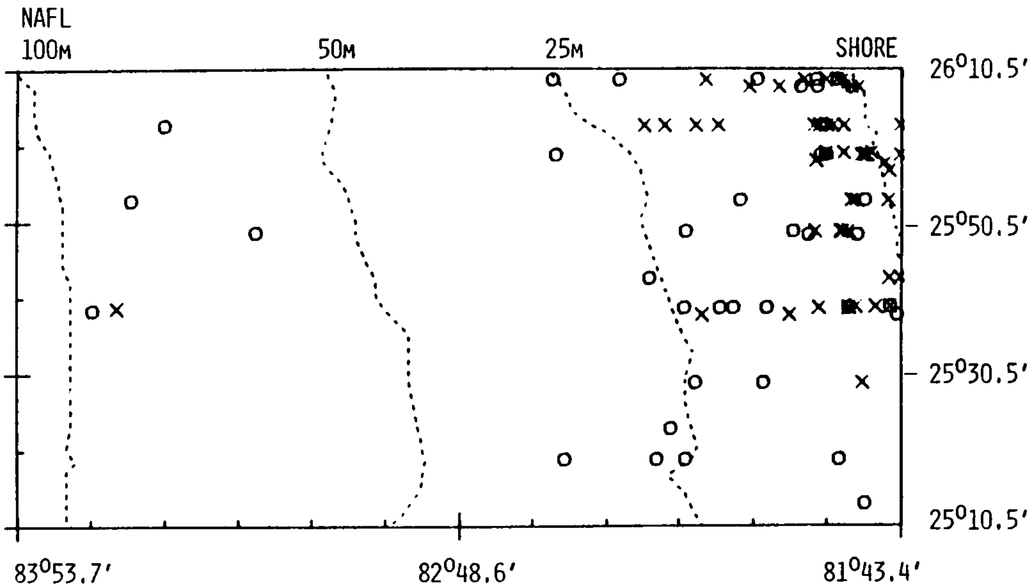


Figure 118. Distribution of all Royal Tern (X) and unidentified fish (O) sightings in the NAFL survey subunit during June (above) and August (below).

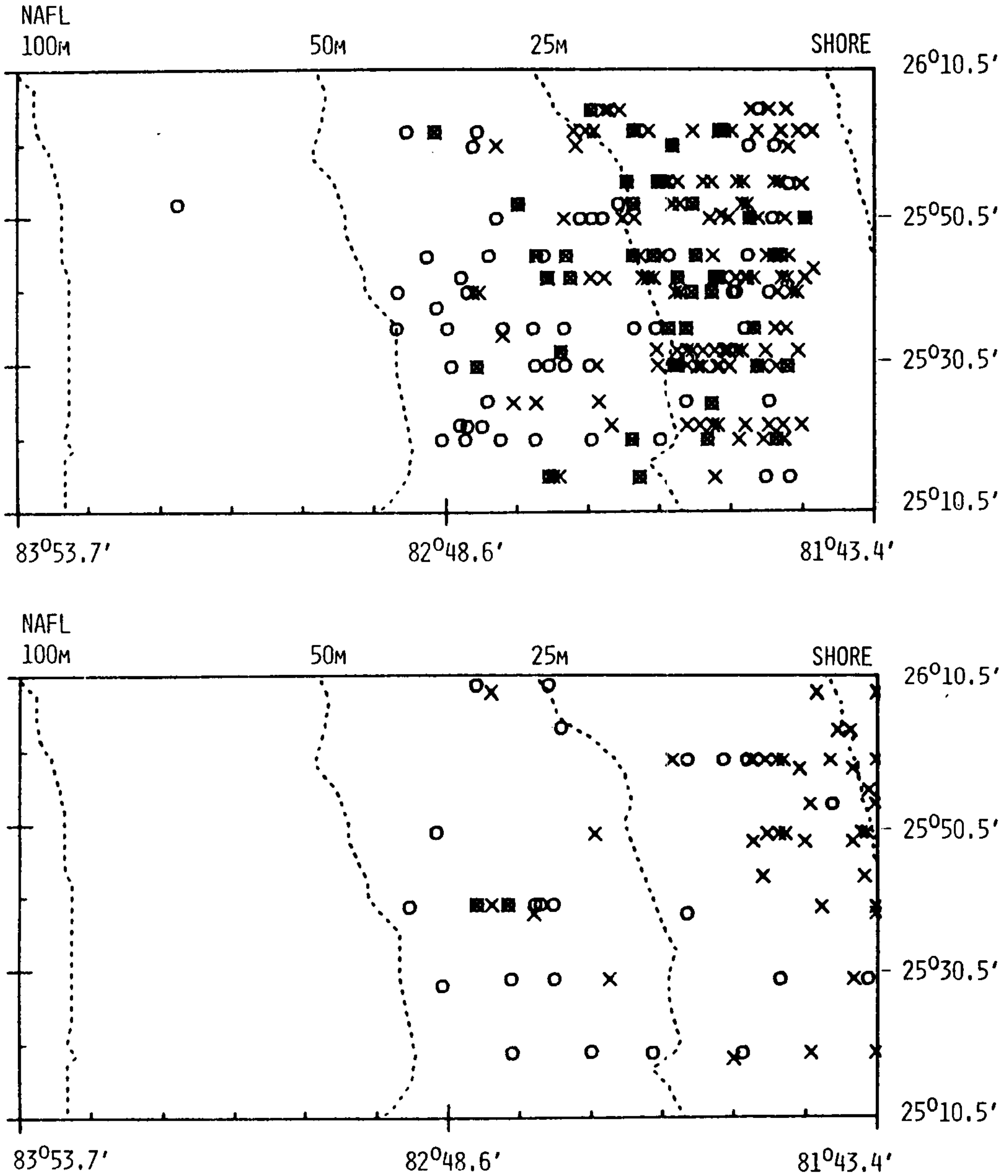
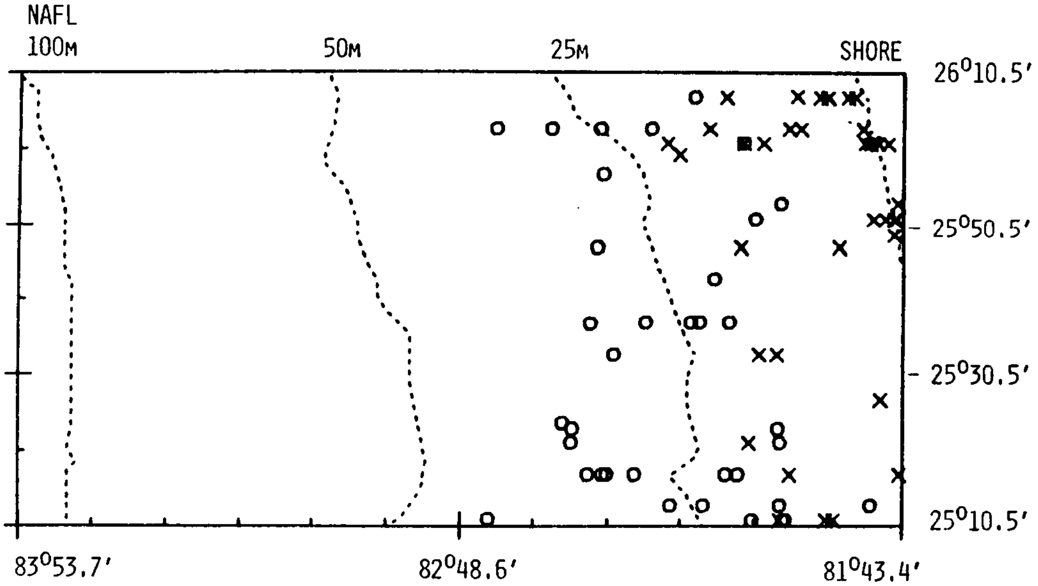


Figure 119. Distribution of all Royal Tern (X) and unidentified fish (O) sightings in the NAFL survey subunit during October (above) and December (below).



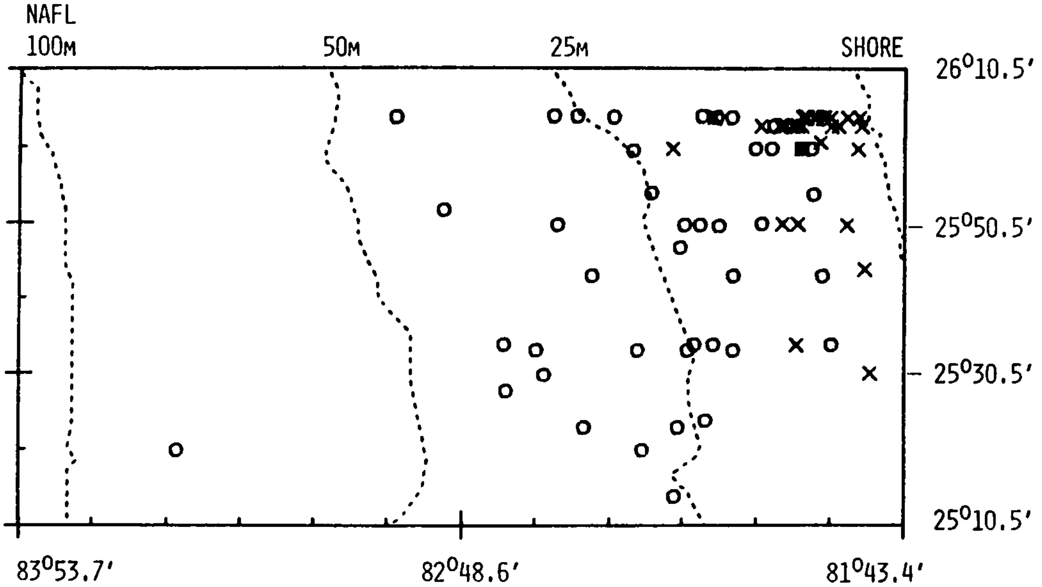


Figure 120. Distribution of all Royal Tern (X) and unidentified fish (O) sightings in the NAFL survey subunit during February (above) and April (below).

are susceptible to contaminating their feet and underparts with oil. Oil on the feathers of nesting adults may be transferred to and can be toxic to tern eggs (Rittinghaus 1956, cited by Hartung 1965; White et al. 1979).

Summary

Royal Terns were seen in all survey subunits and in all months. Sightings averaged farthest from shore in the NAFL subunit. Royal Terns were frequently associated with schools of baitfish, fishing boats, and other bird species. Royal Terns nest in the study area. This species was seen resting on OCS structures in the MILA subunit. It feeds by aerial plunging, and is susceptible to impacts of OCS development.

SANDWICH TERN, *Sterna sandvicensis*

Description

The Sandwich Tern is a pale tern, intermediate in size (body length 41 to 46 cm; wingspan 94 cm) (Tuck and Heinzel 1978) between Royal and Common Terns. It has a white tail and underparts, pale gray wings and back, and a black cap ending in a small crest. The forehead becomes white in winter. The tip of the black bill is mustard yellow. In linear measurements, the Sandwich Tern is near the size of a Royal Tern, but is much more streamlined and slender.

From the air, the Sandwich Tern was difficult to distinguish from Royal and Common-group Terns. It had a longer neck, shallower wingbeats, and was larger than Common-group Terns. On occasion, the yellow tip of the bill was seen from the air. It was distinguished from the Royal Tern by narrower wings and a more slender body.

Distribution

Forty-six Sandwich Tern sightings were recorded in the four survey subunits (Table 45). Thirty-five of these were in the MILA subunit, where Sandwich Terns breed on Shell Key. Two sightings were in the MIFL subunit, one in the BTEX subunit, and the remaining eight were in the NAFL subunit. The low number of sightings throughout the study area may reflect the Sandwich Tern's preference for inshore areas (Pearson 1968; Dunn 1972), which were not intensively surveyed. It is also likely that some Sandwich Terns were missed among flocks of Royal and Common-group Terns.

Sandwich Terns breed in northern Europe, the western Mediterranean Sea, the Black Sea, and the Caspian Sea (AOU 1957). In the Western Hemisphere, they breed from Maryland (Weske et al. 1979) south to Florida, Mississippi, Louisiana, Texas, and off Yucatan (AOU 1957; Portnoy 1977; Clapp et al. in prep.). They also nest in Cuba and the Bahamas (Garrido and Montana 1975).

Abundance

Densities were calculated for Sandwich Terns in the MILA subunit during June, and for the MILA subunit overall. In June, the density was estimated as 0.064 birds/km^2. Over all months the density was estimated as 0.025 birds/km^2.

Table 45. The number of Sandwich Terns sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month		Survey subunits			
		BTEX	MILA	NAFL	MIFL
June		0	47 (21)	1 (1)	0
August		0	11 (6)	1 (1)	0
October		0	26 (4)	6 (5)	0
December		-	-	1 (1)	0
February		1 (1)	0	0	0
April		0	5 (4)	0	2 (2)
	TOTAL	1 (1)	89 (35)	9 (8)	2 (2)

Sandwich Terns were not commonly seen during this study. They are less abundant than Royal Terns in the study area, but this difference cannot account for the scarcity of sightings. In the mid-1970's, the total population of the eastern United States was apparently less than 80,000 adults, of which half bred on the Chandeleur Islands (Portnoy 1977; Clapp et al. in prep.). This is considerably less than numbers of adult Royal Terns in the same region. Most Sandwich Terns migrate south of the study area during winter, but some winter in southern Florida from Tampa Bay, south (Sprunt 1954). This migration out of the study area explains the rarity of winter sightings. The inshore habitat preference of Sandwich Terns and the difficulty of distinguishing them from the other pale terns must also contribute to the scarcity of sightings in the survey.

Habitat Use

The sightings occurred 0 to 115 km from shore. The 21 sightings in MILA during June were clustered around the Shell Key breeding colony (Figure 121). In other seasons and subunits, Sandwich Terns were observed farther offshore, but the average distance from shore was still only 26 km.

Sandwich Terns were observed only over the shallowest parts of the survey subunits, inside the 50-m bathymetric contour (mean water depth 9 m). Pearson (1968) demonstrated that Sandwich Terns in England feed within 25 km of their colony, and often much closer. Dunn (1972) noted that wintering Sandwich Terns in Sierra Leone "usually fed close inshore in marine or estuarine waters", and while feeding, usually could be seen from land. The feeding habitats of North American populations of Sandwich Terns have not been studied in any detail (Erwin 1978).

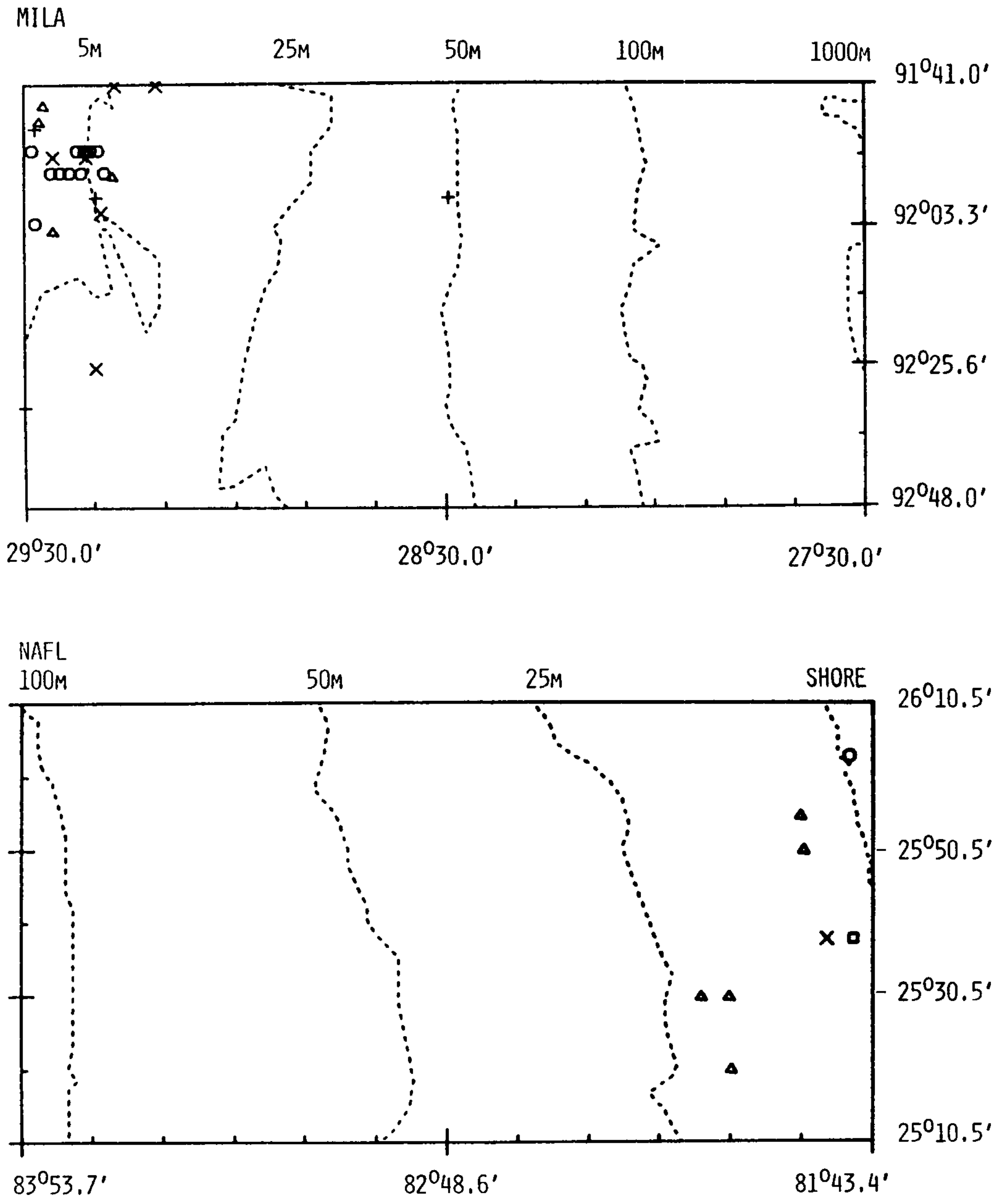


Figure 121. Distribution of all Sandwich Tern sightings in the MILA and NAFL survey subunits during June (O), August (X), October (△), December (□), and April (+).

Sandwich Terns were observed over water averaging 24.5° C (ranging from 16° to 28° C).

Associations

Sandwich Terns were sighted near Royal Terns in the MILA subunit during June and August. Generally, Sandwich Terns tended to be single birds or in small groups. However, Sandwich Terns in large flocks of pale terns would have been difficult to distinguish from the other species.

Reproduction

Young Sandwich Terns can be recognized at close range by the scalloped appearance of the back, and by more dark pigment in the primaries than on adults. These differences were not detected from the aircraft, so no age composition information is available.

Sandwich Terns regularly nest on Shell Key, a National Wildlife Refuge, in the MILA survey subunit 5 to 8 km south of Marsh Island, Louisiana (Portnoy 1977). Most of the sightings from the MILA subunit were within 30 km of this colony.

Behavior

All Sandwich Terns observed in this study were flying. Sandwich Terns plunge for fish, alone or in groups. They sometimes sit on the water, but apparently they roost on land daily.

Potential Impacts of OCS Development

Sandwich Terns may be more vulnerable to oil pollution than most other terns. Sandwich Terns breeding near the mouth of the Elbe River, West Germany, became contaminated in the spring with oil that had washed upon the beach from a winter shipping accident (Rittinghaus 1956, cited by in Hartung 1965). Some eggs became contaminated during incubation, and did not hatch. White et al. (1979) demonstrated that fuel oil was extremely toxic to Sandwich Tern eggs.

Summary

Sightings of Sandwich Terns occurred in all survey subunits with a majority in the MILA subunit during June. Sandwich Terns breed in the MILA subunit on Shell Key. Most Sandwich Terns migrate south of the study area during winter. In the study area, they seem to prefer inshore habitats. The extent to which Sandwich Terns join coastal flocks of feeding terns is unknown. Sandwich Terns and their eggs and nestlings may be susceptible to contamination from oil spills in coastal waters.

BLACK TERN, *Chlidonias niger*

Description

The Black Tern is a small tern with broad wings and a shallowly forked tail (body length 25 cm; wingspan 66 cm) (Watson 1966). In breeding plumage, it has a black head and body with white patches under the base of the tail. The upper surfaces of the wings and tail are gray-brown. The wing linings flash white. Nonbreeding adult Black Terns are much paler. The underparts and most of the head are white with a dark crown. Young birds are similar, but tend to be paler and more brown.

From the air Black Terns look pale, especially when in nonbreeding plumages. Because of their very small size and short tails, they can be confused with Least Terns. However, their broad wings, darker back, and more erratic flight usually distinguish them. The Black Tern also can be confused with the Bridled Tern, which has a longer tail and more pointed wings and is distinctly larger. A Black Tern fluttering over the water can resemble a storm-petrel, but the latter can be distinguished by their white rump patches, longer tails, and more fluttering flight.

Distribution

Black Terns were seen in all survey subunits in at least two months, and in all months except February (Figures 122 and 123; Table 46). During August, they were seen in all subunits. During October, they were seen in all subunits except MIFL, but they were observed from a boat approximately 60 km north of the MIFL subunit on 12 October.

Black Terns breed in freshwater marshes in the interior of North America and Eurasia. In North America, they breed from British Columbia and the prairie provinces of Canada south into central California, and east across the northern prairie states around the Great Lakes, into Pennsylvania, New York, New England, and New Brunswick. The North American population winters along and off the coasts of central and South America, south at least to Surinam and Peru (AOU 1957; Blake 1977). In Eurasia, Black Terns breed from France and Sweden east to central Siberia, and south to areas near the Mediterranean, Black, and Caspian Seas.

Abundance

Densities of Black Terns were calculated for the MILA and NAFL subunits during October (sample sizes were insufficient for other months and subunits). In the MILA subunit during October, a density of 0.11 birds/km^2 was estimated. However, all sightings were within the landward 75 km (about 33% of the subunit). Adjusting the individual density to reflect the portion of the subunit utilized (density/percent subunit utilized), the density within 75 km of shore was 0.33 birds/km^2. In the NAFL subunit during October, the density was 0.51 birds/km^2. The October sightings in the NAFL subunit were in the inshore half of the subunit; therefore, the adjusted density is estimated to be 1.02 birds/km^2.

Black Terns were most common in the NAFL and MILA subunits during October. No other surveys had more than 10 sightings. Group sizes ranged from 1 to 200 individuals (Figure 124). The largest groups and the largest monthly mean group sizes were at NAFL in October and December. The concentration of Black Terns in the NAFL subunit during October coincided with peaks in the numbers of Royal and Common-group Terns.

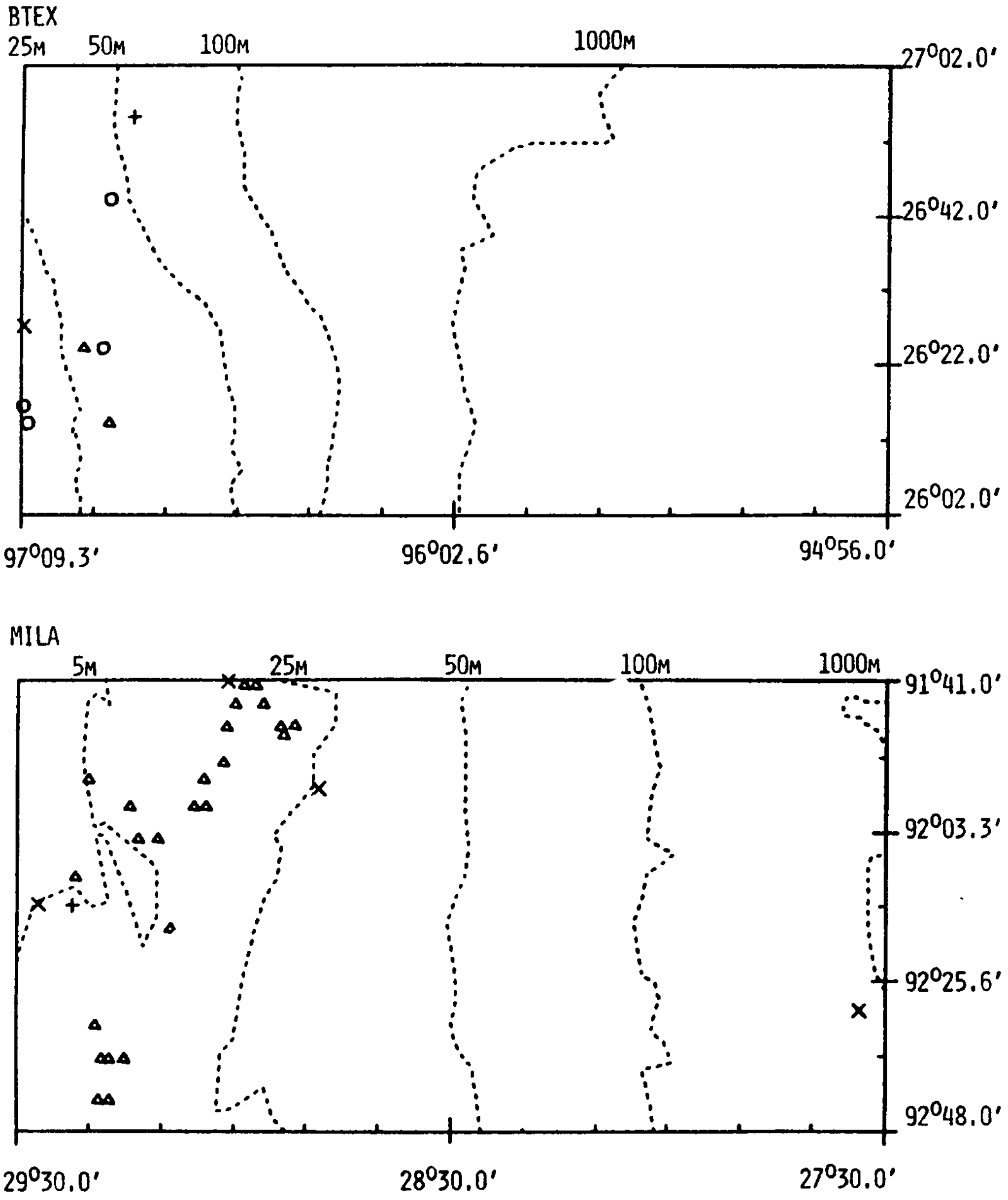


Figure 122. Distribution of all Black Tern sightings in the BTEX and MILA survey subunits during June (O), August (X), October (△), and April (+).

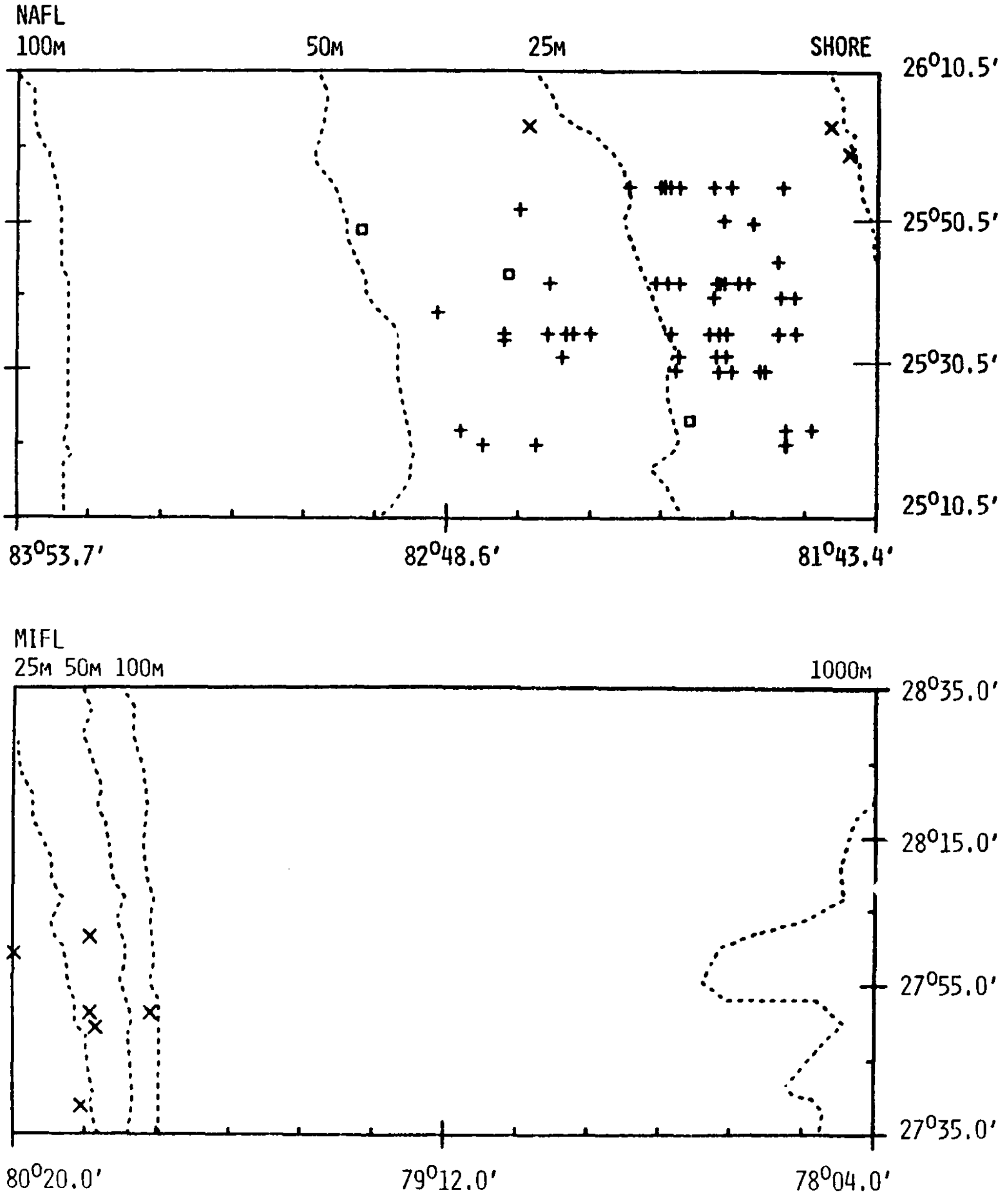


Figure 123. Distribution of all Black Tern sightings in the NAFL and MIFL survey subunits during August (X), October (+), and December (□).

Table 46. The number of Black Terns sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits			
	BTEX	MILA	NAFL	MIFL
June	21 (10)	1 (1)	0	0
August	8 (3)	40 (4)	3 (3)	16 (8)
October	4 (2)	128 (35)	893 (68)	0
December	-	-	52 (3)	6 (2)
February	0	0	0	0
April	2 (1)	1 (1)	0	0
TOTAL	35 (16)	170 (41)	948 (74)	22 (10)

Habitat Use

Distances from shore ranged from 0 to 217 km with sightings in the NAFL and MILA subunits averaging farther offshore than sightings in the other subunits (Figure 125).

Black Terns were observed over water ranging from 5 to 677 m deep (Figure 126). Most sightings were over shallow water, as indicated by the monthly means. The only monthly means greater than 30 m in depth are from surveys with fewer than five sightings.

Surface temperatures associated with Black Tern sightings ranged from 22° to 28° C (Figure 127). In the two October surveys with large sample sizes (NAFL and MILA subunits) mean temperatures were 26.1° and 23.8° C.

Associations

Many of the Black Terns observed (including all the large flocks) were associated with fish schools (Table 47). Royal Terns, Common-group Terns, Magnificent Frigatebirds, and Brown Pelicans also were associated with Black Terns, and in most cases, were over fish schools. One Black Tern was seen hovering over a Manta Ray. Black Terns were seen associated with sargassum windrows and water mass boundaries on five occasions. One of these observations was of five terns over the western boundary of the Gulf Stream.

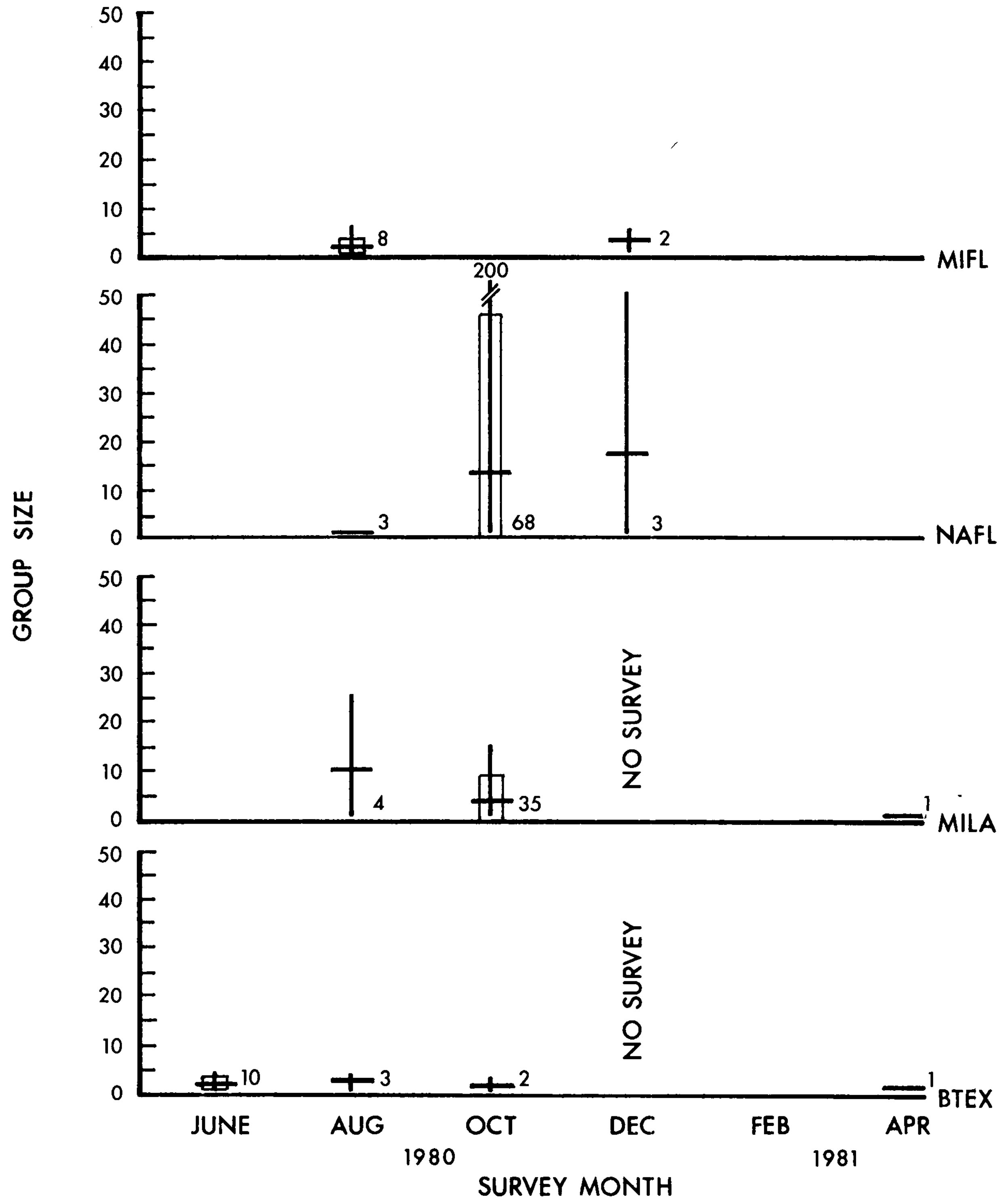


Figure 124. Group size for all sightings of Black Terns by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

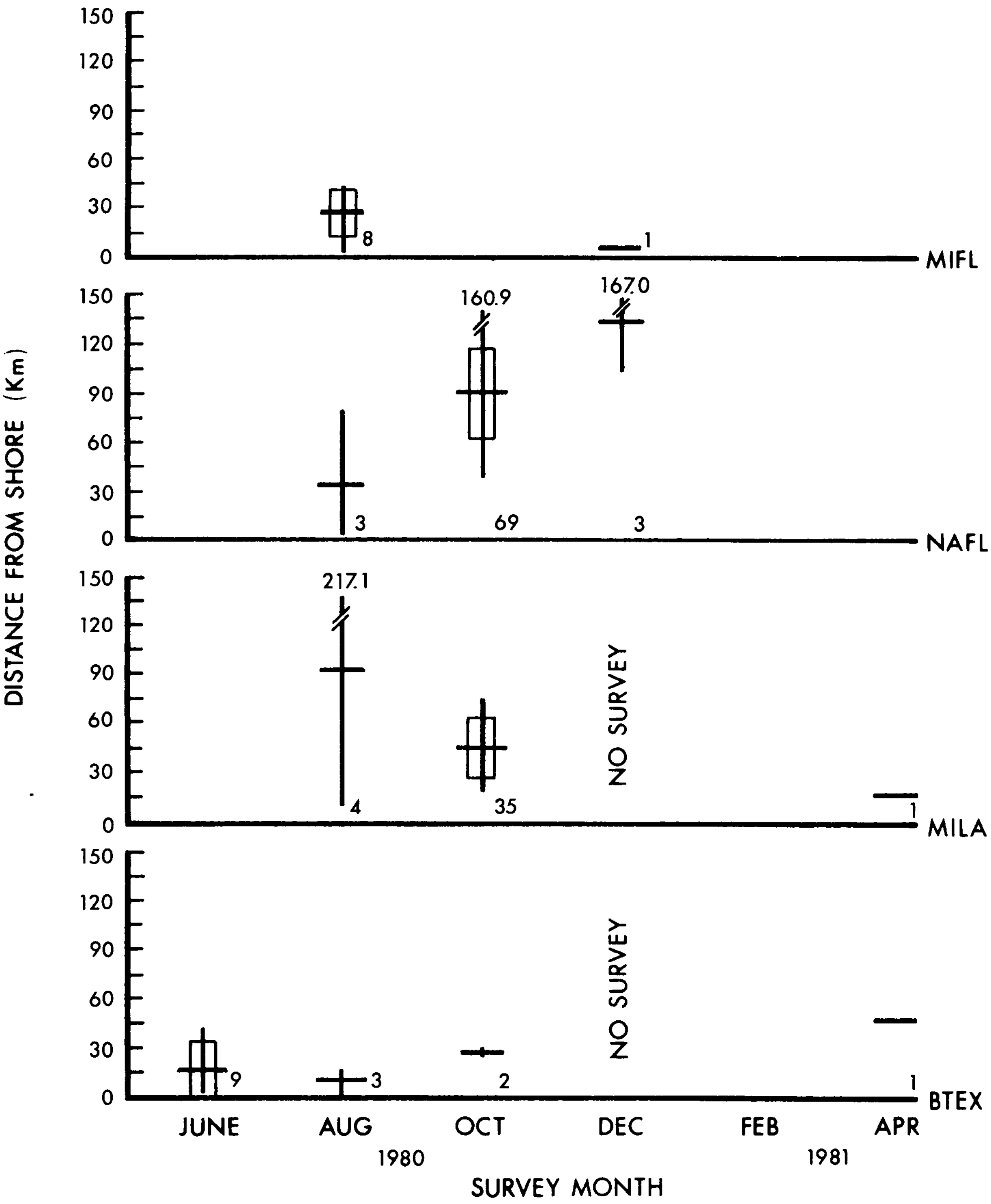


Figure 125. Distance from shore for all sightings of Black Terns by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

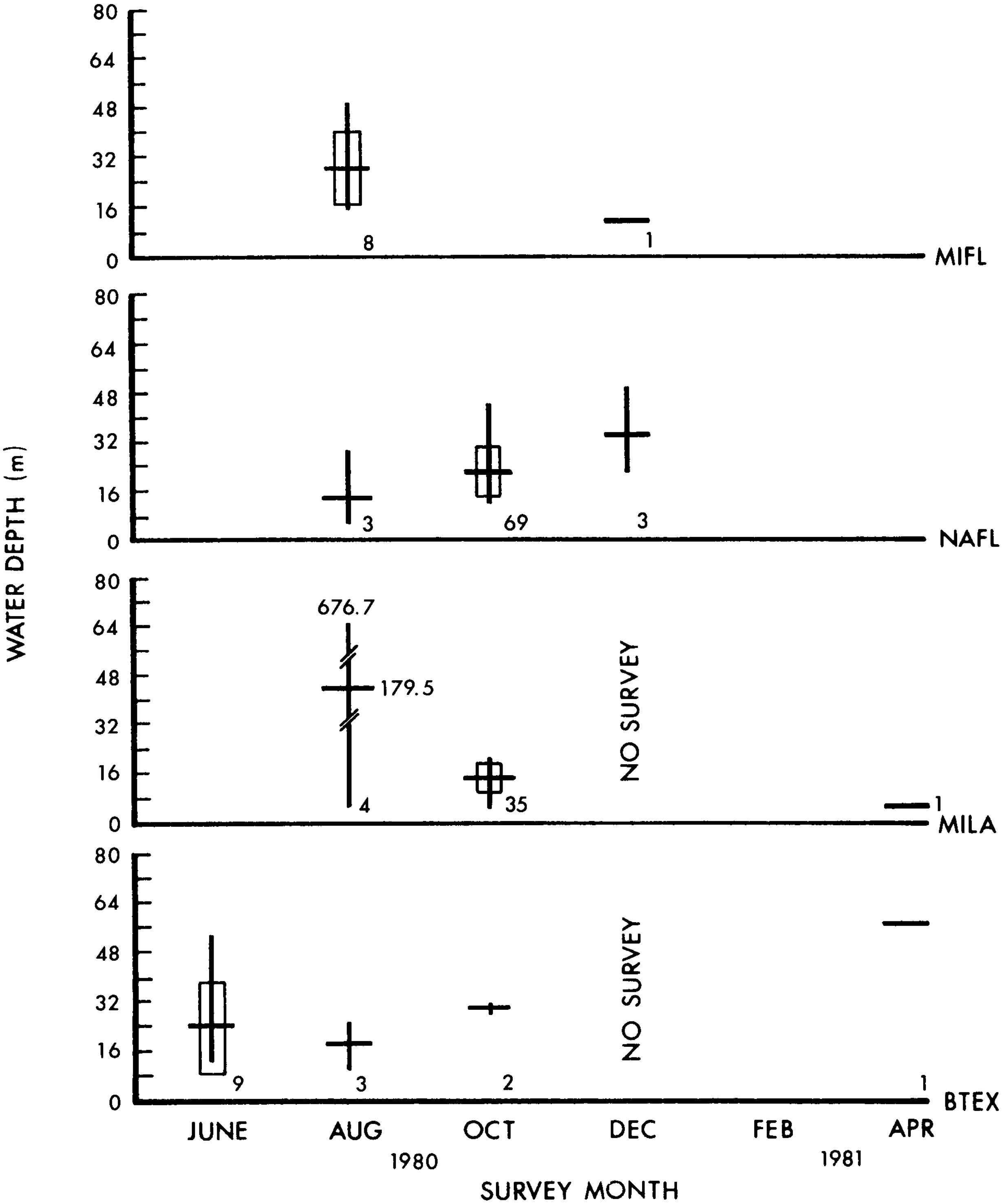


Figure 126. Water depth for all sightings of Black Terns by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

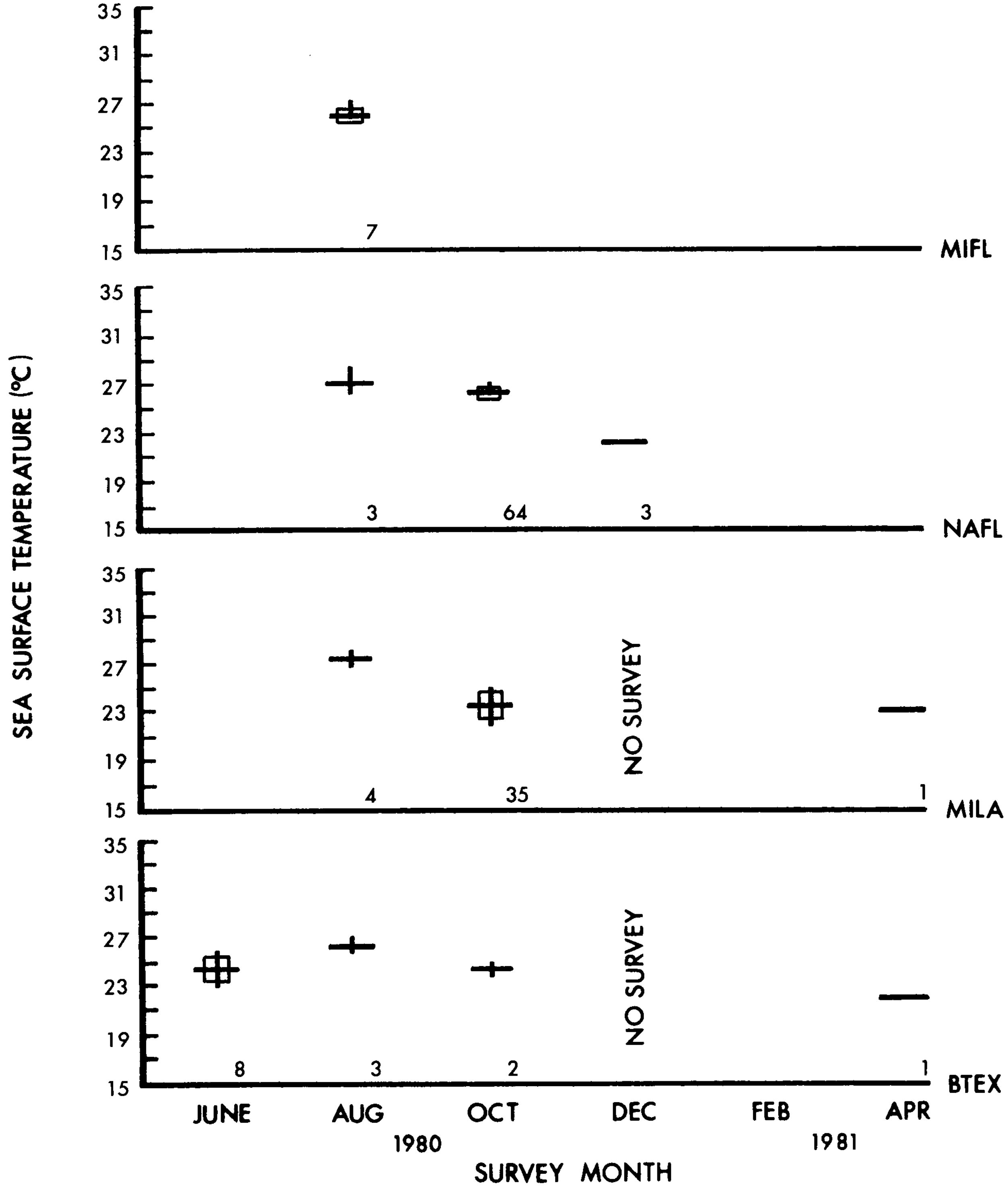


Figure 127. Sea surface temperature for all sightings of Black Terns by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

Table 47. The relationship between fish schools and mixed flocks containing Black Terns.

Bird species included in flocks	No. with fish schools	No. without fish schools
Black Tern only	7	0
Royal Tern	10	1
Royal Tern and Common-group Tern	3	2
Common-group Tern and Frigatebird	1	0
Royal Tern, Common-group Tern, Brown Pelican, Frigatebird	1	0
TOTAL	22	3

Reproduction

Black Terns nest in freshwater marshes. They build nests of reeds on floating mats of dead rushes, on muskrat houses, and on abandoned nests of coots and grebes (Bent 1921). The normal clutch size is three.

Behavior

All of the Black Terns were flying when sighted. They frequently were observed circling or milling over fish schools, usually in the company of other terns. Black Terns feed at sea by swooping or fluttering to the surface to pick small animals from the water. On the breeding grounds, they feed by hawking insects and by picking emerging insects from the water and vegetation.

Potential Impacts of OCS Development

Because the Black Tern is only seasonally abundant in coastal waters of the study area, has not been reported to rest on the water, and feeds on the surface without extensive plunging and diving, oiling is probably rare. Chapman (1979) noted the presence of Black Terns along the coast of South Texas in the fall of 1979 when oil from IXTOC was widespread, but did not mention whether or not the Black Terns were affected.

Summary

Black Terns occurred in all survey subunits and during all survey months except February. Sightings were most common in the NAFL and MIFL subunits where flocks contained up to 200 individuals. Black Terns were usually sighted over shallow water and were often associated with other bird species and fish schools. The Black Tern may not be impacted by OCS development as severely as other terns because of its behavior and seasonal distribution.

BROWN NODDY, *Anous stolidus*

Brown Noddies are difficult to distinguish from Black Noddies (*Anous minutus*), which are known from the study area only by the reported occurrence of one or two birds per year at the Dry Tortugas. It is assumed that the noddies seen during the survey were the more common Brown Noddy.

Description

The Brown Noddy is similar in size to the Sooty Tern (body length 41 cm; wingspan 84 cm) (Watson 1966). It is uniform dark brown, except for the white cap, and the black bill and feet. It has a long wedge-shaped tail, unlike most other terns.

From the air, the noddies may be recognized by tail shape and the overall dark plumage. The white cap sometimes was obvious from the air.

Distribution and Abundance

Brown Noddies were seen twice on scheduled surveys. One bird was 152 km from shore in the MIFL subunit during August. The second bird was 174 km from shore in the NAFL subunit during April. Three sightings were made during opportunistic flights: one on 25 October 1980, about 220 km off western Louisiana, and two near the Dry Tortugas on 9 April 1981.

Brown Noddies nest in the study area only on the Dry Tortugas and are very rare at sea elsewhere in the southeastern United States (AOU 1957). Oberholser (1974) considered the presence of Brown Noddies in Texas hypothetical, based on three sight records and an old report of remains of "several" found on a beach (evidently no specimens were saved). Lowery (1974b) reported only two records from Louisiana, both following tropical storms. Clapp et al. (in prep.) reported one record each from Mississippi and Alabama.

Habitat Use

The five Brown Noddy sightings were over water ranging from 20 to 896 m deep ($\bar{x}$ = 501.8). The shallowest site where noddies were observed was near the colony at the Dry Tortugas. Water temperatures associated with the sightings ranged from 22° C to 27° C ($\bar{x}$ = 24). A Brown Noddy sighted west of the Dry Tortugas on 9 April 1981 was flying with two Sooty Terns.

Reproduction

The Brown Noddy breeds in numerous colonies in the Bahamas, Greater Antilles, and locally on the Caribbean coasts of Central America, and at the Dry Tortugas, Florida. It also breeds on oceanic islands throughout the tropics. Fledged young cannot be distinguished at sea from adults.

Behavior

The Brown Noddies observed were all flying. Brown Noddies sometimes sit on the water, and frequently perch on floating wood (Murphy 1936). No feeding or foraging behavior was observed. Brown Noddies feed on small fish and pelagic invertebrates (Ashmole 1968). Breeding birds feed within 80 km of the colony (Ashmole 1968), explaining the rarity of sightings in the NAFL subunit.

Potential Impacts of OCS Development

Brown Noddies sit on the water, so they may be more likely than other pelagic terns (i.e., Sooty and Bridled Terns) to encounter floating oil. The only Brown Noddy colony in the southeastern United States (Dry Tortugas) is within 50 km of proposed lease sites off Naples.

Summary

Five Brown Noddies were seen during this study including one in the MIFL subunit during August, and one in the NAFL subunit during April. During opportunistic surveys, one was seen in the western Gulf of Mexico during October and two were seen near the Dry Tortugas during April. Brown Noddies nest on the Dry Tortugas and are considered rare elsewhere in the southeastern United States. Because of their habit of sitting on the water, noddies are susceptible to direct oiling. Future gas and oil lease sites are 50 km away from the only breeding colony in the United States. Development of these sites may have adverse effects on the colony.

RIGHT WHALE, *Eubaleana glacialis*

The Right Whale is a Federally endangered species.

Description

The Right Whale is large (length 16.2 m) and robust (Leatherwood et al. 1976). Its basic dorsal coloration is dark brown-gray to black, often mottled with pale blotches. The chin and belly may have blotches of white. The head is about one quarter the total body length (Hall 1981) with a long, narrow, highly arched jaw (Leatherwood et al. 1976). The top of the head has several yellowish to pink bumps or callosities. Callosity patterns may vary, but the largest callosity, called the bonnet, is usually just anterior to the blowhole (Leatherwood et al. 1976). The lower jaw is relatively smooth and lacks the longitudinal creases common in *Baleanoptera* spp. The baleen plates of the Right Whale are up to 2.2 m long, narrow, and vary in color from dark brown-gray to black (Leatherwood et al. 1976). The Right Whale has two blowholes that produce a "V-shaped" blow (Leatherwood et al. 1976). The back is smooth and lacks a dorsal fin. The tail flukes are broad, pointed at the tips, and deeply notched. The Right Whale usually raises the flukes from the water before sounding (Leatherwood et al. 1976).

From the air, the robust body shape and dark coloration were readily visible. The smooth back and large head with highly arched jaws were important identification cues. Callosity patterns were distinguishable from the aircraft. The Right Whale seemed limber in its swimming movements, unlike the more stiff-bodied Sperm Whale, Physeter catodon, seen more commonly during aerial surveys.

Distribution

During aerial surveys only two Right Whales, a mother-calf pair, were sighted. They were seen west of the MIFL subunit (27°48.6' N; 80°25.0' W) on 1 April 1981, just beyond the surf less than 500 m from shore. An unidentified baleen whale that resembled a Right Whale was seen during October in the MIFL subunit, 67 km from shore.

Since Right Whales were protected in 1937, a sighting off Sarasota, Florida (Moore and Clark 1963), and a stranding near Freeport, Texas (Schmidly et al. 1972), are the only records of this species from the Gulf of Mexico (Reeves et al. 1978; Schmidly 1981). Sightings off the Atlantic coast have been more common (Schmidly 1981). Before its numbers were reduced by whaling operations in the North Atlantic Ocean, the Right Whale ranged throughout the temperate zone (Reeves et al. 1978). In the western North Atlantic Ocean, it probably persists in waters off Florida to Iceland, and perhaps in the Gulf of Mexico (Schmidly 1981). Right Whales usually are seen in the study area from late December to early April. Sightings along the Atlantic coast of the United States indicate that Right Whales migrate northward through the study area close to the coast (Leatherwood et al. 1976; Reeves et al. 1978). They are seen off New England during the spring (Leatherwood et al. 1976).

Abundance

Due to low numbers, estimation of the Right Whale population in the western North Atlantic Ocean is difficult. Mitchell (1973) estimated that the population numbered from the high 10's to the low 100's. Recent sightings and strandings have caused several authors (Caldwell and Caldwell 1974; Leatherwood et al. 1976; Winn et al. 1979) to believe the Right Whale population may be increasing. Reeves et al. (1978) warned that the increase in sightings and strandings reported during the last 10 years may only reflect an increase in observer effort.

Habitat Use

The mother-calf pair was in water about 10 m deep. This occurrence in shallow water is not unusual, since sightings from the study area frequently have been only several hundred meters from shore (Caldwell and Caldwell 1974; Winn et al. 1979). The sightings occurred in water where the surface temperature was about 21° C.

Reproduction

Little is known about the reproductive biology of the Right Whale. Breeding probably occurs in the summer (Winn et al. 1979; Schmidly 1981). The gestation period is probably 1 year, and at birth the calf is one-fourth its mother's size (Walker 1975). Calves are born during winter (January and February) south of New England; the location of calving grounds is not known (Winn et al. 1979).

Behavior

The Right Whales sighted during aerial surveys were associated with about 20 Bottlenose Dolphins. They were observed for 20 minutes, and during this time the dolphins remained within 500 m of the whales. The association of Bottlenose Dolphins with Right Whales has been reported commonly (Caldwell and Caldwell 1974).

When the Right Whales were initially sighted, they were close together just beyond the surf. After a few moments, they moved into deeper water. Distance between the two was never greater than 30 m. The adult submerged for longer periods than the calf. The calf was just over one-half as long as the adult.

The Right Whale is a slow-swimming animal that feeds at or near the surface by swimming with its mouth partially open (Gaskin 1976; Winn et al. 1979). They feed primarily on zooplankton, such as euphausiids and copepods (Caldwell and Caldwell 1974; Leatherwood et al. 1976; Winn et al. 1979).

Potential Impacts of OCS Development

The distribution of Right Whales within the study area is probably limited to eastern Florida. Their coastal distribution increases the probability of their encountering an oil or chemical spill from coastal OCS activities. Because they feed at or near the surface, the baleen could be fouled with oil, and oil could be ingested (Reeves et al. 1978). Ship traffic associated with OCS activities also poses a threat, since Right Whales move slow and occur in shallow waters (Reeves et al. 1978). Young animals occurring within the study area may be more vulnerable to these threats than adults, because young spend more time on the surface. If recruitment is reduced in an already rare species, such as the Right Whale that has a low reproductive rate, the impacts would be a serious threat to survival (Reeves et al. 1978).

Summary

Right Whales (a mother-calf pair) were seen in April west of the MIFL subunit. They were seen in shallow water close to shore, and probably were migrating north along the coast. They were associated with Bottlenose Dolphins. A whale sighted in the MIFL subunit in October may have been a Right Whale. Little is known of the life history of the Right Whale. It feeds at or near the surface on zooplankton. Potential impacts of OCS development are severe.

MINKE WHALE, Balaenoptera acutorostrata

Description

The Minke Whale is the smallest of the baleen whales and reaches about 9 m in length (Nishiwaki 1972; Leatherwood et al. 1976). It is dark grey to black on the dorsum and white ventrally. A band of white extends across the upper surface of each flipper. The head is narrow and pointed. The tall, falcate dorsal fin, about two-thirds of the body length posterior from the head, often appears simultaneously with the low, inconspicuous blow (Leatherwood et al. 1976). Minke Whales are often solitary, or in groups of two to three.

During aerial surveys the pointed head and white bands on the flippers were distinctive characteristics.

Distribution

All seven Minke whales sighted were in the MIFL subunit during December and February (Table 48). Their winter appearance in the MIFL subunit may be related to seasonal migrations. Minke Whales have been observed or stranded near all survey subunits except BTEX (Schmidly 1981).

In the western North Atlantic, Minke Whales are distributed from the pack ice south to the Antilles and occasionally are found in the Gulf of Mexico (Lowery 1974a; Leatherwood et al. 1976; Schmidly 1981). Concentrations of Minke Whales may be found in areas where food is abundant in both hemispheres.

The literature (Sergeant 1963; Nishiwaki 1972; Leatherwood et al. 1976; Schmidly 1981) indicates that Minke Whales migrate south in December to winter offshore south of Florida. They move north in May to summer in coastal waters north of Cape Cod. Minke Whales apparently are in the study area primarily during winter; they have been recorded in the study area from November to March, with the exception of one stranding in August (Schmidly 1981).

Abundance

The Minke Whale population in the North Atlantic is estimated to include 50,000 to 70,000 animals (Nishiwaki 1972). Minke Whales are currently being exploited in the North Atlantic by commercial whalers, but the overall effects on the population are not known (Mitchell 1975a).

Habitat Use

Distance from shore varied from 53 to 132 km ($\bar{x}$ = 86 km, n = 4), but distributional patterns are not apparent from the sighting data. Minke Whales were found in waters ranging from 135 to 732 m deep ($\bar{x}$ = 490, n = 4; Table 48).

Minke Whale habitat includes pelagic to nearshore waters (Hall and Kelson 1959; Leatherwood et al. 1976), but may be limited to continental shelf regions (Mitchell 1975a). This whale sometimes enters estuaries, bays, and inlets (Nishiwaki 1972; Leatherwood et al. 1976).

Table 48. Sighting information on the Minke Whale.

Survey subunit	Date	No. of whales	Position (Latitude/Longitude)	Distance from shore (km)	Water depth (m)	Sea surface temperature (°C)
MIFL	10 Dec. 1980	2	27°51.6'N/79°07.3'W	132	659	25
MIFL	10 Dec. 1980	1	27°49.0'N/79°31.7'W	88	732	25
MIFL	27 Feb. 1981	2	28°29.0'N/79°59.9'W	53	135	26
MIFL	28 Feb. 1981	2	27°52.0'N/79°43.4'W	72	436	26

The sea surface temperature at sighting locations ranged from 25° to 26° C ($\bar{x}$ = 25.5° C, n = 4; Table 48). Nothing is known about Minke Whale water temperature preferences.

Reproduction

The seven Minke Whales sighted during the surveys included one adult-calf pair seen in February. The calf was less than one-third the length of the adult.

Mitchell (1975a) summarized the reproductive characteristics of Minke Whales. Females become sexually mature at a length of about 7.3 m. while males mature at about 7 m in length. Mating occurs from December to May, and calving occurs from October to March. Thus, southern areas occupied in this period are important to population maintenance. Females generally have one calf. Calf birth length is 2.4 to 2.8 m (Sergeant 1963), roughly 33 to 38% of the adult female length. This suggests that the calf seen was recently born. The lactation period lasts less than 6 months (Mitchell 1975a).

Behavior

The Minke Whales observed in the surveys included a single individual, the adult-calf pair, and two pairs of adults. The pairs of Minke Whales were swimming within one body length of each other.

Little is known about Minke Whale behavior. They are fast swimmers and can swim at 9 to 24 km/h (Nishiwaki 1972). Segregation of groups by sex as well as by age-class may occur (Mitchell 1975a). Minke Whales feed by filtering food (primarily small shoal fish) through baleen plates.

Potential Impacts of OCS Development

The distribution of Minke Whale habitat in both pelagic waters and nearshore areas, and their seasonal migrations, increase the chances of exposure to oil spills and other effects of OCS development. The influence of oil development on this particular species have not been investigated. Increased boat traffic appears to have caused a decrease in abundance near Japan (Nishiwaki and Sasao 1977). Increased boat-use associated with OCS development might therefore impact Minke Whales in the study area. As filter feeders, Minke Whales may foul their baleen plates with oil.

Summary

Minke Whales were sighted only in the MIFL subunit. An individual and three pairs, including one adult-calf pair, were observed on separate occasions in December and February. Their winter appearance off Florida may be related to seasonal migrations.

SPERM WHALE, *Physeter catodon*

The Sperm Whale is a Federally endangered species.

Description

Sperm Whales are the largest of the toothed cetaceans. They have recently been described in detail by Leatherwood and Reeves (in press). The males may reach a length of 20.5 m. The females are smaller, rarely exceeding 11.6 m in length. Coloration is slate gray to brownish with varying amounts of white or pale color around the lips and on the venter. The head may comprise up to a third of the body size and is rectangular in profile. Seen from above, the head appears "squared off" at the snout, widening slightly posteriorly. The lower jaw ends an appreciable distance from the tip of the snout and contains the only functional teeth. The single blowhole occurs at the front of the head and to the left of the midline. The blow is distinctive and is directed forward and to the left. The dorsal hump is followed by a series of smaller humps or crennulations down the back toward the tail. Except for the smooth head, the body is covered with wrinkles, which are visible near the crennulations when the animal surfaces. The tail stock, when seen from above, narrows markedly from the middle body to the tail, which is large and triangular.

From the air, the Sperm Whale is easy to identify because of its distinctive shape and blow, and because of the crennulations, which are usually visible when the animal surfaces.

Distribution

Sperm Whales were observed in all survey subunits; 23 Sperm Whales (9 sightings) were seen in the BTEX survey subunit, 4 (1 sighting) in the MILA survey subunit, 2 (2 sightings) in the MIFL survey subunit, and 1 in the NAFL survey subunit (Table 49). Two whales were seen together during an opportunistic flight across the Gulf of Mexico from Naples, Florida, to Harlingen, Texas (26°23.6' N;93°00.8' W).

Table 49. Sighting information on the Sperm Whale from the present study, the 1979 survey (Fritts and Reynolds 1981), and incidental shipboard encounters. NTEX = North Texas and STEX = South Texas from Fritts and Reynolds (1981). N/A = not applicable. Dash means data not available.

Survey subunit	Date	Position (Latitude/Longitude)	Distance from shore (km)	Water depth (m)	Sea surface temperature (° C)	No. of adults	No. of calves (<6 m)
STEX	21 Aug. 1979	26°57.8'N/95°07.5'W	369	1,462	28	1	0
NTEX	24 Aug. 1979	27°27.5'N/94°46.6'W	113	978	28	3	1
BTEX	27 June 1980	26°16.1'N/95°45.9'W	137	1,334	27	4	2
BTEX	29 June 1980	26°38.2'N/94°54.4'W	232	1,682	-	1	0
BTEX	18 Aug. 1980	26°23.6'N/93°00.8'W	382	1,883	27	2	0
BTEX	21 Aug. 1980	26°29.2'N/96°00.1'W	120	1,097	26	1	0
BTEX	22 Aug. 1980	26°13.0'N/95°59.1'W	116	987	27	1	0
BTEX	22 Aug. 1980	26°13.0'N/96°04.8'W	106	896	27	2	1
BTEX	22 Aug. 1980	26°22.9'N/96°07.1'W	106	823	27	6	2
BTEX	31 Oct. 1980	26°24.1'N/96°09.2'W	101	731	26	1	1
BTEX	02 Nov. 1980	26°03.0'N/96°04.6'W	106	914	26	1	0
N/A	04 Nov. 1980[a]	23°12.0'N/96°39.0'W	109	2,194	-	3	0
N/A	04 Nov. 1980[a]	23°08.0'N/96°43.0'W	108	2,742	-	4	0
BTEX	06 Nov. 1980[a]	27°00.2'N/95°43.4'W	158	1,005	-	2	1
N/A	24 Aug. 1980[a]	28°20.2'N/89°02.5'W	71	978	-	11	3
MILA	21 Oct. 1980	27°32.0'N/92°06.9'W	229	1069	27	3	1
NAFL	07 Mar. 1981	25°21.5'N/83°47.2'W	199	104	26	1	0
MIFL	03 Mar. 1981	28°18.3'N/78°15.4'W	219	932	21	1	0
MIFL	10 Dec. 1980	27°59.0'N/79°44.8'W	80	366	25	1	0

[a] shipboard sighting.

During the 1979 survey (Fritts and Reynolds 1981), one Sperm Whale was seen in the STEX survey subunit of that survey, and four (one sighting) were seen in the NTEX subunit, which corresponds closely with the BTEX subunit of this study. Three Sperm Whales (one sighting) were seen off the Texas coast, and seven (two sightings) off the Mexican coast from the r/v Gyre. Fourteen Sperm Whales (one sighting) were observed and photographed off the Mississippi Sound from a sport fishing boat during August 1980.

Shipboard observations of Sperm Whales were made during 1979 from the Texas A&M research vessel r/v Gyre in Texas and Mexican waters. These additional sightings were used to supplement flight data because they occurred during the study period and few recent data are available from the Gulf of Mexico and nearby Atlantic waters.

The Sperm Whale was seen in all survey months. Within the BTEX survey subunit, it was seen during June, August, and October. In the MILA survey subunit, the Sperm Whale was seen during October; in the NAFL survey subunit, it was seen during March. During December and March, the Sperm Whale was seen in the MIFL survey subunit. During the 1979 survey (Fritts and Reynolds 1981), the Sperm Whale was observed during August in the NTEX survey subunit. It was seen off Texas and Mexico during November 1979 and off the Mississippi Sound during August 1979 by the crew of the r/v Gyre. Two solitary Sperm Whales, sighted in the MIFL survey subunit, were heading in a southerly direction.

No changes in distribution related to season are known from the Gulf of Mexico, and the data from this study do not show obvious patterns. Sperm Whales migrate between equatorial wintering grounds and more northerly summer areas in the Atlantic Ocean (Best 1969). Bulls lacking mates migrate into higher latitudes than mixed groups of bulls, females, and young (Best 1969). The movements and composition of herds in the Gulf of Mexico are unknown.

Abundance

Within the study area, a total of 61 Sperm Whales were observed in 19 sightings.

The abundance of Sperm Whales off the Texas coast could be due to the productivity of that area caused by its unique bottom topography and currents (see Oceanography section). Historical data (Townsend 1935) on the occurrence of Sperm Whales in the Gulf of Mexico do not include the western half. However, these data were collected from whaling ships that did not randomly cover the Gulf of Mexico.

Sperm Whales were present in the Gulf of Mexico from at least June through November and in March (Table 49). In the BTEX survey subunit, Sperm Whales were most abundant during August (five sightings of 15 whales). During a 1979 survey (Fritts and Reynolds 1981), Sperm Whales also were seen during August (two sightings of five whales). The attraction to this area during August has not been reported, but may relate to abundant food resources.

Group sizes ranged from 1 to 14 animals. The average group size was 3.2 whales (SD = 3.3, n = 19). The maximum range of group sizes occurred during August. Only solitary animals were seen during December, February, and March. Mixed herds average about 20 to 40 animals (Best 1979). Much smaller group sizes were seen during this survey. However, since Sperm Whale herds can be spread over several miles (Best 1979), observers may have missed some animals while tightly circling at low altitudes to get a good view of the animals that had been sighted.

Habitat Use

All but one Sperm Whale were observed beyond the 200 m isobath (Figures 128 and 129). Animals in the Gulf of Mexico ranged 71 to 382 km from shore ($\bar{x}$ = 162 km, SD = 92.2, n = 17, Table 49). The two animals off the Atlantic coast of Florida averaged 142 km from shore. The Sperm Whale in the NAFL subunit was over the continental shelf in waters only 104 m deep, but was 199 km from shore. As noted by Clarke (1953), distribution of Sperm Whales seems to be influenced by depth more so than distance from shore: Sperm Whales were closer to land only where the continental shelf was narrower and farther from land where the shelf was wider.

The Sperm Whale is a deepwater species (Marcuzzi and Pilleri 1971) that is often found near the continental shelf break (Leatherwood and Reeves in press). Continental shelf margins, sea mounts, and other complex bottom topography increase water mixing and upwelling, and therefore increase primary productivity (Dustan et al. 1981).

Water depths where Sperm Whales were sighted ranged from 104 to 2,742 m (Table 49). Off the Texas and Mexican coasts, water depths where Sperm Whales were sighted averaged 1,338 m (SD = 593, n = 14). The Sperm Whales seen off Louisiana were in waters 978 and 1,069 m deep. The water depth for the sighting in the NAFL survey subunit was 104 m, and the water depths for the sightings in the MIFL survey subunit were 366 and 932 m.

The deep water distribution of Sperm Whales (Marcuzzi and Pilleri 1971) probably reflects the habits of their principle prey item, squid. Squid are concentrated in deep waters off continental shelves and spawn nearshore over the shelf (Norris and Prescott 1961; Sergeant 1962a). Cephalopods aggregate in large numbers near areas where cold and warm water currents meet (Marcuzzi and Pilleri 1971) such as at upwellings and along bottom drop-offs where Sperm Whales are found.

In the Southern Hemisphere, where much work has been done on Sperm Whales, mixed groups of females and young males are generally confined to tropical and subtropical waters with a southern limit of 40° S latitude (Matthews 1938, cited by Best 1970). Adult males without a mate migrate into Antarctic waters.

Sea surface temperatures for Sperm Whale sightings within the Gulf of Mexico ranged from 26° to 28° C ($\bar{x}$ = 27, SD = 0.69, n = 12). The whale seen in the NAFL survey subunit was sighted in the Loop Current. Water temperatures outside the current were as low as 20° C, whereas those within the current were about 26° C. One whale seen in the MIFL survey subunit was within the Gulf Stream, in water 25° C; the other was beyond the eastern edge of the Gulf Stream, in water 21° C. Mixed groups of females and young males are limited in distribution by the 20° C isotherm (Gilmore 1959).

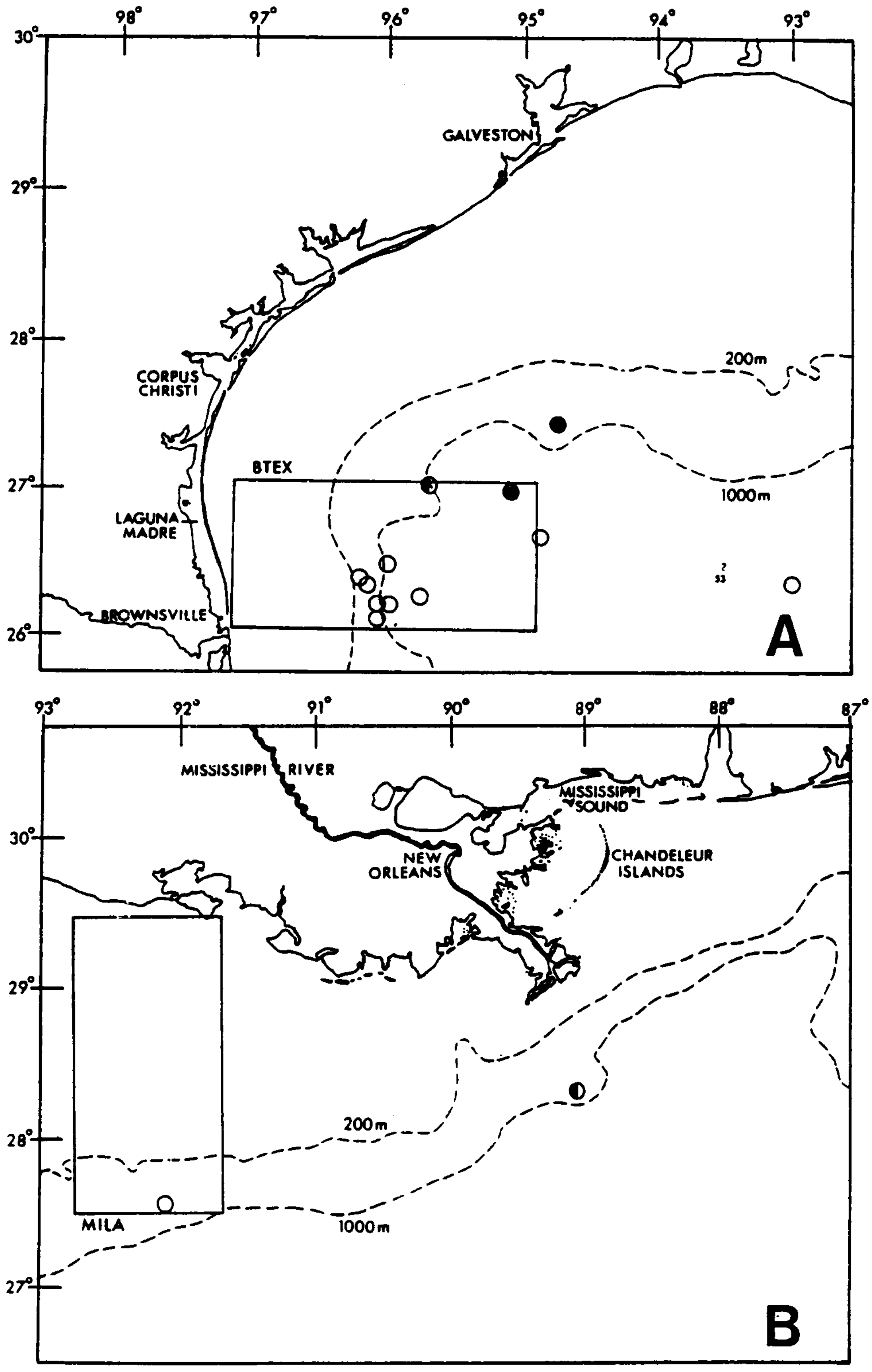


Figure 128. Distribution of all Sperm Whale sightings in and adjacent to the BTEX survey subunit (A) and the MILA survey subunit (B) during the present study (O), in South Texas during the 1979 survey (●) (Fritts and Reynolds 1981), and from incidental shipboard encounters (◐).

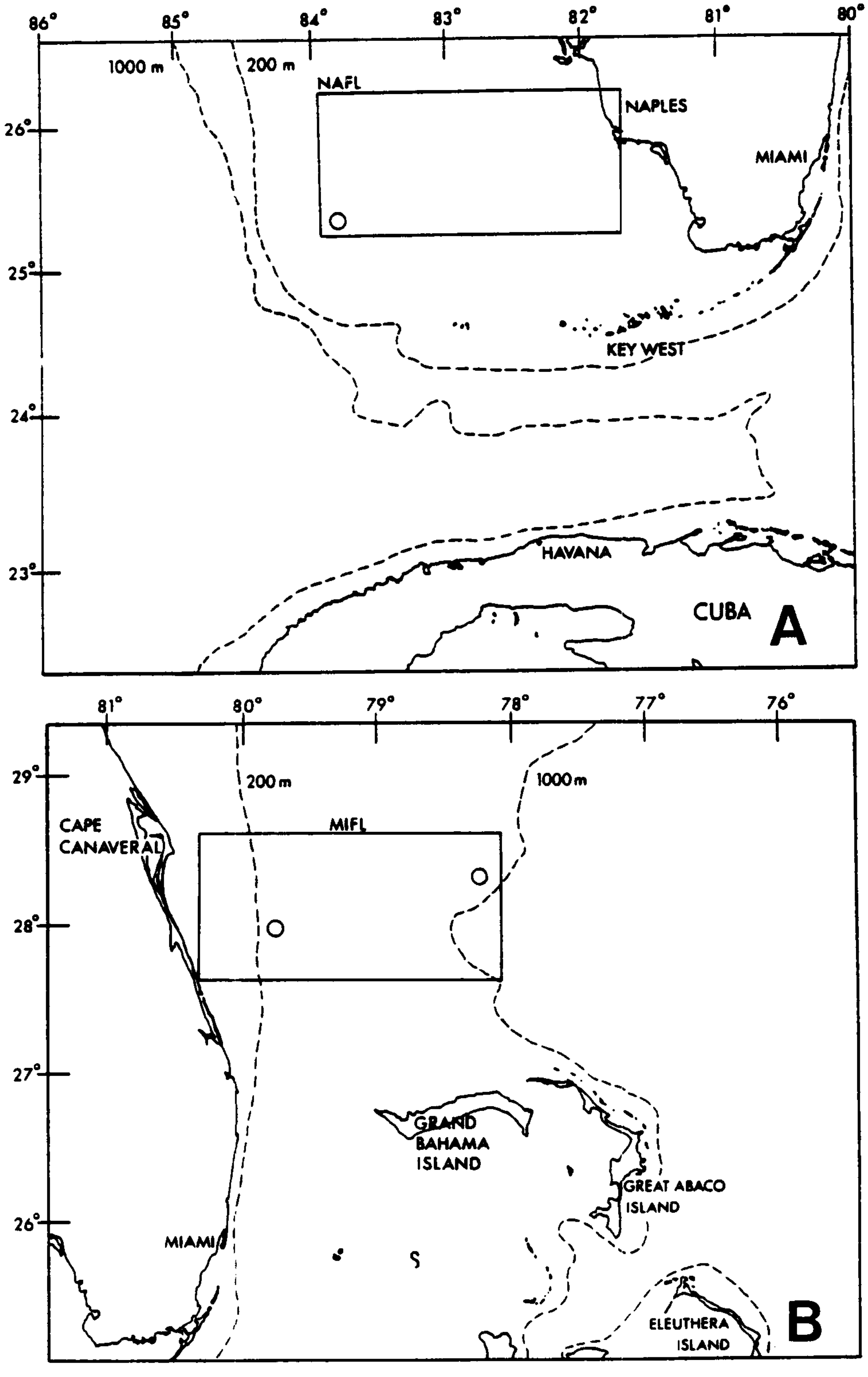


Figure 129. Distribution of all Sperm Whale sightings in the NAFL survey subunit (A) and the MIFL survey subunit (B) during the present study (O).

Associations

Few associations with other cetaceans occurred. One group of whales off Texas was approached by a group of 20 unidentified Stenella spp. The Sperm Whales seen in the MILA survey subunit were within 10 miles of a group of 30 Short-finned Pilot Whales, and both groups were near shipping lanes.

In several instances, Sperm Whales were within 4 km of distinctive oceanographic features. For example, the single whale in the NAFL survey subunit was in the Loop Current. The two whales in the MIFL survey subunit were associated with the Gulf Stream: one in it, one 4 km to the east of it. The whales sighted from a sport boat off the Mississippi River Delta were near a prominent water mass. A major oceanographic feature of the Gulf of Mexico occurs in the western area where most of the whales were sighted. Sweitzer (1898, cited by Leipper 1954) reported an area of 100 mi^2 off the coast of Texas, 40 mi south and 20 mi east of Aransas Pass, which he believed to be the convergence of two opposing currents. This area was known as the graveyard of ships. This convergence is part of the Brownsville Gyre described by Pequegnat et al. (1976). The Gyre begins moving north during spring, and by winter it is off Galveston. The convergence of the Brownsville Gyre and waters coming from Louisiana serve to transport organic materials from onshore waters off the shelf. This Gyre is also characterized by upwelling (Gallaway 1981). The primary current in the Gulf of Mexico, the Loop Current, enters the Yucatan Channel and leaves, after traveling north and then south, through the Florida Straits (Leipper 1970). Although this survey did not sample the area of the Gulf containing the majority of the Loop Current, historically Sperm Whales have been taken near it. Townsend (1935) found Sperm Whales to be distributed in a broad line from the Mississippi River Delta to the Florida Straits, within the area of the Loop Current.

Reproduction

Best (1979) defined Sperm Whale "calves" as animals less than 6.1 m (20 ft) in length. Based on this definition, a total of 12 calves (19%) were observed (in BTEX and MILA) during this study. Adult/calf ratios ranged from 1.0 to 3.7 ($\bar{x}$ = 2.5). Best (1979) estimated that calves make up 6% of the total Sperm Whale population. Although the percentage of calves seen during this study was higher than the overall estimate given by Best (1979), the study area is within low latitudes where females and young predominate.

Little is known about the mating activity of Sperm Whales in the Northern Hemisphere. Mating in the Azores occurs from January to July, peaking in May. Calving extends from May to November, with a peak in August (Clarke 1956, cited by Best 1970).

Mating behavior was not observed, but several large solitary animals were observed in the vicinity of mixed groups (one per group). These individuals may represent "school masters" or breeding males (Best 1979). The terms "school master"and "harem" are used by some authors (Best 1979; Caldwell et al. 1966), because it is believed the large individuals (school masters) mate with adult females in the mixed schools (harems). Males that have not secured a "harem", or group of females, migrate to higher latitudes (Best 1969, 1979; Gambell 1972).

Behavior

Mixed groups (calves and adults) appeared tightly grouped: within half a body length of each other and usually swimming abreast. In some cases, a calf was underneath an adult for at least part of the time. The circling aircraft often disturbed the animals, causing them to change course, dive, or move faster. In one instance, a Sperm Whale was sighted at a distance because of a large splash at the surface; this whale may have been breaching.

Potential Impacts of OCS Development

Oil and gas development activities could impact Sperm Whales. One instance of a Sperm Whale ramming or bumping into an oil rig has been reported (Slijper 1979). Sperm Whales have also been rammed by ships (Slijper 1979). Caldwell et al. (1966) reported several cases of "sleeping" whales killed by ships. Construction of oil rigs and increased ship traffic associated with OCS development activities could increase the danger to Sperm Whale populations.

The effects of contact with oil on cetaceans is unclear. It is also unclear if they can detect oil slicks. One incident which occurred during the surveys suggests that Sperm Whales can detect certain substances on the surface of the water. During the aerial surveys, dye markers (rotamine dye and aluminum powder) were occasionally dropped to indicate position of animals while the survey aircraft circled. On one occasion, a mother/calf pair was swimming at the surface when a marker was dropped in their path. The animals hesitated for several minutes near the edge of the aluminum powder and dye before swimming through it. The observation suggests that they could detect the floating powder, but this conclusion cannot be generalized to include different substances such as oil and other chemicals. Sperm Whales were seen within 7 km of oil globules and slicks during the IXTOC oil spill (Fritts and Reynolds 1981), but evidence is still not available to determine if proximity to petrochemicals would have behavioral or physiological effects on Sperm Whales.

Summary

More Sperm Whales were sighted off the Texas coast beyond the continental shelf than in any other portion of the study area. Only one whale occurred over the shelf, but it was almost 200 km off the west coast of Florida. Average distance from shore was 160 km (SD = 90.8, n = 19). Average depth of the waters where Sperm Whales occurred was 1,167 m (SD = 617, n = 19). Sperm Whales were seen from June through March, and 37% of all whales were sighted during August. Most whales were seen in waters warmer than 25^{o} C.

Sperm Whales were associated with oceanographic features such as the Loop Current, Gulf Stream, and other currents.

Adult/calf ratios within mixed groups ranged from 1.0 to 3.7. Calves made up 20% of all whales seen, which is well above the figure of 6% calves proposed for the total Sperm Whale population by Best (1979). Mixed-group size ranged from 2 to 14. Animals in mixed groups were tightly clustered and often swimming abreast. Not much is known about the effects of oil and gas development on Sperm Whales. They have been killed when rammed by ships and one has been reported to ram or bump into an oil rig.

PYGMY SPERM WHALE, Kogia breviceps

Until 1966, only one species, Kogia breviceps, was recognized in the genus Kogia. Handley (1966) described reliable characteristics that could be used to distinguish a second species, the Dwarf Sperm Whale, Kogia simus. Data from strandings and sightings for both species before 1966 were not separated, and consequently all were recorded as pertaining to Kogia breviceps.

Description

The Pygmy Sperm Whale is a small whale (2.7 to 3.4 m in length) with a heavy body (318 to 408 kg in weight) and a blunt, squarish head (Handley 1966, Leatherwood et al. 1976). The head is small (1/6 to 1/7 of total body length) with an inferior lower jaw that does not extend anteriorly to the tip of the snout (Handley 1966). The blowhole is located mid-dorsally above the eyes (Handley 1966). The flippers are located well forward on the body and may reach lengths of 45.7 cm (Leatherwood et al. 1976). A small, falcate, dorsal fin is located posterior of mid-body (Handley 1966; Leatherwood et al. 1976). The flukes are large, triangular, and notched. External differences between K. breviceps and K. simus are: size (K. simus is smaller, body length 2.1 to 2.7 m) and shape of the dorsal fin (Handley 1966). The dorsal fin of K. simus is tall and falcate, and is located at mid-body (Handley 1966).

The Pygmy Sperm Whale is slate gray dorsally grading to lighter gray on the sides and dull white on the belly (Leatherwood et al. 1976). There is a pale bracket-shaped mark between the flipper and the eye that is often called a false gill (Leatherwood et al. 1976).

The single animal seen during aerial surveys was robust and estimated to be of adult size (< 3 m). It had a blunt head, and the flippers were rounded. The dorsal coloration was dark gray. Initially it was identified as Kogia sp. and later as K. breviceps based on its length.

Distribution

The Pygmy Sperm Whale sighting occurred in the MIFL survey subunit on 11 October 1980. It was 79 km from shore (28°08.0' N; 79°45.5' W).

Pygmy Sperm Whales probably occur in tropical and warm temperate oceans throughout the world (Handley 1966; Mitchell 1975a). In the western North Atlantic Ocean, they range from Nova Scotia south to Cuba and west to Texas in the Gulf of Mexico (Leatherwood et al. 1976). Strandings have been reported along the coast of all states in the study area except Louisiana, Mississippi, and Alabama (Schmidly 1981). No seasonal pattern is detectable from stranding data in the study area (Schmidly 1981).

Abundance

Only one Pygmy Sperm Whale was identified during aerial surveys, suggesting that this species may be rare within the study area. Observations of Kogia sp. at sea are rare (Winn et al. 1979), but strandings are more numerous. Within the study area, strandings frequently occur along the Atlantic coast of Florida (Schmidly 1981). Strandings occur in lower numbers along the coast of the Gulf of Mexico (Schmidly 1981). The inconspicuous behavior of this species (see behavior section) may help explain why more are not sighted at sea.

Habitat Use

The Pygmy Sperm Whale seen during aerial surveys was in waters 461 m deep. The sea surface temperature at the location was 26° C. The Pygmy Sperm Whale is considered a deep water species (Winn et al. 1979).

Reproduction

Little is known about the reproductive biology of this species. The female bears a single young (Handley 1966), and the calf may stay with the mother during its first year (Schmidly 1981). Stranded animals are often females with calves and females that have recently calved (Winn et al. 1979).

Behavior

When sighted, the Pygmy Sperm Whale was motionless at the surface with its tail hanging down in the water. This posture is not uncommon and has been described as basking (Mitchell 1975b; Leatherwood et al. 1976).

Pygmy Sperm Whales may be inconspicuous at sea because they usually rise slowly to the surface, produce an inconspicous blow, and do not roll forcefully at the surface (Leatherwood et al. 1976). In general, the actions are slow, deliberate, and somewhat timid (Handley 1966). The Pygmy Sperm Whale is not a highly social animal and is usually seen in small groups of three to six animals (Mitchell 1975a).

Pygmy Sperm Whales probably feed largely on squid, but also take fish, crabs, and shrimp (Handley 1966; Raun et al. 1970; Leatherwood et al. 1976).

Potential Impacts of OCS Development

The potential impact of oil and OCS activities on this species is unclear. Due to the Pygmy Sperm Whale's habit of resting at the surface, it may be vulnerable to collisions with boats (Winn et al. 1979) associated with OCS development.

Summary

A single Pygmy Sperm Whale was seen in the MIFL subunit during October. Sightings at sea are rare, while strandings are more common. The Pygmy Sperm Whale is rare and little is known of its life history. The potential impacts of OCS development are not well understood.

BEAKED WHALES, Mesoplodon spp.

Includes:	True's Beaked Whale, Mesoplodon mirus Gervais' Beaked Whale, Mesoplodon europaeus Blainville's Beaked Whale, Mesoplodon densirostris

Species of Beaked Whales are extremely difficult to distinguish at sea (Leatherwood et al. 1976). Proper identification of stranded animals usually depends on examination of skull characteristics. Most beaked whales observed in the field were identified only as Mesoplodon spp. Thus, these three species of beaked whales are discussed together.

Description

The Mesoplodon spp. expected in this study area, unlike Ziphius cavirostris, all have prominent beaks. They have relatively small heads, large bodies, small flippers, and a small dorsal fin set well behind the mid-point of the body. The flukes are broad and may be shallowly notched. Two throat groves are visible on stranded specimens. Even with stranded specimens, identification to species is difficult. Adult males can be distinguished from females and immatures because they have a pair of erupted teeth. These teeth are also useful in distinguishing individual species. Females and young are difficult to identify without using skull characteristics.

True's Beaked Whale (Mesoplodon mirus) is about 4.9 m in length. The mid-body is large in girth. The small head has a slight indentation near the blowhole, a slight bulge to the forehead, and a prominent beak. The flippers are 1/14 (7%) of the body length. The dorsal fin is small, slightly falcate, and located on the posterior third of the back. Mesoplodon mirus has a prominent ridge along the tail stock. The width of the tail is about 1/5 (20%) of the body length. This species is black to dark gray on the dorsum, lighter gray on the lateral body, and white on the ventral surface. The body is sometimes covered with light spots and tooth rakes (Leatherwood et al. 1976).

Gervais' Beaked Whale (Mesoplodon europaeus) is larger than M. mirus and reaches a length of 6.7 m. It is slender and appears laterally compressed. The head is very small and has a narrow beak. The flippers are about 1/12 (8%) of the body length. The dorsal fin varies from triangular to falcate in shape, and is located behind the mid-point of the back. The flukes are less than 20% of the body length and are not notched. Gervais' Beaked Whale is dark grayish-black on the dorsum and lighter on the venter (Leatherwood et al. 1976).

Blainville's Beaked Whale (Mesoplodon densirostris) is intermediate in length between True's Beaked Whale and Gervais' Beaked Whale. It can reach 5.2 m in length. This whale is like Gervais' Beaked Whale in being laterally compressed or spindle-shaped. The head of Blainville's Beaked Whale is distinctive because it appears conical in shape when seen from above. From the side, the wedge-shaped prominences near the angle of the jaw are visible. The single pair of teeth is located on these prominences, and is particularly obvious in males. The flippers are about 10% of the body length. The dorsal fin is located just behind the middle of the body and varies from triangular to falcate in shape. The flukes are about 20% of the body length and are seldom notched. Blainville's Beaked Whales are black on the dorsum and lighter on the venter. They, like True's Beaked Whales, have blotches and scars (Leatherwood et al. 1976).

Since descriptions of beaked whales come mostly from stranded specimens, colorations reported must be suspect. The coloration is known to darken on a dead or dying, sunburned whale (Sergeant 1962a). None of the beaked whales observed from the plane appeared dark or black; most appeared to be tan. The discrepancy in color could result from color distortion of animals seen under water, or from our poor knowledge of color in life.

Distribution

Fifteen beaked whales were observed in six sightings during the survey period (Table 50). The BTEX survey subunit contained the most beaked whale sightings: one beaked whale was seen in June, six (in one sighting) in August, and one in February (Figure 130). Three beaked whales were seen in one sighting during December in the MIFL survey subunit (Figure 131). During opportunistic flights, they were observed in deep waters beyond the NAFL survey subunit near Howell's Hook ($24^{o}16.8'$ N; $83^{o}59.9'$ W) in April, and 283 km west of Tampa, Florida ($28^{o}2.1'$ N; $85^{o}41.1'$ W) in December.

True's Beaked Whale is known only from the North Atlantic. It has been recorded from Nova Scotia to Florida, but northern records occur in summer only (Leatherwood et al. 1976). Within the study area, there are six recorded strandings: 3 from North Carolina, 2 from South Carolina, and 1 from Florida (Schmidly 1981). There are no records from the Gulf of Mexico.

The range of Gervais' Beaked Whale is similar to True's Beaked Whale. It has been recorded from New York to Florida, in the Caribbean and Gulf of Mexico (Leatherwood et al. 1976). Within the study area, Gervais' Beaked Whales have stranded along the North Carolina, Georgia, and Florida coasts in the Atlantic, and the Florida and Texas coasts in the Gulf of Mexico (Schmidly 1981).

Blainville's Beaked Whale is distributed in tropical and temperate waters of the world (Rice 1977). As emphasized by Davies (1963, cited by Moore 1966), this may be the only species of Mesoplodon that occurs on both sides of the equator. In the Atlantic waters of North America, it has been recorded from Nova Scotia to Florida, and once in the Gulf of Mexico. In the study area, this whale has stranded along the coasts of North Carolina, South Carolina, Georgia, Florida, and Louisiana (Schmidly 1981).

Moore (1966) summarized distributions of the three species of beaked whales as follows: M. mirus is principally in the northwestern North Atlantic and stays between the Gulf Stream and shore; M. europaeus is principally in the southwestern North Atlantic; and M. densirostris seems to be distributed farther offshore than the other two and apparently is farther south in the North Atlantic than M. europaeus.

No seasonal movements are known for these three species of beaked whales. The only pattern to the strandings of beaked whales is seen in True's Beaked Whale, which occurs farther north in summer months (Schmidly 1981).

Abundance

The species of the genus Mesoplodon are reported to be rare everywhere (FAO 1978). The apparent rarity has been ascribed to their small size and solitary nature, and to their offshore distribution (Moore 1966). Beaked whales were seen singly and in groups of two to six.

Table 50. Sighting information on unidentified beaked whales. OPPO = opportunistic flight.

Survey subunit	Date	No. of whales	Position (Latitude/Longitude)	Distance from shore (km)	Water depth (m)	Sea surface temperature (° C)
BTEX	27 June 1980	1	26°16.0'N/94°58.6'W	218	2,012	28
BTEX	20 Aug. 1980	6	26°25.9'N/95°47.0'W	151	1,298	26
BTEX	05 Feb. 1981	1	26°54.0'N/96°13.7'W	111	576	21
MIFL	16 Dec. 1980	3	27°53.0'N/78°36.5'W	176	914	25
OPPO	14 Dec. 1980	2	24°16.8'N/83°59.9'W	185	1,719	23
OPPO	30 Apr. 1981	2	28°02.1'N/85°41.1'W	283	658	22

Habitat Use

Beaked whales were in waters from 576 to 2,012 m deep. Four of the six sightings occured in water over 900 m deep. Sea surface temperatures ranged from 21° to 28° C (Table 50). No associations with currents, water mass boundaries, or sargassum were noted.

In general, these whales generally occur far offshore in deep waters. They are known to feed on squid. Their offshore distribution is similar to other squid-eaters such as Sperm Whales and Risso's Dolphins.

Reproduction

Beaked whales occurred singly or in small groups of two to six. No calves were observed in any of the groups.

Little is known of the natural history of beaked whales. Female Gervais' Beaked Whales have stranded with calves during May and June in the study area (Schmidly 1981).

Behavior

When first sighted, animals were hanging at the surface but dived while the aircraft circled. No other behaviors were observed.

Potential Impacts of OCS Development

Effects of OCS development are unknown. Because beaked whales are offshore species, direct contact with oil spills and oil development activities is probably unlikely.

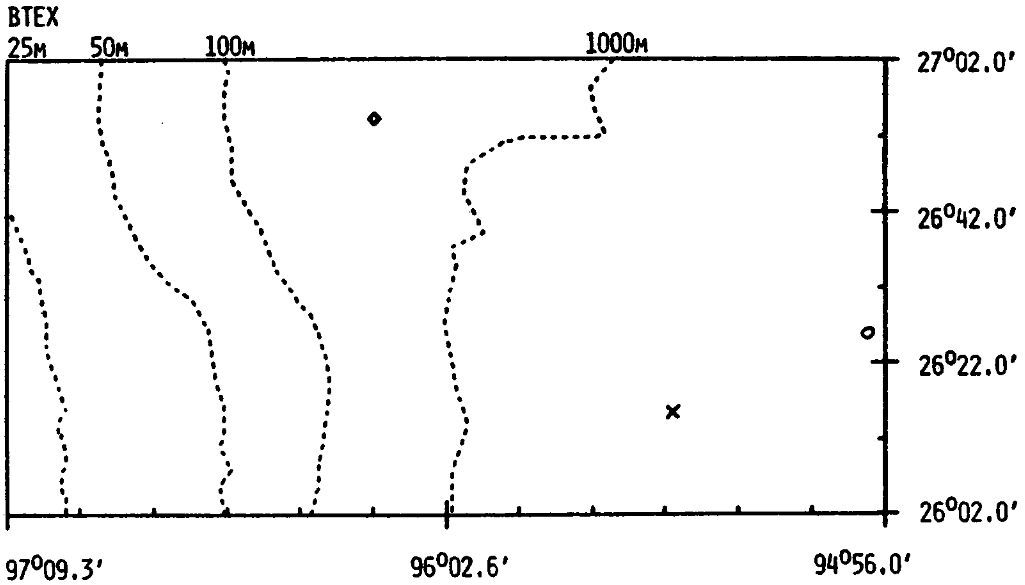


Figure 130. Distribution of all beaked whale sightings in the BTEX survey subunit during June (O), August (X), and February (◇).

Summary

Three species of beaked whales of the genus *Mesoplodon* are known from the study area. Beaked whales seen during this survey (excluding Cuvier's Beaked Whale) were identified as *Mesoplodon* spp. because identification to species was not possible from the air. Coloration of the beaked whales observed at sea was significantly different from those described for stranded animals. These discrepancies may be attributable to change in coloration of dead animals. Beaked whales were sighted in the MIFL and BTEX survey subunits, and off the west coast of Florida. These sightings occurred during June, August, December, February, and April. A seasonal pattern was not apparent. They were observed farther than 100 km from shore and in waters whose depths exceeded 550 m. The beaked whales occurred singly and in small groups. No calves were observed. Their pelagic habits should limit direct effects of OCS development.

CUVIER'S BEAKED WHALE, *Ziphius cavirostris*

Description

Cuvier's Beaked Whale may reach a length of about 7 m (Leatherwood et al. 1976) or 8 m (Schmidly 1981). The females are usually longer than males of the same age. This is a robust whale with an inconspicuous beak from which the alternate common name, Goosebeaked Whale, is derived. The small head is separated from the body by an

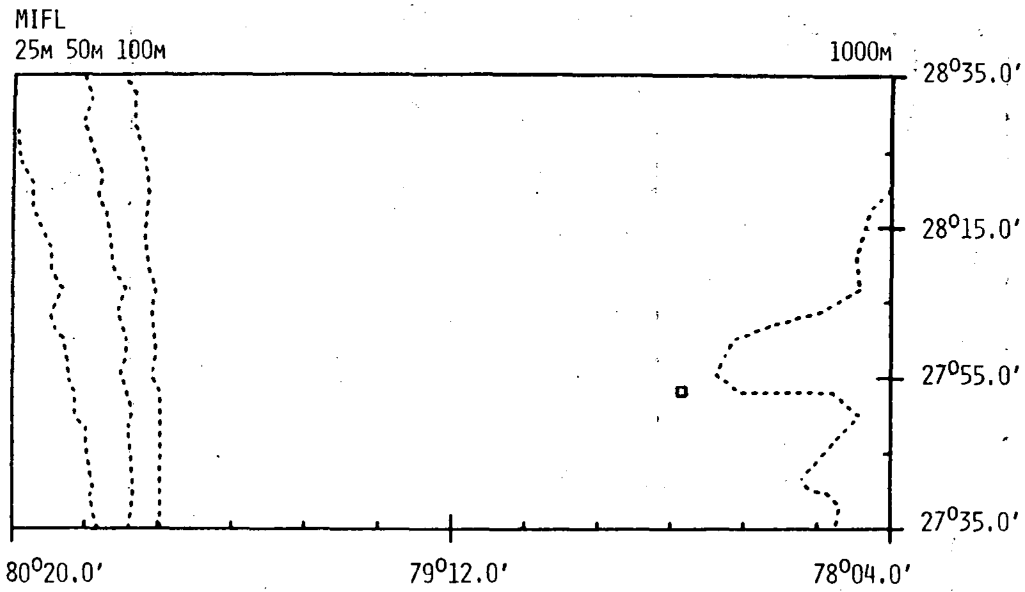


Figure 131. Distribution of all beaked whale sightings in the MIFL survey subunit during December (□).

indentation. The middle of the body is wide and chunky. The dorsal fin is set well behind the midpoint of the body. The flukes lack a deep central notch in the rear margin. The adult male has two teeth protruding from the tip of the lower jaw.

Coloration is variable (Leatherwood et al. 1976; Schmidly 1981). The dorsal surface may be black, grayish, dark brown, or fawn with small white or cream-colored blotches. The ventral surface and the area of the head are generally lighter in coloration than the dorsum. The adult male has a white head and is frequently scarred.

The only Cuvier's Beaked Whale observed in this study appeared chocolate brown with a white head. It was estimated to be 6 to 7.5 m in length.

Ziphius cavirostris is difficult to differentiate from Mesoplodon spp. from an aircraft, but the following features are useful in attempting to distinguish members of this group. The light head coloration contrasting with the dark dorsum is distinctive in Z. cavirostris, as is the relatively tall dorsal fin. The chunky body shape and position of the dorsal fin well back on the dorsum are also characteristic. Other distinguishing characters, which sometimes may be visible to aerial observers, include the small flippers set well forward on the body and the lack of a distinctive central notch in the flukes.

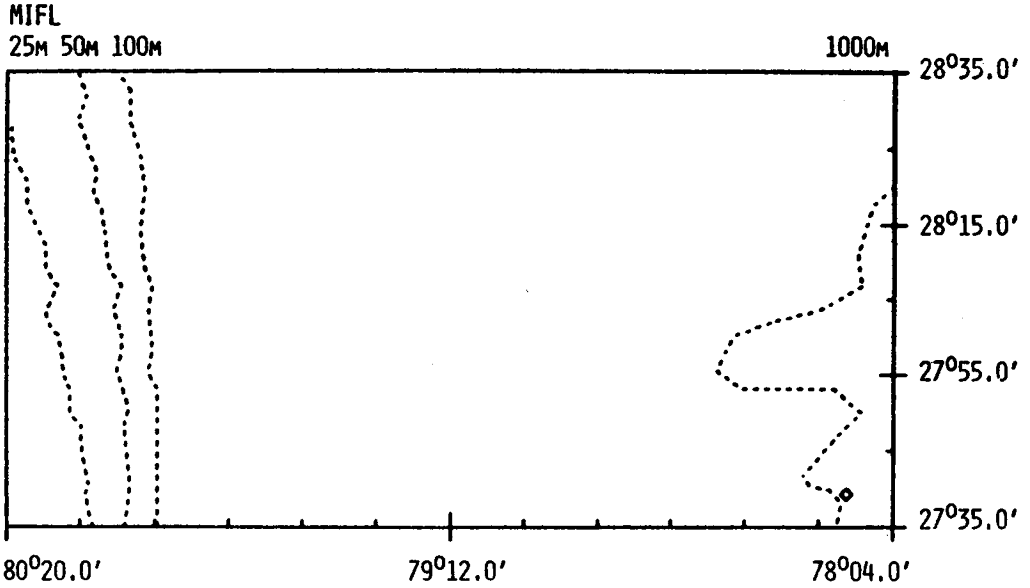


Figure 132. Distribution of all Cuvier's Beaked Whale sightings in the MIFL survey subunit during February (◇).

Distribution

One Cuvier's Beaked Whale was observed 204 km from shore (27°39.0' N; 78°11.4' W) in the MIFL survey subunit (Figure 132). This species is poorly known but cosmopolitan in offshore waters. Most available information is from stranding records (Lowery 1974a; Leatherwood et al. 1976; Schmidly 1981). In the western Atlantic Ocean it has been reported from Massachusetts to Florida and the West Indies; and in the Gulf of Mexico, from the Louisiana, Florida, and Texas coasts (Caldwell and Caldwell 1974; Schmidly 1981). It may undertake long migrations (Marcuzzi and Pilleri 1971), but movement patterns are unknown.

The only sighting of Cuvier's Beaked Whale occurred on 27 February 1981. Strandings have been reported for all months of the year on the Atlantic coast, and during the fall and spring on the Gulf of Mexico coast (Schmidly 1981). Nishiwaki (1972) reported migrations of these whales off Japan and the year-round occurrence of whales in certain areas.

Abundance

Our results add little to available information about this species. Herd size is usually small (Nishiwaki 1972). Leatherwood et al. (1976) reported that groups may contain 10 to 25 individuals, but solitary animals are most common.

Cuvier's Beaked Whale is the most commonly stranded beaked whale in the northern Gulf of Mexico: seven strandings have been reported on the Gulf coast and the Florida Keys (Schmidly 1981). Additional strandings have occurred along the U.S. east coast within the study area. The high frequency of strandings of Ziphius in relation to other beaked whales could be due to greater abundance, or to a greater tendency to come close to shore (Leatherwood et al. 1976). Stranding records on the Atlantic coast of North America may represent strays (Mead 1975a, cited by Schmidly 1981).

Habitat Use

The Cuvier's Beaked Whale observed was 204 m offshore in waters 1,049 m deep. The sea surface temperature at the location of the sighting was 23° C.

Leatherwood et al. (1976) suggested that Cuvier's beaked whale is a pelagic species. Its main diet includes squid, demersal fish, sea cucumbers, and starfish (Nishiwaki 1972).

Reproduction

Individuals are thought to attain sexual maturity at about 4.5 to 5 m in length. Length at birth is unknown, but juveniles as small as 3.1 m have been captured (Nishiwaki 1972).

Behavior

The Ziphius observed during this study was floating at the surface of the water and the animal dove as the aircraft circled for the second time. This species is known to throw the flukes in a dive, but this behavior was not seen. It is also known to jump completely out of the water.

Potential Impacts of OCS Development

The effects of OCS development on Cuvier's Beaked Whale are unknown. This whale's habit of feeding on bottom benthic animals, suspension feeders, and fish could expose it to hydrocarbons assimilated from sediment or the water column. This is an offshore species, therefore direct contact with oil spills and oil development activities is probably unlikely.

Summary

Ziphius cavirostris was positively identified in the MIFL survey subunit during February. It was 204 km from shore in water 1,049 m in depth. Cuvier's Beaked Whale is a pelagic species and little is known of its natural history and behavior.

Impacts of OCS development can only be surmised because no direct effects are known. Food sources may bring Cuvier's Beaked Whales in contact with accumulated hydrocarbons in bottom sediments. Their pelagic distribution should limit direct impact from oil spills and OCS exploration activities.

PYGMY KILLER WHALE, *Feresa attenuata*

Description

The Pygmy Killer Whale has a slender body and attains a length of about 2.1 to 2.7 m (Mitchell 1975a; Leatherwood et al. 1976). The head is rounded with an underslung lower jaw but no rostrum. The dorsal fin is falcate, about 20 to 30 cm tall, and is located in the center of the back (Leatherwood et al. 1976). Body coloration is gray to black on the dorsum, sometimes darkest around the dorsal fin, and often lighter on the sides. Generally, there are patches of white on the head, around the lips and chin, and on the ventral body.

From the air, the small body size, rounded head, dark color, and white patches are diagnostic cues.

Distribution

One sighting of 20 to 25 Pygmy Killer Whales was made 130 km offshore in the BTEX subunit (26°56.0' N; 6°05.1' W). The identification was based on both observations and photographs taken during the sighting.

Little is known about the distribution of Pygmy Killer Whales. In the western Atlantic, they probably are distributed in tropical and subtropical waters (Lowery 1974a; Leatherwood et al. 1976). Pygmy Killer Whales have been reported from the Lesser Antilles, southeastern and northwestern Florida, and southern Texas adjacent to the BTEX subunit (James et al. 1970; Leatherwood et al. 1976; Schmidly 1981). This species is most likely found offshore, but data are not available on movements (Winn et al. 1979).

Pygmy Killer Whales were observed only during the October survey (on 1 November 1980). This species has been reported in the study area during winter, spring, and summer months (Schmidly 1981). Seasonal distribution patterns are unknown (Caldwell and Caldwell 1974).

Abundance

Population estimates are not available for Pygmy Killer Whales in the study area, but the species is considered uncommon (Winn et al. 1979; Schmidly 1981). The status of the population within the study area is unknown. Pygmy Killer Whales have been taken in the commercial dolphin fisheries of the Lesser Antilles (Caldwell and Caldwell 1974). Elsewhere in the Atlantic and Pacific, they have been taken incidentally in nets (Mitchell 1975a).

Habitat Use

The single sighting of Pygmy Killer Whales was over waters 659 m deep, 130 km offshore. No data are available on the habitat preferences or associations of this species. The sea surface temperature at the sighting location was 25° C. Pygmy Killer Whales probably are restricted to warm waters (Winn et al. 1979), but data are not available on temperature preferences.

Reproduction

One adult-calf pair was identified from a photograph of the group that was sighted. The calf appeared to be one-half to two-thirds the size of the adult. Breeding information is unavailable. A young juvenile, possibly newborn, reported by Mitchell (1975a) was 82.2 cm long.

Potential Impacts of OCS Development

The lack of knowledge about Pygmy Killer Whales makes it difficult to determine the vulnerability of this species to OCS development.

Summary

One group of 20 to 25 Pygmy Killer Whales was seen on 1 November 1980 in the BTEX subunit. Information from the surveys and in the literature is insufficient to determine the significance of the sighting.

FALSE KILLER WHALE, *Pseudorca crassidens*

Description

Male *Pseudorca crassidens* reach a length of 5.7 m; females have been known to reach 5 m (Nishiwaki 1972). The body is long and slender. The head tapers from the blowhole to a blunt snout. Neither an enlarged melon nor a beak is present. The dorsal fin is tall, falcate, and pointed. The flippers are narrow and tapered with a hump on the leading edge. The flukes are notched. False Killer Whales are uniformly black except for the gray anchor-shaped blaze on the ventral surface between the flippers.

False Killer Whales have been confused with pilot whales (Caldwell et al. 1970; Leatherwood et al. 1976). The slender, less robust body shape, the narrow pointed dorsal fin, and the lack of a distinct melon are characters visible from the air which distinguish *P. crassidens* from *Globicephala* spp.

Distribution

False Killer Whales were observed only in the MIFL survey subunit only during June 1980. Strandings have occurred during July, November, December, and January (Caldwell et al. 1970; Odell et al. 1980). However, seasonal patterns are unclear.

The False Killer Whale is a pelagic species. It has been reported in the western North Atlantic from Maryland south to the Lesser Antilles and the southeastern Caribbean, including the Gulf of Mexico (Caldwell and Caldwell 1974). It is widely distributed in tropical, subtropical, and warm temperate waters worldwide (Nishiwaki 1972; Leatherwood et al. 1976; Schmidly 1981). Few sighting and stranding records exist from the study area (Schmidly 1981), which may be a result of a predominantly offshore distribution or small population size. Schmidly (1981) commented that the population of False Killer Whales may be somewhat larger than is suggested by the stranding records because stranded False Killer Whales are sometimes mistaken for *Globicephala* spp.

Abundance

During this study 24 animals were seen including five herds totaling 16 animals on 2 June 1980, and one herd of 8 animals on 3 June 1980. Average herd size was four (range = 2-8; SD = 2.2) Two mother-calf pairs were seen in one herd of eight animals.

False Killer Whales are known to travel in herds containing hundreds of individuals (Brown et al. 1966; Leatherwood et al. 1976). Nishiwaki (1972), however, stated that large groups may be rare.

Habitat Use

Sightings were in waters ranging from 640 to 741 m deep ($\bar{x}$ = 709, SD = 40.8) and were 87 to 116 km from shore (Figure 133, Table 51). Even though the False Killer Whale is a pelagic species, it is known to mass-strand (Leatherwood et al. 1976; Odell et al. 1980). A herd of three animals was associated with one unidentified dolphin, possibly *Stenella* sp.

Reproduction

Most animals observed were estimated to be 4 to 5 m in length. These animals were probably adults since Norman and Fraser (1948, cited by Odell et al. 1980) and Purves and Pilleri (1978) reported that sexual maturity is attained by both sexes at a length of 3.7 to 4.3 m. Calves constituted 17% of the 24 False Killer Whales sighted. Calves are sighted at all times of the year (Leatherwood et al. 1976). Hall and Kelson (1959) and Fraser (1937, cited by Nishiwaki 1972) reported various sizes of fetuses at the same time of year. This information suggests breeding may occur throughout the year (Nishiwaki 1972).

Behavior

Individuals in herds sighted during the present study were tightly spaced (within 0.5 m). One group of animals was moving fast when first sighted. False Killer Whales are known to jump completely out of the water when traveling (Leatherwood et al. 1976).

No feeding behavior was observed during the aerial surveys. False Killer Whales feed on squid and fish, and frequently steal fish from fishing lines (Brown et al. 1966). Preliminary evidence suggests that they may also feed on small cetaceans in the Pacific Ocean (Perryman and Foster 1980). Brown et al. (1966) reported that wear on the teeth of False Killer Whales was reminiscent of the wear reported by Caldwell and Brown (1964) on the teeth of killer whales (*Orcinus orca*), which feed on dolphins.

Potential Impacts of OCS Development

Effects of oil development activities on False Killer Whales are unknown. Few of these animals seem to be present in the study area (Schmidly 1981). Their offshore distribution probably minimizes potential impact.

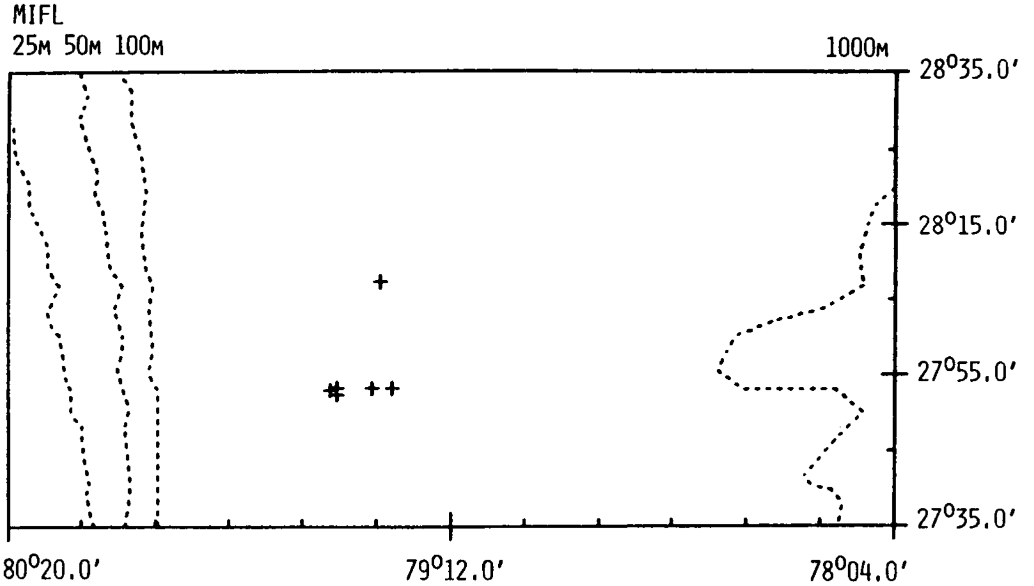


Figure 133. Distribution of all False Killer Whale sightings in the MIFL survey subunit during June (+).

Summary

Small numbers of False Killer Whales (24 total) were observed only in the MIFL survey subunit. They were sighted only on two consecutive days in June at least 93 km from shore and in water depths averaging 709 m deep. Most were adults; 17% sighted were calves. Individuals within herds were tightly grouped. Oil development effects may not be significant.

PILOT WHALES, Globicephala spp.

Includes	Long-finned Pilot Whale, Globicephala melaena
	Short-finned Pilot Whale, Globicephala macrorhynchus

Characters distinguishing Globicephala macrorhynchus from G. melaena are subtle, making the pilot whales difficult to distinguish when seen from the air. Leatherwood et al. (1976) used latitude 38° N (approximately Cape Hatteras) as the range boundary between Long-finned Pilot Whales in the north and Short-finned Pilot Whales in the south. The southernmost stranding records of G. melaena were from North Carolina and Georgia, but these records are unverified (Schmidly 1981). Therefore, the discussion below will focus primarily on G. macrorhynchus.

Table 51. Sighting information on the False Killer Whale in the MIFL subunit during June.

Date	No. of whales	Position (Latitude/Longitude)	Distance from shore (km)	Water depth (m)	Sea surface temperature (° C)
02 June 1980	3	27°53.0'N/79°21.0'W	103	640	27
02 June 1980	5	27°53.0'N/79°24.0'W	98	676	27
02 June 1980	3	27°53.0'N/79°29.4'W	90	731	25
02 June 1980	3	27°52.0'N/79°29.4'W	90	731	25
02 June 1980	2	27°52.6'N/79°30.5'W	87	731	25
03 June 1980	8	28°07.0'N/79°22.9'W	116	748	27

Description

Pilot whales have a robust body shape and are sexually dimorphic. Males of the Long-finned Pilot Whale may reach a length of 6.0 m. Females are smaller, about 5.5 m. Short-finned Pilot Whale males reach lengths of 5.3 m and females measure to 4.7 m in length (Leatherwood et al. 1976).

The head of both species is blunt and bulbous. The bulbous part of the head (melon) protrudes beyond the mouth in older individuals. Adult males have a squarish shape when viewed from above. The dorsal fin is located forward of the midbody and has a long base, recurved shape, and blunt tip. Sergeant (1962a) asserted that adult males of *G. melaena* may be distinguished from females and immature males in the field by the shape of the dorsal fin as well as the shape of the head and greater body length. On large males, the leading edge of the dorsal fin is thicker, the upper contour more rounded, and the tip more blunt than in females and young. Kritzler (1952) described similar, but more general characteristics for determining the sex of *G. macrorhynchus* in the field. The pectoral fins of pilot whales are long, slender, and recurved near the junction with the body. The fins are up to one-fifth the body length or more in the Long-finned Pilot Whale (hence the common name) and one-sixth the body length or less in the Short-finned Pilot Whale. The tail stock is strongly keeled, more so in adult males than females. The flukes are large and triangular with a central notch.

Coloration in the Long-finned Pilot Whale is blackish gray to black-brown with an anchor-shaped gray area on the chin and belly. *Globicephala melaena* also has a dorsal saddle of lighter gray behind the dorsal fin (more evident in larger animals) and a blaze or streak behind the eye (for a more detailed description, see Sergeant 1962a). The Short-finned Pilot Whale has the same general body color of *G. melaena* with similar but darker ventral markings, making the markings less conspicuous (Sergeant 1962a). *Globicephala macrorhynchus* also has a light-colored saddle behind the dorsal fin, but no post-orbital blaze has been described. Young animals of both species are a light or medium gray.

During this study, a color pattern was noted on Short-finned Pilot Whales that has not previously been described for pilot whales in the Atlantic Ocean. Directly behind the head is a large, very dark inverted chevron, the apex of which points towards the dorsal fin. It is bordered anteriorly by the coloration of the head. A conspicuous pale area borders the posterior margin of the chevron. From its distinct anterior edge, the pale coloration fades evenly into the body coloration near the area of the dorsal fin (Figure 134). This pattern was most distinct on large, dark animals and was more difficult to see in smaller, lighter animals. A similar color pattern anterior to the dorsal fin has been described for G. scammoni (considered to be G. macrorhynchus by Mitchell 1975a) in the Pacific by Norris and Prescott (1961). From the photographs accompanying Norris and Prescott's description, the pattern seems smaller and less bold in the Pacific animals. In the animals seen in this study, the saddle behind the dorsal fin seemed to vary in intensity and size; the saddle was often seen extending far onto the tail stock, forward along the dorsal fin, and down the sides.

Distribution

Pilot whales were observed in the BTEX, MILA, and MIFL survey subunits (Figures 135 and 136). In the MIFL survey subunit, 680 pilot whales were seen in 69 sightings (including opportunistic surveys). These whales constituted 83% of all pilot whales seen in the study area. A total of 111 (13%) pilot whales were sighted in the BTEX survey subunit in three sightings (including opportunistic surveys). One sighting of 33 (4%) pilot whales occurred in the MILA survey subunit.

Of the two species of pilot whales occurring in the Atlantic Ocean, G. melaena is antitropical in distribution (Davies 1960, 1963), and G. macrorhynchus occurs at lower latitudes. Globicephala macrorhynchus occurs in the tropical and warm temperate regions of the Atlantic, Pacific, and Indian Oceans (Davies 1960). Specifically, its range in the western Atlantic seems to be from Cape Hatteras, North Carolina, to the Venezuelan coast, including the Caribbean and the Gulf of Mexico. The Short-finned Pilot Whale is reported to be an offshore species (Lowery 1974a), which is where it was sighted in this study (Figures 135 and 136).

Pilot whales were observed in all survey months except December. The distribution of pilot whales within the MIFL survey subunit was concentrated during February but tended to be dispersed in April (Figure 136). These differences may reflect distributional changes in food and current patterns. Based on stranding records for the study area (Schmidly 1981), plus the data presented here, it is probable that the Short-finned Pilot Whale is present within the study area year-round.

Of the pilot whales sighted in the MIFL survey subunit, 56% (384) were seen during April, 32% (218) during February, 5% (33) during August, and 6% (45) during June. In the BTEX survey subunit, 68% (75) were seen during April and 32% (36) during February. Pilot whales in the MILA survey subunit were observed only in October. The seasonal increase in abundance of pilot whales in the MIFL survey subunit may reflect the movement of new animals into the study area in early spring (February and April). During February, pilot whales were heading generally north and west. From Table 52, 60% of the herds were heading in a northerly direction (north, northeast, and

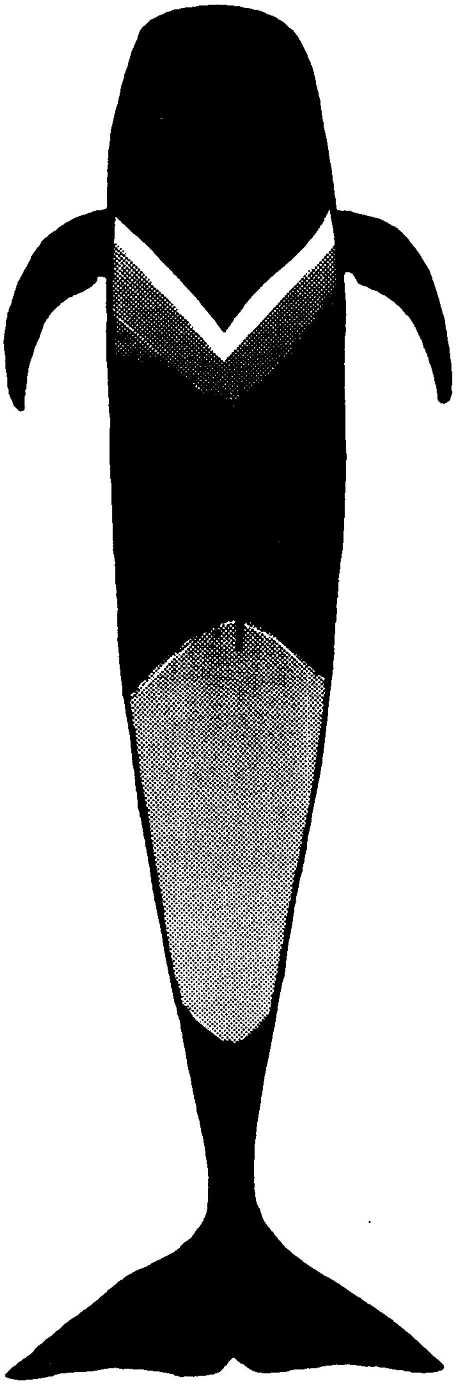


Figure 134. Diagram of dorsal color pattern in Short-finned Pilot Whales as seen from aircraft. Colors matted are relative and were chosen to show comparative shading.

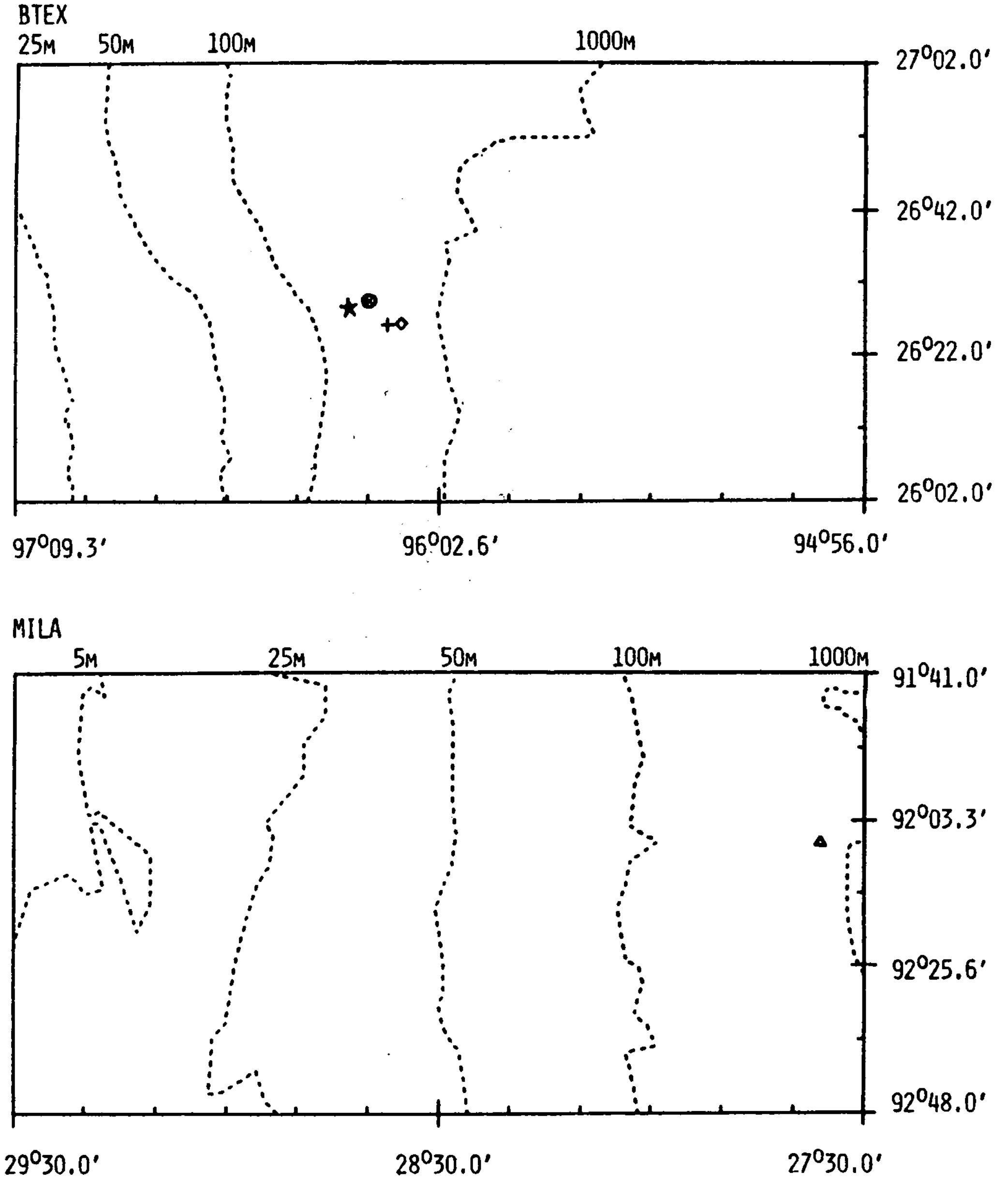


Figure 135. Distribution of all Short-finned Pilot Whale sightings in the MILA and BTEX survey subunits during October (△), February (◇), April (+), August 1979 (⊗), November 1979 (★).

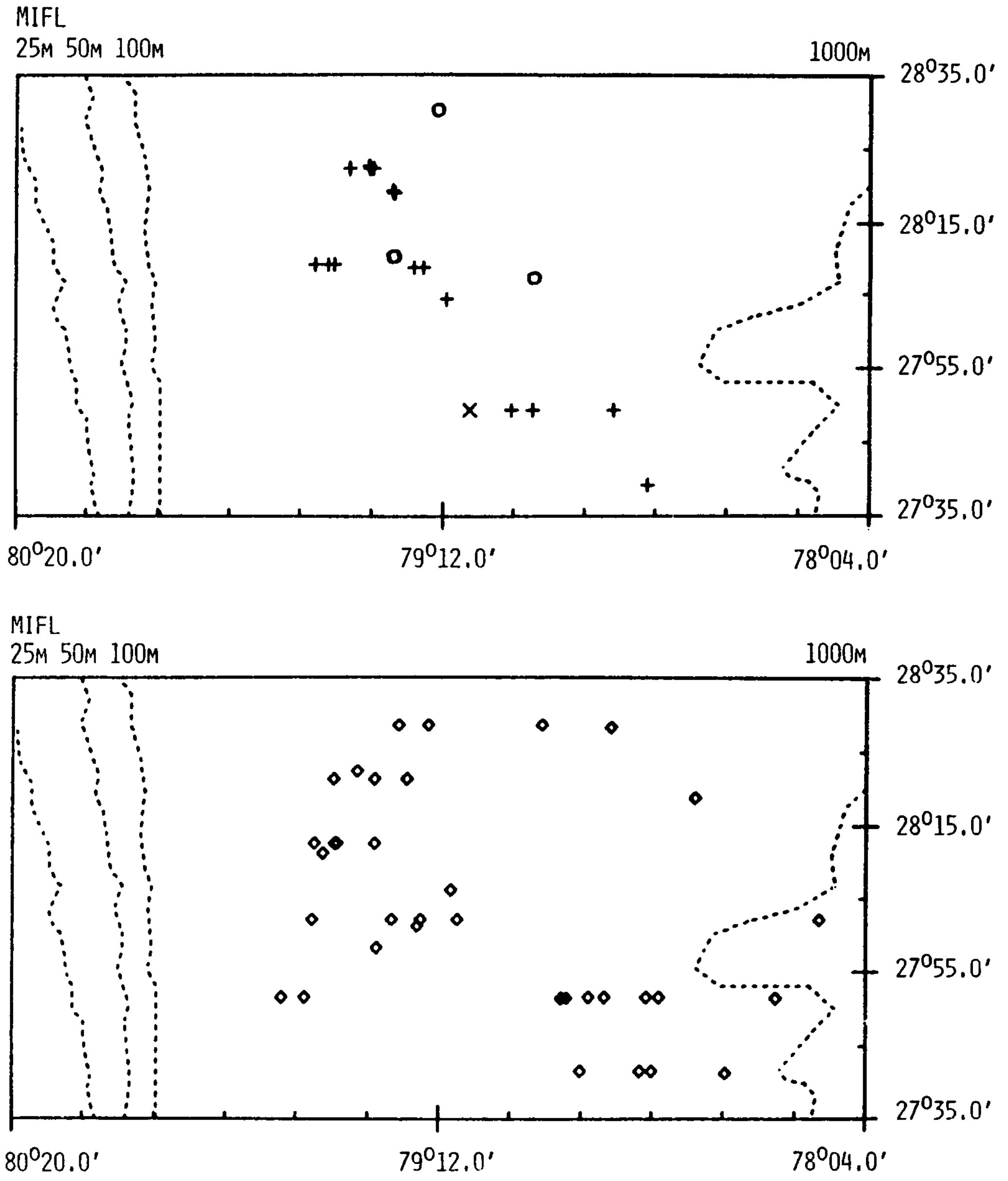


Figure 136. Distribution of all Short-finned Pilot Whale sightings in the MIFL survey subunit during June (O), August (X), February (+), and April (◇).

Table 52. The direction of movement of Short-finned Pilot Whales during February and April in the MIFL survey subunit.

Direction of movement	February		April	
	No. of sightings	Percent of sightings	No. of sightings	Percent of sightings
North	2	20	2	9.1
Northeast	1	10	0	0.0
East	1	10	0	0.0
Southeast	0		2	9.1
South	1	10	8	36.4
Southwest	0		6	27.3
West	2	20	3	13.6
Northwest	3	30	1	4.5

northwest). Fifty percent of the herds were heading in a westerly direction including west and northwest. During April, the heading of pilot whales was opposite. They were heading generally south and west. About 73% of the herds were headed south, including south, southeast, and southwest. About 45% of the herds were headed west, including west, southwest, and northwest. Although these orientations are noteworthy, data are insufficient for interpretation of seasonal movements.

Sergeant (1962b) outlined inshore/offshore migrations of Long-finned Pilot Whales following the movements of spawning squid onto the continental shelf in late summer and off again in winter. Similar movements have been described for G. macrorhynchus in the Pacific Ocean off southern California (Norris and Prescott 1961). These whales (G. melaena and G. macrorhynchus of the North Pacific) are reported to move northward in summer and southward in winter. The increased abundance of tuna in the area around Puerto Rico in summer is accompanied by the appearance of Short-finned Pilot Whales in the area (Caldwell and Erdman 1963). This is the only report of a seasonal movement of Short-finned Pilot Whales in the Western Atlantic.

Abundance

Sample sizes in the MIFL survey subunit were large enough in February and April to calculate densities of Short-finned Pilot Whales (Table 53). The density of individual animals was 0.32 x 10^{-1} whales/km^2 during February. During April, the density of individual animals was 0.93 x 10^{-1} whales/km^2. The pooled density estimate for pilot whales was 0.29 x 10^{-1} whales/km^2. Pilot whale sightings were not evenly distributed over the subunit. They were restricted to deep water (100 m and more). Because waters

Table 53. Density and group size estimates for on-line sightings of Short-finned Pilot Whales. "All" represents combined months. * = variance too small for calculation.

Survey subunit	Month	No. of sightings	Group density (groups/km^2)	Variance	Mean group size	Standard error	Individual density (whales/km^2)
MIFL	February	12	0.38×10^{-2}	*	8.2	1.97	0.32×10^{-1}
MIFL	April	17	0.85×10^{-2}	*	10.9	2.08	0.93×10^{-1}
MIFL	All	33	0.27×10^{-2}	*	10.9	1.53	0.29×10^{-1}

beyond 111 km from shore were sampled only one third as often as those areas within 111 km, density estimates presented are probably underestimates.

Based on stranding and sighting records, Schmidly (1981) speculated that G. macrorhynchus is one of the more common species of cetaceans in the study area. Moore (1953) and Layne (1965) reported Short-finned Pilot Whale strandings were more numerous than those of any other cetacean in Florida waters. Moore (1953), however, cautioned against estimating abundance of pilot whales relative to other cetaceans based on strandings, because pilot whales tend to mass-strand. Other more frequently sighted cetaceans, such as the Bottlenose Dolphin, do not mass-strand. Lowery (1974a) suggested pilot whales are "fairly common" in the northern Gulf of Mexico and regularly occur offshore of Louisiana. A fishery exists for this whale in the Lesser Antilles, but Caldwell and Caldwell (1975) presumed that the population size was affected little by this exploitation.

Across seasons, average herd size was fairly constant in the MIFL survey subunit, about 10 individuals per herd (Figure 137). In February and April, the herds were sometimes scattered over relatively localized areas (e.g., 10 to 30 km in length) and may have been dispersed subgroups of larger herds. The larger herds seen in the western Gulf are difficult to evaluate due to the small number of sightings. Pilot whale herds are known to sometimes contain 60 or more individuals, but smaller groups are more common (Leatherwood et al. 1976).

Habitat Use

Mean distance from shore by month in the MIFL survey subunit ranged from 123 to 143 km and included 69 sightings in four survey months (Figure 136 and 138). Distances from shore in the BTEX survey subunit were from 111 and 115 km in the 2 months pilot whales were observed there. Pilot whales were observed 215 km from shore in the MILA survey subunit on one occasion (Figure 138). In the BTEX survey subunit, the sightings of pilot whales during the February and April surveys occurred 78 days apart and yet were within 3.5 km of each other. During an opportunistic flight 4 days before the scheduled

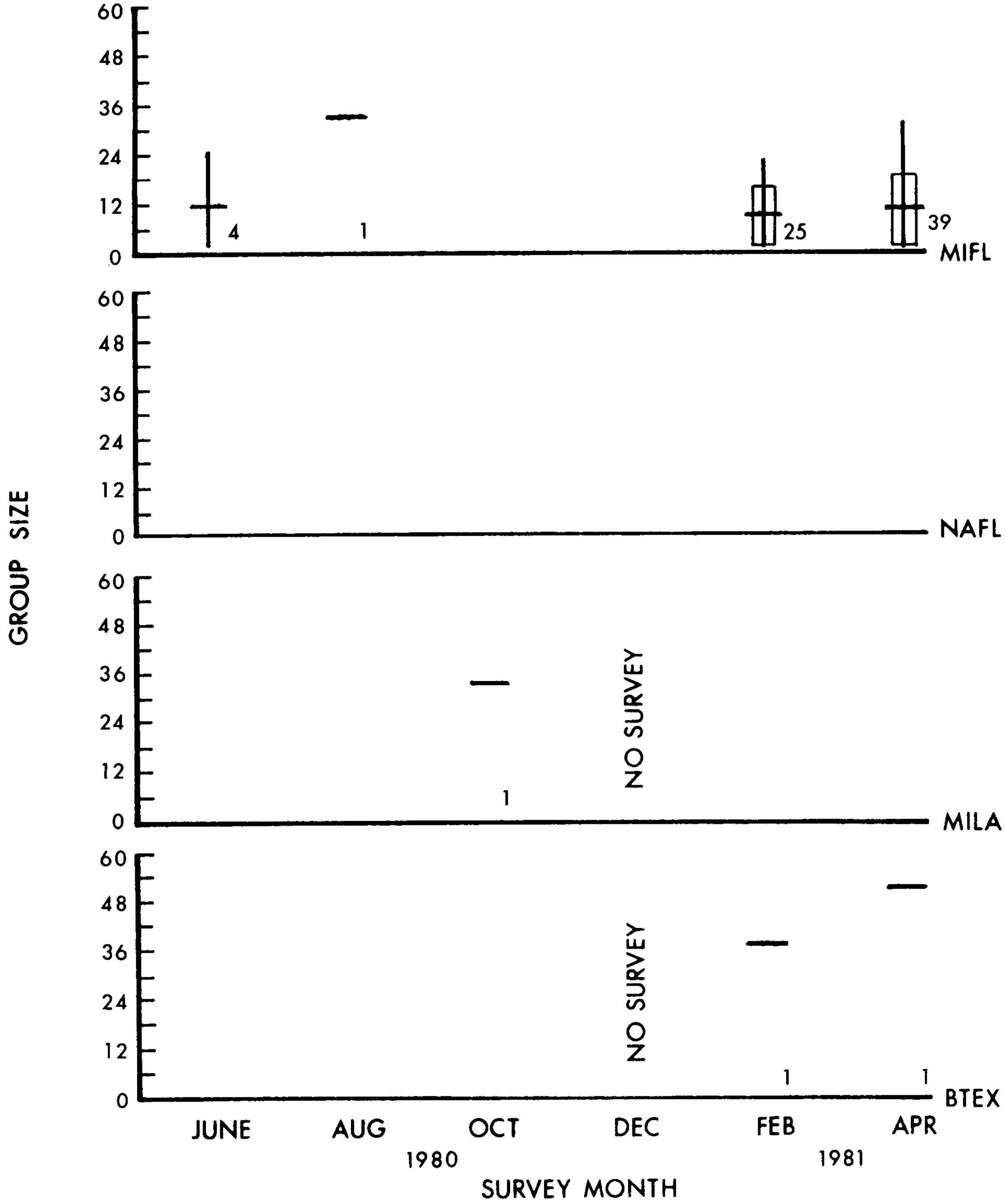


Figure 137. Group size for all sightings of Short-finned Pilot Whales by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

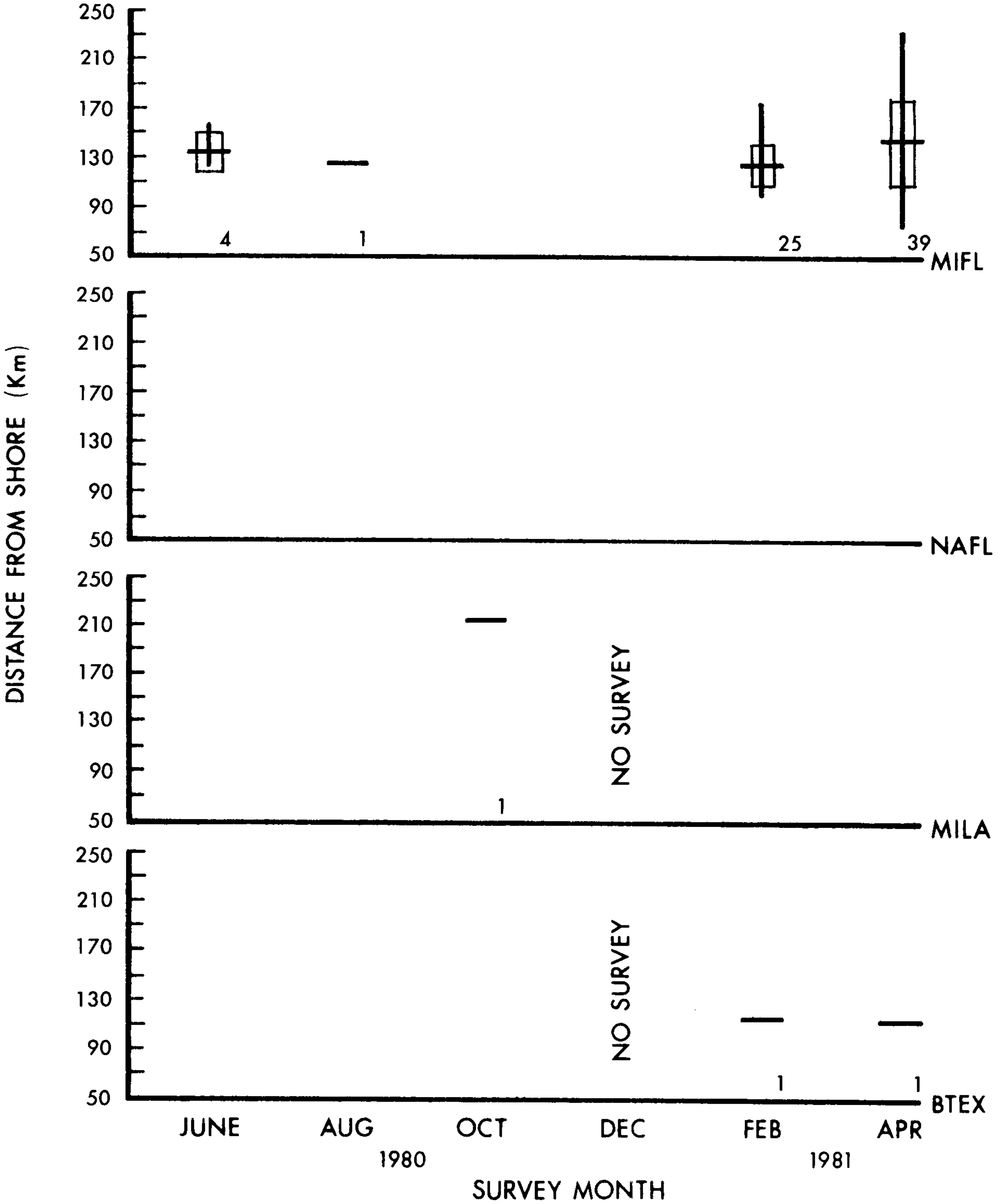


Figure 138. Distance from shore for all sightings of Short-finned Pilot Whales by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

April survey, another herd of pilot whales was seen within 11.0 km of the first sighting location. During August of the 1979 aerial survey by Fritts and Reynolds (1981), a group of 10 to 15 pilot whales was observed within 11 km of these sighting locations. Whether the four sightings constitute repeated encounters with the same group of animals remaining near or returning to the same area is unknown. It seems likely that the concentration of pilot whales in this area is due to exceptional ecological conditions, such as an abundant food source.

Pilot whales were observed in water ranging from 618 to 1,143 m deep. Average water depths at sighting locations in the MIFL survey subunit ranged from 618 to 806 m. Water depths at the sighting locations in the BTEX survey subunit ranged from 685 to 786 m. The water depth at the pilot whale sighting in the MILA survey subunit was 841 m (Figure 139).

Pilot whales feed in deep offshore waters (Lowery 1974a), which accounts for the offshore distribution in this study. They feed on squid and fish (Leatherwood et al. 1976) and in some areas may follow the migrations of their prey (Norris and Prescott 1961; Sergeant 1962b).

Sea surface temperatures where pilot whales were sighted ranged from 21° C during February and April in the BTEX survey subunit to 28° C during June in the MIFL survey subunit (Figure 140). The animals were most frequently sighted in water temperatures of 22° to 24° C in the MIFL survey subunit.

Associations

Three sightings in which pilot whales were associated with water masses occurred in the MIFL survey subunit (two in February and one in June). The sightings consisted of 12, 17, and 17 animals, respectively. Five sightings of pilot whales included associations with other species. Two pilot whale groups occurred with *Stenella* sp. In June, a small group of 9 Short-finned Pilot Whales was observed with 20 to 25 *Stenella* sp. During February, 1 sighting of 41 pilot whales, spread into subgroups, also included 4 *Stenella* sp. and 1 shark. A concentration of flyingfish and 3 sharks were associated with 13 pilot whales in the MIFL survey subunit during April.

Reproduction

Of the 824 total animals observed, 45 (5%) were calves or young. Large herds were more likely to include calves. Approximately 42% of all sightings were of herds of 10 or more animals; 56% of such herds had one or more calves. Only 7% of all groups with less then 10 animals included calves and none had more than 1 calf. Of the 21 sightings where calves were present, 38% (8) consisted of one calf per group, 33% (7) consisted of two calves per group, 24% (5) consisted of three calves per group, and 5% (1) consisted of eight calves per group. Calves were seen in every month that adults were noted.

Births of Long-finned Pilot Whales occur throughout the year but peak in summer (Sergeant 1962b). Information obtained from mass strandings of Short-finned Pilot Whales indicates a long breeding and calving season. Calves are about 1.4 m in length at birth. The interval between calving is about 3 years. Females reach sexual maturity at about 3 m and males reach sexual maturity at about 5 m (Mitchell 1975a).

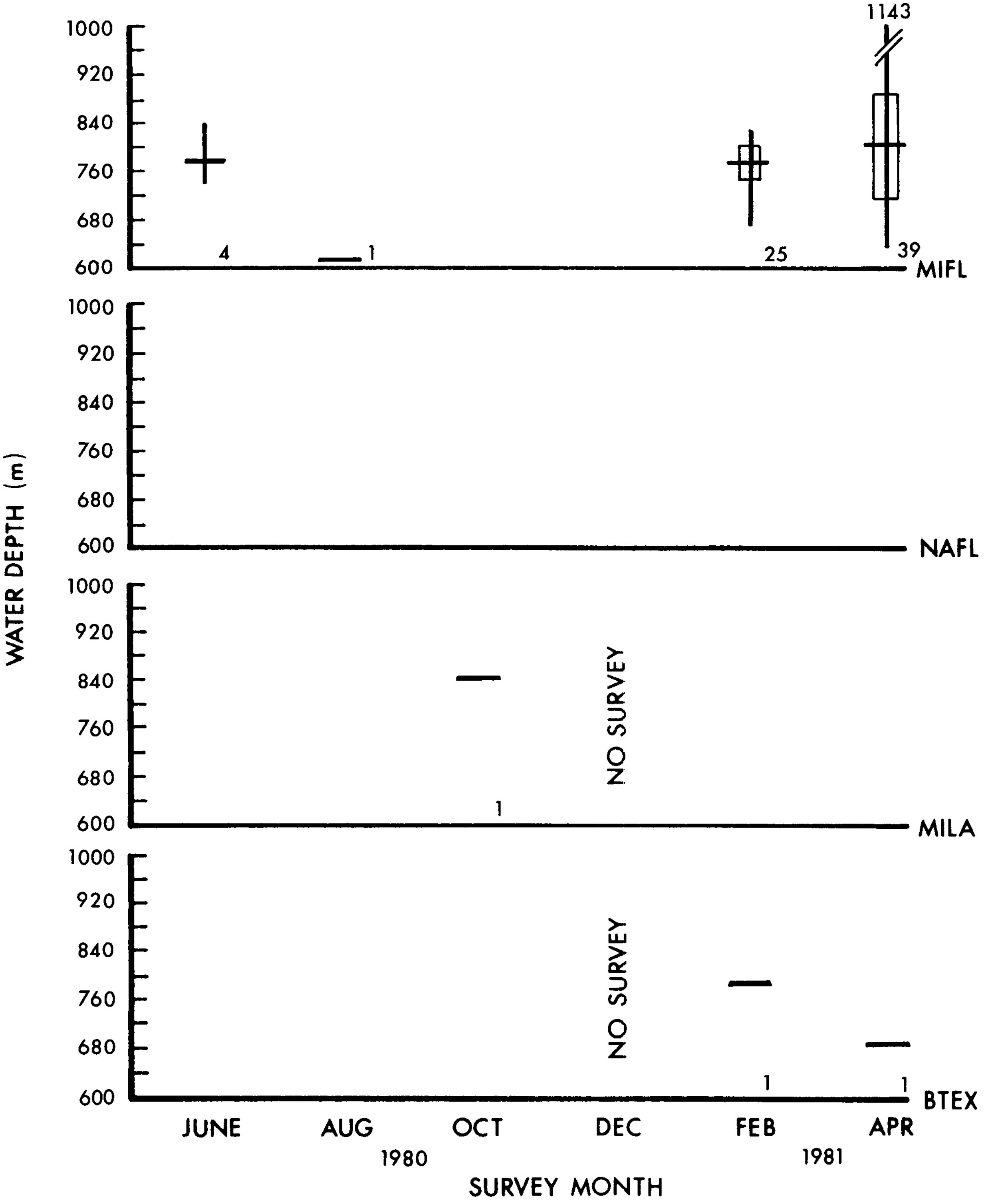


Figure 139. Water depth for all sightings of Short-finned Pilot Whales by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

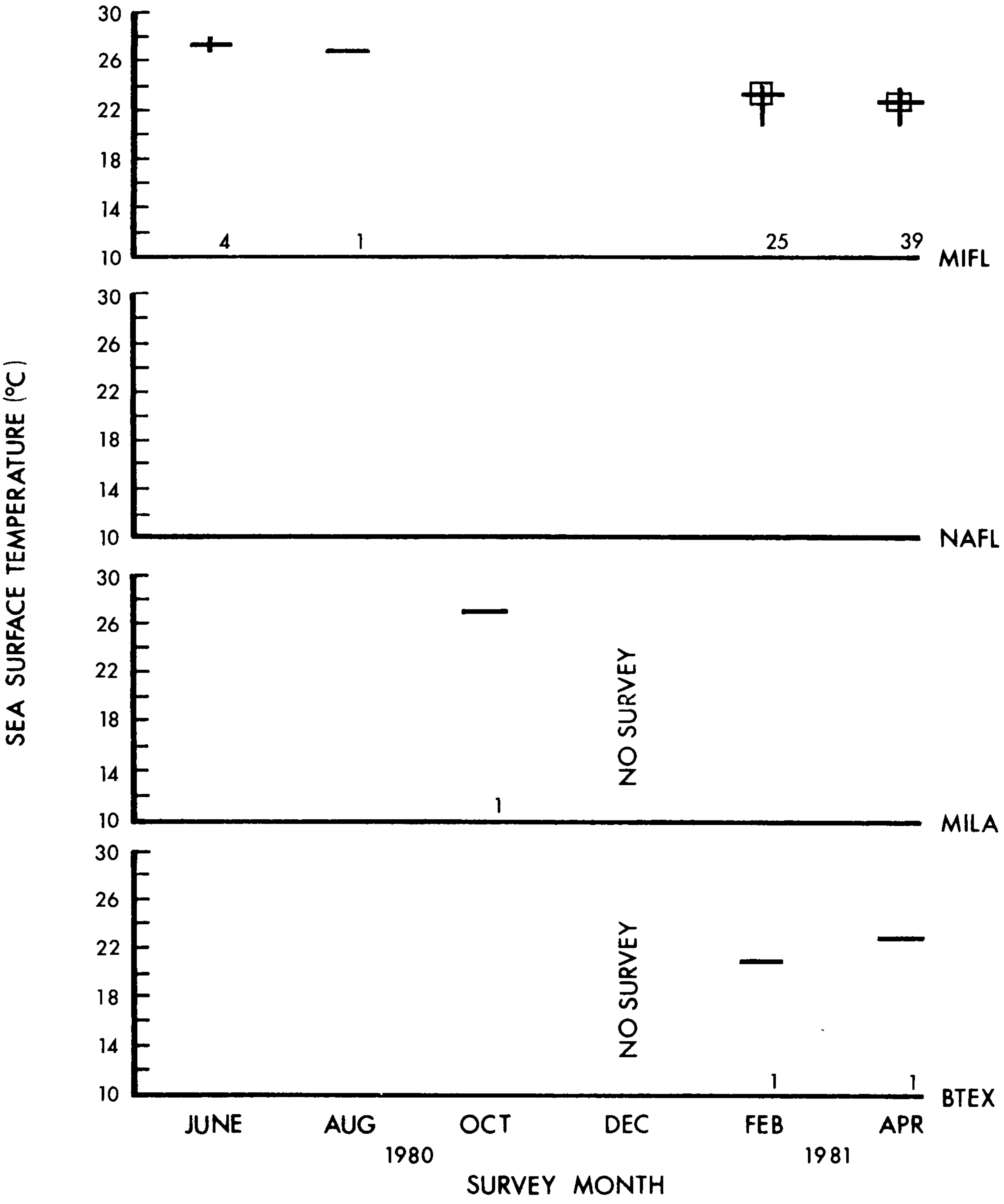


Figure 140. Sea surface temperature for all sightings of Short-finned Pilot Whales by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

Behavior

Some of the herd formations seen in this study resembled structured ranks of foraging groups, whereas others appeared to be unstructured loafing groups (Norris and Prescott 1961). Nine groups of variable sizes were in abreast formation. At least three larger herds were in broad transverse lines relative to the line of movement. The school or pod in this formation has been termed by Norris and Prescott (1961) as a traveling or hunting school. Norris and Dohl (1980a) suggested it is a food-searching pattern that allows the animals to scan a wide area of ocean in search of prey. The group of four *Stenella* sp. associated with the large group of pilot whales may have been taking advantage of the greater foraging abilities of the larger group of Short-finned Pilot Whales. Off California, small cetaceans are reported to follow foraging pilot whales to locate food (Norris and Dohl 1980a), but little information is available about feeding behavior of pilot whales and associated species in the Atlantic Ocean.

Of the loafing groups observed, the whales were facing all directions, and little or no forward motion was observed. In the loafing groups, individual behavior was observed. Spy hops, tail slaps, and head slaps occurred occasionally. The context of such behaviors is unknown.

In contrast to some cetaceans (see *Stenella* spp. and *Tursiops truncatus* species accounts), pilot whales did not appear to react strongly to the presence of the survey aircraft. Individuals frequently rolled onto their side, possibly to look at the aircraft.

Potential Impacts of OCS Development

Direct effects of OCS development on pilot whales are unknown. *Globicephala macrorhynchus* occurs in the MIFL survey subunit for much, if not all, of the year. The offshore distribution of pilot whales makes impacts from oil spills unlikely, although spills in south Florida could be carried north by the Gulf Stream and could then affect the animals.

Summary

Pilot whales were observed in all survey subunits except NAFL and in all months but December. They were most abundant in MIFL, especially during February and April. They were distributed at distances over 100 km from shore. Sightings occurred in waters deeper than 450 m and with sea surface temperatures ranging from 21° to 28° C. Several herds of whales were associated with small cetaceans such as *Stenella* spp. Calves constituted 5% of all Short-finned Pilot Whales sighted. Large groups usually contained more calves than did small groups. Several behaviors, including spy hopping, head slapping, and tail slapping, were observed mostly in loafing groups. Direct effects of OCS development are unknown but would probably be greatest off eastern Florida during February and April.

BOTTLENOSE DOLPHIN, *Tursiops truncatus*

The taxonomy of *Tursiops* spp. is somewhat confused because of a lack of study specimens in many areas (Mitchell 1975a; Ross 1977). As many as 20 species have been attributed to the genus *Tursiops* (Hershkovitz 1966), and some cannot be differentiated in the field (Van Gelder 1960). However, participants at a recent review of small cetacean biology suggested that "there is only one species of Tursiops, with sharply defined geographic races varying in body size and tooth size and distributed differentially relative to sea temperature and depth" (Mitchell 1975a). Stocks along the eastern United States may consist of a large offshore and a smaller inshore form, but this has not been documented (Mitchell 1975a). Both forms are typically referred to as T. truncatus. Based on preliminary analysis, only limited gene flow occurs between offshore and onshore populations (Duffield 1980). Because the relative size of the two forms is difficult to determine accurately from the air, it was not possible to differentiate confidently the "large" and "small" forms in this study.

Description

The Bottlenose Dolphin is the species most frequently trained for television, movies, and other entertainment; and it is the most commonly held cetacean in oceanariums and public exhibits throughout the world (see review by Leatherwood and Reeves in press).

Male Bottlenose Dolphins reach maturity at 2.5 to 3.0 m in length and 180 to 230 kg in weight (Ridgway and Benirschke 1977). Females are slightly smaller, but cannot be differentiated from males at a distance. Bottlenose Dolphins generally appear robust with short stubby snouts, a tall falcate dorsal fin near midbody, and deeply notched flukes. Fluke width may be 10% to 13% of the total body length (Ridgway 1972b). Relative stoutness and beak length may vary within the same group.

Coloration is usually dark gray dorsally to lighter gray sides, and white or pink on the belly. The dark coloration on the back may appear as a distinct cape near the head (Leatherwood et al. 1976). Markings include subtle striping from the blowhole to the rostrum and from the eye to the flipper, and a small genital blaze; but these are difficult to see on many animals. Color variants include albinos or cinnamon-buff colored individuals (Caldwell and Caldwell 1972), and the extent and shading of the dorsal coloration on this species varies geographically (Perrin 1972).

From the air the robust body shape, short rostrum, and gray color are the most obvious distinguishing features.

Distribution

Bottlenose Dolphins were sighted on all monthly surveys in each survey subunit (Figures 141 through 144). A total of 3316 Bottlenose Dolphins were seen in the four survey subunits. The largest number was seen in the NAFL subunit and the second largest number was in the MILA subunit. In the NAFL and MIFL subunits, Bottlenose Dolphins were most common in winter with peak abundance occurring in February. A February peak was also observed in data from the MILA subunit, although December surveys were not completed there. In the BTEX subunit, peak abundance occurred in October (December surveys were not completed). Thus, our data suggest a greater abundance of Bottlenose Dolphins within our subunits during winter, but further sampling is needed to confirm this trend.

Changes in seasonal abundance are poorly known in most areas of the southeastern United States. Several authors reported increased abundance off Texas during the winter

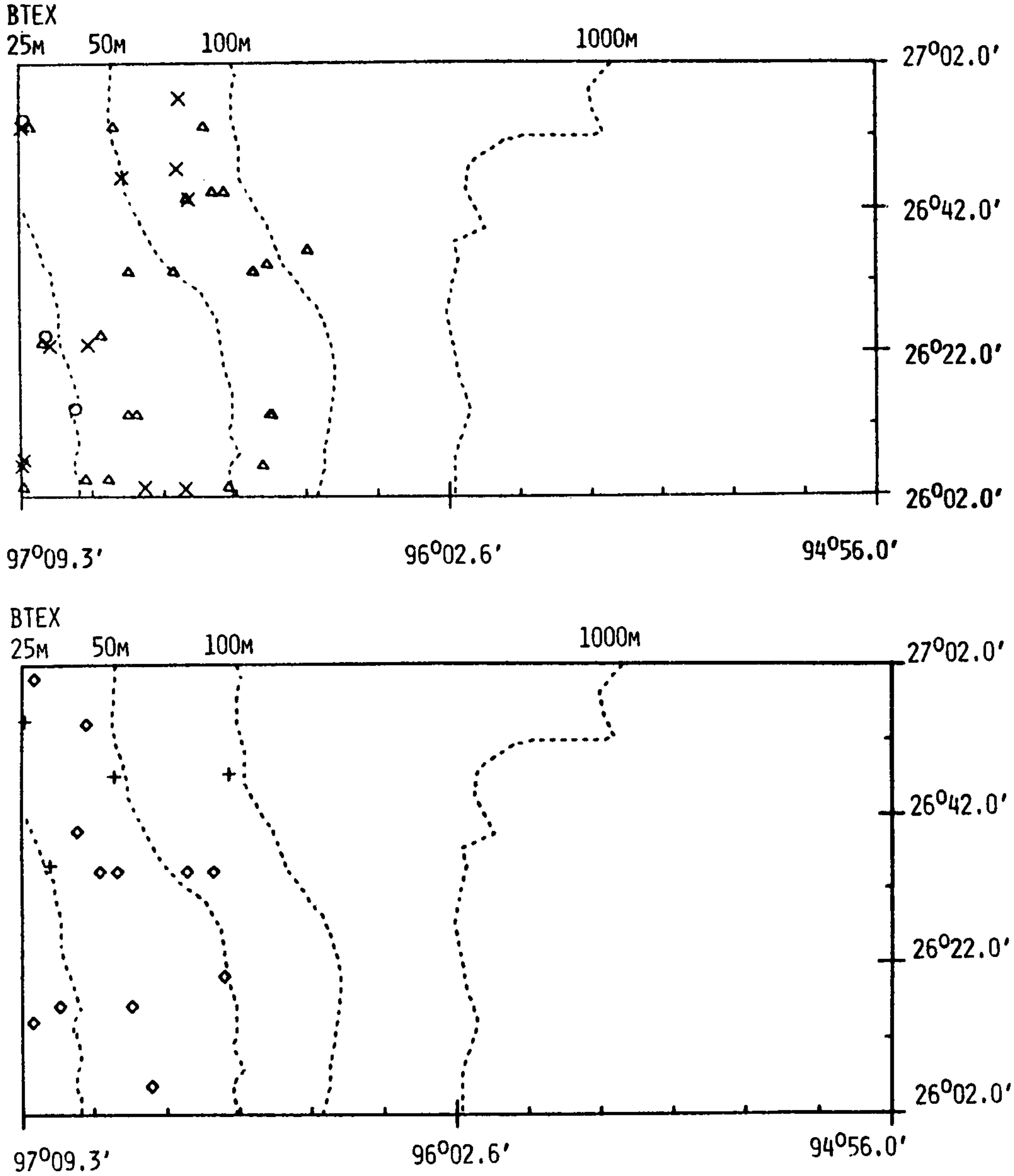


Figure 141. Distribution of all Bottlenose Dolphin sightings in the BTEX survey subunit during June (O), August (X), October (△), February (◇), and April (+).

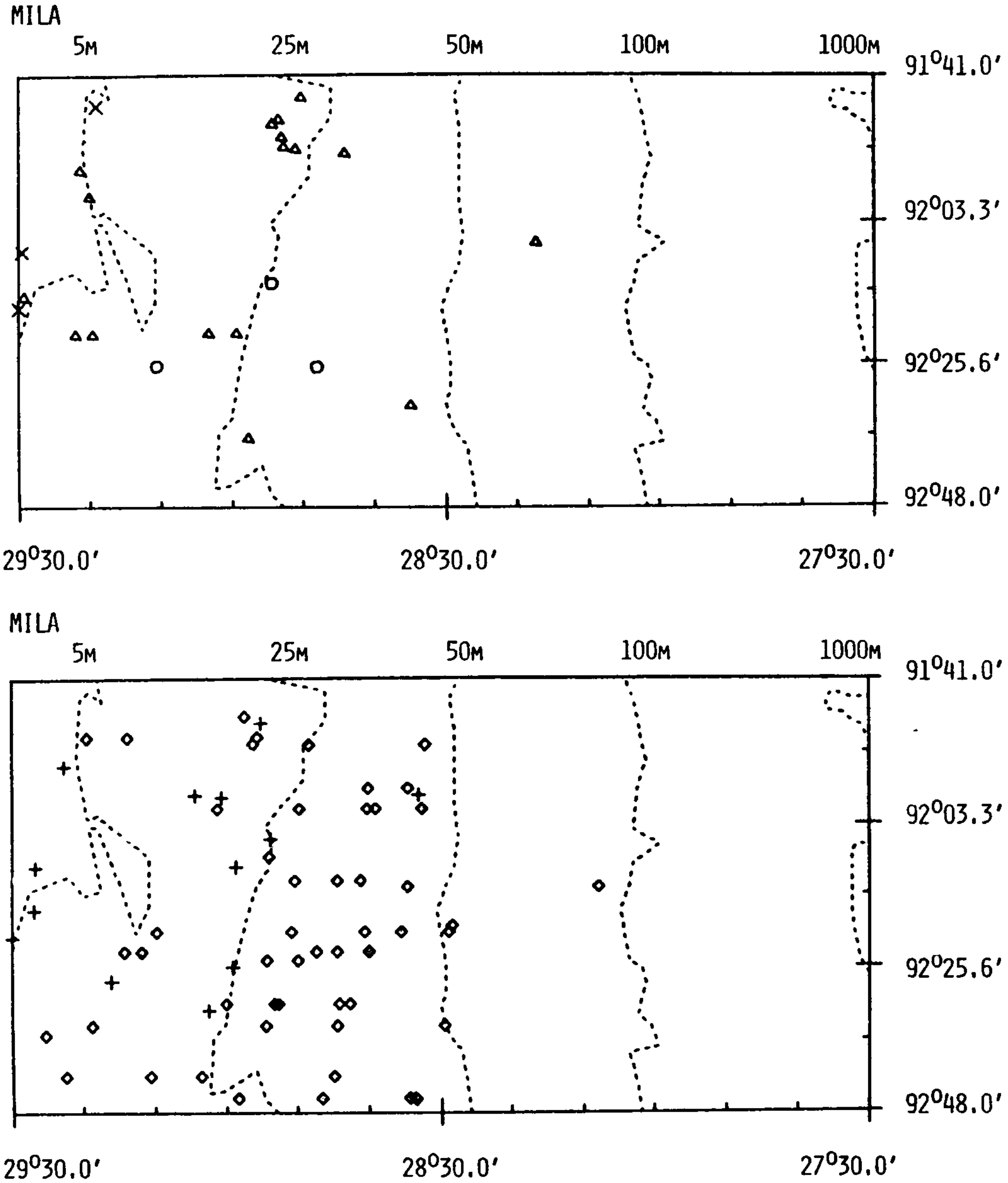


Figure 142. Distribution of all Bottlenose Dolphin sightings in the MILA survey subunit during June (O), August (X), October (△), February (◇), and April (+).

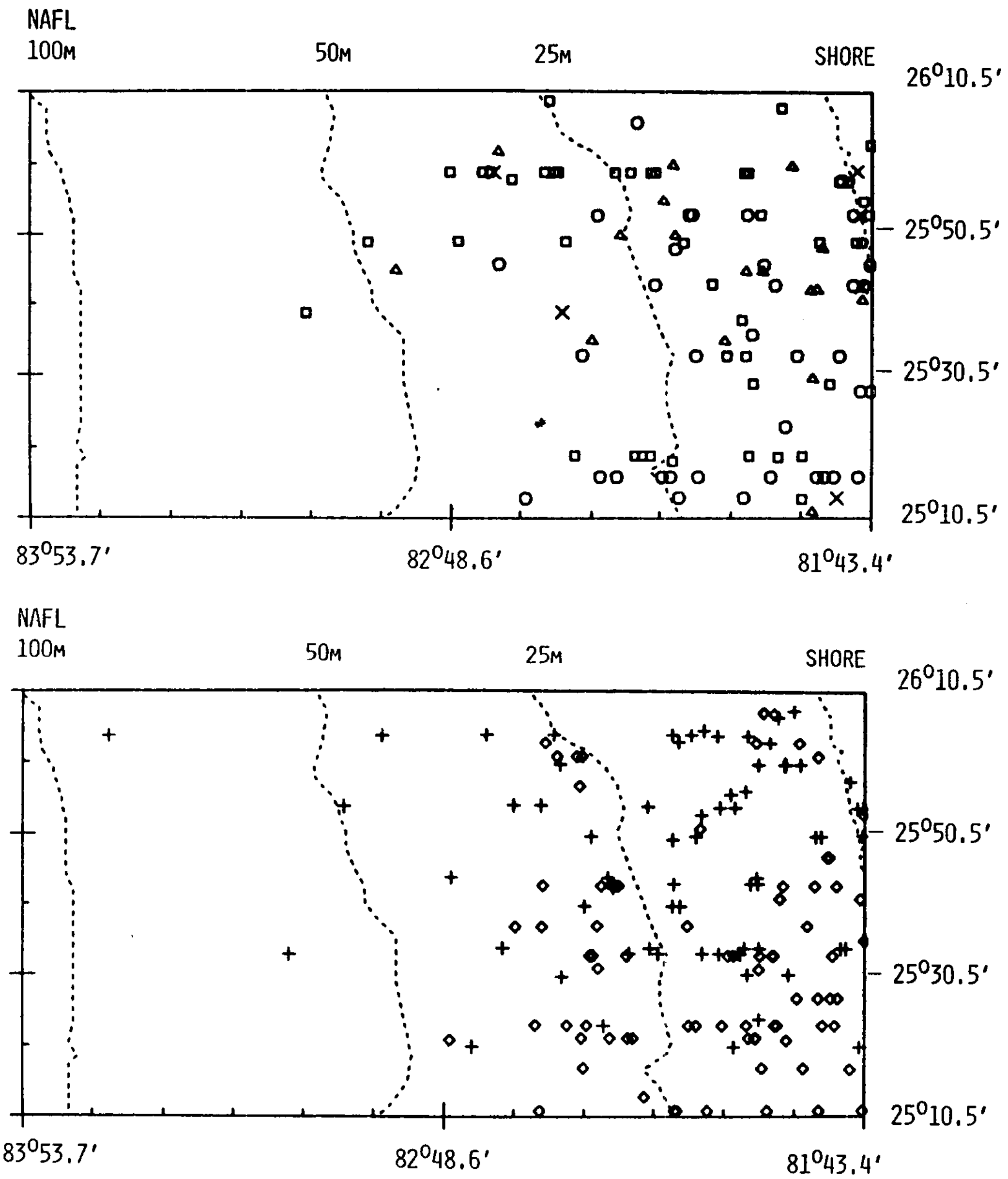


Figure 143. Distribution of all Bottlenose Dolphin sightings in the NAFL survey subunit during June (O), August (X), October (△), December (□), February (◇), and April (+).

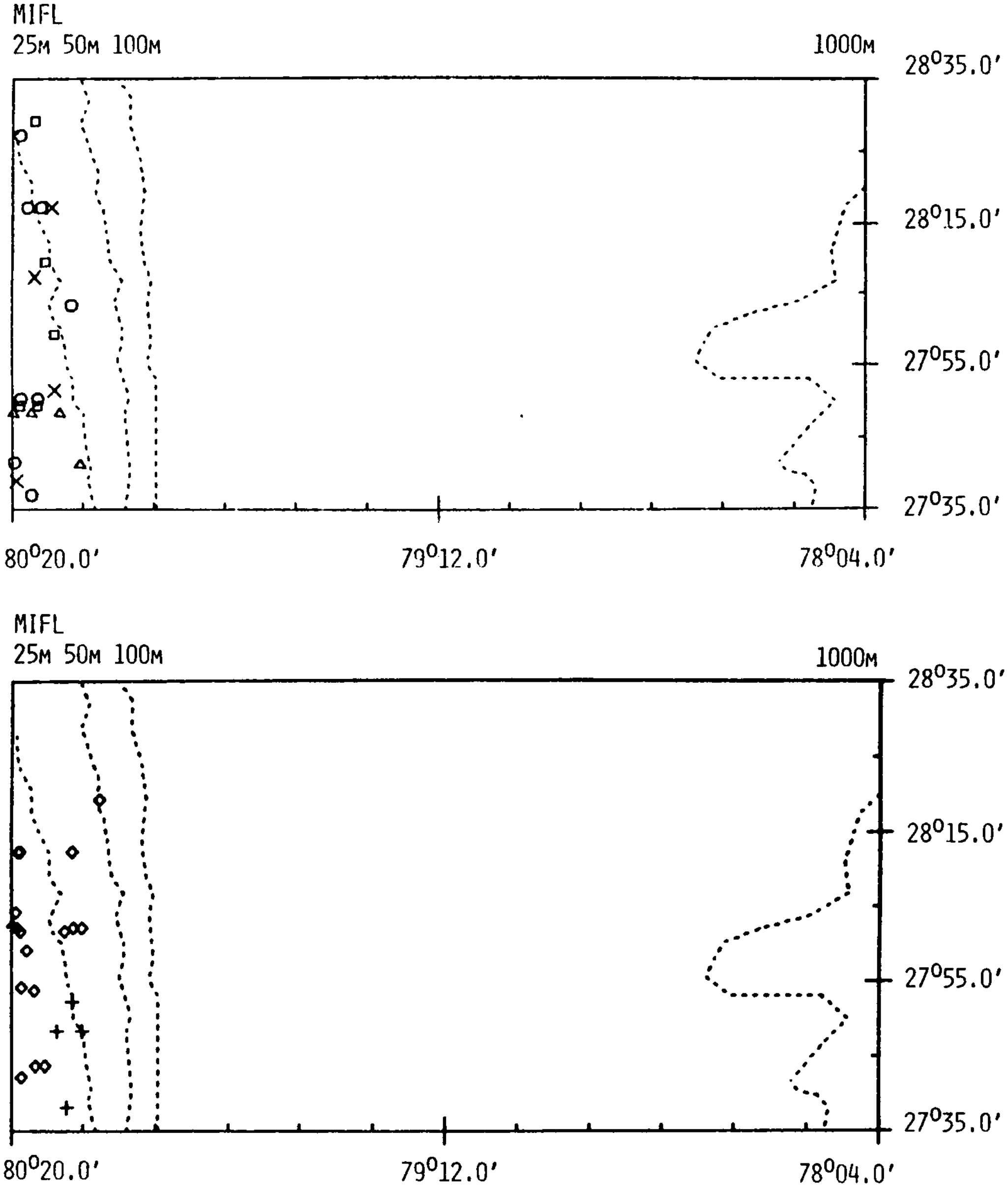


Figure 144. Distribution of all Bottlenose Dolphin sightings in the MIFL survey subunit during June (O), August (X), October (△), December (□), February (◇), and April (+).

(Shane 1980; Gruber 1981; Leatherwood and Reeves in press). Shane (1980) reported twice as many dolphins in the Aransas Pass area of Texas during the winter as during the summer, but seasonal abundance shifts reportedly did not occur in some Texas bays (Gunter 1942). Results from this study showed an October increase in abundance (Table 54), although the lack of a December survey could mask a larger increase in winter. Irvine et al. (in press) reported only local distribution shifts (not changes in abundance) of resident animals by season in Florida. Most studies to date have been localized and may have encompassed only parts of the range of individual dolphins being studied. Consequently, it is unclear if reported abundance shifts (e.g., the seasonal influx of animals into an area) represent a seasonal change in range or merely more intensive seasonal use of particular areas within a limited range.

Bottlenose Dolphins are found throughout the world in coastal areas in tropical to warm temperate waters (Mitchell 1975a; Leatherwood et al. 1976). In the western North Atlantic, they range as far north as offshore areas near Nova Scotia and coastal areas of the New York Bight (Mitchell 1975a; Leatherwood et al. 1976). Mitchell (1975a) suggested that the large form generally occupies colder waters than the small form, but few specimens are available from offshore areas to substantiate this hypothesis. Distribution is almost continuous from New Jersey south through the eastern sea board, the Gulf of Mexico, and the Caribbean, including the continental shelf and around oceanic islands (Leatherwood et al. 1976).

In the southeastern United States, Bottlenose Dolphins are common inshore, often penetrating into bays, estuaries, and rivers (Caldwell and Caldwell 1972; Leatherwood et al. 1976; Wells et al. 1980). Most of the Bottlenose Dolphins collected for public exhibits have been captured in coastal areas in Texas, Mississippi, and Florida (Caldwell and Caldwell 1972; Leatherwood and Reeves in press).

Long-range movements apparently do occur in some areas. Bottlenose Dolphins offshore in the Atlantic Ocean may follow seasonally migrating food supplies for long distances (Leatherwood and Reeves in press), and coastal dolphins along the Outer Banks of North Carolina are supplemented by dolphins moving north in the spring and south in the fall (True 1891; D. Lee, North Carolina State Museum, Raleigh, pers. comm.). In Argentina, identified members of a study herd disappeared for 6 months and then were founded 300 km away (Wursig and Wursig 1977; Wursig 1978). The same animals returned to the original study area 9 months later.

Abundance

Sightings were numerous enough to allow calculation of density estimates for some months in each survey subunit (Table 55). Bottlenose Dolphin densities ranged from 0.024 dolphins/km^2 in the MIFL subunit in June to 0.40 dolphins/km^2 in the MILA subunit in October. Composite densities of Bottlenose Dolphins/km^2 for all months were 0.067 in the BTEX subunit, 0.093 in the MILA subunit, 0.088 in the NAFL subunit, and 0.027 in the MIFL subunit. These estimates should be viewed with caution because sample sizes were small in many months and the composite figures do not reflect the wide variations in monthly densities shown in Table 55.

Because Bottlenose Dolphins were generally sighted near shore, density calculations for entire subunits are misleading. Bottlenose Dolphins were actually denser nearshore than calculated and the density well offshore was often zero (Figures 141 through 144).

Table 54. The number of Bottlenose Dolphins sighted during this study. The number in parenthesis represents the number of sightings. Dash means no survey.

Month	Survey subunits								Opportunistic flight	
	BTEX		MILA		NAFL		MIFL			
June	41	(9)	124	(9)	140	(45)	39	(16)	0	
August	87	(15)	8	(5)	31	(9)	41	(6)	10	(4)
October	189	(27)	234	(23)	70	(22)	6	(5)	12	(7)
December	-		-		306	(52)	90	(16)	21	(6)
February	80	(14)	373	(82)	480	(109)	273	(39)	204	(40)
April	20	(5)	272	(16)	353	(85)	62	(12)	14	(6)
TOTAL	417	(70)	1011	(135)	1380	(322)	511	(94)	261	(63)

For instance, all the sightings in the MIFL subunit occurred within the 50-m contour, which comprises about 7% of the total subunit. An adjusted June density (e.g., calculated density/.07) of 0.343 dolphins/km^2 would therefore more realistically reflect Bottlenose Dolphin density in appropriate areas of the MIFL subunit. Adjusted monthly densities for other subunits ranged from 0.076 dolphins/km^2 in the BTEX subunit in February to 1.00 dolphins/km^2 in the MIFL subunit in February. Adjusted composite density estimates were 0.203 dolphins/km^2 in the BTEX subunit, 0.270 dolphins/km^2 in the MILA subunit, 0.176 dolphins/km^2 in the NAFL subunit, and 0.386 dolphins/km^2 in the MIFL subunit.

Approximately 17,000 Bottlenose Dolphins were killed by net fisheries off New Jersey and North Carolina in the late 19th and early 20th centuries (review by Mead 1975b; Mitchell 1975b), but estimates of the numbers not taken are unavailable. Downward trends in population size have been reported in Texas by Gunter (1954), but were not quantified. Few Bottlenose Dolphins are found in Biscayne Bay, Dade County, Florida (Odell 1976; FAO 1978), an area that previously supported a live-capture fishery (Gray 1964). Results of this study, and reports by several authors (see reviews by Wells et al. 1980, Leatherwood and Reeves in press) indicate that Bottlenose Dolphins are still common in coastal areas of the southeastern United States and in the Gulf of Mexico.

A number of studies resulted in local density estimates useful for comparison with results from the present study (see review by Leatherwood and Reeves in press). Results from different studies should be compared with caution because methods and survey conditions (geography, survey month, weather) are seldom identical. Offshore and inshore habitat differences are particularly extreme because most inshore surveys

Table 55. Density and herd size estimate for on-line sightings of Bottlenose Dolphins. "All" represents combined months. * = variance too small for computation.

Survey subunit	Month	No. of sightings	Group density (groups/km^2)	Variance	Mean group size	Standard error	Individual density (dolphin/km^2)
BTEX	October	11	0.22×10^{-1}	*	5.1	2.2	0.11
BTEX	February	8	0.61×10^{-2}	*	4.0	0.8	0.25×10^{-1}
BTEX	All	29	0.12×10^{-1}	0.61×10^{-5}	5.7	1.1	0.67×10^{-1}
MILA	June	7	0.58×10^{-2}	*	14.6	3.5	0.85×10^{-1}
MILA	October	10	0.29×10^{-1}	*	13.7	6.3	0.40
MILA	February	37	0.15×10^{-1}	0.32×10^{-4}	5.8	1.2	0.90×10^{-1}
MILA	April	10	0.47×10^{-2}	*	21.2	7.5	0.99×10^{-1}
MILA	All	66	0.93×10^{-2}	0.15×10^{-4}	10.1	1.8	0.93×10^{-1}
NAFL	June	29	0.22×10^{-1}	0.17×10^{-3}	3.1	0.6	0.67×10^{-1}
NAFL	October	10	0.13×10^{-1}	*	3.1	0.7	0.38×10^{-1}
NAFL	December	29	0.19×10^{-1}	0.96×10^{-4}	6.1	1.3	0.12
NAFL	February	59	0.73×10^{-1}	0.27×10^{-2}	5.2	0.9	0.38
NAFL	April	44	0.18×10^{-1}	0.44×10^{-4}	4.3	0.7	0.82×10^{-1}
NAFL	All	175	0.18×10^{-1}	0.88×10^{-4}	4.7	0.4	0.88×10^{-1}
MIFL	June	7	0.70×10^{-2}	*	3.4	1.1	0.24×10^{-1}
MIFL	February	13	0.15×10^{-1}	*	4.8	1.2	0.70×10^{-1}
MIFL	All	27	0.73×10^{-2}	0.44×10^{-4}	3.7	0.7	0.27×10^{-1}

include depths ranging from 1 to 4 m. Densities of Bottlenose Dolphins in surveys of estuarine areas were generally more than twice as large as those in surveys of offshore areas. These differences have not been previously reported. It is unclear if inshore-offshore densities vary or if dolphins in shallow areas are more easily seen or counted than dolphins in deeper offshore waters. Densities from other offshore surveys have not been adjusted to compensate for the amount of unsuitable habitat (e.g., > 50 m deep) surveyed. Consequently, real densities inshore may be somewhat higher than reported in the literature.

Average monthly herd sizes ranged from 1.2 to 17 dolphins per herd; 3 to 7 were the most common herd sizes (Figure 145). The standard deviations of the monthly averages were similar to or greater than the mean in 20 of 22 instances (91%), indicating that observed group size varied widely. Differences in average herd sizes by subunit were significant only in MILA between August and April and between August and June. The largest herds and the greatest variation in average herd size occurred in the MILA subunit. Average herd size appeared slightly larger during December, February, and April in the NAFL and MIFL subunits, but trends were not clearcut. Average herd sizes by month, including all subunits, were not significantly different. Composite averages

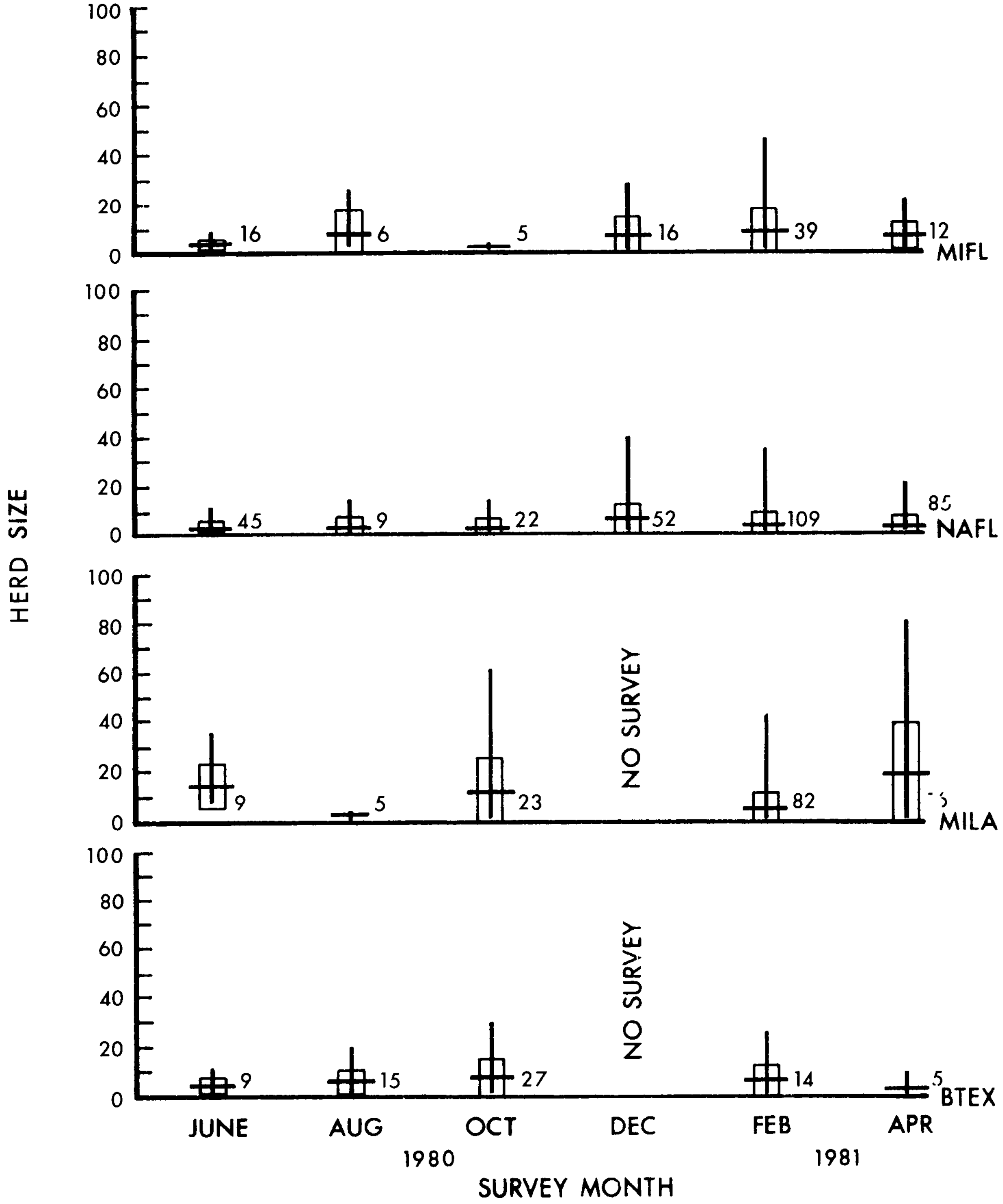


Figure 145. Herd size for all sightings of Bottlenose Dolphins by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

for each subunit indicated that herd sizes in the NAFL subunit were significantly smaller than those in the MILA subunit.

The herd sizes observed in this study were generally similar to sizes reported by other observers. Bottlenose Dolphins are most frequently sighted in herds of 1 to 12 animals (see review by Wells et al. 1980), but group sizes of 200 and 600 dolphins have been sighted off Mississippi (Leatherwood and Platter 1979) and North Carolina (True 1885), respectively. Solitary dolphins made up 10% to 15% of the sightings during long-term studies in Texas (Gruber 1981) and western Florida (Irvine et al. 1979; Irvine et al. in press). Herd size may vary substantially according to depth and complexity of habitat, with larger herds usually in more open-water habitats (see review by Wells et al. 1980).

Habitat Use

Average sighting distance from shore ranged from 7 km during August in the MILA subunit to 83 km in February in NAFL (Figure 146). They were sighted in the Intracoastal Waterway or just off the beach in the BTEX, NAFL, and MIFL subunits and out to 197 km from shore in NAFL. Sightings were generally farther offshore ($\bar{x}$ per month = 58 to 84 km offshore) in the NAFL subunit where the continental shelf is widest, and closest to shore ($\bar{x}$ per month = 15 to 25 km offshore) in the MIFL subunit where the 100-m contour is nearest shore.

Monthly differences in distance from shore were statistically significant only in the MILA survey subunit. Average distance from shore in MILA during August was significantly less than during February and October. The overall mean distance from shore in the BTEX subunit was 33 km; in MILA, 63 km; in NAFL, 77 km; and in MIFL, 19 km. Distribution patterns in the southeastern United States are unclear. A naturally marked Bottlenose Dolphin moved 95 km between Aransas Pass and the Matagorda Ship Channel, Texas (Gruber 1981), but Irvine et al. (in press) reported only localized changes in distribution near Sarasota, Florida, as resident dolphins apparently followed local fish movements during winter. In Texas, Shane (1980) and Gruber (1981) identified summer, winter, and year-round residents. Leatherwood and Reeves (in press) reported that Bottlenose Dolphin distribution may shift closer to shore in eastern Florida and Texas in winter.

Depths at sighting locations ranged from 1 to 219 m (Figure 147). Average depth by month varied from 3 m in the MILA subunit in August to 50 m in the BTEX subunit in October (Figure 147). Twelve of the twenty-two monthly averages (55%) were at depths between 18 and 22 m, perhaps indicating prime Bottlenose Dolphin habitat. Significant differences between average monthly depths occurred in the BTEX and MILA subunits, but not in the NAFL and MIFL subunits. The dolphins were in significantly deeper water in BTEX ($\bar{x}$ = 40 m) than in the other subunits (MILA, $\bar{x}$ = 20 m; NAFL, $\bar{x}$ = 23 m; MIFL, $\bar{x}$ = 20 m).

It is noteworthy that the average depths in MIFL where the continental shelf is narrow were similar to those in NAFL where the continental shelf extends well offshore. A comparison of Figures 143 and 144 suggests that water depth has a more important influence on distribution than does distance from shore. The majority of sightings occurred within the 50-m contour regardless of whether it was 25 km from shore as in the MIFL subunit, or 115 km as in the NAFL subunit. The greater number of

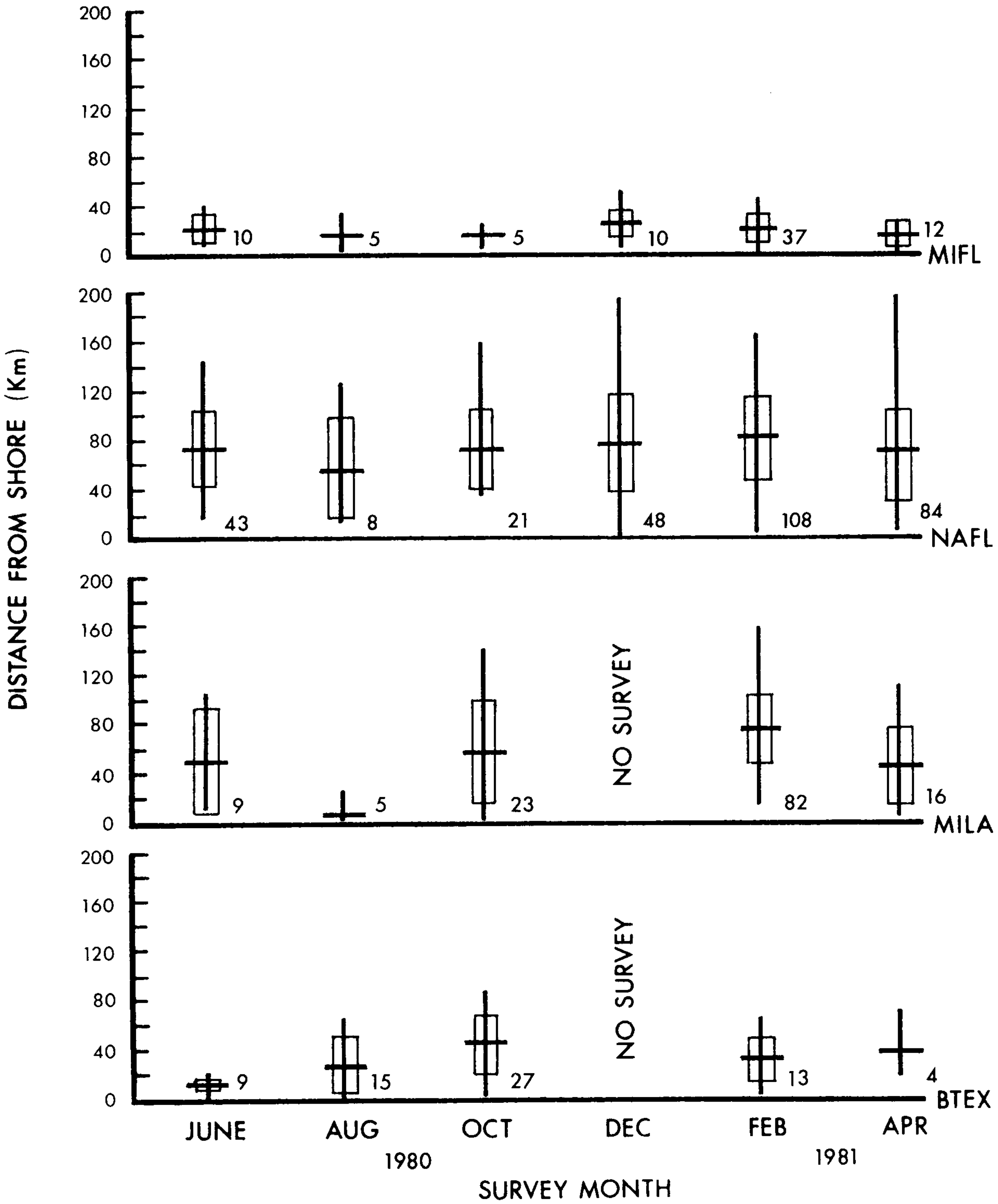


Figure 146. Distance from shore for all sightings of Bottlenose Dolphins by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

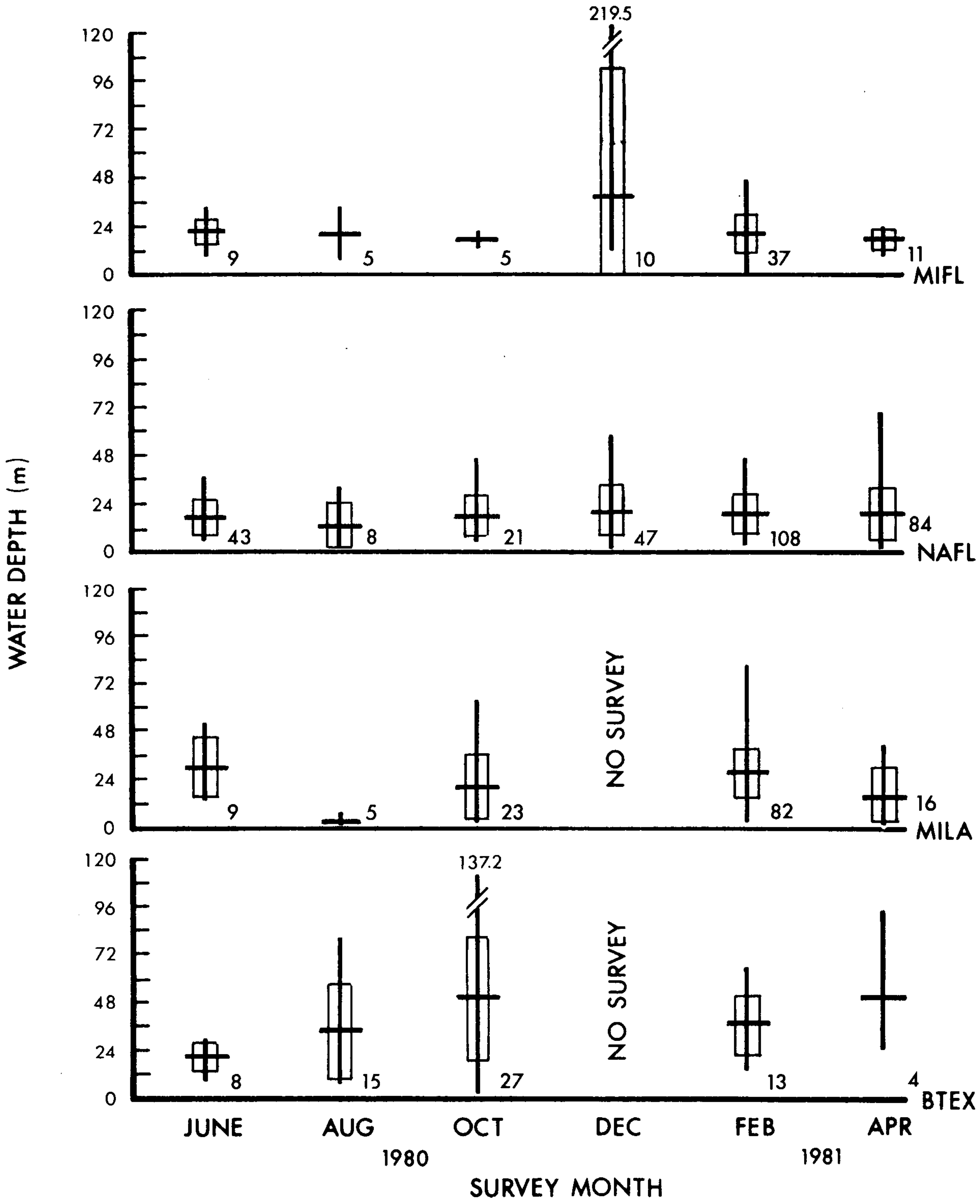


Figure 147. Water depth for all sightings of Bottlenose Dolphins by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

Bottlenose Dolphins in the NAFL and MILA subunits as compared to the BTEX and MIFL subunits may in part be due to the greater area of shallow waters in the former subunits.

Seasonal changes in depths at sighting locations were obvious only in MILA (Figure 142). Sixty-two percent of all sightings occurred between the 25- and 50-m contours during February, but in all other survey months combined only 17% of the sightings were beyond the 25-m contour. If dolphins move farther offshore in winter, it may be to use waters warmer than the most inshore waters.

Little is known about habitat use and preferred depths of Bottlenose Dolphins. Field studies have usually occurred in shallow (< 10 m deep) coastal areas in Florida, Texas, or Mississippi (see review by Wells et al. 1980), because access to these areas is logistically convenient and relatively inexpensive compared to costs for pelagic studies which require ocean-going ships or long-range aircraft. As a consequence, little more is known about Bottlenose Dolphins a few kilometers off the coast than is known about many pelagic cetaceans. The present study is the first to correlate depth with offshore distribution of Bottlenose Dolphins in the southeastern U.S.

Only a few studies have attempted to correlate Bottlenose Dolphin abundance or density with habitat type. Dolphin density is highest in channels in salt marsh habitats (Leatherwood and Platter 1979; Leatherwood et al. in press) and may vary seasonally in estuarine habitats (see review by Wells et al. 1980). Several studies indicate that Bottlenose Dolphins are particularly abundant near ship channels and seasonally near natural channels or "passes" into the Gulf of Mexico (Barham et al. 1980; Shane 1980; Gruber 1981; Irvine et al. in press; Leatherwood et al. in press). During aerial surveys by Odell and Reynolds (1980) dolphins were concentrated in shallow areas of the panhandle of Florida where the bottom dropped off steeply nearshore, but they were more evenly distributed in southwestern Florida where the continental shelf extended well offshore. As noted earlier (see Distribution Section) results from the present study show similar concentrations related to depth contours. Irvine et al. (1981) did not report densities during aerial surveys of western coastal Florida (28°32' N to 25°08' N), but the percentage of dolphins sighted differed off the beach (51%), in estuarine (35%), and in marshland habitats (14%); numbers sighted also varied in salt water (71%), brackish water (29%), and fresh water(0%).

Available information suggests that areas inshore may be occupied by a number of populations with distinct ranges. A home range for a Bottlenose Dolphin was first identified by Caldwell (1955) near Cedar Key, Florida (29°08' N; 83°03' W). Apparent resident groups have been subsequently identified along 40 km of coast north of Sarasota, Florida (Irvine and Wells 1972; Irvine et al. 1979; Wells et al. 1980; Irvine et al. in press), in Aransas Pass, Texas (Shane and Schmidly 1978; Shane 1980), in southwestern Matagorda Bay, Texas (Gruber 1981), and perhaps in the Mississippi Sound (Leatherwood and Platter 1979). Caldwell and Caldwell (1972) suggested that the home range of Bottlenose Dolphins may be dumb-bell shaped, with two use-areas connected by a narrow traveling range, but this hypothesis is unconfirmed. Shane (1980) noted some evidence of overlapping range limits for some individuals. Different age-sex classes of the dolphins captured and studied by Irvine et al. (in press) had dissimilar but overlapping ranges within the herd home range (Wells et al. 1980).

Bottlenose Dolphins were sighted in water temperatures averaging from 16° to 28° C (Figure 148). They were generally not sighted in offshore areas which would be influenced by the Gulf Stream or the Loop Current in the Gulf of Mexico.

The Bottlenose Dolphin in the southeastern United States is tolerant of a wide range of water temperatures. This species has been reported to be a resident of areas off Texas where water temperatures range from 11° to 29° C (Shane 1980; Gruber 1981). Similar variations in water temperature occur in other areas of the southeastern United States (U.S. Department of Commerce 1972). Because marine mammals are effective thermoregulators (Ridgway 1972a; Irving 1973), it is reasonable to speculate that seasonal movements of Bottlenose Dolphins in the southeastern United States may not be as closely associated with sea surface temperatures as to the movements of prey fish.

Associations

Bottlenose Dolphin associations (62 sightings) included: 22 fish schools (35%), 19 shrimp boats (31%), 8 water masses (13%), 5 oil slicks (in the MILA subunit; 8%), 4 sharks (6%), 2 miscellaneous boats (3%), 1 group of spinner and unidentified dolphins (2%) and 1 raft of sargassum (2%). Sightings of dolphins with shrimp boats varied as follows: 10 in MILA (53%), 7 in BTEX (37%), 1 in NAFL (5%), and 1 in MIFL (5%). Seasonal patterns of dolphin associations with shrimp boats were not apparent. Average herd size of the dolphins associating with the shrimp boats ($\bar{x}$ = 10 dolphins/herd; SD = 8.0; n = 19 herds) was somewhat larger than average herd size sighted overall (about 7 dolphins/herd).

Bottlenose Dolphins follow shrimp boats to feed on fish stirred up by the trawls, or they gather near stationary boats to eat trash fish culled from the shrimp catch and thrown overboard (Gunter 1942; 1951; Norris and Prescott 1961; Caldwell and Caldwell 1972; Leatherwood 1975; Shane and Schmidly 1978; Gruber 1981). Terns and gulls often circle over the boats and compete with dolphins for fish at the surface (Gruber 1981). The dolphins can hear and apparently recognize different stages of a shrimp boat fishing operation, and they may approach from considerable distances to be present when food will be available (Gunter 1954; Norris and Prescott 1961; Gruber 1981). Working shrimp boats, by attracting dolphins, may therefore be responsible for localized changes in dolphin distribution and activity cycles (Gruber 1981). However, evidence is not available to determine if shrimping activities influence dolphin distribution, and therefore, habitat use over wide areas.

Associations with oil slicks were noted in the MILA subunit (three in October and two in February) where oil rigs are abundant. The dolphins were associated with shrimp boats and fish schools during each survey month and in each survey subunit. In three of the four sightings where sharks and dolphins were sighted near each other, the dolphins were feeding on or were near a fish school. Interactions between the dolphins and sharks were not observed, but the proximity is noteworthy because sharks and dolphins are considered natural enemies (see review by Wood et al. 1970).

Reproduction

A total of 101 calves were sighted, comprising 3.0% of all the Bottlenose Dolphins observed. Calves were sighted most frequently in October and were most consistently observed in NAFL (Figure 149). Too few calves were seen to suggest seasonal trends.

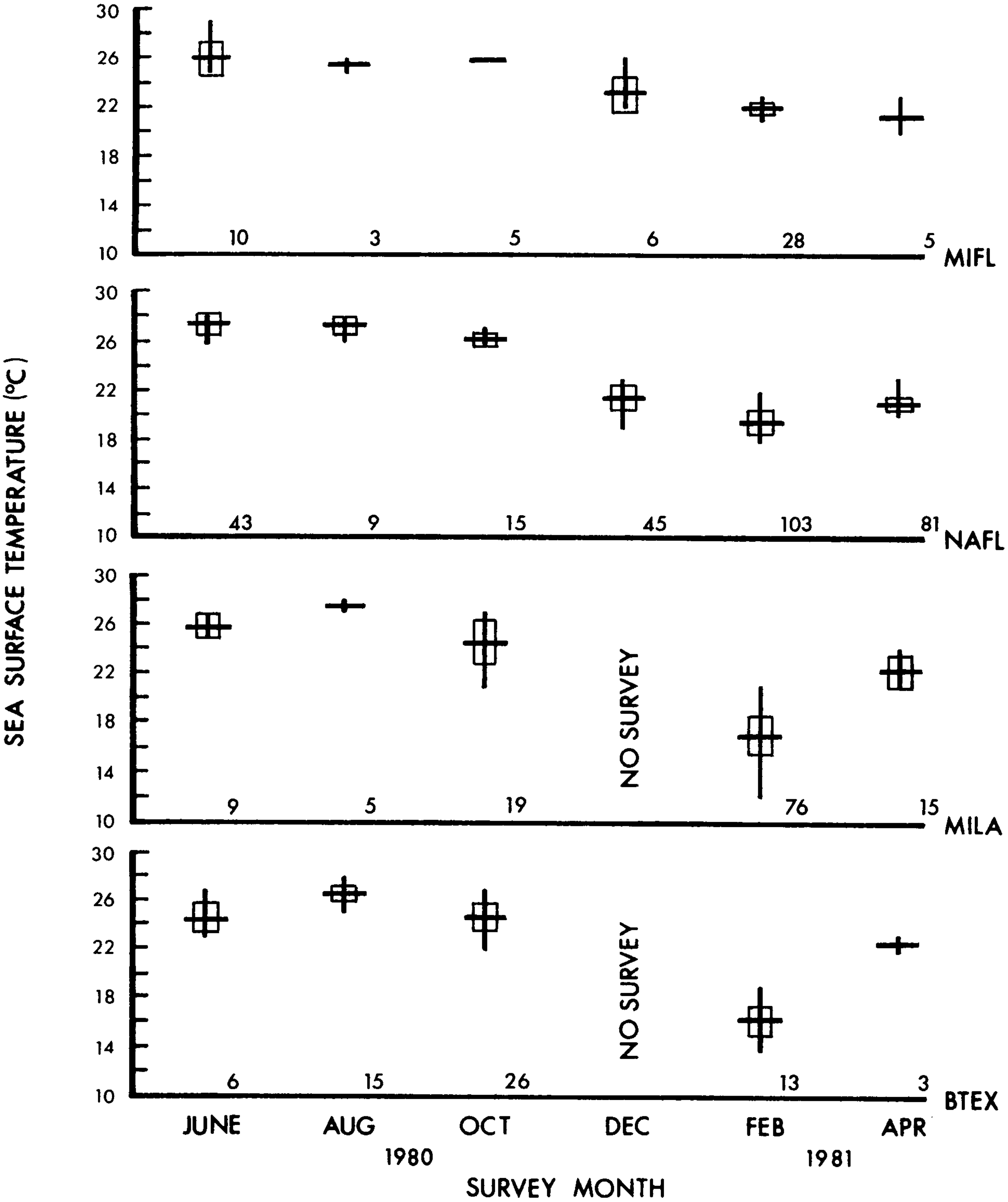


Figure 148. Sea surface temperature for all sightings of Bottlenose Dolphins by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

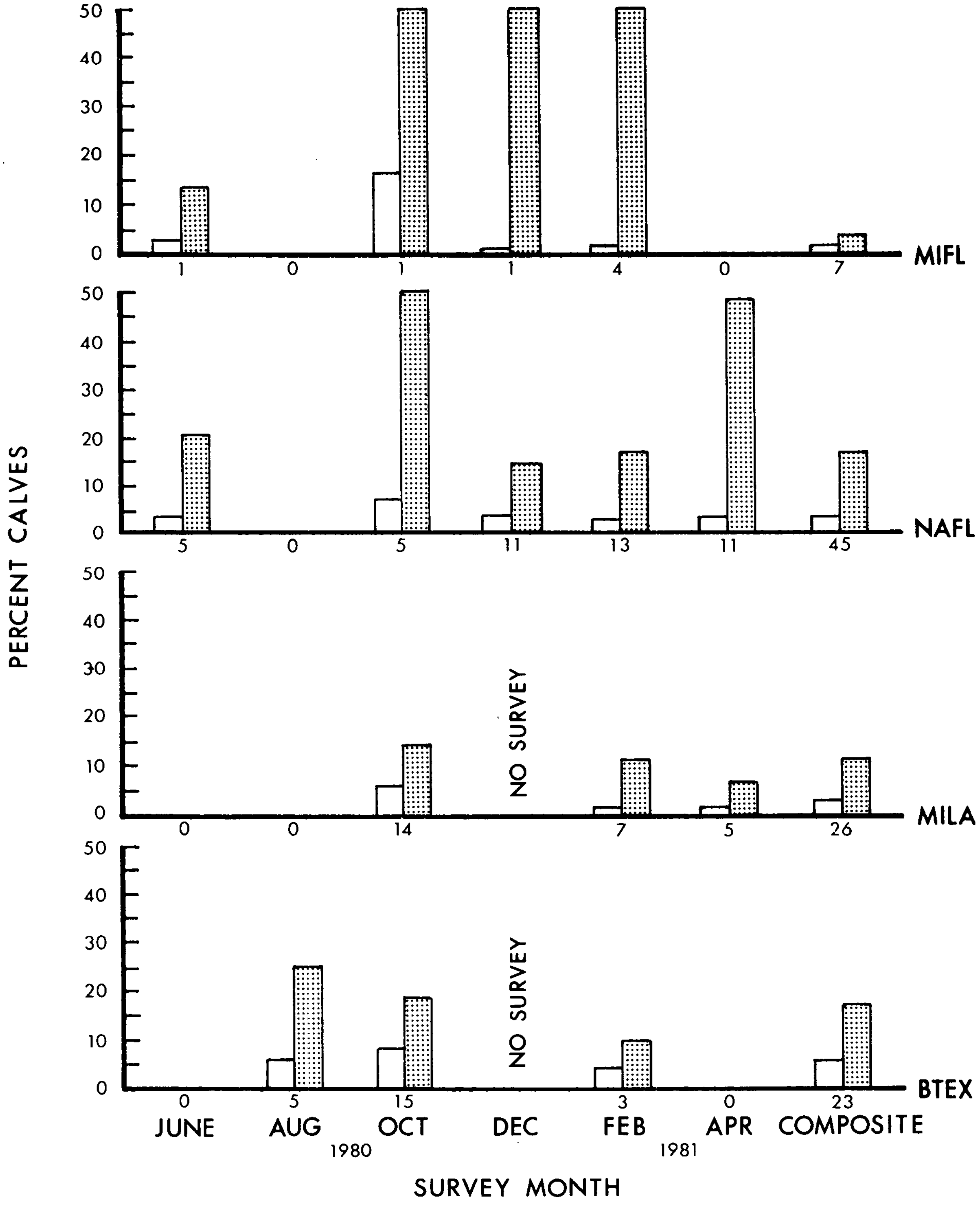


Figure 149. Percent of Bottlenose Dolphins seen that were calves, by month and survey subunit. Open bars are the percentage of calves in all sightings; stipled bars represent the percentage of calves from groups containing calves. Numbers on x-axis represent the number of calves sighted.

Calves comprised 15.1% of the herds containing mother-calf pairs. This suggests that mother-calf pairs were not evenly dispersed among the groups sighted (Figure 149). Segregation of age and sex classes in dolphin herds has been reported previously (Norris and Dohl 1980a; Wells et al. 1980), but has not been quantified.

The overall percentage of calves (3%) is low compared to results of other studies. Studies of Bottlenose Dolphin populations in estuarine areas often report about 8% to 10% calves. Coastal surveys of western Florida and Texas recorded calf percentages of 2.1 to 5.3% (Odell and Reynolds 1980; Irvine et al. 1981; Leatherwood et al. in press).

The reasons why more calves are observed in estuaries than offshore is unclear. Inshore areas may be used as nurseries or calves may be more obvious to aerial observers in estuarine habitats. Some calves observed from photographs were under the cow, and may have been avoiding the noise of the aircraft. Avoidance by either diving or hiding under a larger animal would be more effective in deep waters offshore than in estuaries and may help account for the low number of calf sightings. Such behaviors are difficult to quantify.

Reproductive parameters for Bottlenose Dolphins are not well known. Much of the available life-history information comes from captives in Florida, but results from captives do not necessarily apply to free-ranging animals. Few field studies have been conducted upon which to base speculation (Ridgway and Benirschke 1977; Norris and Dohl 1980b; Wells et al. 1980).

Bottlenose Dolphins may live 25 to 40 years (Ridgway 1968; Sergeant et al. 1973). The best available aging techniques count dentinal layers, but reliability of the estimates is uncertain (see review by Leatherwood and Reeves in press). Assuming a growth of one tooth ring per year, adult males (245 to 260 cm in length) reach sexual maturity at 12 to 13 years while adult females (220 to 235 cm in length) mature at 5 to 12 years (Harrison et al. 1972; Sergeant et al. 1973). Females mature at 6 to 7 years in Japan (Odell 1975). In the Pacific Ocean, dolphins in northern temperate waters reach maturity later than conspecifics in the eastern Tropical Pacific (Walker 1981). Mating occurs throughout the year (Brown and Norris 1956 and others). Ovulation has been reported as spontaneous (Slijper 1966) or induced (Harrison et al. 1972). Peak mating times are during the spring and perhaps during the fall in the southeastern United States (Harrison and Ridgway 1971 and others), but may be different elsewhere in the world (see review by Saayman and Tayler 1979). Gestation is about 12 months and the calving interval is about 2 years (see review by Harrison et al. 1972). Calves nurse for 12 to 18 months, but may begin to take fish at 3 to 6 months (see review by Leatherwood and Reeves in press).

Behavior

Behaviors observed in Bottlenose Dolphins included feeding, possible reproductive or courtship behavior (rubbing and swimming belly to belly), and an assortment of head slaps, tail lobs, and low breaches. The context of any observed behavior was difficult to determine from a circling aircraft. Presence of the aircraft clearly influenced behaviors in some instances, causing the animals to change direction or swimming formation. Occasionally, dolphins avoided the plane by diving when it circled near them. Herd formations, with the calves near the middle of the group, have been reported by Leatherwood (1977) in the Mississippi Sound, but were not seen in the present study.

Feeding was obvious when the dolphins moved quickly on an erratic course that sometimes terminated with a "pinwheel" (sensu Lawrence and Schevill 1954) by the dolphin as the fish was caught. Upside-down swimming, which echolocating dolphins may do to reduce interference from echos off the surface of the water (Leatherwood 1975), was observed on occasion. A total of 22 sightings were of dolphins feeding or in close proximity to a fish.

Bottlenose Dolphins eat a wide variety of foods including: mullet (Mugil spp.), weakfish or seatrout (Cynoscion spp.), menhaden (Brevoortia spp.), spot (Leiostomus spp.), kingfish (Menticirrhus sp.), shrimp (Penaeus sp.), squid (Loligo spp.), and a variety of others (see review by Leatherwood and Reeves in press). Mullet is a primary food in the southeastern United States (Gunter 1942; Caldwell and Caldwell 1972), but the diet varies at higher latitudes and away from shore where mullet are not prevalent.

Irvine et al. (in press) suggested that feeding strategies of inshore dolphins may differ from those of pelagic animals. Feeding behavior often varies with habitat (Wells et al. 1980). Dolphins in shallow areas frequently forage alone or in small groups on scattered fishes, but dolphin groups in deeper water feed cooperatively on schooled fish. In inshore areas of western Florida, Bottlenose Dolphins are believed to feed arhythmically, exerting an almost constant pressure on food resources (Irvine et al. in press). Some pelagic cetaceans such as Stenella spp. and Delphinus sp. feed at predictable intervals (see review by Norris and Dohl 1980b), but feeding patterns of pelagic T. truncatus are unknown.

Potential Impacts of OCS Development

Bottlenose Dolphins appear well adapted to the presence of humans in the southeastern U.S. (Leatherwood and Reeves in press), but are still subject to impact from increased shipping, pollution, or oil spills associated with OCS development. This species frequents channels, harbors, and inland waterways in Texas and western Florida where commercial or recreational boat traffic is common (Shane 1980; Barham et al. 1980, Gruber 1981; Irvine et al. in press; Leatherwood and Reeves in press). In these areas, they are occasionally hit by boats, drowned in nets, shot, or harpooned (see review by Leatherwood and Reeves in press). The lack of dolphins in Biscayne Bay in southeastern Florida is possibly due to boat traffic or human-related loss of food resources (Odell 1976; FAO 1978). Pollution has also been blamed for the absence of Bottlenose Dolphins in San Diego Bay, California (FAO 1978), and may be indirectly affecting Tursiops in the North Sea (Mitchell 1975a).

The limited information available indicates that Bottlenose Dolphins are not adversely affected by direct contact with oil spills. Bottlenose Dolphins near Aransas Pass (Shane and Schmidly 1978) and Port O'Conner, Texas (Gruber 1981), moved through dense patches of recently spilled oil without showing obvious ill effects. A total of 41 dolphins (4 sightings) were observed in or adjacent to oil slicks in this study. These, however, are the only known sightings of small cetaceans in oil slicks.

The Bottlenose Dolphin could prove important as an "indicator species" for evaluating the environmental health of areas subject to development of OCS resources. Dolphin abundance can be monitored, and populations can be compared. Sick or injured Bottlenose Dolphins are frequently stranded (see papers in Geraci and St. Aubin 1980), and provide a source of specimens to monitor population health and stability. Studies of dolphin feeding habits will help identify energy and potential hydrocarbon transfer pathways in the food chain. Studies of a conspicuous predator, such as T. truncatus, can provide baseline information on biological communities against which to monitor effects of OCS exploration and development. As the most widespread and abundant cetacean species in inshore waters of the southeastern U.S., the Bottlenose Dolphin is the most likely to encounter and be affected by oil and gas activities.

Summary

Bottlenose Dolphins were seen in all subunits in each survey month. They were usually sighted from near the beach to about the 50-m contour and were farther offshore where the continental shelf was widest. Fifty-five percent of the monthly average water depths at sighting locations were 18 to 22 m. Calculated densities ranged from 0.024 to 0.40 dolphins/km^2. Densities adjusted for habitat use ranged from 0.076 dolphins/km^2 in the BTEX subunit during February to 1.0 dolphins/km^2 in the MIFL subunit during February. Changes in seasonal abundance were clearcut only in the NAFL subunit where numbers were higher from December to April. Average herd size by month was usually 3 to 7 dolphins/herd, but standard deviations of the means were generally as large as the means. Seasonal variations in herd size were significant only in the MILA subunit, and composite averages were significantly different only between the MILA and NAFL subunits. Calves were not distributed evenly among the herds. They comprised 15% of the animals in herds containing mother-calf pairs, but only 3% of all Bottlenose Dolphins sighted.

Bottlenose Dolphins appear well adapted to human activities and apparently are not immediately affected by direct contact with oil. They have been extirpated from some areas by pollution, however, and therefore may be useful indicators of environmental quality.

RISSO'S DOLPHIN, Grampus griseus

Description

The following description comes largely from Leatherwood et al. (1976).

The Risso's Dolphin is a large dolphin (about 4 m) with a blunt, bulbous head, and a V-shaped crease on the forehead. The flippers are long and pointed. The body anterior to the dorsal fin is robust. Posterior to the dorsal fin, the tail stock tapers rapidly to the flukes. The dorsal fin is located about mid-body and is tall, pointed, and falcate. The flukes are broad, posteriorly concave, and deeply notched.

Young animals are gray at birth but darken to almost black as they get older. Adults have distinctive regions of grayish white on the chest and belly. The heads of adults become almost white with age, and the bodies become whitish to silver-gray. The bodies of adults are usually covered with scars. Generally, the flippers, dorsal fins, and tail flukes of adults are dark, although the rest of the body may be pale.

From the air, the white, blunt head and robust body of the adult Risso's Dolphin are distinctive. Other useful identification cues are the prominent dark dorsal fin and dark flukes.

During aerial surveys, distinctive dorsal color patterns were seen that could be categorized into four morphs. The first morph included animals that were all dark: dark brown to almost black. Animals in the second morph were largely dark, but had a whitish head. The third morph was whitish anterior to the dorsal fin and dark posteriorly. The last morph included animals that were largely white except for the dorsal fin area and the tail flukes. In all morphs, the dorsal fin and tail flukes were darker than the rest of the body. When dolphins were submerged, the contrast between pale and dark portions of the body was enhanced.

Distribution

During aerial surveys, about 274 Risso's Dolphins were sighted on 12 occasions. Seven sightings (67 animals) occurred in the MIFL survey subunit (Figure 150), and only one sighting (9 animals) occurred in the BTEX survey subunit. A total of 191 to 198 animals (three sightings) were seen during opportunistic surveys adjacent to the Dry Tortugas, Florida (Figure 151). Seven Risso's Dolphins (one sighting) were seen off Fort Walton Beach, Florida during an opportunistic survey. No sightings occurred in the MILA and NAFL survey subunits.

Risso's Dolphin was seen in the MIFL survey subunit during three bimonthly surveys (Figure 150), and in the BTEX survey subunit only during November. During opportunistic surveys, sightings occurred near the Dry Tortugas during December and March (Figure 151), and about 260 km south of Fort Walton Beach, Florida, during April.

The sighting in the BTEX survey subunit represents the first record of Risso's Dolphin in the western Gulf of Mexico (Jennings 1982). Sightings from aerial surveys combined with stranding records indicate that this species is probably present throughout the deep water areas of the study area, and may be present throughout the year. Our sightings also provide the first data from pelagic areas, supplementing available stranding records from the study area (Schmidly 1981).

Risso's Dolphin occurs in tropical and temperate oceans throughout the world (Mitchell 1975a). It occurs from Newfoundland south to the Lesser Antilles in the western North Atlantic Ocean (Mitchell 1975a), and has been reported in the eastern and northern Gulf of Mexico (Paul 1968; Leatherwood et al. 1976). Risso's Dolphin may migrate seasonally in the North Atlantic, but this is still in question (Mitchell 1975a). In the eastern North Pacific Ocean there may be a seasonal range expansion northward during the summer (Dohl et al. 1981; Leatherwood et al. 1980).

Abundance

No estimates are available of the numbers of Risso's Dolphins occurring in the study area. On the basis of stranding records, it is not common (Leatherwood et al. 1976). The oceanic range of this species may cause it to go largely unnoticed (Leatherwood et al. 1976), and dead animals may not wash ashore, making strandings rare. Our sightings support the belief that Risso's Dolphins may not be as rare the paucity of stranding records suggest (Leatherwood et al. 1976).

Eleven sightings were of groups composed of 3 to 25 individuals ($\bar{x} = 11$; SD = 5.7). A twelfth sighting was of a collective of 157 to 162 dolphins in 18 groups, ranging in size from 1 to 25 members ($\bar{x} = 9$; SD = 5.7), and spread over 18 km. More animals may have

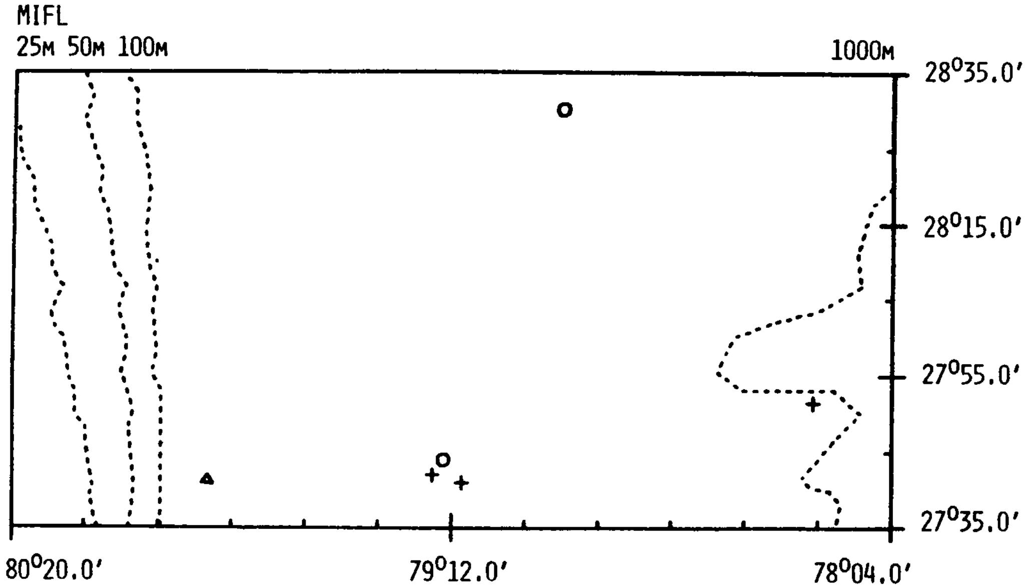


Figure 150. Distribution of all Risso's Dolphin sightings in the MIFL survey subunit during June (O), October (△), and April (+) survey periods.

been in the area than were observed. On two of three occasions when we deviated from the survey line for better views, we discovered 13 previously undetected animals in three groups. Large groups of Risso's Dolphin, up to 550 animals, have been seen off California in the Pacific Ocean (Leatherwood et al. 1980; Dohl et al. 1981), and off Newfoundland in the Atlantic Ocean (Mitchell 1975a).

Habitat Use

Risso's Dolphins were seen in waters over the continental slope where the depths ranged from 200 to 1,530 m (Table 56). Risso's Dolphin is reported to occur in waters where depths range from 100 to 1,000 m off California (Dohl et al. 1981). In the northwestern North Atlantic, it is commonly seen over the continental slope (Winn et al. 1979). The lack of sightings in the MILA and NAFL survey subunits may be explained by the broad continental shelf in these subunits. In the MILA survey subunit, the 200-m isobath is about 185 km from shore. The 200-m isobath is extralimital to the NAFL survey subunit (Figure 151). In the MIFL and BTEX survey subunit where sightings occurred, the 200-m isobath is from 40 to 100 km offshore. Sightings occurred 56 to 260 km from shore.

Sightings occurred where sea surface temperatures ranged from 22° C during March and April to 27° C during June. Risso's Dolphins in the Pacific Ocean off California expanded their range northward from May to August, and were concentrated in the south from September to February (Dohl et al. 1981). Leatherwood et al. (1980)

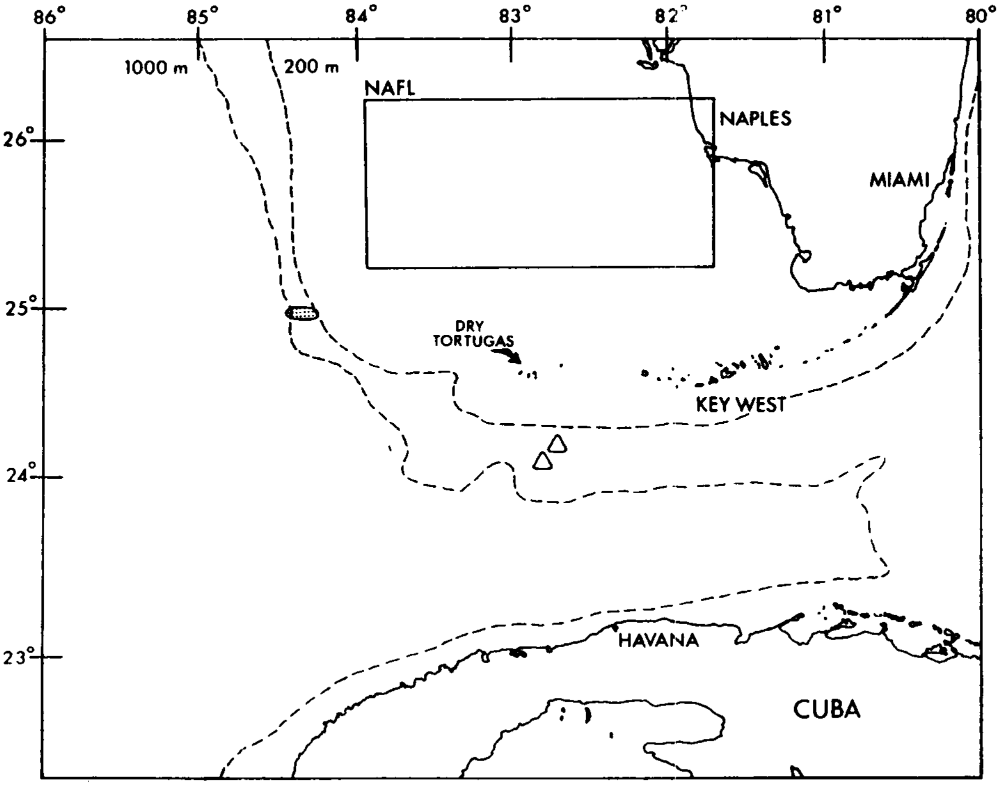


Figure 151. Distribution of all Risso's Dolphin sightings during opportunistic surveys off southwestern Florida adjacent to the Dry Tortugas during December (stippled) and March (△).

reported similar findings. Seasonal movements of the Risso's Dolphin seem to be related to water temperature (Leatherwood et al. 1980).

Risso's Dolphins sighted in the MIFL survey subunit during October were near an unidentified whale, possibly a Right Whale. Off California, Risso's Dolphins were associated with other cetaceans including Lissodelphis, Lagenorhynchus, Phocoenoides, Physeter, and Megaptera (Dohl et al. 1981).

Reproduction

Little is known of the reproductive biology of this species (Winn et al. 1979). During aerial surveys, four dark-morph animals with body lengths about 75% of adult lengths were considered subadults. Juveniles were seen throughout the year in an aerial survey off California (Dohl et al. 1981). Ratios of juveniles to adults sighted were comparable to ratios observed during this study. Risso's dolphin is about 1.5 m long at birth and becomes sexually mature when about 3 m long (Mitchell 1975a).

Table 56. Sighting information on Risso's Dolphin. OPPO = opportunistic flight.

Survey subunit	Date	No. of dolphins	Position (Latitude/Longitude)	Water depth (m)	Sea surface temperature °C
BTEX	01 Nov. 1980	9	26°46.0'N/96°26.1'W	200	25
MIFL	03 June 1980	3	27°43.6'N/79°13.4'W	540	27
MIFL	04 June 1980	6	28°30.0'N/78°55.2'W	810	26
MIFL	13 Oct. 1980	8	27°41.0'N/79°42.9'W	370	27
MIFL	28 Feb. 1981	12	28°25.3'N/78°03.3'W	955	24
MIFL	31 Mar. 1981	8	27°40.6'N/79°10.4'W	485	23
MIFL	01 Apr. 1981	7	27°51.0'N/78°16.4'W	915	22
MIFL	01 May 1981	23	27°41.7'N/79°15.0'W	485	24
OPPO	14 Dec. 1980	157	25°00.0'N/84°15.6'W to 84°26.3'W	420 to 1,530	24
OPPO	4 Mar. 1981	16	24°05.3'N/82°48.4'W	745	25
OPPO	4 Mar. 1981	18	24°09.2'N/82°44.1'W	670	22
OPPO	30 Apr. 1981	7	28°00.6'N/85°55.9'W	865	22

Behavior

Risso's Dolphin feeds largely on cephalopods and fish (Mitchell 1975a; Winn et al. 1979). The numerous scars on the bodies of adults may be the result of encounters with the beaks of cephalopods or the teeth of other Risso's Dolphins (Leatherwood et al. 1976).

This species was occasionally seen in tight "chorus line" formations, but was generally arranged in irregular formations.

Potential Impacts of OCS Development

The impact of OCS development on the Risso's Dolphin is unclear. The generally deep-water range of this species decreases its chances of encountering coastal oil or chemical spills.

Summary

Risso's Dolphin was seen during scheduled surveys in the BTEX and MIFL survey subunits and during opportunistic surveys in the northeastern Gulf of Mexico and adjacent to the Dry Tortugas, Florida. Sightings occurred throughout the year. Most sightings were of small groups of animals, but one sighting was of a collective of about 160 animals. All sightings occurred over the continental slope in waters from 200 to 1,530 m deep. Most animals sighted were considered adults. The impacts of OCS development are unknown.

SPOTTED DOLPHIN, *Stenella* spp.

Includes:
Stenella plagiodon
Stenella frontalis
Stenella dubia

Several Spotted Dolphin species (*S. plagiodon*, *S. frontalis* and perhaps *S. dubia*) known in the Atlantic Ocean and adjacent waters may comprise a single species, but there is no agreement as to what the specific name should be (Mitchell 1975a). *Stenella frontalis* and *S. plagiodon* are sympatric, but *S. frontalis* is relatively uncommon in the study area (Leatherwood et al. 1976; Schmidly 1981). The different forms cannot be distinguished when seen from the air; therefore, the Spotted Dolphins sighted during this study were not differentiated.

Description

Except as noted, the following description is taken from Leatherwood et al. (1976). Spotted Dolphins may reach a length of 2.4 m. They are generally more robust than other *Stenella* spp., but tend to be more slender than *Tursiops* spp. The dorsal fin is pointed and distinctly falcate. The color is dark purplish gray on the back, shading to light gray to white on the venter. Spotted Dolphins may have a spinal blaze and a light white line extending from the eye to the flipper. Flippers and trailing edges of the flukes may be darker than the rest of the body. The lips may be white and the tip of the beak is characteristically white.

The back of large animals is often heavily speckled with white spots, and the belly may be densely spotted with dark spots. Observations during the present study indicated that on some animals a blaze of intense spotting, dubbed a "feather blaze", may extend dorsoposteriorly towards the dorsal fin from the light, lateral coloration (see Figure 117c in Leatherwood et al. 1976). Changes in color with age are described by Caldwell and Caldwell (1966), and Leatherwood et al. (1976).

Stenella spp. must be carefully observed to distinguish species. They are all small (< 3 m) and slender with long beaks and dark capes. Intraspecific coloration may be variable, especially among immature animals, and differences between species are often subtle. Several circles by the survey aircraft were usually necessary to distinguish species, and usually only animals at the surface could be identified. Dolphins observed only briefly or not seen clearly because of rough water, poor light, or behavior of the animals usually were not identified to species. The following paragraphs discuss characters of Spotted, Striped, and Spinner Dolphins useful for identification from the air (also see Table 57).

From the air, Spotted Dolphins are more slender than *Tursiops*, but more robust than other *Stenella* spp. The shading of the dark dorsal coloration into the lighter color on the side, the spinal blaze, and the prominent white beak tip on a dark rostrum are characteristic of *S. plagiodon*. The dorsal coloration of *S. frontalis* lacks a spinal blaze and the body may be more slender. Spots on the animals are only occasionally visible from the aircraft.

Table 57. Identification cues used during aerial surveys to differentiate *Stenella* spp.

Characteristic	Spotted Dolphin	Striped Dolphin	Spinner Dolphin
Beak	Prominent white tip	Dark	Long with dark tip
Dorsal coloration	Dark with indistinct border; spinal blaze present from blowhole to dorsal fin; "feather blaze" sometimes present	Dark with distinct border, especially near head; no spinal blaze; conspicuous "feather blaze"	Dark with distinct border; no spinal blaze; no "feather blaze"
Tail stock	Generally more pale than back	Distinctly pale	Dark
Size and shape	Length to 2.4 m; robust body shape	Length to 2.7 m; intermediate body shape between Spotted and Spinner Dolphins	Length to 2.1 m; slender body shape

Distribution

Spotted Dolphins were observed in all survey subunits but were most common in MIFL (442 animals, 29 sightings). The NAFL subunit had 196 animals seen (16 sightings); BTEX, 52 animals (3 sightings); and MILA, 5 animals (2 sightings). Sightings were relatively frequent only in the MIFL subunit during February (21 sightings), and in the NAFL subunit during April (9 sightings; Figures 152 and 153); however, the data is too sparse to define seasonal trends.

The marked increase in sightings in the MIFL subunit during February and April and in the NAFL subunit during April are difficult to explain. The concentrations appear to coincide with the spring movements toward shore described by Moore (1953) and Caldwell and Caldwell (1966), but the animals observed in the present study generally did not approach the coast. It is unclear whether they came into the survey subunits from farther offshore or were moving parallel to the coast. Increased seasonal abundance in these areas has not been reported previously.

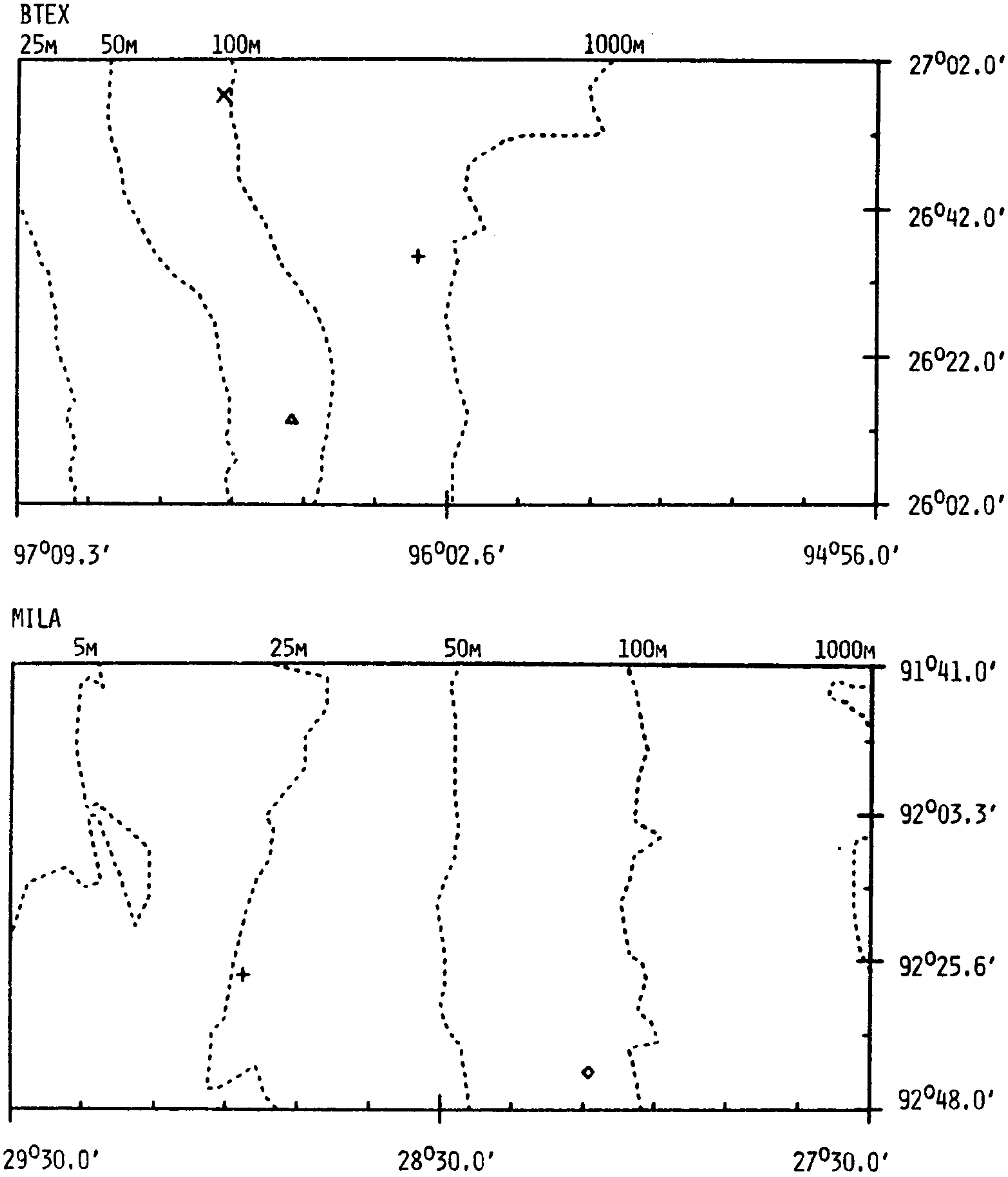
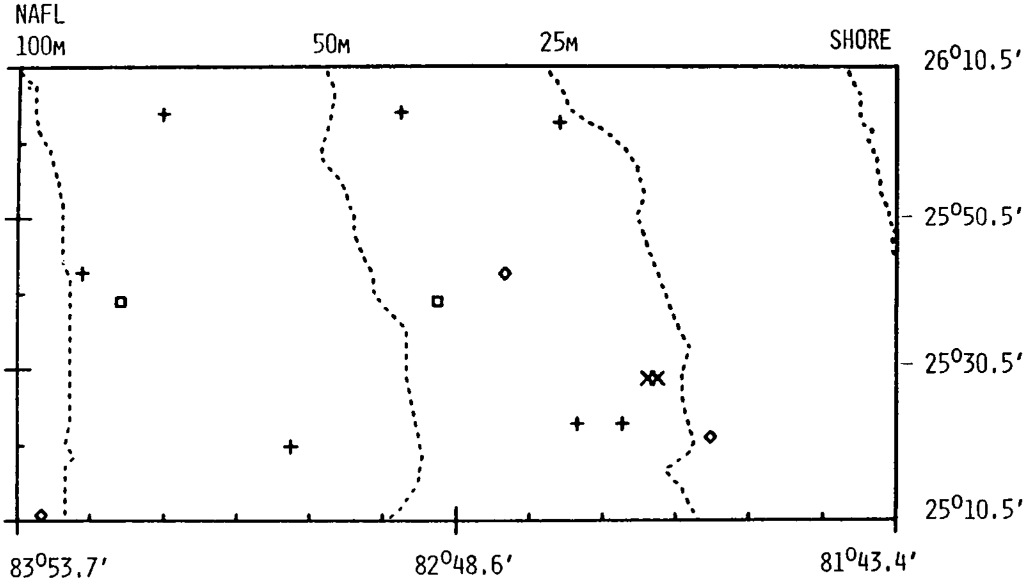


Figure 152. Distribution of all Spotted Dolphin sightings in the BTEX survey subunit (above) during August (X), October (△), and April (+), and in the MILA survey subunit (below) during February (◇) and April (+).



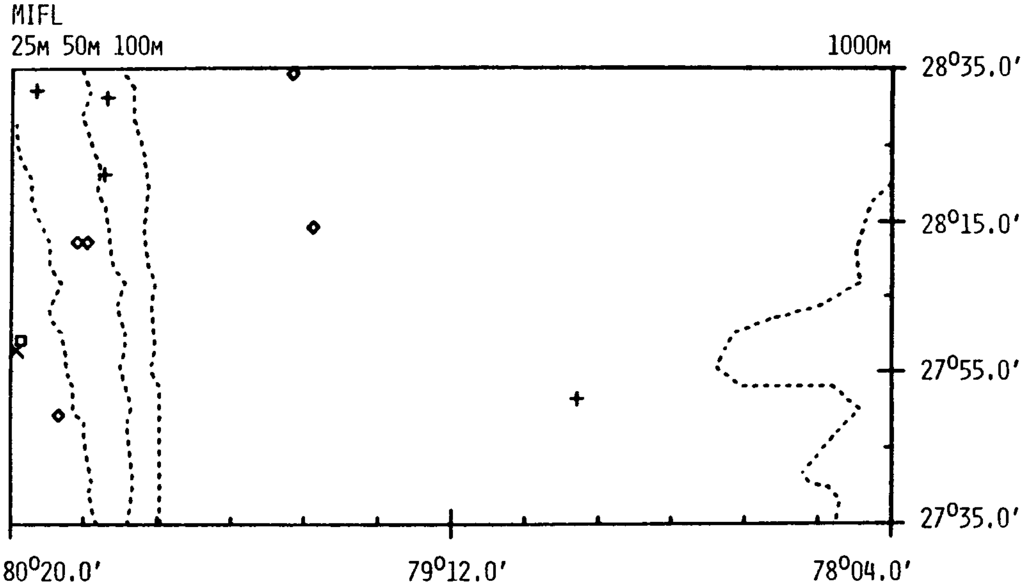


Figure 153. Distribution of Spotted Dolphin sightings in the NAFL and MIFL survey subunits during August (X), December (□), February (◇), and April (+).

The sighting results are in agreement with available information from the literature. Spotted Dolphins are reported to be an offshore species in the western Atlantic, ranging from Cape May, New Jersey, to Panama, including the Gulf of Mexico (Caldwell and Caldwell 1966; Leatherwood et al. 1976; Winn et al. 1979; Schmidly 1981). They are more common south of Cape Hatteras (Leatherwood et al. 1976; Winn et al. 1979). Caldwell and Caldwell (1966) reported that Spotted Dolphins were not found in the Caribbean Islands, but a more recent report (Winn et al. 1979) indicated that some are taken in Antillian cetacean fisheries.

Abundance

There were not enough on-line sightings in any month to justify density calculations. Most of the 21 sightings in the MIFL subunit during February occurred off-line, either between survey legs or during transits. While not directly useful for density calculations, these sightings strongly suggest that Spotted Dolphins were common off eastern central Florida during the spring.

Spotted Dolphins are considered to be the most common marine mammal in offshore waters of the southeastern United States (Moore 1953; Caldwell and Caldwell 1966, 1973; Schmidly 1981), although estimates of abundance are not available. The high number of sightings and reports from the Florida panhandle and off St. Augustine probably reflect efforts to capture Spotted Dolphins for oceanaria. These areas are not known to be centers of population abundance (Winn et al. 1979). Relatively few animals are stranded because they are usually well offshore and therefore are less likely to swim or wash up on the coast when injured or sick (Winn et al. 1979; Schmidly 1981).

Results of this study provide new information on herd size, although the samples in most areas were limited. Herd sizes ranged from 1 to 225 dolphins/herd with averages in months with more than two sightings ranging from 7 to 21 dolphins/herd (Figures 154 and 155). Literature reports indicate that herds generally number 6 to 10 animals, but groups of several hundred have been reported (Caldwell 1955, 1960; Caldwell and Caldwell 1966; Leatherwood et al. 1976). Seasonal changes in herd size have not been documented.

Habitat Use

Sighting distance from shore ranged from 20 km in the MIFL subunit to 269 km in the NAFL subunit, with averages ranging from 54 to 168 km offshore in the MIFL and NAFL subunits, respectively (Figure 156).

Spotted Dolphins are believed to replace Bottlenose Dolphins (*Tursiops truncatus*) in the nearshore and offshore waters of the Gulf of Mexico. Spotted Dolphins are usually found more than 5 to 12 miles (8 to 19 km) offshore (Gunter 1942; Caldwell and Caldwell 1966; Leatherwood et al. 1976). The assumption that this is primarily an offshore species is supported by the fact that only 23 (11%) of 206 records for *S. plagiodon* are of strandings (Schmidly 1981). Spotted Dolphins are usually located within 75 to 100 mi (120 to 160 km) of the coast, but seasonally they may range 150 to 200 mi (240 to 320 km) offshore (Caldwell and Caldwell 1966). Sightings reported by Caldwell (1960) and Caldwell and Caldwell (1966) ranged from 7 to 160 mi (11 to 256 km) offshore.

Seasonal inshore-offshore movements of Spotted Dolphins have been reported off eastern Florida and in the northern Gulf of Mexico. Off St. Augustine, Florida, they

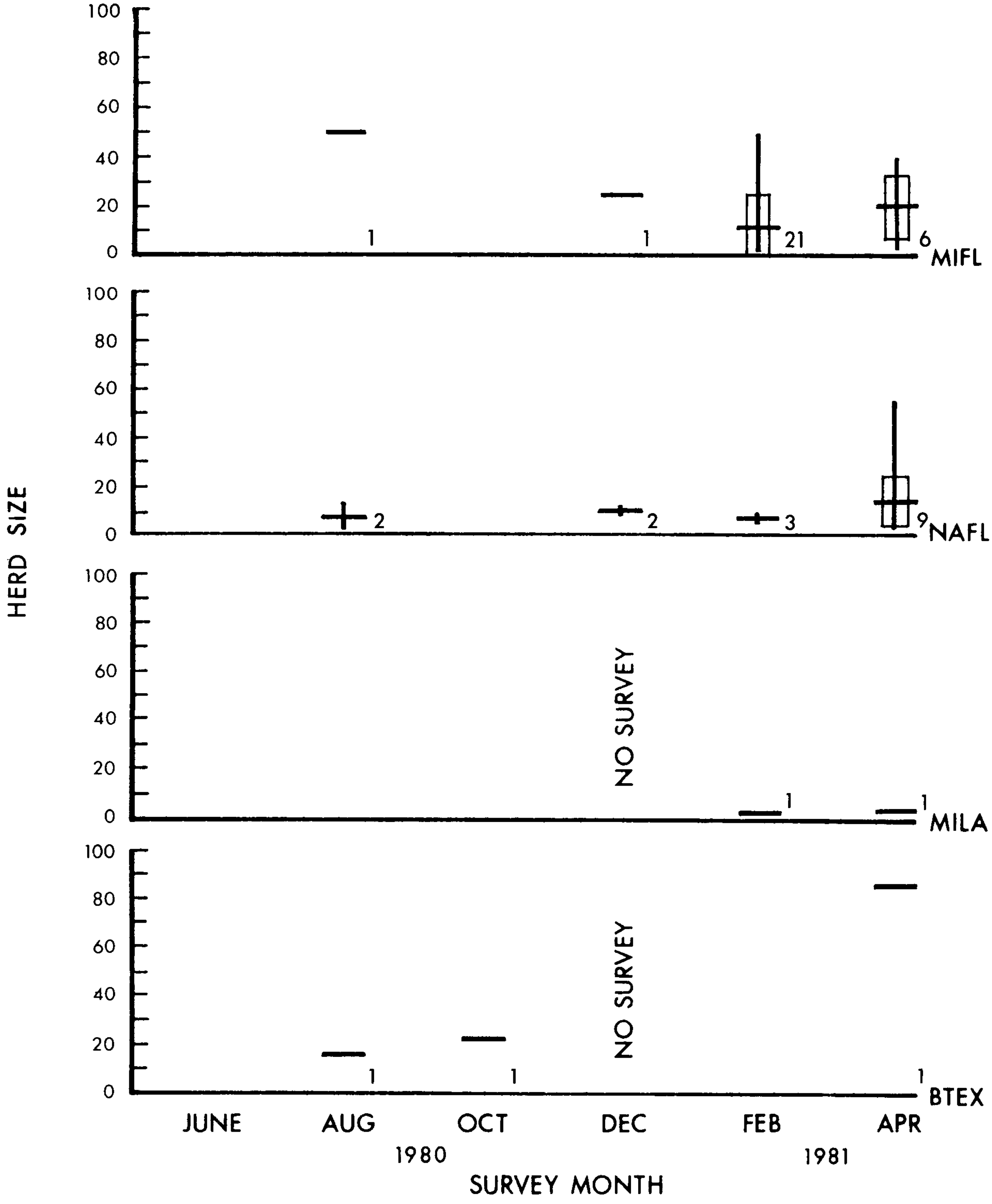


Figure 154. Herd size for all sightings of Spotted Dolphins by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

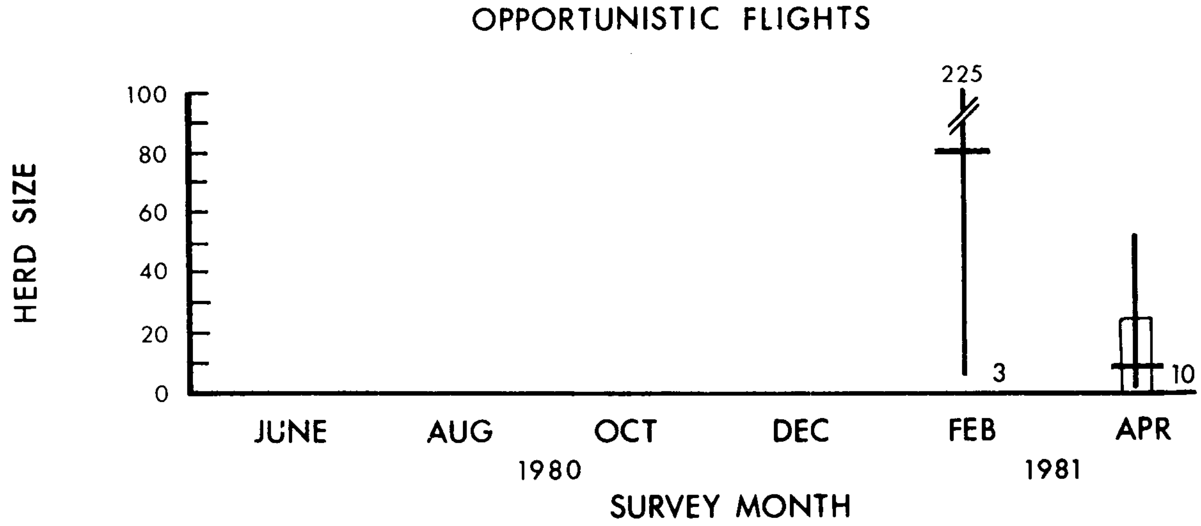


Figure 155. Herd size for all sightings of Spotted Dolphins by month during opportunistic flights. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

approach within 9 mi (15 km) of the coast during summer, but are generally 90 mi (145 km) offshore in winter (Caldwell and Caldwell 1966). The lack of sighting records along the eastern United States during September and October, may indicate that Spotted Dolphins are well offshore during this period (Winn et al. 1979). Moore (1953) reported that these dolphins migrate into the northern Gulf of Mexico as the water warms in the spring. However, Caldwell and Caldwell (1966) indicated that migrations may be seasonal onshore-offshore movements which vary in direction depending on coastal geography. Spotted Dolphins may approach the beaches in the panhandle of Florida during spring (Caldwell and Caldwell 1966). A probable subadult was harpooned in the channel at Aransas Pass, Texas, in the summer of 1940 (Gunter 1941a). Other nearshore movements have not been reported.

During scheduled surveys, the depth of water at sighting locations of Spotted Dolphins ranged from 18 to 823 m and monthly averages ranged from 53 to 458 m (Figure 157). On opportunistic flights, Spotted Dolphins were sighted at locations ranging from 7 to 2,546 m in depth (Figure 158). Water temperatures at sighting locations ranged from 13° C on opportunistic flights off Onslow Bay, North Carolina in March 1981 to 28° C during scheduled surveys in the NAFL subunit in August 1980 (Figures 159 and 160).

Few details are available about depth and temperature preferences of Spotted Dolphins. They have been sighted in waters where depths ranged from 10 to 1,160 fathoms (18.4 to 2,135 m) (Caldwell 1960). Preferred depths are probably associated with

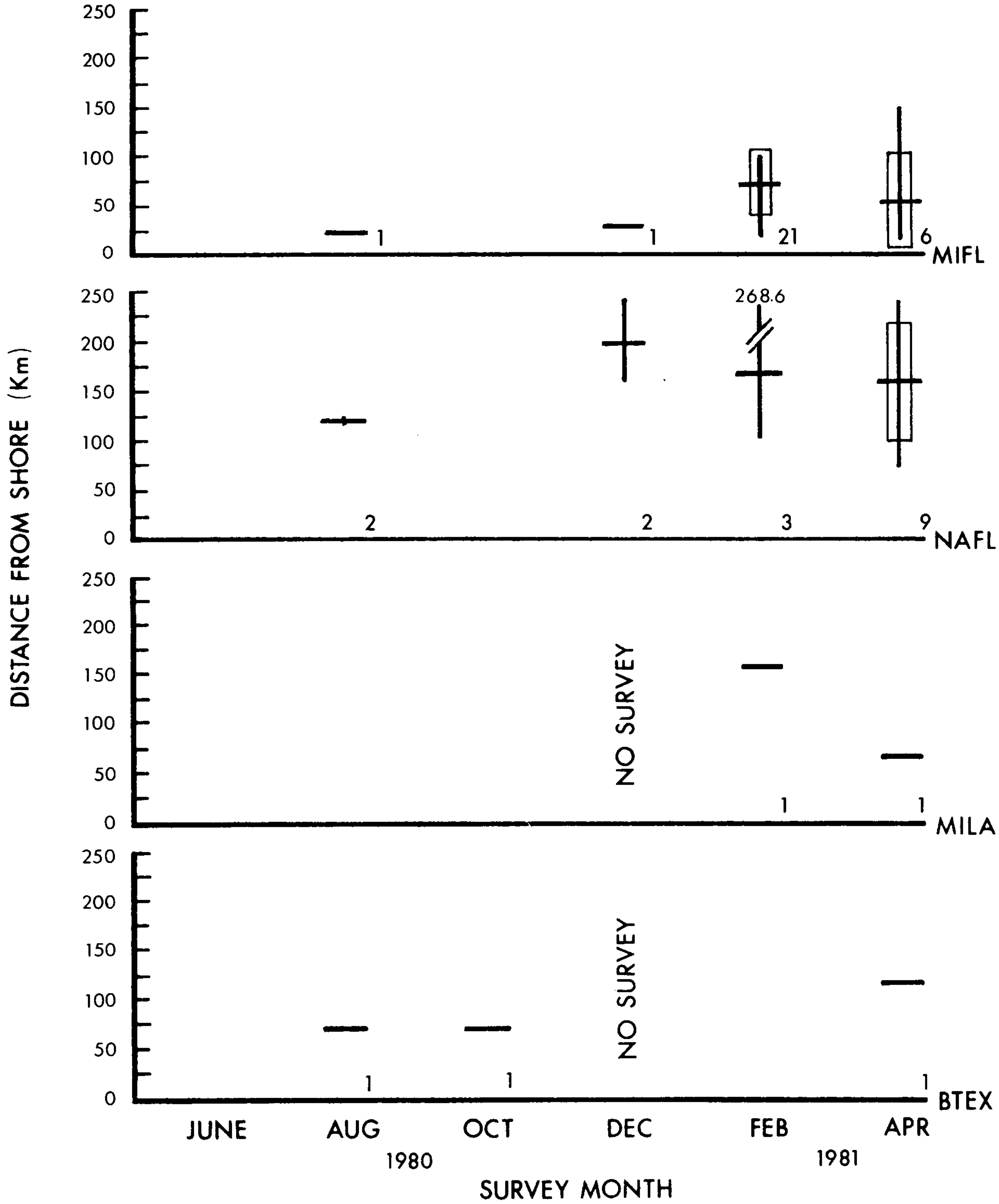


Figure 156. Distance from shore for all sightings of Spotted Dolphins by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

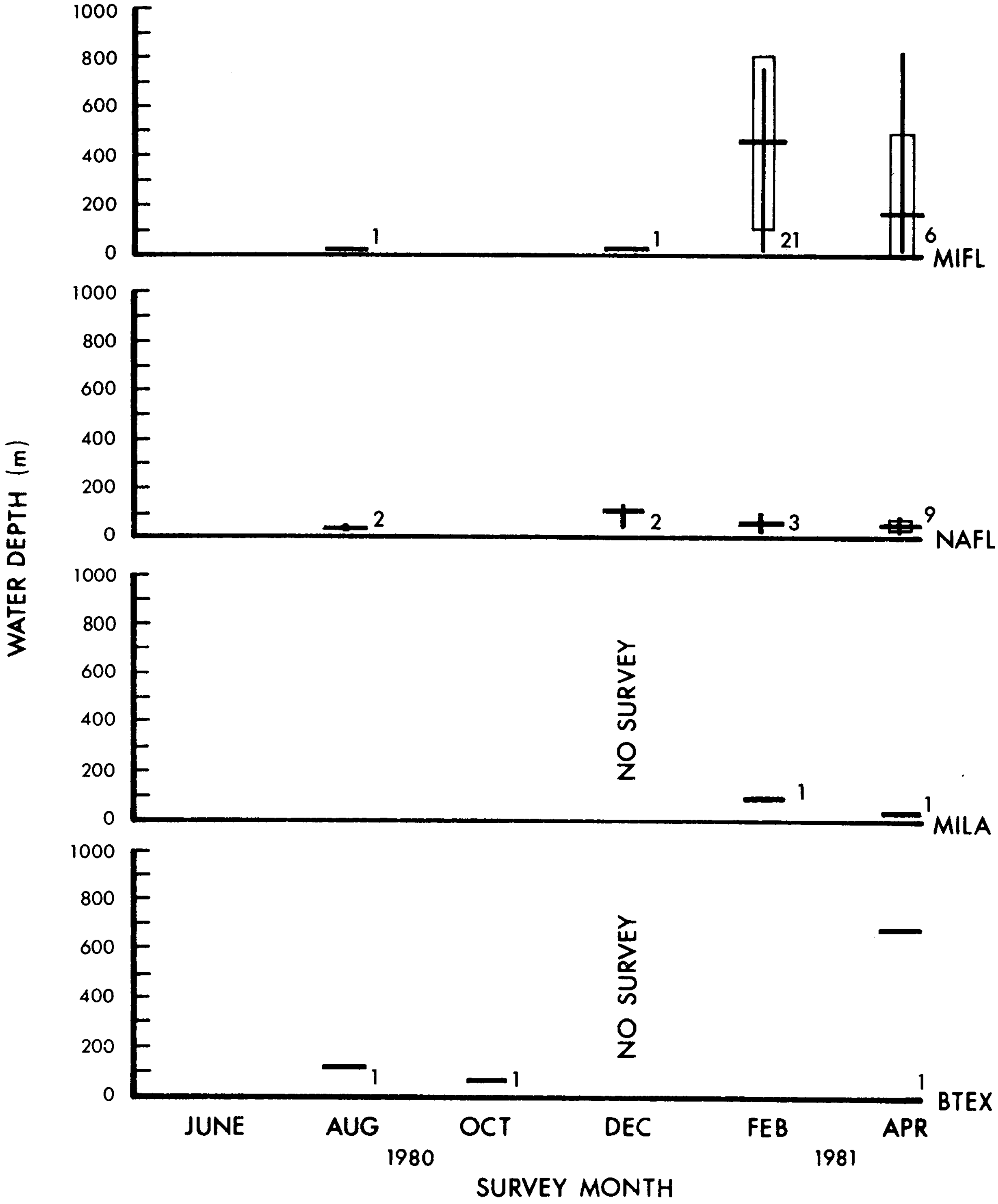


Figure 157. Water depth for all sightings of Spotted Dolphins by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

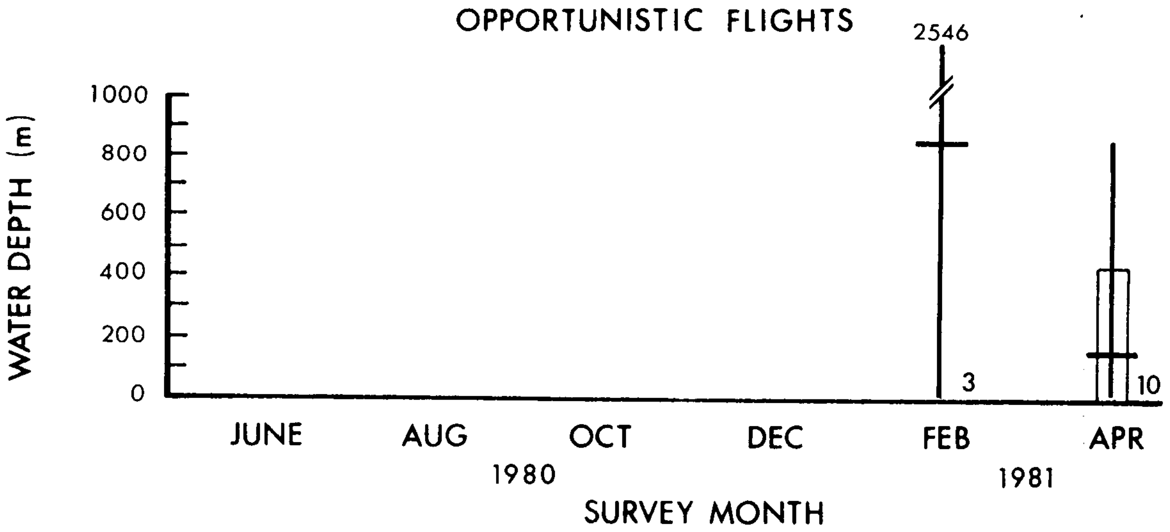


Figure 158. Water depth for all sightings of Spotted Dolphins by month during opportunistic flights. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

available food and water temperatures (Caldwell and Caldwell 1966). Generally the average depth at sighting locations was considerably deeper for Spotted Dolphins (Figure 157) than for the more coastal Bottlenose Dolphin (Figure 147). Movements of Spotted Dolphins closer to shore during spring, summer, and mild winters may be related to changes in water temperatures (Moore 1953; Caldwell and Caldwell 1966), but the relationship was not obvious during this study.

Associations

Spotted Dolphins were seen apparently feeding near a large group of sharks that were 1.5 to 2.0 m long. They have previously been sighted with sharks by Caldwell (1960), but the association is somewhat unusual because some sharks are predators of dolphins (Wood et al. 1970).

During one sighting, a Spotted Dolphin had a remora attached to its body and was twisting and splashing as if attempting to detach the parasite. Sightings of remoras on Spotted Dolphins have been reported by Mahnken and Gilmore (1960).

Reproduction

Little is known about Spotted Dolphin reproduction. Sexual behavior has been observed from May to July (Caldwell 1960), and a newly captured animal gave birth in

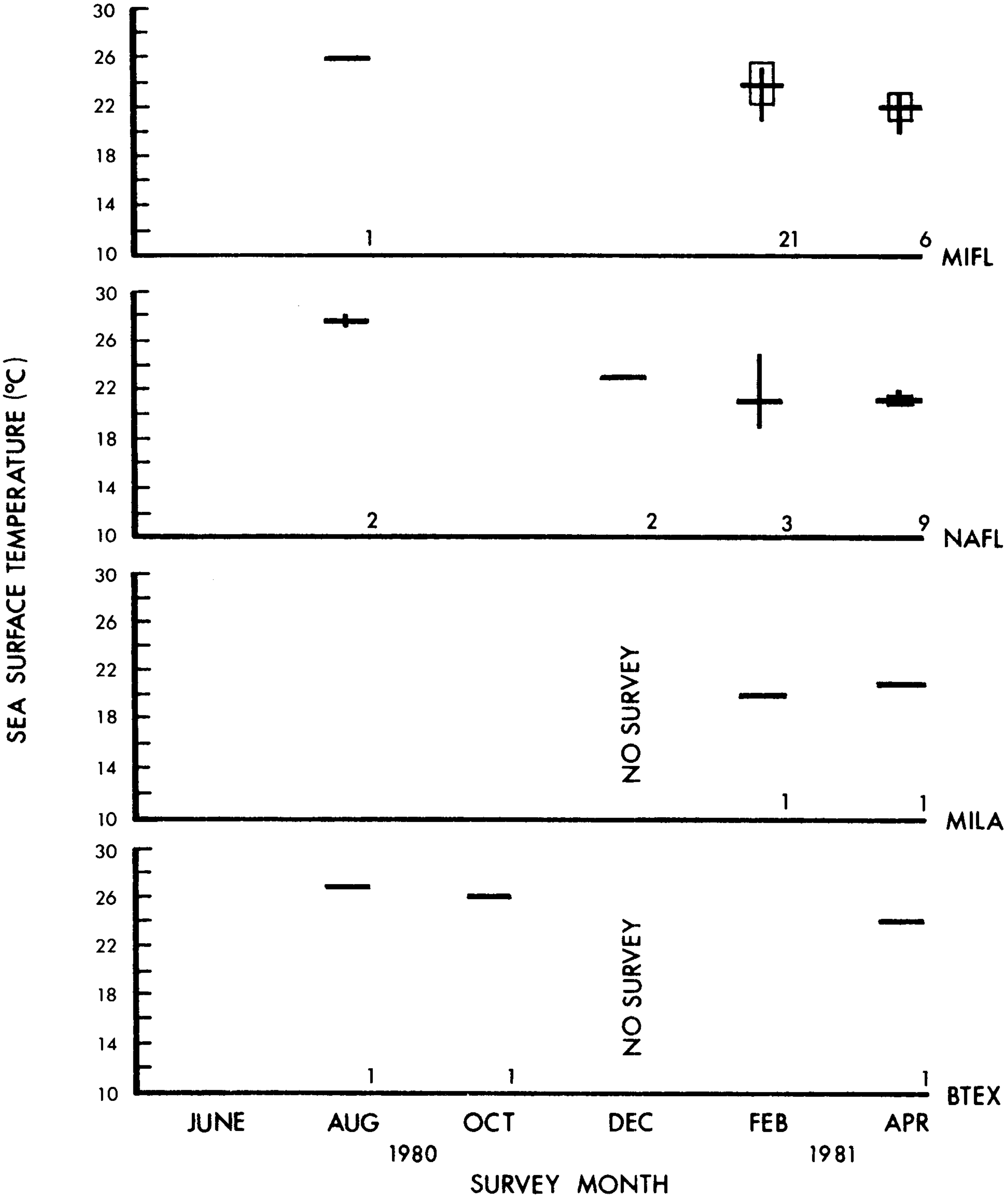


Figure 159. Sea surface temperature for all sightings of Spotted Dolphins by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

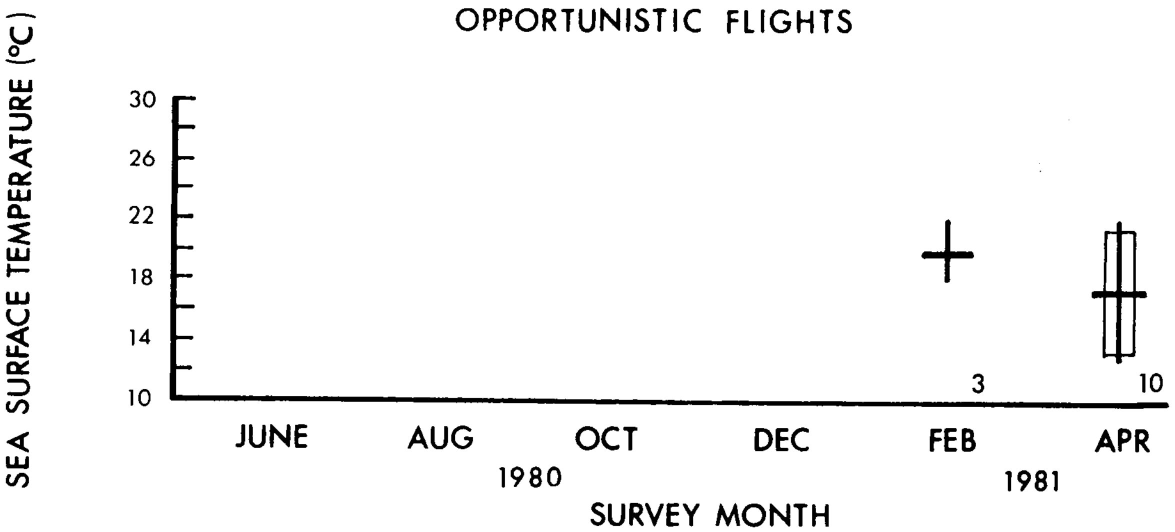


Figure 160. Sea surface temperature for all sightings of Spotted Dolphins by month during opportunistic flights. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

August (Caldwell and Caldwell 1966), but reproductive seasonality is unknown. Groups approaching the coast generally do not include calves (Caldwell and Caldwell 1966).

A total of 13 calves, comprising 2% of the 810 Spotted Dolphins observed, was sighted during surveys. The percentage of calves observed is probably well below the actual percentage, because three of the calves were only seen in photographs and more were probably present but not observed. Calves were sometimes located directly below the presumed mother, perhaps to avoid the noise of the survey aircraft. It is also possible that more calves were missed because observers were concentrating on species descriptions and counts.

Behavior

On three occasions Spotted Dolphins were observed feeding near large fish schools although what they were eating could not be determined. Spotted Dolphins are known to eat squid, herring, anchovies, and carangids from the surface and epipelagic zones (Moore 1953; Caldwell 1955; Caldwell and Caldwell 1966; Leatherwood et al. 1976; Winn et al. 1979). They may follow "hardtails" (Caranx sp.) towards the panhandle of Florida in the spring (Caldwell and Caldwell 1966), and they will sometimes feed behind shrimp boats and trawlers (Moore 1953; Caldwell 1955).

Few behaviors could be distinguished from the air. The circling aircraft probably caused avoidance behavior by the animals on three occasions. In these instances, the animals submerged when the aircraft circled over them and surfaced when the plane was on the opposite side of the circle. On several other occasions, animals appeared to disperse from original group formations because of the proximity of the aircraft, but such changes were only subjective impressions and could not be quantified.

Potential Impacts of OCS Development

Spotted Dolphins are not known to have been impacted by oil spills or oil-development activities. They are not restricted to inshore and nearshore waters, so are probably less vulnerable than Bottlenose Dolphins to OCS development. Oil spills in the northern Gulf of Mexico during spring and summer could affect Spotted Dolphins approaching the coast.

Summary

Spotted Dolphins were observed in all survey subunits during at least 2 months. They are considered the most common cetacean in nearshore and offshore waters. Their offshore distribution generally complimented the nearshore distribution of Bottlenose Dolphins although considerable overlap was sometimes observed. Spotted Dolphins were sighted 20 to 269 km from shore, and monthly average distances ranged 54 to 168 km from shore. Sightings increased during the spring in the NAFL (April) and MIFL (February and April) subunits, possibly because of seasonal movements toward or along shore. Spotted Dolphins usually range well offshore, but they may be subject to OCS impacts when near the coast. Human activities are not known to impact this species.

STRIPED DOLPHIN, *Stenella coeruleoalba*

Some of the literature on Striped Dolphins uses the name *Stenella styx* instead of *Stenella coeruleoalba*. *Stenella coeruleoalba* is a senior synonym of *S. styx* and is the appropriate name (Mitchell 1975a).

Description

The Striped Dolphin is larger than other dolphins of the genus *Stenella* in the Atlantic and grows to at least 2.7 m. The back is dark gray to bluish gray from the head to behind the dorsal fin. A series of black stripes extends from the corner of the mouth to the eye, from the eye to the flipper, and from the eye to the anal region. The last stripe separates a pale gray field on the side from the white underparts. The pale gray field extends from the side of the forehead back to the flukes and over the slope of the tail stock anterior to the peduncle. A splash of gray color (dubbed a "feather blaze" by aerial observers) sweeps dorso-posteriorly from above and slightly posterior to the flippers; the feather blaze extends almost to the base of the dorsal fin. The underparts of the body are white from the chin to the anal region, interrupted only by the dark stripes from the eyes to the flippers, and by the dark flippers. The rostrum is dark.

From the air, the dark cape with distinct margins, the dark rostrum, and the feather blaze are useful identification cues for Striped Dolphins. Spotted Dolphins may also have a feather blaze, but the beak tip is often white and spotting usually obscures the lateral margins of the dorsal coloration (also see Table 57).

Distribution

Striped Dolphins were observed in all survey subunits, but were seen regularly only in the NAFL subunit where they were recorded in every survey month except December. Striped Dolphins were seen during June, February, and April in the MIFL subunit, during June and October in the BTEX subunit, and during October in the MILA subunit (Figures 161 and 162).

On opportunistic flights, Striped Dolphins were observed during October in the northeastern Gulf of Mexico, and during March north of the MIFL subunit, south of the Dry Tortugas, and off North Carolina.

In the Atlantic Ocean, Striped Dolphins are found from Nova Scotia to South Africa, including the Caribbean and Gulf of Mexico (Nishiwaki 1972; Leatherwood et al. 1976; Prescott et al. 1980). They probably prefer warm waters and are usually found off the edge of the outer continental shelf (Leatherwood et al. 1976). Striped Dolphins are also found in the Mediterranean Sea and in warm to temperate waters of the Pacific Ocean.

Abundance

A total of 866 Striped Dolphins (55 sightings) was seen. Density could be calculated only for February sightings in the MIFL subunit, and was 0.076 dolphins/km^2. Sighting information suggests that Striped Dolphins are more prevalent around Florida than in the western or northern Gulf of Mexico.

The seasonal abundance of Striped Dolphins is difficult to evaluate because the number of sightings varied by month. The apparent influx of Striped Dolphins into the MIFL and NAFL subunits during February may indicate seasonal migrations in these areas (Figures 161 and 162). However, the direction of movement of these herds at the time of sightings were inconsistent, and regional abundance information is unavailable from the literature. The number of sightings in the relatively shallow NAFL subunit is somewhat surprising because the Striped Dolphin is reported to prefer offshore waters (Leatherwood et al. 1976).

In the Western Atlantic, Prescott et al. (1980) estimated Striped Dolphins to be relatively abundant from Georges Bank to the Caribbean. Although little is known about populations in the Atlantic Ocean, Caldwell and Caldwell (1974), in the absence of any information of declining stocks, stated populations were stable. In the eastern tropical Pacific, Striped Dolphins are less common than Spinner and Spotted Dolphins (Perrin 1975; Au et al. 1979). They are probably the most common cetaceans off Japan (Nishiwaki 1972) where they are harvested commercially there (FAO 1978).

Herd sizes ranged from 1 to 130 dolphins/herd and averaged 16 dolphins/herd overall. Average herd sizes were generally larger during February ($\bar{x}$ = 26 in the NAFL subunit; $\bar{x}$ = 21 in the MIFL subunit) than during other months. Little is known about the herd size of Striped Dolphins. Off Japan, 86% of the herds taken in the drive fishery numbered less than 500 animals (Miyazaki and Nishiwaki 1978). The herds are usually

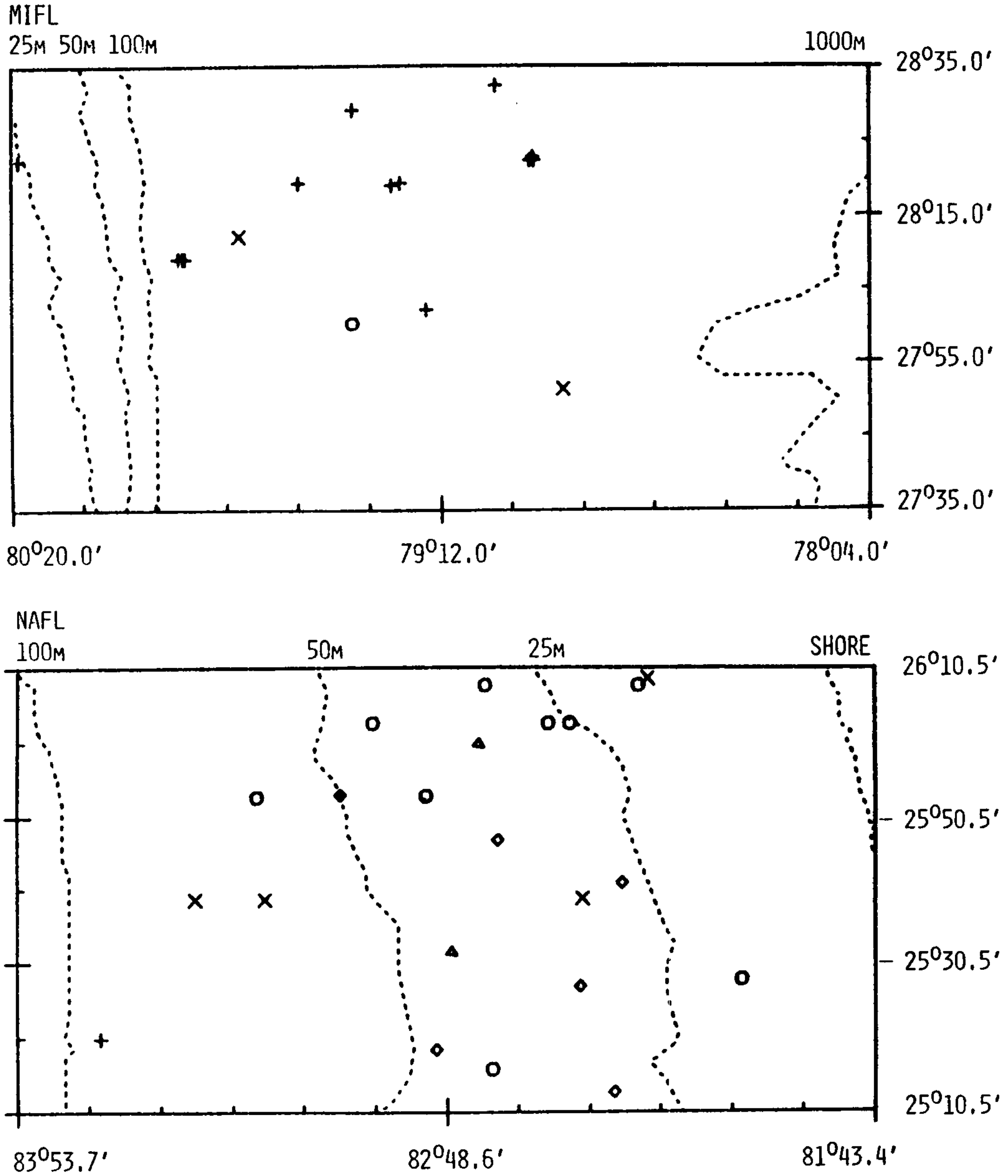


Figure 161. Distribution of Striped Dolphin sightings in the MIFL survey subunit (above) during June (O), February (+), and April (X) and in the NAFL survey subunit (below) during June (O), August (X), October (△), February (◇), and April (+).

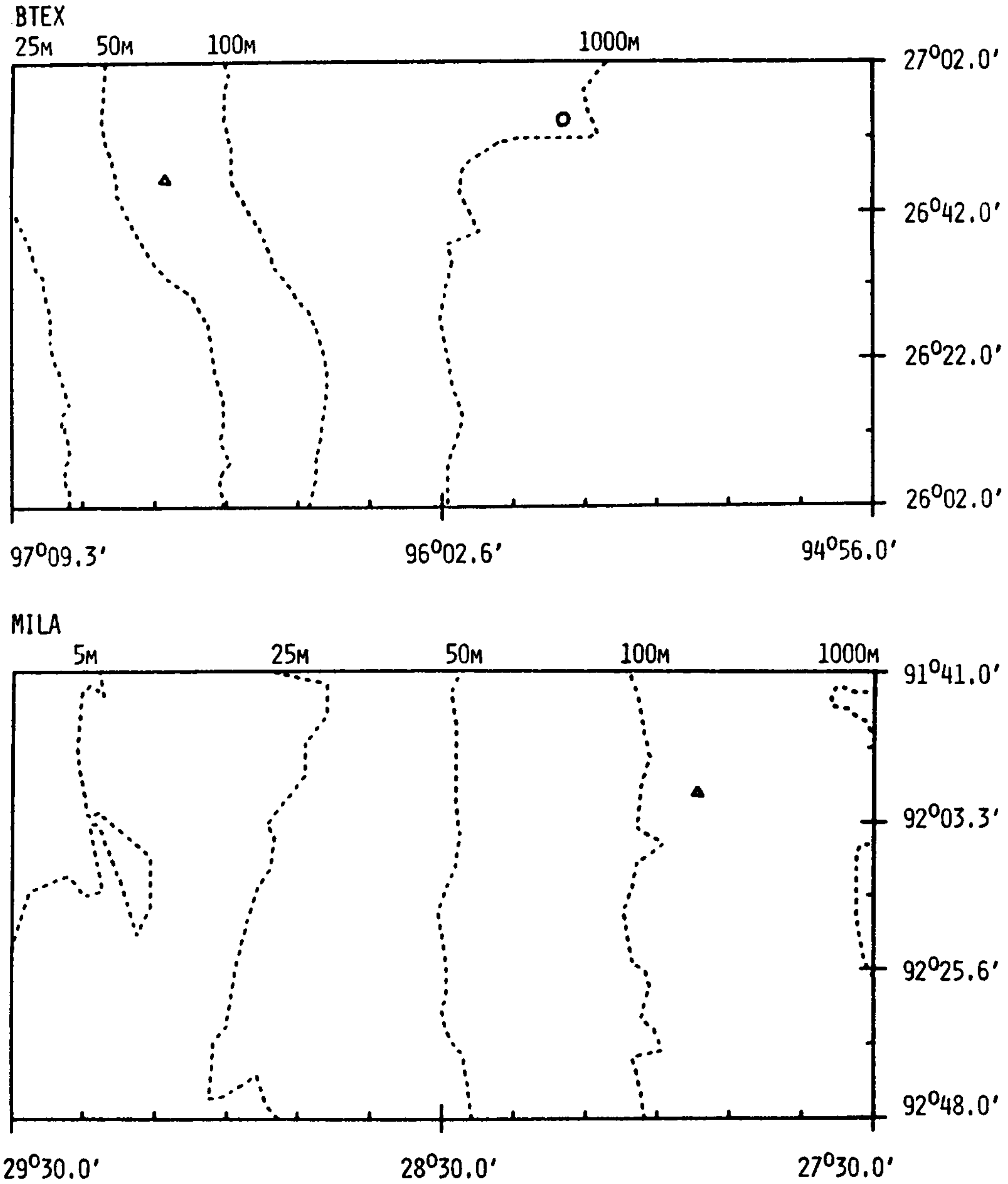


Figure 162. Distribution of all Striped Dolphin sightings in the BTEX and MILA survey subunits during June (O) and October (△).

segregated by age and reproductive status, and most number between 250 and 450 dolphins/herd (Miyazaki and Nishiwaki 1978).

Habitat Use

Sighting locations ranged 24 to 253 km from shore with monthly averages ranging 100 to 160 km from shore. During the months with the most sightings, average distance from shore was 106 km in the NAFL subunit (June) and 100 km in the MIFL subunit (February) (Figure 163).

Striped Dolphins were observed in water from 20 to 942 m in depth (Figure 164). Average depths in the NAFL subunit were considerably less than in other subunits. It is noteworthy that the average depth in the MIFL subunit during February was about 15 times greater than the average depth in the NAFL subunit during June (Figure 164), whereas the average distance from shore in these subunits during the same months differed only by about 6% (Figure 163). These results seem to indicate that distribution was associated more with distance from shore than with depth. This correlation is noteworthy because the distribution of some other species in these subunits (e.g., Bottlenose Dolphins and Loggerhead Turtles) appeared to be determined by depth, not distance from shore. Follow-up studies are needed to clarify any seasonal patterns of habitat use. Little is currently known about either migratory movements or habitat preferences of Striped Dolphins in the study area.

Leatherwood et al. (1976) and Prescott et al. (1980) suggested that Striped Dolphins generally occur along the continental shelf edge. Off New England and the Central Atlantic states, Striped Dolphins were usually found beyond the 1,800-m contour (Hain et al. 1981). In the eastern tropical Pacific they have a pelagic distribution: most sightings have occurred far from the continetal shelf (Au et al. 1979).

Striped Dolphins were observed in water with surface temperatures of 19° to 28° C (Figure 165). Temperature preferences for this species are unknown, but it occurs in considerably colder temperatures at higher latitudes.

Associations

Striped Dolphins were observed with other vertebrates in 14 (25%) of the 55 sightings. They were observed with Short-finned Pilot Whales, Spotted Dolphins, unidentified Stenella spp., and unidentified dolphins. Sooty Terns, Bridled Terns, Audubon's Shearwaters, and Herring Gulls were identified flying over Striped Dolphins.

Reproduction

Striped Dolphin calves were observed on 11 occasions (17 animals), comprising 2% of all individuals sighted. Calves of Striped Dolphins were seen during June, August, October, and February. Apparent copulatory behavior by two pairs of animals was observed on 28 February in the MIFL subunit.

Reproduction of Striped Dolphins in the Atlantic has not been studied. About 8% of the Striped Dolphins from the Japanese drive fishery during 1963 through 1973 were suckling calves, and several reproductive seasons were reported (Miyazaki and Nishiwaki 1978).

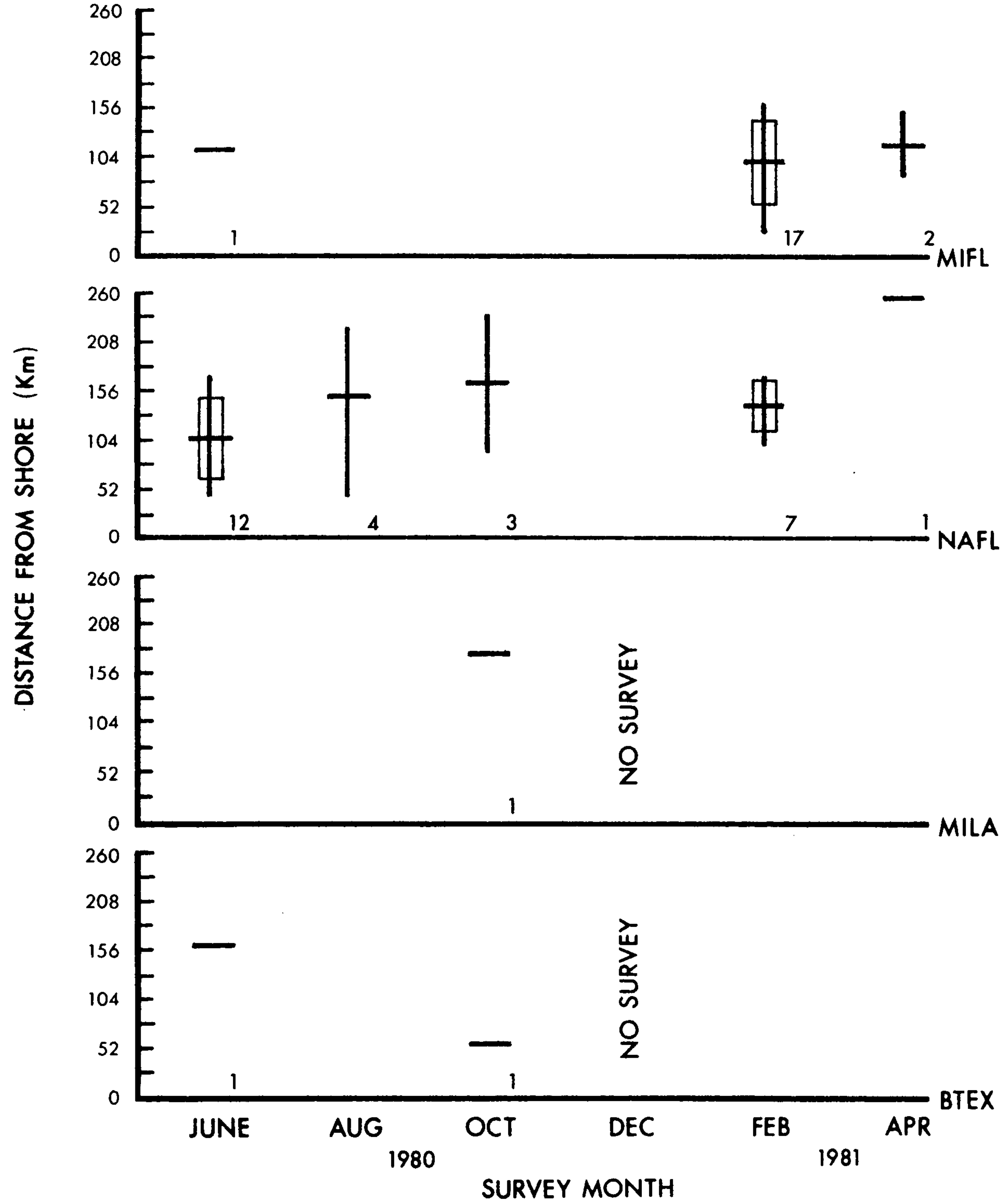


Figure 163. Distance from shore for all sightings of Striped Dolphins by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

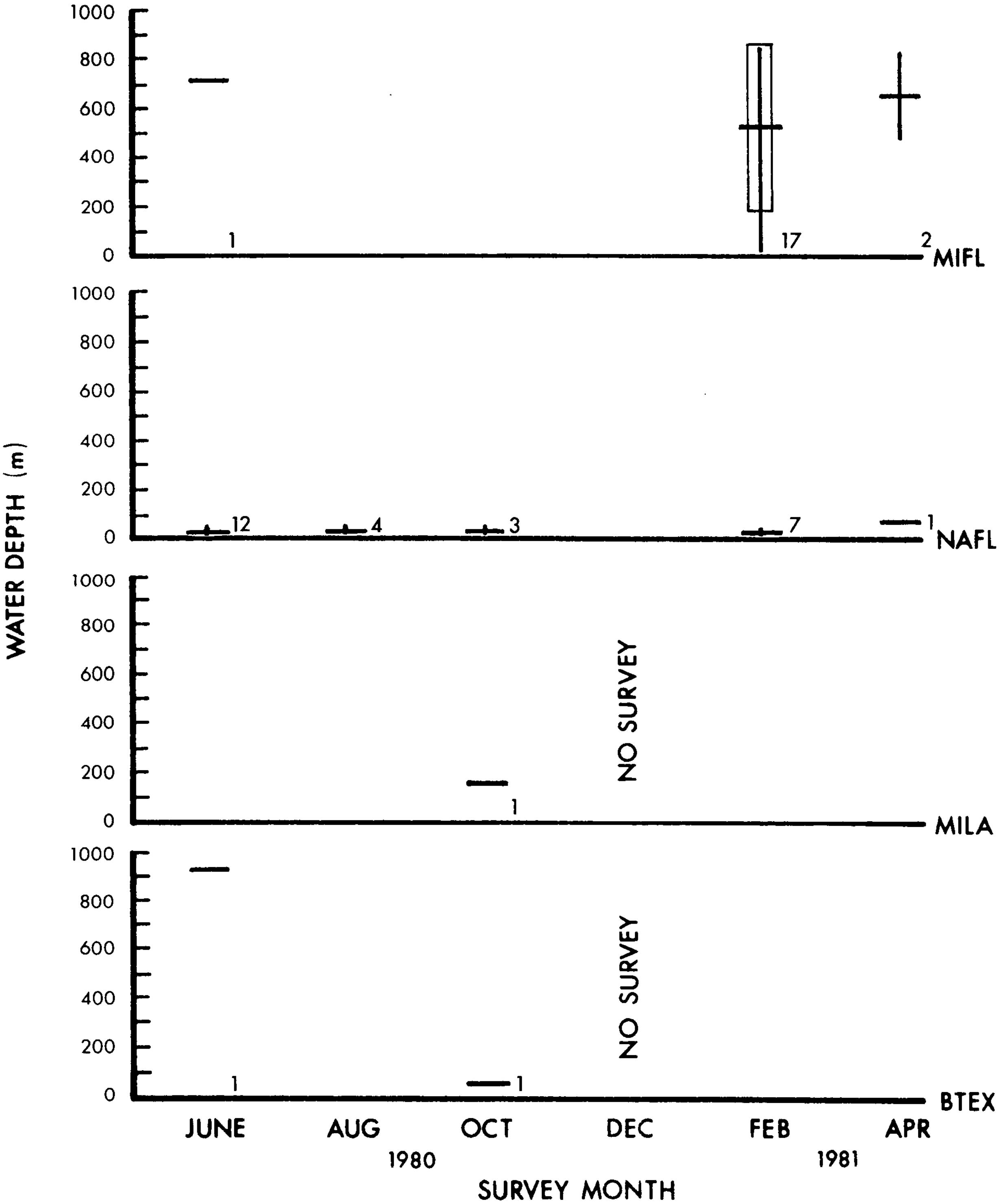


Figure 164. Water depth for all sightings of Striped Dolphins by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

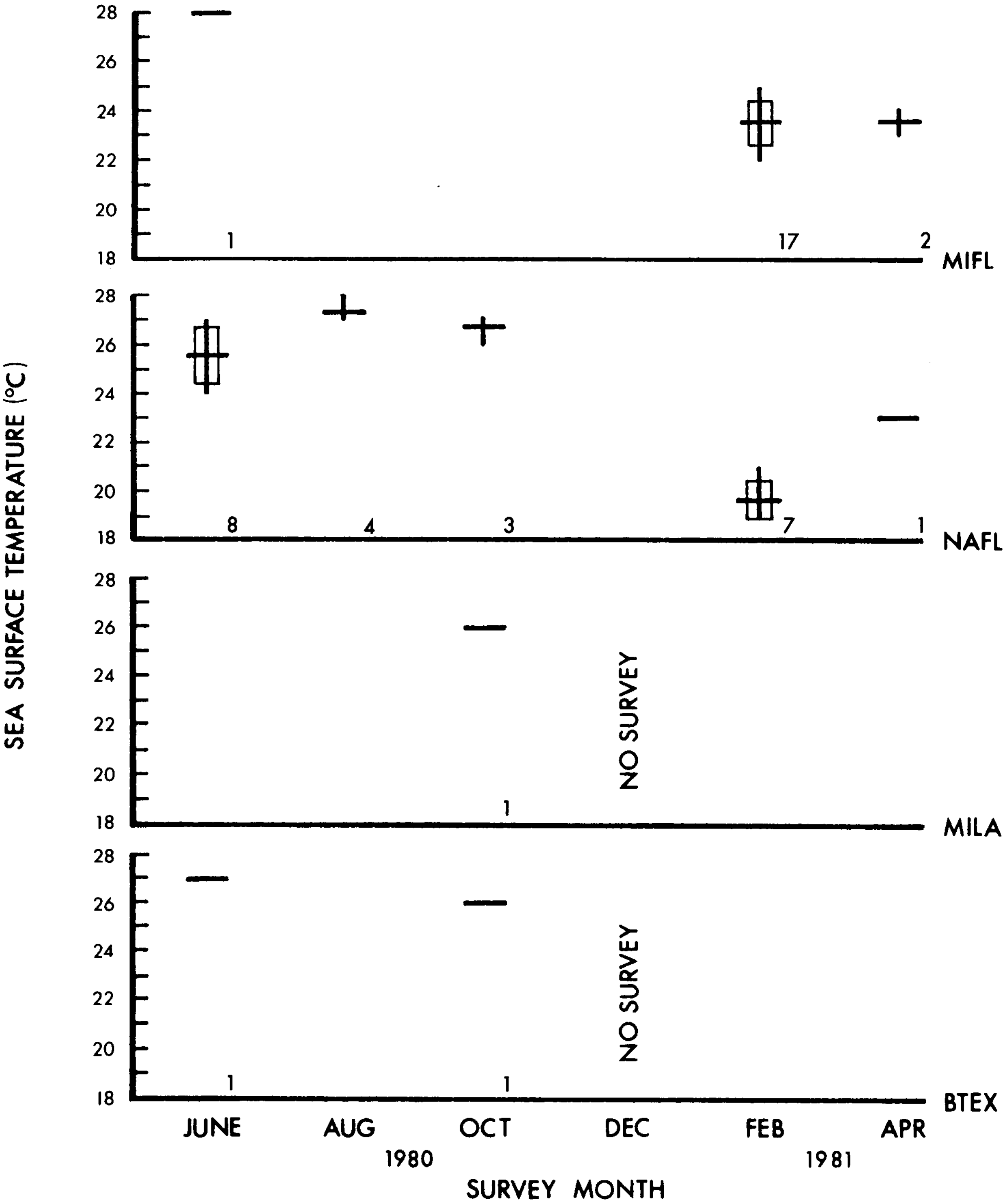


Figure 165. Sea surface temperature for all sightings of Striped Dolphins by month and survey subunit. Statistics include mean (horizontal bar), ± 1 SD for more than five sightings (box), range (vertical bar), and number of sightings (numbers on x-axis).

Behavior

On several occasions Striped Dolphins bunched together into tighter groups as the survey aircraft circled. On five occasions they jumped or tail-slapped as the aircraft circled.

Potential Impacts of OCS Development

No impacts of OCS development on Striped Dolphins have been documented. The reported preference of this species for pelagic water along the edge of the continental shelf suggests that direct contact with OCS development is unlikely. However, the results of this study indicate that Striped Dolphins do range into water 30 to 50 m deep off southwestern Florida. They could be subject to OCS development in this area.

Summary

Striped Dolphins were sighted occasionally in every survey subunit but were regularly seen (28 sightings) only in the NAFL subunit. During the months with the most sightings, average distances from shore were 100 and 106 km. This is farther out than the average distances from shore for Spotted Dolphins, but considerable overlap in the distribution of the two species was noted. Striped Dolphins apparently migrated into the MIFL subunit between the February and April surveys, and possibly migrated into the NAFL subunit before June. Density could be calculated only for the MIFL subunit in February, and was 0.076 dolphins/km^2. OCS development impacts on Striped Dolphins should be minimal because most of the population is found in pelagic waters.

SPINNER DOLPHIN, *Stenella* spp.

Includes: *Stenella longirostris*
Stenella clymene

Two species of Spinner Dolphin (*Stenella longirostris* and *S. clymene*) are present in the study area. *Stenella longirostris* has until recently been the only Spinner Dolphin on most lists of cetaceans. *Stenella clymene* is externally similar to *S. longirostris* and was rediscovered as a valid species only recently (Perrin et al. 1981). They were not differentiated because characteristics necessary to distinguish the two species from an aircraft were not apparent.

Description

Spinner Dolphins are smaller and more slender than other *Stenella* spp. in the study area (Leatherwood et al. 1976; Schmidly 1981). Maximum size is about 2.1 m. The beak of *S. longirostris* is quite long, but the beak of *S. clymene* is shorter (Perrin et al. 1981). Spinner Dolphins have a dark gray to black cape extending to the tail stock, a dark beak tip, dark flippers, and dark flukes. The ventral margin of the cape approximately parallels the ventral margin of a tan-colored lateral field, and the belly is white. Color patterns vary among stocks of Spinner Dolphins in the Pacific (Perrin 1972, 1975; Perrin et al. 1979), but stock differences are unknown in the Atlantic and Caribbean (Leatherwood et al. 1976; Perrin et al. 1981).

From the air, Spinner Dolphins are identified by the small size, slender body shape, and dark cape extending back to the tail stock (also see Table 57). On most sightings, the extreme length of the beak was apparent and suggested the animals were *S. longirostris* rather than *S. clymene*.

Distribution

Spinner Dolphins were identified nine times in aerial surveys. They were seen in the NAFL subunit on five occasions, once each in the MIFL and BTEX subunits, and during opportunistic flights off southeastern Florida and the Mississippi Sound (Table 58). Spinner Dolphins were observed once each in February, March, August, October, December, and twice each in June and April surveys.

The Spinner Dolphin is a deep-water species that occurs in tropical and subtropical seas. Spinner Dolphins are widespread in the warm waters of the Pacific, Indian, and Atlantic Oceans, and the Gulf of Mexico and Caribbean Sea. In the study area, they are known from strandings off Texas, Florida, Georgia, South Carolina, and North Carolina (Layne 1965; Mead et al. 1980; Perrin et al. 1981, Schmidly 1981). It is uncertain if Spinner Dolphins in the Gulf of Mexico represent a distinct population or are strays from the Caribbean (Mead et al. 1980).

Abundance

Sightings of Spinner Dolphins were too infrequent for calculation of density. The survey results indicate that Spinner Dolphins were widespread but generally uncommon near the continental shelf in the Gulf of Mexico. They were encountered much less frequently than Spotted or Striped Dolphins. Few were sighted during the present study possibly because flights did not extend into prime (offshore) Spinner Dolphin habitat.

No population estimates are available for Atlantic stocks of Spinner Dolphins. They may be the most common cetacean in the Caribbean (Leatherwood et al. 1976). Winn et al. (1979) suggested, because of a lack of data to the contrary, that the North Atlantic population was stable. Perrin (1975) estimated the population of Eastern Spinner Dolphins (the stock inhabiting the Pacific Ocean east of 115^{o} W and north of 6^{o} N) at 400,000 to 1,100,000 animals.

Herd sizes varied from 3 to 85 dolphins/herd. Herd sizes of more than 500 animals are regularly observed in the eastern Pacific (Au et al. 1979), and herd sizes of several hundred also are known from the Atlantic and Caribbean (Leatherwood et al. 1976; Perrin et al. 1981).

Habitat Use

The sightings of Spinner Dolphins averaged 129 km from shore (ranging 58 to 254 km from shore). All were in blue water beyond the turbid inshore zones.

The Spinner Dolphins observed were in water averaging 334 m deep (ranging from 24 to 1,609 m). The shallowest sightings were in the NAFL subunit, an unexpected occurrence because of the predominantly oceanic distribution of this species.

Table 58. Sighting information on the Spinner Dolphin. OPPO = opportunistic flight.

Survey subunit	Date	No. of dolphins	Position (Latitude/Longitude)	Distance from shore (km)	Water depth (m)	Sea surface temperature (° C)
BTEX	25 Apr. 1981	85	26°26.0'N/96°11.0'W	106	686	23
NAFL	16 June 1980	3	25°18.5'N/82°35.2'W	107	35	26
NAFL	18 June 1980	4	25°43.5'N/82°16.7'W	61	24	28
NAFL	15 Aug. 1980	20	25°53.5'N/83°36.7'W	154	71	27
NAFL	07 Mar. 1981	4	25°11.5'N/83°49.9'W	230	113	25
NAFL	05 Apr. 1981	4	26°04.7'N/82°31.6'W	58	25	21
MIFL	11 Oct. 1980	15	28°08.0'N/80°05.0'W	69	47	26
OPPO	14 Dec. 1980	60	25°19.8'N/84°20.5'W	254	256	24
OPPO	20 Feb. 1981	22	28°59.8'N/87°50.0'W	121	1,609	19

The habitats used by Spinner Dolphins in the Atlantic are uncertain. In the eastern Pacific, a number of populations are known to occupy coastal habitats whereas others have an entirely oceanic range (Perrin 1975). In Hawaii, Spinner Dolphins feed at night in water more than 500 m deep, but during the day they approach islands and move into waters of 50 m or less (Norris and Dohl 1980b). Spinner Dolphins feed on small mesopelagic fishes and squid.

Spinner Dolphins were observed in water with surface temperatures of 19° to 28° C. The only of group of Spinner Dolphins seen in the MIFL subunit (11 October 1980) was in the Gulf Stream. Otherwise, Spinner Dolpins were not recorded as associated with currents.

In the eastern Pacific, Au et al. (1979) reported that White-bellied Spinner Dolphin populations tend to occur along the 10° divergence zone, an area of weak upwelling. Off Peru they tend to be limited to the waters west of the cool Humbolt Current.

Associations

Of the nine Spinner Dolphins observations, four groups (44%) were associated with other marine mammals including: Bottlenose Dolphins, Spotted Dolphins, unidentified dolphins, and Short-finned Pilot Whales.

The tendency of Spinner Dolphins to associate with (Pacific) Spotted Dolphins (*Stenella attenuata*) is well documented (see review by Norris and Dohl 1980b). Norris and Dohl (1980b) hypothesized that the nocturnal Spinner Dolphins may rest while close to the diurnally feeding Spotted Dolphins, which would be more alert during the day.

Reproduction

Two calves were observed. Both observations were in the NAFL subunit. In each instance, the herd contained four animals and was associated with Bottlenose Dolphins.

Perrin et al. (1977) studied growth and reproduction of Eastern Spinner Dolphins by necropsy of animals captured in the Yellowfin Tuna fishery in the eastern Pacific. They concluded that females matured in 3 to 5 years and bore calves at approximately 2-year intervals. Post-reproductive females were present in low numbers in the population. Gestation apparently was about 10 months. Age at sexual maturity is unclear for male Spinner Dolphins, but Perrin et al. (1977) believed it occurred between 6 and 11 years of age. Sex ratio was about equal, with a slight excess of females among adults. Although few reproductive tracts of Spinner Dolphins from the Atlantic-Caribbean area have been examined, reproductive parameters of dolphins from a mass stranding in Florida (Mead et al. 1980) were generally similar to results presented by Perrin et al. (1977).

Behavior

Spinner Dolphins remained at the surface more than the other Stenella spp. observed. They were not observed diving out of view, and they jumped more than other dolphins. On two occasions, Spinner Dolpins were observed using the low jumps analyzed by Au and Weihs (1980). Spinner Dolphins in the Atlantic Ocean apparently spin less frequently than they do in the Pacific (Leatherwood et al. 1976).

Potential Impacts of OCS Development

Spinner Dolphins are not known to be impacted by OCS development. The generally pelagic distribution of this species reduces the probability of direct contact with OCS activities. However, Spinner Dolphins do range over the OCS in southwestern Florida and they could be vulnerable in that area.

Summary

Nine herds of Spinner Dolphins were sighted, five of them in the NAFL subunit. Average distance from shore was 129 km, and average depth at sighting locations was 334 m. The sightings over the continental shelf in the NAFL subunit were surprising because Spinner Dolphins are reported to be a basically pelagic species. Seasonal trends in sightings were not apparent. Spinner Dolphins will generally range offshore of most OCS development activities.

WEST INDIAN MANATEE, *Trichechus manatus*

The West Indian Manatee is a federally endangered species.

Description

The West Indian Manatee is a large (length to 4.6 m; weight to 1,000 kg), herbivorous aquatic mammal with a gray or brown fusiform body and a horizontally flattened paddle-shaped tail (Hartman 1979a). The head is small with stiff whiskers on the muzzle. The rest of the body has widely scattered hairs on the back. They have no dorsal fin. Manatees are often difficult to see because often only the head and nostrils are exposed when they breathe; however, cruising animals may roll at the surface like a cetacean.

From the air, the large size and paddle-shaped tail are distinctive. Manatees are rarely sighted far offshore.

Distribution

Manatee sightings occurred during transit to or from surveys in the NAFL and MIFL subunits (Table 59). The sightings near the NAFL subunit occurred in creeks and channels east of the beach and southwest of Naples, Florida. The sightings near the MIFL subunit were in the Atlantic Ocean ($\bar{x}$ = 0.9 km from shore, n = 4), in Mosquito Lagoon, and in the Indian River-Banana River complex.

These sightings occurred in areas where manatees are relatively common. The population in the United States is focused in coastal Florida where manatees penetrate rivers, creeks, and estuaries with access to the coast. During the summer, the range expands, with a few animals moving to the Carolinas or to western Florida (NFWL 1980c). A few records exist from as far as New Jersey on the Atlantic coast and Louisiana and Mississippi on the Gulf coast. Manatees have occasionally been sighted in Texas and are probably stragglers from Mexico (Husar 1977).

During the winter, the range of the manatee becomes localized in Florida, and remains south from about Crystal River (28°55' N) on the west coast to about Jacksonville (30°21' N) on the east coast (NFWL 1980c). During cold weather, manatees gather at artesian springs and around warm water effluents from industrial sources (Moore 1956; Layne 1965; Hartman 1979b, 1979c). The range has apparently expanded to present limits because of the proliferation of warm water sources in north and central Florida, which now provide shelter from cold weather in areas well north of historical limits (Layne 1965; Irvine and Campbell 1978; Hartman 1979a, 1979b, 1979c). The historical winter range was formerly south of about 27°52' N on the Atlantic coast and 26°45' N on the west coast of Florida (Moore 1951a, 1951b). Two power plants in the Indian River (west of the MIFL subunit) are a focus of manatee winter distribution in the area (Shane 1980), but no warm water sources are located near the NAFL subunit.

Outside of the United States, West Indian Manatees are found from eastern Mexico south to the coast of Brazil (Husar 1977; Whitehead 1977). They also occur in the Caribbean including Puerto Rico, Hispanola, Cuba, Jamacia, Andros (Husar 1977), and rarely in the Bahama Islands (Odell et al. 1978).

Abundance

The survey data provide no new information on manatee abundance. Ten manatees (four sightings) were observed southwest of Naples and nine were seen (six sightings) near the MIFL survey subunit (Table 59).

Although abundance figures are imprecise, recent estimates indicate the U.S. population of manatees may contain as few as 1,000 animals (Brownell et al. 1978). Manatees are protected by the Endangered Species Act because of dramatic declines in population size from historical levels. Centers of winter abundance in Florida include

Table 59. Sighting information on the West Indian Manatee. Dash means no data available. Number in parenthesis represents calf included in number of manatees.

Survey subunit	Date	No. of manatees	Position (Latitude/Longitude)	Water depth (m)	Sea surface temperature (° C)
NAFL	18 Oct. 1980	1	26°02.5'N/81°52.7'W	-	-
NAFL	19 Oct. 1980	4	25°54.7'N/81°41.7'W	2	-
NAFL	19 Oct. 1980	1	25°54.7'N/81°41.7'W	2	-
NAFL	19 Oct. 1980	4	25°54.7'N/81°41.7'W	2	-
MIFL	03 June 1980	1	27°36.8'N/80°20.4'W	8	27
MIFL	17 Oct. 1980	1	-	-	-
MIFL	27 Feb. 1981	1	27°40.1'N/80°20.7'W	11	24
MIFL	02 Apr. 1981	1	28°05.6'N/80°33.4'W	13	21
MIFL	03 Apr. 1981	3 (1)	-	-	21
MIFL	01 Mar. 1981	2 (1)	28°48.5'N/80°47.5'W	2	22

the Crystal River, southwestern Florida from about Naples to Whitewater Bay in the Everglades National Park, canals and waterways from Miami to West Palm Beach, and the Indian River-Banana River complex (inshore from the MIFL survey subunit) south to St. Lucie Inlet (Moore 1953; Layne 1965; Irvine and Campbell 1978; Hartman 1979a, 1979b, 1979c; Irvine et al. 1981). During the winter, manatees tend to be congregated near warm water sources, except in undeveloped southwestern Florida (Irvine and Campbell 1978; Hartman 1979b, 1979c). As the weather warms, they disperse from these areas (Irvine and Campbell 1978; Hartman 1979c).

Habitat Use

The surveys provided no new information on habitat use. Manatees are known to prefer shallow water (see review by Husar 1977).

Manatees are believed to prefer warm tropical and subtropical water (Husar 1977). They may be sensitive to winter water temperatures below 20° C (Brownell et al. 1978; Campbell and Irvine 1978), and may die after severely cold weather (air temperatures 0° C) in Florida (see summary by Husar 1977).

Reproduction

Two calves (10% of all sightings) were sighted. In other studies, the percentage of calves has varied by area and study techniques, but was usually 10% or less (see review by Irvine et al. 1981).

Behavior

Most of the manatees sighted were stationary on the bottom. The animals seen offshore and in Mosquito Lagoon were moving slowly just below the surface. Manatee behavior is reviewed in detail by Hartman (1979b).

Potential Impacts of OCS Development

Manatees in the study area generally inhabit protected inshore areas and therefore are unlikely to be directly affected by oil or chemicals from an offshore spill. A spill in nearshore areas could impact manatees if the pollutants washed into estuarine waterways. Manatees, as a marine herbivore, could be impacted if grass beds are killed, thus reducing available food, or if contaminated grasses are ingested. No information is available to determine if manatees can avoid an oil spill or if they will eat contaminated grass.

Manatees would be affected by increased boat traffic in OCS staging areas. Manatees suffer such a high mortality from collisions with motor boats in Florida (Irvine et al. 1978; Hartman 1979a, 1979b), that the already endangered Florida population may be declining as a result (Brownell et al. 1978). Loss of habitat in OCS staging areas due to construction and dredging could also impact manatees.

Summary

A total of 19 manatees was seen during transit flights in Florida: 10 inshore south of Naples and nine off the beach or inshore of the MIFL survey subunit. The animals were in shallow habitats, typical for manatees. Manatees frequent protected inshore waters and probably would not be severely affected by an offshore oil or chemical spill unless the spill affected grass beds where the animals feed. Increased boat traffic in OCS staging areas would affect manatees, which have suffered high mortality from boat collisions in the past.

GEOGRAPHIC OVERVIEW BY SURVEY SUBUNIT

The geographic overview discusses physical and biological aspects of the survey subunits which are pertinent to understanding the fauna present in each subunit. The Gulf of Mexico and, to a certain extent, the South Atlantic constitutes a system of interrelated habitats and environments. Comparisons have been made whenever possible. Various authors (e.g., Uchupi and Emery 1968; Ashmole 1971; Havran and Collins 1980) have considered the continental shelf break to occur in water depths from 130 to 200 m. In this report, the shelf break is arbitrarily set at the 200-m depth contour.

The biological oceanography discussion centers around phytoplankton, because it is the predominant primary producer in the marine environment. The faunal discussion primarily considers fish and invertebrates selected from those nekton (free-swimming organisms) that have some importance as food for the survey fauna. These include schooling fish (e.g., mullet and menhaden), cephalopod molluscs such as squid, and some crustaceans such as shrimp.

During this study (including opportunistic surveys), 88 species were observed including 4 species of marine turtles (2,282 individuals), 34 species of marine birds (59,112 individuals), and 15 species of marine mammals (9,365 individuals). The numbers of individuals and sightings of these species are presented by survey subunit in Table 60 and will be a helpful reference throughout the following discussion. Thirty-five additional species of migratory or land-based birds also were seen.

BTEX SURVEY SUBUNIT

Oceanography

Physiography. The western border of the BTEX survey subunit lies adjacent to Padre Island, the longest barrier island off Texas. Water depths at the western margin of the subunit vary from less than 1 m to 27 m because only the southwestern corner contacts the shore line. The deepest water (2,651 m) in the subunit is near the southeastern corner (Table 61).

To the north the continental shelf curves northeast, and this results in shallower waters in the northern half of the subunit than in the southern half at comparable distances from shore. The continental shelf in the BTEX subunit is narrower than elsewhere on the Texas coast. The 200-m isobath is 83 km from shore in the south and 120 km from shore in the north. At the 200-m isobath a definite bathymetric break occurs in the gradient between the continental shelf and the continental slope (Woodbury et al. 1973). The BTEX subunit has an area of 24,642 km^2 nearly half of which is water over 1,000 m deep (Table 61). Waters between 100 and 1,000 m deep compose 23% of the area whereas waters 50 to 100 m and 25 to 50 m each account for about 15% of the area. Water less than 25 m deep covers about 3% of the area. The BTEX subunit has the

Table 60. The number of marine turtles, birds, and mammals seen during aerial surveys. Number in parenthesis represents the number of sightings.

Taxa	Survey subunits								Opportunistic surveys	
	BTEX		MILA		NAFL		MIFL			
	Brownsville		Mash Is.		Naples.					
MARINE TURTLES										
Family Cheloniidae										
Green Turtle	0		0		3	(3)	3	(3)	5	(5)
Loggerhead Turtle	15	(15)	15	(15)	973	(931)	727	(622)	279	(241)
Kemp's Ridley Turtle	2	(2)	0		6	(5)	2	(2)	2	(2)
Unidentified turtle	3	(3)	4	(4)	103	(102)	63	(62)	29	(29)
Family Dermochelyidae										
Leatherback Turtle	0		2	(2)	10	(10)	23	(21)	13	(12)
TOTAL	20	(20)	21	(21)	1095	(1051)	818	(710)	328	(289)
BIRDS										
Family Gaviidae										
Common Loon	1	(1)	1	(1)	131	(100)	4	(4)	231	(130)
Family Podicipedidae										
Unidentified grebe	0		0		0		1	(1)	1	(1)
Family Procellariidae										
Northern Fulmar	0		0		0		0		7	(5)
Cory's Shearwater	28	(20)	7	(3)	6	(6)	149	(56)	840	(26)
Greater Shearwater	0		0		2	(2)	1	(1)	1	(1)
Audubon's Shearwater	4	(4)	1	(1)	45	(12)	59	(29)	425	(23)
Unidentified shearwater	15	(8)	0		7	(7)	211	(19)	7	(7)
Black-capped Petrel	0		0		0		5	(5)	5	(4)
Unidentified petrel	0		0		0		1	(1)	0	
Family Hydrobatidae										
Unidentified storm petrel	8	(7)	4	(3)	1	(1)	19	(15)	7	(5)
Family Phaethontidae										
White-tailed Tropicbird	0		1	(1)	0		0		1	(1)
Unidentified tropicbird	0		0		1	(1)	3	(3)	0	

Table 60. Continued.

Taxa	Survey subunits								Opportunistic surveys	
	BTEX		MILA		NAFL		MIFL			
Family Pelecanidae										
American White Pelican	453	(7)	395	(11)	0		139	(5)	228	(11)
Brown Pelican	21	(7)	1	(1)	243	(102)	987	(70)	96	(16)
Family Sulidae										
Masked Booby	6	(5)	2	(2)	0		2	(1)	0	
Brown Booby	0		1	(1)	0		0		5	(1)
Northern Gannet	28	(20)	313	(240)	30	(28)	14	(12)	256	(95)
Unidentified sulids	0		0		3	(2)	1	(1)	1	(1)
Family Phalacrocoracidae										
Double-crested Cormorant	4	(2)	92	(4)	219	(31)	2	(2)	8	(4)
Family Fregatidae										
Magnificent Frigatebird	1	(1)	0		96	(83)	13	(13)	15	(10)
Family Ardeidae										
Great Blue Heron	0		0		2	(2)	0		3	(2)
Little Blue Heron	2	(1)	0		2	(1)	0		1	(1)
Cattle Egret	211	(4)	5	(3)	6	(2)	7	(1)	0	
Reddish Egret	3	(1)	2	(1)	0		0		0	
Great Egret	0		0		0		0		4	(4)
Snowy Egret	22	(2)	32	(5)	49	(6)	0		22	(2)
Unidentified egret	80	(13)	138	(20)	171	(27)	9	(1)	190	(13)
Louisiana Heron	0		0		0		0		8	(2)
American Bittern	0		0		0		1	(1)	0	
Unidentified dark heron	19	(6)	0		1	(1)	3	(1)	4	(3)
Unidentified heron	0		11	(1)	0		0		200	(1)
Family Ciconiidae										
Woodstork	2	(1)	0		1	(1)	3	(1)	0	
Family Threskiornithidae										
White Ibis	0		0		0		0		1	(1)
Unidentified dark ibis	3	(2)	0		0		0		0	
Roseate Spoonbill	41	(6)	0		0		0		3	(2)
Family Anatidae										
Snow Goose	129	(2)	0		0		0		1,024	(2)
Unidentified goose	0		0		0		1	(1)	2	(1)

Table 60. Continued.

Taxa	Survey subunits								Opportunistic surveys	
	BTEX		MILA		NAFL		MIFL			
Blue-winged Teal	7	(3)	2	(1)	4	(1)	2	(1)	0	
Cinnamon Teal	0		0		0		0		1	(1)
Redhead	18	(2)	0		0		0		0	
Lesser Scaup	0		400	(2)	0		0		0	
Unidentified scaup	0		0		0		0		1,004	(3)
Surf Scoter	1	(1)	0		0		0		0	
Unidentified duck	1	(1)	4,921	(7)	0		38	(2)	1,629	(7)
Family Accipitridae										
Swallow-tailed Kite	0		1	(1)	0		0		0	
Mississippi Kite	2	(1)	0		0		0		0	
Red-shouldered Hawk	0		0		0		0		1	(1)
Broad-winged Hawk	0		0		5	(4)	0		1	(1)
Unidentified hawk	1	(1)	0		1	(1)	0		1	(1)
American Bald Eagle	0		0		0		1	(1)	0	
Osprey	0		0		2	(2)	0		0	
Family Falconidae										
Unidentified falcon	0		0		0		3	(3)	0	
Family Scolopacidae/Charadriidae										
Unidentified curlew	3	(1)	0		0		0		0	
Willet	4	(1)	0		12	(1)	0		0	
Unidentified phalarope	10	(3)	3	(1)	0		20	(3)	165	(27)
Unidentified shore bird	155	(6)	2	(1)	15	(5)	144	(12)	1,193	(97)
Family Laridae										
Unidentified jaeger	2	(2)	1	(1)	2	(2)	3	(3)	1	(1)
Great Black-backed Gull	0		0		0		0		1	(1)
Herring Gull	496	(88)	2,612	(388)	315	(175)	243	(81)	577	(236)
Ring-billed Gull	383	(59)	1,037	(50)	60	(49)	0		9	(9)
Laughing Gull	2,367	(243)	5,233	(417)	326	(159)	58	(27)	1,527	(81)
Franklin's Gull	32	(11)	0		0		0		20	(1)
Bonaparte's Gull	0		209	(61)	3	(2)	2	(2)	6,269	(57)
Black-legged Kittiwake	0		0		0		0		2	(2)
Unidentified gull	1,430	(136)	5,022	(224)	583	(117)	650	(12)	3,661	(119)
Gull-billed Tern	0		1	(1)	0		0		0	
Common-group Tern	22	(14)	658	(143)	440	(89)	225	(13)	428	(60)
Sooty Tern	4	(3)	2	(2)	224	(65)	224	(45)	60	(29)

Table 60. Continued.

Taxa	Survey subunits								Opportunistic surveys	
	BTEX		MILA		NAFL		MIFL			
Bridled Tern	9	(7)	1	(1)	9	(7)	36	(24)	13	(7)
Least Tern	17	(8)	0		2	(2)	0		1	(1)
Royal Tern	843	(295)	1,645	(350)	2,287	(497)	633	(154)	623	(74)
Sandwich Tern	1	(1)	89	(35)	9	(8)	2	(2)	3	(2)
Black Tern	35	(16)	169	(40)	948	(74)	22	(10)	22	(8)
Brown Noddy	0		0		1	(1)	1	(1)	2	(2)
Unidentified noddy	0		0		0		0		1	(1)
Unidentified pale tern	898	(87)	6,540	(138)	655	(91)	159	(27)	236	(24)
Unidentified dark tern	26	(10)	4	(4)	53	(37)	52	(25)	22	(13)
Unidentified tern	0		1,106	(10)	4	(2)	169	(4)	1	(1)
Black Skimmer	60	(2)	1	(1)	165	(3)	0		3	(1)
Family Caprimulgidae										
Unidentified night hawk	4	(2)	0		0		0		0	
Family Apodidae										
Chimney Swift	0		0		0		0		1	(1)
Family Hirundinidae										
Unidentified swallow	0		0		0		0		5	(1)
Family Muscicapidae										
Unidentified thrush	0		0		0		2	(1)	0	
Unidentified warbler	0		0		0		31	(3)	10	(1)
Family Emberizidae										
Unidentified tanager	0		1	(1)	0		0		0	
Unidentified land bird	257	(45)	27	(14)	157	(28)	1,325	(111)	4,920	(165)
Unidentified white bird	412	(109)	2,459	(130)	380	(118)	80	(43)	178	(75)
Unidentified dark bird	64	(42)	70	(19)	1,175	(58)	43	(28)	107	(45)
Unidentified bird	35	(8)	8	(4)	30	(11)	14	(2)	24	(8)
TOTAL	8680	(1328)	33,230	(2345)	8883	(2024)	5817	(884)	26,338	(1539)

Table 60. Concluded.

Taxa	Survey subunits								Opportunistic surveys	
	BTEX		MILA		NAFL		MIFL			
MARINE MAMMALS										
Family Balaenidae										
Right Whale	0		0		0		2	(1)	0	
Family Balaenopteridae										
Minke Whale	0		0		0		7	(4)	0	
Family Physeteridae										
Sperm Whale*	23	(9)	4	(1)	1	(1)	2	(2)	2	(1)
Pygmy Sperm Whale	0		0		0		1	(1)	0	
Family Ziphiidae										
Unidentified _Mesoplodon_	7	(2)	0		0		0		0	
Cuvier's Beaked Whale	0		0		0		1	(1)	0	
Unidentified beaked whale	1	(1)	0		0		3	(1)	4	(2)
Family Delphinidae										
Pygmy Killer Whale	22	(1)	0		0		0		0	
False Killer Whale	0		0		0		24	(6)	0	
Short-finned Pilot Whale	86	(2)	33	(1)	0		674	(69)	31	(4)
Bottlenose Dolphin	417	(70)	1,011	(135)	1,380	(322)	511	(94)	261	(63)
Risso's Dolphin	9	(1)	0		0		67	(7)	201	(21)
Spotted Dolphin	52	(3)	5	(2)	196	(16)	442	(29)	337	(13)
Striped Dolphin	71	(2)	10	(1)	359	(28)	378	(20)	48	(4)
Spinner Dolphin	85	(1)	0		34	(5)	15	(1)	82	(2)
Unidentified _Stenella_	7	(1)	12	(1)	201	(19)	191	(10)	132	(15)
Unidentified dolphin	176	(22)	212	(22)	463	(95)	303	(65)	715	(38)
Unidentified whale	3	(3)	0		0		27	(7)	9	(3)
Family Trichechidae										
West Indian Manatee	0		0		10	(4)	7	(5)	2	(1)
TOTAL	959	(118)	1287	(163)	2644	(490)	2655	(323)	1824	(167)

Table 61. The percent and area of each subunit at various bathymetric ranges.

Bathymetry (m)	BTEX		MILA		NAFL		MIFL	
	% of subunit	Area (km^2)	% of subunit	Area (km^2)	% of subunit	Area (km^2)	% of subunit	Area (km^2)
0 to 5	0	0	5	1,232	1	246	0	0
5 to 25	3	739	24	5,914	26	6,407	5	1,232
25 to 50	15	3,696	22	5,421	32	7,885	7	1,725
50 to 100	13	3,204	22	5,421	36	8,871	4	986
100 to 1,000	23	5,668	26	6,407	5	1,232	78	19,221
over 1,000	46	11,335	1	246	0	0	6	1,479

largest area of waters of 1,000 m or deeper of any of the four subunits and has a relatively narrow zone of water less than 50 m deep.

The gradient of the continental shelf in the BTEX subunit is less than 1°. The gradient of the continental slope is steeper, generally about 5°. The portion of the subunit beyond the continental slope is the continental rise, which grades into the abyssal ocean floor beyond the subunit.

The continental shelf and slope of the BTEX survey subunit are characterized by progradation and upbuilding of fluvial, deltaic, and interdeltaic sediments of Tertiary to Recent age contributed by the Mississippi River, Rio Grande, and other rivers (Bernard and LeBlanc 1965, cited by Bernard et al. 1978; Uchupi and Emery 1968; Davies 1972). Marine erosion of coastal deposits is a less important source of sediment (van Andel and Poole 1960). Mud is the dominant sediment in the Gulf of Mexico off South Texas, covering both the outer continental shelf and slope (USDOI 1976, 1979).

Hydrology. Movements of water in the Gulf of Mexico are controlled by many interrelated forces: freshwater inflow, wind-induced currents, gravity waves, tides, internal waves, and movements related to density differences (Figure 166) (USDOI 1976). The longshore current in the BTEX subunit flows to the southwest along the shore during winter and averages 21.5 cm/sec (Smith 1975). The summer currents alternate to the southeast and to the northwest direction and result in little net transport.

Circulation in the deeper waters is dominated by a large counterclockwise gyre termed the Brownsville Gyre by Gallaway (1981), which is present year-round (Sturges and Horton 1981). The gyre is located northeast of Brownville, Texas, in winter. In spring it begins moving north, sometimes as far as Galveston, Texas (Gallaway 1981). Waters from the Gulf of Campeche, for example, are thus moved as far as Galveston (Sturges and Horton 1981). The gyre is driven by wind and by the introduction of a large ring from the Loop Current (Sturges and Horton 1981). The ring transports nutrients and

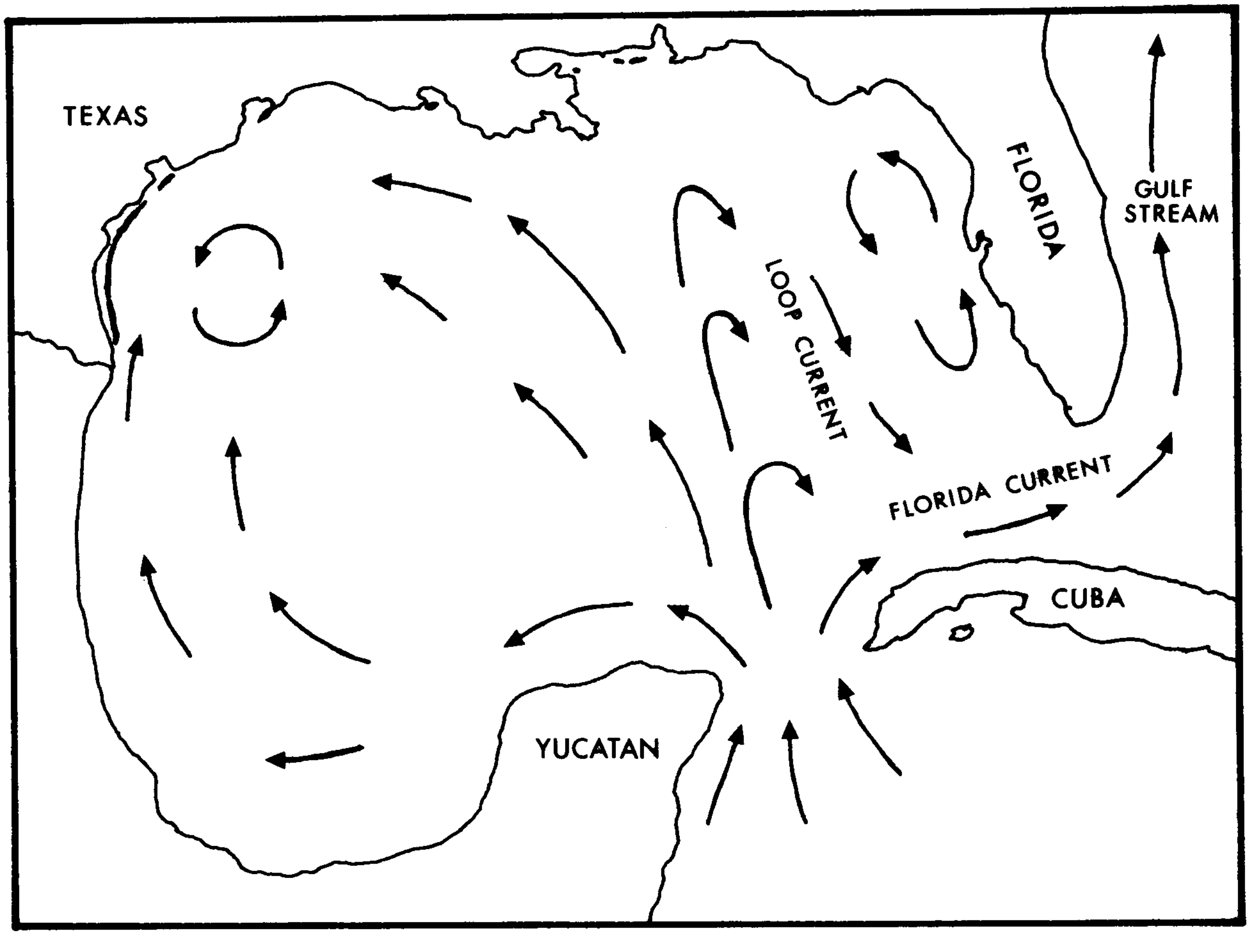


Figure 166. Generalized surface currents in the Gulf of Mexico (adapted from Gallaway 1981).

salt into the western Gulf, and into the gyre system. The ring provides momentum to the gyre (Sturges and Horton 1981).

In the BTEX subunit waters from Louisiana converge with the gyre and with water flowing northward up the Mexican coast. The convergence transports inshore water carrying organic materials out of the shelf system to deep waters (Gallaway 1981). Nutrient mixing and upwelling characteristics of the gyre to make the area a productive one. The strength and location of the gyre is probably a major variable in the BTEX subunit and potentially would affect the vertebrates in the area.

Biological Aspects. As in all marine systems, phytoplankton forms the basis of the food webs of higher organisms. Diatoms and dinoflagellates are the main identifiable primary producers in the Gulf of Mexico (El-Sayed et al. 1972). Coccolithophores are also seasonally present (Kamykowski et al. 1979).

Phytoplankton in the shelf waters of the BTEX survey subunit exhibit seasonal and spatial trends. Kamykowski et al. (1979) reported the standing crop of phytoplankton in shelf waters off South Texas to be greatest in winter based on measurements of chlorophyll. Standing crops decreased in spring and increased again in fall. Kamykowski et al. (1979) also reported a general decrease in phytoplankton concentrations with increasing distance from shore. This gradient is typically related to lower nutrient availability in open marine waters. Inshore waters tend to be areas of upwelling and river discharge; both are important sources of nutrients (El-Sayed et al. 1972).

Areas with the largest standing crop are usually the most productive (Raymont 1963). This generally is true for the BTEX survey subunit; Kamykowski et al. (1979) found that sample stations closest to shore had the greatest carbon uptake (about 15 mg $C/m^2/h$). However, the outer shelf station showed a surge of productivity (about 12 mg $C/m^2/h$) in the spring, even though the standing crop was consistently low. Increased productivity was perhaps the result of mid-shelf upwelling during February, in conjunction with environmental conditions (e.g., water temperature and salinity) conducive to growth (Kamykowski et al. 1979). Primary production in the area encompassing the BTEX subunit has been estimated to average 150 to 250 mg $C/m^2/d$ (USDOI 1976). This is the same range of productivity estimated for the NAFL survey subunit, but lower than that of the MILA subunit (USDOI 1976). Productivity tends to decrease in a southerly direction in South Texas waters, which suggests a northerly source of nutrients (Kamykowski et al. 1979). Outflow from the Mississippi River extends into the South Texas waters (Smith 1979), and the river may be an important nutrient source for phytoplankton in the waters of the BTEX survey subunit.

Two genera of dinoflagellates of particular note are Gymnodinium and Gonyaulax; with optimal nutrient supplies and environmental conditions (e.g., salinity and temperature), their numbers increase to bloom proportions and may cause a red tide (discoloration of marine water due to extreme concentrations of dinoflagellates). These dinoflagellates produce neurotoxins which cause fish kills, shellfish poisonings, and skin and respiratory inflammations in humans (USDOI 1975).

Phytoplankton species constitute a major portion of the diets of schooling fish such as menhaden (Brevoortia spp.) (Gunter 1945). These plankton feeders are in turn an important food source for birds and some mammals. A major schooling species is the Gulf Menhaden (Brevoortia patronus), which occurs throughout the northern Gulf of Mexico. The species is generally considered to be a shallow water inhabitant; individuals have been caught in shrimp trawls at depths of 33 m (Christmas and Gunter 1960). The Finescale Menhaden (B. gunteri) also occurs in the subunit, but it is confined to the northwestern Gulf of Mexico (Hoese and Moore 1977). Both menhaden species as well as other clupeoids and anchovies (Anchoa spp.) are conspicuous in shallow waters of the BTEX survey subunit (USDOI 1976).

The Gulf Menhaden is a commercially fished species, whose catch has steadily increased since 1957 (Henry 1971). The 1978 catch was 6.7×10^7 kg (NOAA 1979), an increase of 5.2×10^7 kg over the 1957 harvest. Catch-per-unit-effort data would provide indications on how the menhaden populations are faring in the face of increased exploitation. Unfortunately information is not available. It should be noted, however, that off the eastern U.S. coast large increases in the fishery during the 1950's were followed by a substantial decline in the 1960's, and Henry (1971) believes some east coast waters may have suffered from overfishing. Another point of concern is pollution and its detrimental effects on the marine environment (USDOI 1973).

The predominant shrimp in the BTEX survey subunit is the Brown Shrimp (Penaeus aztecus). Major Brown Shrimp grounds are located within the narrow continental shelf (USDOI 1976); the species is most abundant between depths of 20 and 37 m. Harvests reflect seasonal movements of the species. Peak yields occur in July and August in shallow water. Smaller harvests in the fall, winter, and spring are in progressively deeper water, extending to 73 m by spring (CWR 1979).

Small populations of White Shrimp (Penaeus setiferus) occur in the subunit, and their harvest also indicates seasonal movement. Gunter (1950) reported a primary peak in numbers of White Shrimp taken from South Texas bays and the inshore Gulf in the fall, and a secondary spring peak. Harvests declined during the winter and summer. White shrimp grounds are concentrated shoreward of 20 m (CWR 1979).

Shrimp are an important food source for birds, including terns and cormorants (Wass 1974). They are also taken by Bottlenose Dolphins (Gunter 1942). Their value to larger marine mammals is probably limited because penaeids do not usually occur in deep water.

Two species of squid, the Common Squid (Loligo pealei) and Thumbnail Squid (Lolliguncula brevis), occur off the coast of South Texas. The Common Squid inhabits waters to 180 m deep; the Thumbnail Squid is rarely taken from depths greater than 15 m (Martin 1979). Squid are preyed upon by a wide variety of cetaceans (Fitch and Brownell 1968) and birds (Wass 1974).

Flyingfish were seasonally common in the BTEX survey subunit. Greatest numbers were seen in June after which sightings decreased to a low of one sighting in February. Flyingfish are not usually seen close to shore (Hoese and Moore 1977). Those seen in the BTEX survey unit were typically 125 km or more from shore in waters from 75 to 1,280 m deep. A further discussion of flyingfish is presented in the MIFL subunit account.

Flyingfish are preyed upon by several species of birds, including the Magnificent Frigatebird (Palmer 1962) and Audubon's Shearwater (Jehl 1974). Cetaceans also feed on them opportunistically. The eggs of flyingfish and needle fish may be an important food for marine turtles in pelagic waters (Fritts 1981a).

OCS Development

The BTEX survey subunit of this study extends over the southernmost portion of the outer continental shelf and slope off Texas. OCS development has not been extensive in this area, but some activity has occurred, and future exploration and development is expected (Havran and Collins 1980). The most recent data published by USDOI (1981c) indicated that, in the Federal OCS Administrative Areas extending into BTEX, 22 lease blocks contain active leases and 38 contain expired leases (Table 62). Sixty-six lease blocks in the above areas are proposed for leasing through August 1982 (USDOI 1981c).

Table 62. Lease statistics for Federal OCS administrative areas extending into the BTEX survey subunit (USDOI 1981c).

Federal OCS Administrative Area	Number of lease blocks containing:						
			Proposed leases				
	Active leases	Expired leases	OCS sale No. 62 and 66	OCS sale No. A 66	OCS sale No. 67	OCS sale No. 69	Total Proposed
Alaminos Canyon	0	0	0	0	0	0	0
Corpus Christi	2	0	3	0	5	0	8
East Breaks[a]	6	8	0	2	8	0	10
North Padre Island	8	6	2	2	2	8	14
North Padre Island East Addition	4	7	0	7	2	0	9
Port Isabel	0	0	0	0	0	5	5
South Padre Island	2	5	0	2	0	9	11
South Padres Island East Addition	0	12	4	2	3	0	9
TOTAL	22	38	9	15	20	22	66

[a] Although the East Breaks Area extends into the BTEX survey subunit, the lease blocks containing active, expired, or proposed leases in this area are outside of the survey subunit.

Faunal Composition

During this study, 2 species of marine turtles (20 individuals), 24 species of marine birds (7,203 individuals), and 9 species of marine mammals (959 individuals) were identified in the BTEX survey subunit.

Marine Turtles. Low numbers of two species of marine turtles were seen in the BTEX subunit. The majority was Loggerhead Turtles. Kemp's Ridley Turtle was identified on only two occasions. The western Gulf of Mexico reportedly supports three additional species of sea turtles including the Green Turtle, Leatherback Turtle, and Hawksbill Turtle (Rabalais and Rabalais 1980). Sea Turtles stranded on the South Texas coast from 1976 to 1979 were predominantly Loggerhead Turtles, with low numbers of Kemp's Ridley and Green Turtles, one Leatherback Turtle, and no Hawksbill Turtles (Rabalais and Rabalais 1980). Pringle (1981), however, reported three Hawksbill Turtle strandings during 1980 along the Texas coast.

Historically, Kemp's Ridley Turtles nested from Port Aransas, Texas, south to Tuxtlas in Veracruz, but nesting in recent years has been sporadic (Hildebrand 1963; Lund

1974) except near Rancho Nuevo, Tamaulipas, Mexico. Since the mid-1960's various attempts have been made to augment the number of Kemp's Ridley Turtles nesting on Padre Island (Lund 1974).

Marine Birds. The most abundant species of marine birds seen in the BTEX subunit were the Laughing Gull, Royal Tern, Herring Gull, and Ring-billed Gull. Seven other species of gulls and terns were present in low numbers. One of these, Franklin's Gull, was seen only in the BTEX subunit. Gulls and terns accounted for about 91% of all marine birds seen in the subunit. Phalaropes, jaegers, and Black Skimmers were seen only occasionally.

Six species of the pelicans and their allies (pelecaniforms) were observed in low numbers. Of these, the American White Pelican, an inland or coastal inhabitant, was observed in greatest numbers. Brown Pelicans in Texas suffered a great reduction in numbers during the 1950's (Oberholser 1974), and the sightings during this study suggest that numbers are still low.

Only two species of shearwaters were identified, Cory's Shearwater and Audubon's Shearwater. The number of shearwaters seen was low although sightings occurred in every survey month except April. Previous sightings of shearwaters off Texas have been uncommon, and sightings of Cory's Shearwater have occurred only in recent years (Oberholser 1974; Clapp et al. 1982). Sightings from this study indicate that shearwaters may be present in low numbers during most of the year. Storm petrels also were seen regularly but in low numbers.

Marine Mammals. The BTEX subunit had the second largest number of species of marine mammals of all survey subunits, but the fewest individuals. The marine mammals most frequently sighted were the Bottlenose Dolphin, Sperm Whale, and Stenella spp. On a few occasions, the Short-finned Pilot Whale, beaked whales, and Risso's Dolphin were also seen. The only sighting of the Pygmy Killer Whale during the study occurred in the BTEX subunit. More species may have been present than were identified since 22 sightings were of unidentified dolphin groups. Most of those species reported from the subunit area, but not seen during the study, are considered by Schmidly (1981) to be uncommon or rare in the western Gulf of Mexico.

The number and frequency of Sperm Whales sightings in the BTEX subunit was greater than expected. The presence of Sperm Whales in this area has been documented previously by only four strandings (Schmidly 1981) and two aerial sightings (Fritts and Reynolds 1981). The sighting of Risso's Dolphin in the BTEX subunit during this study is the first record of this species in the western Gulf of Mexico.

The number of species of marine mammals may be high in the BTEX subunit because the narrow continental shelf enables pelagic species to range close to the coast while remaining in deep water. The occurrence of species, including the Sperm Whale, beaked whales, Short-finned Pilot Whale, and Risso's Dolphin, that are usually found in waters beyond the continental shelf, supports this contention.

MILA SURVEY SUBUNIT

Oceanography

Physiography. The northernmost border of the MILA subunit contacts East Cote Blanche Bay in the east and South Point of Marsh Island, Louisiana, centrally. The boundary at the northwestern corner is 15 km from shore. The water depth in the MILA survey subunit ranges from 1 to slightly over 1,000 m (Table 61). The continental shelf is wider here than in Texas (183 to 202 km wide). Nearly 75% of the subunit consists of water 100 m or less in depth. MILA has little water over 1,000 m deep. Water 100 to 1,000 m makes up 26% of the area and water 50 to 100 m makes up 22%. Over half of the area has water less than 50 m in maximum depth. The slope of the shelf is less than 1°. The bottom topography is more complex (but better known because of oil exploration) along the northern Texas and Louisiana coasts than near the BTEX subunit. Hummocks are more prevalent on the outer shelf and along the slope off Louisiana and northern Texas as a result of salt and mud diapirs (Uchupi and Emery 1968; Woodbury et al. 1973). The relief associated with these domes is often on the order of 60 m (Bouma et al. 1976). The continental slope in the northwestern Gulf consists of two parts, a steep lower slope that breaks off abruptly at the Sigsbee scarp and a 1° to 2° gradient upper slope where domes and depressions are prevalent (USDOI 1979).

The continental shelf and slope of the MILA survey subunit were formed by the prograding and upbuilding of terrigenous sediments contributed largely by the Mississippi River during the Tertiary Period (Uchupi and Emery 1968). The Mississippi remains a major controlling factor on the surficial sediments within the subunit. Most of the sediments carried to the Gulf of Mexico are subsequently dispersed westward by longshore currents (USDOI 1976). The sediments become finer with increasing distance from land. The particles closest to shore are the size of sand and sediments grade to silt and clay farther out (Uchupi and Emery 1968).

Hydrology. Inshore circulation on the Louisiana shelf and thus in the MILA subunit is influenced by freshwater inflow from the Mississippi and Atchafalaya Rivers. This inflow produces density differences along the coast that in turn creates a longshore pressure gradient. The flow is to the west along the Louisiana coast (Figure 166). The wind stress is also to the west (Sturges and Horton 1981). Generalized currents in February and August in the deep water near the shelf break also flow west (USDOI 1980).

Biological Aspects. The Mississippi River is a major influence on the phytoplankton of the northwestern Gulf of Mexico. High turbidity depresses phytoplankton photosynthesis as far as 80 km from the mouth of the river. However, waters to the west of the delta (and within the MILA survey subunit) are some of the most productive of the entire Gulf because nutrients from the Mississippi River are carried westward by longshore currents. Primary productivity estimates are 250 to 500 mg $C/m^2/d$ (USDOI 1976).

Phytoplankton in this region of the Gulf exhibit considerable richness and seasonality. For example, approximately 79 km west of the mouth of the Mississippi River an assemblage of at least 25 genera of marine and estuarine phytoplankton are found. This occurrence indicates the substantial influence of freshwater inflow on the marine environment. Standing crops of inshore phytoplankton peak between October and March. Lower concentrations occur in the spring and summer. Nearshore and offshore, maximal standing crops occur between June and August; minimal crops occur from October through March (USDOI 1979).

As in the BTEX subunit, diatoms and dinoflagellates constitute the majority of the phytoplankton species, and the same decrease in abundance occurs with increasing distance from shore.

Phytoplankton is an important food source for several schooling fish, including the Gulf Menhaden (Gunter 1945). The Gulf Menhaden population is centered off western Louisiana (Hoese and Moore 1977), and major fishing grounds are found from the Mississippi Sound to Matagorda, Texas (USDOI 1976). Consequently, the inshore portions of the MILA survey subunit should have large numbers of menhaden, as well as large numbers of other clupeoids and anchovies. A discussion of the Gulf Menhaden fishery is presented in the section on the BTEX survey subunit.

The inshore waters to the immediate east of the MILA survey subunit are wintering grounds for a number of so-called industrial fish (USDOI 1976). However, specific migration data for these fish were not available.

The White Shrimp is the predominant commercial penaeid species throughout Louisiana inshore waters. Brown shrimp are also abundant in these waters. Depths and seasons of maximum harvests for both species are similar to those of the BTEX subunit. Shrimp are a food source for such birds as Herring and Laughing Gulls. The same species of squid (Common and Thumbnail) common to the BTEX survey subunit are found in the MILA subunit. These molluscs are not fished commercially in the United States, but they are a major food source of cetaceans (Fitch and Brownell 1968).

Flyingfish were less common in this subunit than the other three. As is typical of all species of flyingfish, they are more prevalent away from shore (Hoese and Moore 1977). Those sighted in the MILA subunit ranged from 148 to 227 km from shore in water 224 to 1,033 m deep.

OCS Development

The MILA survey subunit encompasses part of the most intensively developed offshore hydrocarbon-producing area in the world (Havran and Collins 1980). Significant oil- and gas-producing fields (those that have produced an average of at least 5,000 barrels of oil per day or 100,000 million cubic feet of gas per day over the most recent 6-month period, or those that are capable of producing such amounts) are located within this survey subunit (Havran and Collins 1980; USDOI 1981c). Of the four survey subunits, MILA has been most extensively leased (Table 63): lease blocks in the Federal OCS Administrative Areas extending into the MILA subunit contain 556 active leases, 279 expired leases, and 171 proposed leases through August 1982 (USDOI 1981c).

Faunal Composition

During this study, 2 species of marine turtles (21 individuals), 25 species of marine birds (25,151 individuals), and 5 species of marine mammals (1,287 individuals) were identified in the MILA subunit.

Table 63. Lease statistics for Federal OCS administrative areas extending into the MILA survey subunit (USDOI 1981c).

Federal OCS Administrative Area	Number of lease blocks containing:					
			Proposed leases			
	Active leases	Expired leases	OCS sale No. A 66 and 66	OCS sale No. 67	OCS sale No. 69	Total Proposed
East Cameron	64	67	5	7	3	15
East Cameron South Addition	46	27	4	2	3	9
Eugene Island	108	40	12	8	2	22
Eugene Island South Addition	78	20	3	1	3	7
Garden Banks	4	6	0	10	9	19
Green Canyon	13	1	4	15	6	25
South Marsh Island	25	16	4	0	2	6
South Marsh Island North Addition	27	6	4	2	1	7
South Marsh Island South Addition	49	23	7	4	3	14
Vermilion	90	41	19	9	9	37
Vermilion South Addition	52	32	8	1	1	10
TOTAL	556	279	70	59	42	171

Marine Turtles. Only two species of marine turtles were seen in the MILA subunit, and few individuals were observed. A total of 15 Loggerhead Turtles and 2 Leatherback Turtles was seen. Strandings during 1980 indicate that the Green Turtle and Kemp's Ridley Turtle also are present in Louisiana waters (Pringle 1981).

Loggerhead turtles have nested in low numbers on the Chandeleur Islands off the Louisiana coast (Lund 1974), but nesting records for other species in the area are not available.

Marine Birds. The number of species of marine birds identified in the MILA subunit was similar to other survey subunits (25 species), but the number of individuals was more than three times that in any other subunit.

Gulls and terns accounted for 96% of all marine birds seen in the MILA subunit. The most abundant species were the Laughing Gull, Herring Gull, Royal Tern, and

Ring-billed Gull which composed 42% of the marine birds seen. Unidentified gulls and terns accounted for 50% of the marine birds seen. Phalaropes, jaegers, and Black Skimmers were seen in low numbers (< 1% of marine birds).

Seven species of pelicans and their allies (about 3% of the marine birds) were identified in the MILA subunit. The most abundant species nearshore was the Northern Gannet. The American White Pelican and Double-crested Cormorant were common in coastal or inland habitats. The White-tailed Tropicbird, Brown Pelican, Masked Booby, and Brown Booby were each seen on only one or two occasions.

The abundance and distribution of the Northern Gannet in this subunit were greater than expected when compared with previous records for the State (Lowery 1974b). Lowery (1974b) reported large numbers (5,000 to 10,000) of Magnificent Frigatebirds on the Chandeleur Islands; however, none were seen in the MILA subunit.

Numbers of the Brown Pelican have decreased dramatically in Louisiana. Since 1962, native pelicans have not bred in the State (Lowery 1974b). In 1968, Brown Pelicans were reintroduced to Louisiana and a small population is now breeding in the state. One Brown Pelican was seen during this study in the MILA subunit.

A total of only eight shearwaters, petrels, and their allies (procellariiforms) was seen, including Cory's Shearwater, Audubon's Shearwater, and unidentified storm petrels.

Several sightings in the MILA subunit were of birds rarely seen in Louisiana waters (Duncan and Havard 1980): the Masked Booby, Brown Booby, White-tailed Tropicbird, and Bridled Tern. The Cory's Shearwaters represented the first records for Louisiana waters.

The large number of birds seen in the MILA subunit may be related to the high productivity of Louisiana coastal waters, which results from the nutrient-laden outflow of the Mississippi River (Gallaway 1981; see Oceanography section). Currents in the Gulf of Mexico move waters from the Mississippi Delta westward (Gallaway 1981) and therefore influence the productivity of waters in the MILA subunit.

Marine Mammals. Of all survey subunits, the lowest diversity of marine mammals and second lowest number of individuals were encountered in the MILA subunit. The most abundant species was the Bottlenose Dolphin, which accounted for about 79% of all marine mammals seen in the subunit. The Sperm Whale, Short-finned Pilot Whale, Spotted Dolphin, Striped Dolphin, and *Stenella* sp. were seen only on one or two occasions each and accounted for about 5% of the marine mammals. The remaining 16% were unidentified dolphins.

The species identified during the present study are the same as those reported from Louisiana waters by Lowery (1974a) and Schmidly (1981). The number of Spotted Dolphins was unexpectedly low. It is considered common in the offshore waters (> 8 km) of Louisiana (Lowery 1974a).

The small percentage (27%) of water greater than 100 m deep in the MILA subunit may help explain the low numbers of species and the low number of individuals of pelagic species identified in the MILA subunit. The Sperm Whale, Short-finned Pilot Whale, and Striped Dolphin are primarily pelagic (Leatherwood et al. 1976). The nutrient-rich waters of Louisiana, which may influence bird distribution and abundance in the MILA subunit, do not seem to similarly attract marine mammals.

NAFL SURVEY SUBUNIT

Oceanography

Physiography. The NAFL survey subunit extends 9 km over land in the extreme northeastern corner of the subunit. The southeast corner is about 56 km from the coast. The coast of this area generally consists of sandy beaches in the north and mangrove islands in the south. The survey subunit is almost entirely over the continental shelf. The shelf gradient is less than 1°. The water depth varies from 1 to 130 m. Over 35% of the area is water 50 to 100 m deep, and 60% is less than 50 m deep (Table 61). The shelf break is 40 km due west of the northwest corner of the subunit and 31 km due west of the southwest corner. The continental slope along western Florida as well as along Yucatan consists of an upper and lower segment (Uchupi and Emery 1968). From the shelf break to a depth of about 2,400 m the gradient is less than 2°. This upper slope is cut by ridges and troughs. Below 2,500 m is the steeper slope of the Florida escarpment off Florida and the Campeche escarpment off Yucatan. Each has local gradients of 20° (Uchupi and Emery 1968). The Florida and Campeche escarpments are cut by several canyons and troughs (Uchupi and Emery 1968).

The sediments within the NAFL survey subunit consist primarily of relict carbonates including shells, coralline algae, and oolites (Uchupi and Emery 1968; USDOI 1976). These sediments cover most of the shelf within the boundaries of the survey subunit.

Hydrology. The main influence on water circulation over the continental shelf off southwest Florida in the NAFL survey subunit is wind; however, freshwater discharge from the Everglades is important in inshore circulation in the Tortugas shelf area. In waters 10 m deep or less, the flow is north along the shore (Jones et al. 1973). Deeper waters of the shelf are subject to seasonal changes. From January through March surface currents flow generally south. From May through September, a multiple eddy system occurs where the flow is north at 27°35'N and south at 26°30'N. In April, November, and December, flow is variable and can be any direction at any given location (Jones et al. 1973).

The pelagic water circulation in the eastern Gulf of Mexico is dominated by the Loop Current which enters through the Yucatan Channel and exits through the Florida Straits. As the current exits, its western boundary passes near the continental slope off southwest Florida (Figure 166). The velocity of the water transported by the Loop Current varies from 50 to 200 cm/sec at the surface. The Loop Current influences a counterclockwise gyre off the west central Florida shelf, which is strongest in winter (USDOI 1976). The path of the Loop Current varies seasonally. In late winter and early spring, it penetrates north to about 27°N and in early summer as far north as 29°N. The Loop Current is warmer than the surrounding water, especially in winter. In some years, warm eddies or rings pinch off from the upper portion of the loop and travel into the western Gulf.

There are areas of upwelling along the Loop Current near the Florida continental shelf off Naples and another north of Yucatan (Austin 1971, cited by USDOI 1976). These are potential areas where food sources for marine mammals may concentrate. The location of prime commercial and sport fishing grounds is strongly influenced by the Loop Current since plankton is concentrated along the boundary zone of the currents (Jones et al. 1973).

Biological Aspects. Diatoms and dinoflagellates are the dominant identifiable phytoplankton off the west coast of Florida. Diatoms usually dominate the coastal waters, both in concentration and number of species. Dinoflagellates at times dominate the open Gulf at least in number of species (Steidinger 1973). Most data indicate a seasonal gradient for the peak standing crop and primary productivity of phytoplankton off Southwest Florida. Estuarine and coastal areas usually have a peak in spring and summer; nearshore and offshore waters have a peak in winter (Steidinger 1973).

Primary productivity estimates by USDOI (1976) are 150 to 250 mg $C/m^2/d$ for the Gulf off Southwest Florida, including the area of the NAFL survey subunit. Regions of the Gulf traditionally considered to be the most productive are those where nutrient replenishment is greatest in the form of upwelling, storm-induced vertical mixing, and river discharge. Thus, Campeche Bank off the Yucatan Peninsula (upwelling) and the vicinity of the Mississippi Delta (river discharge) are generally considered to be the most productive. The fact that upwelling occurs for most of the year over the slope and outer shelf off Southwest Florida (Tampa Bay to Florida Keys) (Bogdanov et al. 1968, cited by Steidinger 1973) suggests productivity in the NAFL survey subunit may be considerably greater than would otherwise be expected.

Red tides, caused by several dinoflagellate species (i.e., *Gymnodinium* and *Gonyaulax*), are relatively common off Southwest Florida. Blooms of *Gymnodinium breve* occur annually in some coastal Gulf areas; however, several interrelated environmental factors must be optimal for the bloom to develop into a red tide (Steidinger 1973). Red tides are discussed further in the MIFL survey subunit account of phytoplankton.

The major vertebrates of commercial concern in the subunit are schooling fish such as menhaden, although other clupeoids and anchovies (*Anchoa* spp.) are also important (USDOI 1973). The menhaden fishery in the NAFL subunit is considerably smaller than in the other subunits and is not in danger of being overfished. In 1971 only 2.9×10^5 kg were harvested (Taylor et al. 1973). The total harvest of all of West Florida's commercial fisheries is estimated to be only 5% of its potential (Bullis 1968, cited by Taylor et al. 1973). As in most coastal Gulf areas, however, loss of estuarine habitat essential for the completion of at least some phase of most fishes' development continues to occur. Pollution is also a potential problem with increasing coastal development in Southwest Florida. Fish kills as far south as Tampa Bay have become fairly common since the early 1970's (Taylor et al. 1973). The combination of loss of some estuarine habitat and pollution of much remaining habitat can have serious deleterious effects on the marine environment.

The Pink Shrimp (*Penaeus duorarum*) is the only penaeid commercially harvested within the NAFL survey subunit, although White and Brown Shrimp are harvested commercially along the northwestern Florida coast (USDOI 1976; CWR 1979). Recruitment of Pink Shrimp in the NAFL subunit is essentially continual, which explains the broad harvest peak of October through May. The species occurs primarily in water 20 to 27 m deep (CWR 1979).

Squid common to the NAFL subunit are mentioned in the BTEX subunit discussion. Flyingfish were very common in the NAFL survey subunit. They were most abundant in June when 155 sightings were made. Sightings declined through the summer, fall, and winter, but by March began increasing. Flyingfish are not usually seen close to shore (Hoese and Moore 1977). Sightings in this study ranged from 135 to 242 km offshore in waters 39 to 109 m deep.

OCS Development

The NAFL survey subunit has been explored for hydrocarbon reserves less than any of the survey subunits in the Gulf of Mexico. Of the four Federal OCS Administrative Areas (Charlotte Harbor, Miami, Pulley Ridge, and West Palm Beach) extending into this subunit, only Charlotte Harbor has been subjected to Federal leasing; and it contains only 14 active lease blocks (USDOI 1981c). Future exploration and development is expected in this region: 180 lease blocks in the Charlotte Harbor Area are proposed for leasing through 1982 (USDOI 1981c), and lease blocks in the Pulley Ridge Area are being considered for 1983 lease sales (Havran et al. 1981).

Faunal Composition

During this study, 4 species of marine turtles (1,095 individuals), 24 species of marine birds (6,868 individuals), and 6 species of marine mammals (2,642 individuals) were identified in the NAFL subunit.

Marine Turtles. Of the four species of marine turtles observed in the NAFL subunit, 89% were Loggerhead Turtles and 2% were of Leatherback Turtles, Kemp's Ridley Turtles, and Green Turtles. These individuals represent the largest number of turtles identified in all subunits. Unidentified turtles accounted for 9% of all turtles seen.

The west coast of Florida from Cape San Blas to the Florida Keys once supported a fishery for marine turtles, primarily Green Turtles and Kemp's Ridley Turtles (Caldwell and Carr 1957). This fishery may have been responsible for the decline in numbers of these species. The Loggerhead Turtle was a less preferred species in this fishery, and was taken only occasionally.

Relatively little nesting occurs on the west coast of Florida compared with the Atlantic coast, but more turtles were seen in the NAFL subunit than in the MIFL subunit. This suggests that turtles are concentrated in response to another stimulus, such as food resources. The continental shelf is broad in the NAFL subunit and provides more suitable foraging habitat for marine turtles than the MIFL subunit.

Marine Birds. The number of species (24) identified in the NAFL subunit was similar to that in other survey subunits but the number of individuals was the second lowest number of all four subunits. However, this subunit supported more tern species (8) and larger numbers of terns than other subunits. Terns accounted for about 67% of all marine birds seen in the NAFL subunit. Black Skimmers (165 individuals) and Black Terns (948 individuals) were more abundant in the NAFL subunit than in any other survey subunit. Laughing Gulls, Herring Gulls, and Ring-billed Gulls were seen in low numbers. Gulls accounted for 19% of the marine birds seen.

The pelicans and their allies accounted for 9% of the marine birds seen in the NAFL subunit. The most abundant species in order of decreasing abundance were the Brown Pelican, Double-crested Cormorant, and Magnificent Frigatebird. Frigatebirds were more abundant in the NAFL subunit than in any other survey subunit. There were low numbers of Northern Gannets and no boobies were seen, although three unidentified sulids could have been boobies.

Four species of shearwaters, petrels, and their allies occurred in low numbers. The most abundant species was Audubon's Shearwater followed by storm petrels, Cory's Shearwaters, and Greater Shearwaters.

Common Loons occurred in higher numbers (131 individuals) than in other subunits and accounted for 2% of the marine birds seen in the NAFL subunit.

Because the NAFL subunit is located farthest south and has a more subtropical climate than the other subunits, some replacement of temperate forms with tropical forms might be expected. Contrary to expectations, no species were unique to the NAFL subunit. Subtropical or tropical species present in the subunit included the Magnificent Frigatebird, tropicbirds, Brown Noddy, and Sooty Tern. The Masked and Brown Booby were expected but were not seen. However, Brown Boobies were seen about 65 km south of the NAFL subunit on the Rebecca Light during an opportunistic survey.

The occurrence and relative abundance of species seen during this study provide much new data on marine birds of the eastern Gulf of Mexico. There were many unexpected or otherwise noteworthy findings. The large number of Common Loons observed as far as 114 km from shore in the NAFL subunit was unexpected. Previously, they were thought to occur closer to shore and in smaller numbers (Woolfenden and Schreiber 1973). The distance from shore at which Magnificent Frigatebirds were seen provides new data on the species' distribution. The abundance and distribution of Cory's Shearwater in the Gulf of Mexico previously were underestimated.

Based on the number of fish schools seen during this study, the broad shelf and shallow waters in the NAFL subunit are highly productive. The abundance of many species of marine birds, including the Common Loon, Brown Pelican, Magnificent Frigatebird and several terns is probably related to the abundance of fish, which constitute a major portion of their diets.

The occurrence and abundance of the Sooty Tern, Magnificent Frigatebird, and Brown Noddy are probably related to the proximity of the NAFL subunit to nesting sites located in the Marquesas Keys and Dry Tortugas off of Key West, Florida.

Marine Mammals. The NAFL survey subunit had the second lowest number of mammal species of all survey subunits but the second highest number of individuals. The most abundant species was the Bottlenose Dolphin. The Striped Dolphin and Spotted Dolphin were common, and the Spinner Dolphin was seen occasionally. The number of unidentified *Stenella* sp. was higher than in other survey subunits suggesting that species of this genus are more abundant than recorded. The West Indian Manatee was seen in low numbers in bays and estuaries east of the beach. A single Sperm Whale was seen offshore.

Little is known about the marine mammals off southwestern Florida. Although stranding records for Short-finned Pilot Whales are common along the Gulf coast of Florida, no sightings occurred in the NAFL subunit. Because strandings of Stenella sp. (especially Striped and Spinner Dolphins) are rare in this area, the data from this study are valuable in documenting the abundance of these species in the eastern Gulf of Mexico.

Because the NAFL subunit is characterized by a broad continental shelf and relatively shallow water (95% of the subunit is within the 100-m isobath), frequent sightings of pelagic species were not expected. However, the Sperm Whale and Striped Dolphin, which generally occur beyond the continental shelf (Leatherwood et al. 1976), were sighted. It is uncertain if other pelagic species that were not identified in the NAFL subunit occur in this area. Short-finned Pilot Whales, False Killer Whales, and beaked whales have been stranded in this area (Schmidly 1981); Risso's Dolphins were sighted during opportunistic flights south of the NAFL subunit. The Sperm Whale may have been associated with the Loop Current in the eastern Gulf of Mexico which flows over the continental shelf adjacent to the NAFL subunit. The position of the Loop Current varies seasonally and may influence the distribution of pelagic species in the eastern Gulf (Leipper 1970).

MIFL SURVEY SUBUNIT

Oceanography

Physiography. The western boundary of the MIFL survey subunit approaches the coast in the south near Ft. Pierce, Florida, and is 22 km off Cape Canaveral in the north. Water depths range from 1 to 1,097 m. Water less than 25 m deep makes up less than 5% of the area and forms an extremely narrow strip along the coast. About 11% of the area has water 25 to 100 m deep (Table 61). The majority of the area (78%) consists of water 100 to 1,000 m deep. Unlike the other subunit with limited shallow water (BTEX), the MIFL subunit has only 6% of its area as water over 1,000 m deep.

The continental shelf ends abruptly in a slope called the Florida-Hatteras slope, located 61 km from shore on the northern boundary and 44 km from shore on the southern boundary of the subunit. The Florida-Hatteras slope is not related to the continental slope in this area but is believed to be shaped primarily by the western edge of the Gulf Stream (Zeigler and Patton 1974). The Blake Plateau extends from the Florida-Hatteras slope (750-800 m) out to about the 1,000-m contour where the true continental slope begins. The Blake Plateau is bounded on the west by the Florida-Hatteras slope, on the south by the Bahama Banks and the Straits of Florida, and on the east by the Blake escarpment, Blake-Bahama Basin, and the Blake outer ridge, all of which make up the continental slope. Northward toward Cape Hatteras, the plateau becomes shallower and merges into the conventional continental slope (Zeigler and Patton 1974).

The sediments of the Florida coastline to the immediate west of the MIFL survey subunit consist of fine to coarse quartz and carbonate sand derived from erosion of the shoreface, onshore transport from nearby shoal regions, and southerly longshore drift (Field and Duane 1974).

Hydrology. Circulation on the continental shelf in the MIFL survey subunit is affected primarily by freshwater inflow, wind, and the nearby Gulf Stream. Freshwater inflow influences water salinity and temperature, which results in density gradients that ultimately produce currents. Wind affects water circulation by setting up surface currents. Inshore currents off eastern Florida are intermittent (Jacobson 1974). Drift-bottle studies over the continental shelf show that currents flow south in May, late summer, and early fall. At other times of the year, the southward flow is interrupted by the Gulf Stream, which rides up over the shelf and carries the surface water northward. Sea bed drifters show a northerly drift of bottom waters over the shelf and the Florida-Hatteras slope off Florida. They also reveal a convergence toward Cape Canaveral from offshore and a southerly drift inshore south of the cape (Jacobson 1974). The area off Cape Canaveral is also characterized by upwelling.

The Gulf Stream separates the warm saline waters of the Sargasso Sea from the colder less saline waters of the continental shelf. Temperature and salinity vary seasonally over the shelf and slope, yet are fairly constant within the Gulf Stream. In the Gulf Stream between the Straits of Florida and Cape Hatteras, water speeds have been measured at 100 to 300 cm/sec (Gross 1972). Current speeds are highest at the surface. The Gulf Stream extends to the Blake Plateau (> 1,000 m). Bottom currents on the Blake Plateau average 25 cm/sec (Jacobson 1974). The maximum speed of the Gulf Stream occurs in summer.

At the surface, the Gulf Stream is 50 to 75 km wide (Jacobson 1974). The stream axis can fluctuate laterally up to 20 km. The western boundary of the Gulf Stream was usually visible on the basis of a series of oceanic fronts which have contrasting water colors and temperatures detectable from the survey aircraft. At these fronts, there are also salinity changes not detectable from the aircraft (Gross 1972). Choppy water indicating an area of convergence (surface waters that flow from opposing directions and sink at the region where they meet) also marked the boundary. These fronts varied from almost overlapping to several kilometers apart. The inshore waters ranged from green to gray-blue. The Gulf Stream waters were a deep cobalt blue.

Biological Aspects. All marine food webs involving higher organisms are phytoplankton-based. Between Cape Hatteras and the MIFL survey subunit, diatoms are the dominant phytoplankton of the shelf waters, extending as far east as the Gulf Stream. Coccolithophores and dinoflagellates are dominant in the stream (Hulburt 1967; Marshall 1979).

Phytoplankton densities decrease seaward. Hulburt (1967) reported 18,390 to 305,100 cells/liter in shelf waters off Jacksonville, Florida, and from 4,530 to 8,040 in the Gulf Stream at the same latitude. Phytoplankton densities also vary seasonally. For example, diatoms are in greatest abundance in the cool months, mainly late fall, winter, and early spring (Marshall 1979).

Locations and seasonality of large standing crops are dependent on a number of environmental factors, not the least of which is nutrient availability. Nutrients are derived from several sources. Inner shelf waters are close to riverine and estuarine outflow, which are generally thought to provide a major source of the typically limited nitrate and phosphate (Thomas 1966, cited by Roberts 1974). However, Haines and Dunstan (1975, cited by Marshall 1979) presented data indicating a predominately in situ origin of inshore particulate organic matter (POM), involving a recycling of phytoplankton material. A similar suggestion centering around mixing of nutrient-rich bottom sediments was made earlier by Hulburt (1967). Another possible nutrient source for shelf phytoplankton is the subsurface water of the Gulf Stream (see review by Marshall 1979).

Phytoplankton populations in slope waters appear to derive their nutrients in situ by the intrusion to the surface of deeper nutrient-rich waters (Ketchum et al. 1958).

The seasonality of phytoplankton densities on the continental shelf is influenced by seasonal riverine and estuarine outflow. Phytoplankton densities will be greater when riverine discharge rates are high enough to carry nutrients to the sea, before they are substantially diluted (Thomas 1966, cited by Roberts 1974).

Measurements of primary productivity of phytoplankton are limited from shelf and slope waters in the vicinity of the survey subunits. One of the few available values is based on a survey by Thomas (1966, cited by Roberts 1974) extending 25 km off the Georgia coast. He estimated an extremely high net primary productivity of 547 g $C/m^2/yr$ (average of 1.5 g $C/m^2/d$). Typical production estimates for Georgia estuaries and sounds average 0.3 g $C/m^2/d$ (Ragotzkie 1959, cited by Roberts 1974). Thomas (1966, cited by Roberts 1974) used the ^{14}C method which, although widely accepted as the most accurate method of estimating primary productivity (Raymont 1963), is believed by some researchers (e.g., Sellner et al. 1976) to underestimate primary productivity. The only other available productivity values for shelf waters come from a second study by Thomas (1971), which estimated productivity by release rates of dissolved organic and particulate matter (DOM and POM). Generally, Thomas found a decrease in release rates seaward, indicating lowered productivity. The data were not amenable to establishing comparisons of annual production estimates for the two studies.

In the South Atlantic region, short-lived high production rates of phytoplankton frequently occur causing blooms with densities of up to 4 x 10^7 cells/liter (USDOI 1975). Red tides, caused by blooms of one or more dinoflagellate species (i.e., Gonyaulax spp. and Gymnodinium spp.), are the most common and deleterious. The neurotoxins produced by red tides are responsible for massive fish-kills (Howell 1953), shellfish poisoning, and human skin irritations and respiratory infections (USDOI 1975). Red tides occur most commonly in estuaries and are usually associated with high levels of freshwater runoff, warm water temperatures, and sufficient sunlight (USDOI 1975).

Phytoplankton are subject to current, wind, and tidal action and can be moved great distances. For example, the Loop Current of the Gulf of Mexico is reported to have transported water containing large populations of Gymnodinium breve from the southwest coast of Florida to the east coast, where a full-scale red tide then developed (Murphy et al. 1975, cited by Marshall 1979).

One of the primary vertebrate fauna of concern in the MIFL survey subunit is schooling fish, predominantly Atlantic Menhaden (Brevoortia tyrannus). The continental shelf at depths less than 36 m is the area of greatest schooling of the species (USDOI 1978). Schooling is greatest during migration, an essentially north and south movement in spring and fall, respectively (Roberts and Able 1974).

Atlantic Menhaden are an important food source for marine mammals and birds within the study area (Roberts and Able 1974). They also constitute the largest U.S. commercial fishery along the Atlantic coast (Henry 1971). The harvest from North Carolina to Florida averaged 3.3 x 10^7 kg/yr from 1971 to 1973 (see review by Martin 1979). Over 75% of the annual landings during this period were from North Carolina. However, populations off eastern Florida are probably smaller than those off North Carolina because Florida waters are approaching the southern limit of menhaden occurrence (based on Roberts and Able 1974).

Since 1967, the Atlantic coast menhaden fishery has undergone a significant decline. Schaaf (1975, cited by Martin 1979) believed that present landing rates are too high to allow a maximum sustainable yield. Henry (1971), however, felt that at least in Chesapeake Bay there may be excessive predation as well as economic overfishing. Man's continued exploitation of this declining resource could disrupt complex food webs.

Other schooling fish frequently taken as food by turtles, birds, and mammals in the survey subunit include anchovies (Anchoa spp.) and silversides (Menidia spp.) (Wass 1974).

Traditional shrimping grounds in the South Atlantic are generally concentrated within the 20-m contour, where water temperatures vary seasonally (Roberts and Able 1974). Based on shrimp landings, eastern Florida has larger White Shrimp populations than either Brown or Pink Shrimp. Off North Carolina, landings by decreasing weight are Brown, Pink, and White Shrimp (Roberts and Able 1974). The preferred habitats of all three species are estuarine during post larval and juvenile stages, but vary for adults. Brown Shrimp are most abundant in 30- to 60-m depths with a muddy substrate; pinks are most common at 12 to 40 m with a sand or sandshell bottom; and whites are usually in less than 18-m depths with a muddy bottom (Roberts and Able 1974). Shrimp are an important food source for a variety of birds, including the Double-crested Cormorant and Royal Tern (Wass 1974).

Several species of squid, including the Common Squid and Thumbnail Squid, occur frequently in the South Atlantic. Squid are not commercially exploited (Martin 1979) but are preyed upon by a number of marine mammals (Caldwell and Caldwell 1974), and by birds such as the Greater Shearwater, Sooty Shearwater, and Northern Gannet (Wass 1974).

Another obvious faunal element is the flyingfish, named because of the abnormally lengthened pectoral fins which allow the fish to break the surface of the water and glide for considerable distances. Two genera known to occur in the South Atlantic are Cypselurus and Cheilopagon (Staiger 1965). More sightings of flyingfishes were made in the MIFL subunit than any of the other three subunits. Numbers were greatest in June, when 186 sightings were made. Flyingfish are typically an offshore fauna ranging from 83 to 112 km from land in water depths of 306 to 633 m.

OCS Development

The outer continental shelf in the South Atlantic is still in the early stages of exploration (Jackson 1980). Geophysical surveys of the area were initiated in 1960, the first lease sale (Sale 43) was held in March 1978, and exploratory drilling began in May 1979 (Jackson 1980). Only six exploratory wells have been drilled in the South Atlantic; all were "dry holes" (USDOI 1981a). All drilling and exploration associated with OCS

Lease Sale 43 have stopped. Additional tracts in the South Atlantic could be offered in one or both of the two reoffering sales (Sales RS-2 and RS-4) scheduled through 1985 (Havran 1981). Lease sale 56 was held in August 1981; sale 78 is scheduled for 1983.

Four Federal OCS Administrative Areas extend into the MIFL survey subunit: Ft. Pierce, Orlando, Pillsbury, and Walker Cay (USDOI 1981b). To date, Federal leasing has not occurred in any of these areas, and lease blocks are not presently proposed for leasing (USDOI 1981a).

Faunal Composition

During this study, 4 species of marine turtles (818 individuals), 25 species of marine birds (4,099 individuals), and 13 species of marine mammals (2,654 individuals) were identified in the MIFL subunit.

Marine Turtles. Fewer turtles were seen in the MIFL subunit than in the NAFL subunit. Of the four species of marine turtles identified, the most abundant was the Loggerhead Turtle (88% of marine turtles) followed by the Leatherback Turtle (3%), Green Turtle (< 1%), and Kemp's Ridley Turtle (<1%). Unidentified turtles accounted for 8% of the turtles seen.

The preponderance of Loggerhead Turtles was expected because relatively large numbers of this species nest on the Atlantic coast of Florida. Although large numbers of Green Turtles once nested on Florida beaches (Carr and Ingle 1959), nesting at present occurs in low numbers (Huff et al. 1981); therefore, the low numbers seen in this subunit were not surprising. Most of the few records of Leatherback Turtles nesting in the United States are from Florida. The Leatherback Turtle was more numerous in the MIFL subunit than in any other survey subunit. Leatherback Turtles seen in the MIFL subunit occurred in greater numbers and in more coastal habitats than expected on the basis of nesting reports and previous records. Kemp's Ridley Turtle occurs largely in the Gulf of Mexico (Lund 1974) and low numbers were expected in the MIFL subunit.

Marine turtles seen in the MIFL subunit during this study were concentrated between shore and the western boundary of the Gulf Stream, about 55 km from shore, suggesting that marine turtles may actively avoid the Gulf Stream. The narrow continental shelf in the MIFL subunit may limit the number of turtles. When the densities of Loggerhead Turtles in the MIFL and NAFL subunits areas are adjusted (density/percent of subunit utilized) to reflect the portion of each subunit utilized by this species (16% and 95%, respectively), the density is nearly twice as great in the MIFL subunit (0.28 turtles/km^2) as in the NAFL subunit (0.15 turtles/km^2).

A seasonal peak in the abundance of marine turtles occurred from April to August in the MIFL subunit. This peak corresponds to the nesting season, which is from May to August for Loggerhead Turtles. Lower numbers in non-nesting periods may indicate migration from the survey subunit or reduced activity during colder months.

Marine Birds. Although the MIFL subunit had 25 species of marine birds, it had the lowest number of individuals of all survey subunits. The percentage of gulls and terns in this subunit was not as great as in other survey subunits, although Bridled Terns and Sooty Terns were seen in higher numbers than in other subunits. Seven tern species (37%

of marine birds) were identified. Only three species of gulls (24% of marine birds) were seen: the Herring Gull, Laughing Gull, and Bonaparte's Gull.

The pelicans and their allies accounted for 27% of the marine birds in the MIFL subunit. The Brown Pelican was the most abundant species of this group, and was seen in higher numbers in the MIFL subunit than in any other subunit. The American White Pelican was seasonally common in estuarine areas during winter.

Shearwaters, petrels, and their allies were more numerous and more diverse than in other subunits. They accounted for 11% of the marine birds in the MIFL subunit. Cory's Shearwater and Audubon's Shearwater were seen in low numbers throughout the year, but occurred in higher numbers during October. One Greater Shearwater was observed. Unidentified shearwaters accounted for about half of all shearwaters. Single Black-capped Petrels were seen on five occasions and were unique to the MIFL subunit. Storm petrels were seen more frequently in the MIFL subunit than in any other subunit.

The Sooty Shearwater was the only species expected but not seen in the subunit. The absence of the Sooty Shearwater may be related to an inability to distinguish it from other shearwater species from the air. The high number of shearwaters (especially Cory's Shearwaters) in the MIFL subunit was unexpected. The low numbers of gulls and terns may have been due to the lack of shallow water.

The most obvious oceanographic features that separate this subunit from the others are its location in the Atlantic Ocean rather than the Gulf of Mexico, and the presence of the Gulf Stream moving through the subunit. The higher relative abundance of several pelagic species (the shearwaters, the Black-capped Petrel, Sooty Tern, Bridled Tern, jaegers, and tropicbirds) may be related to trophic relationships with fauna in the Gulf Stream. Many of these species opportunistically feed along current boundaries and convergences similar to those that are created by the Gulf Stream in the MIFL subunit. The Black-capped Petrel was seen only in the MIFL subunit. Records for this species indicate that its distribution is largely confined to Atlantic waters.

Both Cory's Shearwater and Greater Shearwater migrate through the MIFL subunit. The relative abundance of these species may be explained by differences in their preferred habitats. The Cory's Shearwater is basically a warm-water species, while the Greater Shearwater prefers colder water and tends to move rapidly through warm-water regions along its migratory route. Because the waters of the MIFL subunit are relatively warm, Cory's Shearwaters remain in the area longer and are more likely to be seen here than elsewhere.

The proximity of nesting sites of Audubon's Shearwater, Magnificent Frigatebird, and Sooty Tern helps explain the abundance of these species in the MIFL subunit. Audubon's Shearwater nests in the Bahama Islands, the Sooty Tern on the Bahama Islands and Dry Tortugas, and the Magnificent Frigatebird on the Marquesas Keys.

Marine Mammals. The number of individuals and the diversity of marine mammals was greater in the MIFL subunit than in any other subunit. The most abundant species were the Short-finned Pilot Whale, Bottlenose Dolphin, Spotted Dolphin, and Striped Dolphin. The Risso's Dolphin was seen regularly, but in lower numbers. Five species were sighted only in or near the MIFL subunit: the Right Whale, Minke Whale, Pygmy Sperm Whale, Cuvier's Beaked Whale, and False Killer Whale. They were all seen in low numbers. Low numbers of the Sperm Whale, Spinner Dolphin, and West Indian Manatee were also sighted.

The high number of marine mammal species may be explained in part by the wide range of water depths (0 to over 1,000 m) in the MIFL subunit. Twelve of the 14 species identified are usually found in deep water. Only the Bottlenose Dolphin and the Manatee are primarily inshore species. Because 84% of the subunit is beyond the 100-m isobath and the bottom drops off sharply, pelagic species are more likely to approach the East Florida coast than areas with a wide continental shelf. The MIFL subunit is affected by the Gulf Stream, creating biologically productive convergences and upwellings which attract marine predators such as marine mammals.

The Right Whale, Minke Whale, False Killer Whale, and Short-finned Pilot Whale were seen seasonally and sightings probably were of migrants. The sightings of Right Whales and Minke Whales included mother-calf pairs. Both species calve in the warm southern limit of their migratory range.

SUBUNIT COMPARISONS

Marine Turtles

The abundance of marine turtle sightings in the NAFL and MIFL subunits, and the paucity of sightings in the BTEX and MILA subunits were striking. One explanation for this difference is the proximity of the subunits with the most turtles to nesting beaches along the Atlantic coast of Florida. While nesting occurs or has occurred on a small scale on beaches along much of the Gulf of Mexico, the most significant nesting beaches in the Gulf are located on Florida beaches. Whether the paucity of marine turtles in the western Gulf in relation to the eastern Gulf and adjacent waters is related to natural habitat differences or to human activities cannot be determined on the basis of existing evidence.

Less obvious differences in marine turtle abundance and distribution occur between the NAFL and MIFL survey subunits. High numbers of turtles were seen in both subunits. Turtles were distributed through 95% of the NAFL subunit while they were limited to waters west of the Gulf Stream in the MIFL subunit (16% of the subunit). Adjusted density calculations that compensate for the portion of each subunit used (density/percent of subunit utilized) indicate turtles are almost twice as dense in the areas where they occur in the MIFL subunit as in the NAFL subunit. The Atlantic coast of Florida supports a major nesting beach for marine turtles, while the west coast of Florida has relatively little nesting (Lund 1974). Why then are so many turtles present off the west coast of Florida? One possible explanation is that the NAFL subunit is a major feeding area. The waters in the NAFL subunit are shallow with only 5% being greater than 100 m deep. The Loggerhead Turtle, which accounted for about 80% of all marine turtles seen during this study, is believed to feed on benthic organisms, such as crabs and molluscs. The large expanse of shallow water (on the continental shelf) provides a vast area for feeding.

Marine Birds

Only subtle differences in the abundance and distribution of marine birds were noted between survey subunits. Twenty-four species were present in both the BTEX and NAFL subunits, while 25 species were present in the MILA and MIFL subunits. The most noteworthy difference occurred in the MILA subunit where more than three times as many individuals were sighted as in any other survey subunit. The large number of birds seen may have been related to the proximity of the MILA subunit to the Mississippi Flyway, a major migratory route for many species of birds including some gull species. Gulls accounted for about 56% of the birds seen in the MILA subunit. The numbers of some winter migrants are low in the southern portions of their range, suggesting that some species may prefer cooler areas of the northern Gulf of Mexico or may winter in the area where suitable habitat is first encountered. Another possible factor is that the shallow waters in the northern Gulf of Mexico are highly productive and provide abundant food resources for marine birds. The numerous shrimp boats in the MILA subunit may attract animals to this area. The abundant oil and gas platforms in the MILA subunit may provide perch and roost sites for birds.

The marine avifauna of the MIFL subunit differed slightly from that of the subunits in the Gulf of Mexico. In the Gulf of Mexico subunits, gulls and terns accounted for 90% to 97% of the marine birds seen. In the MIFL subunit, gulls and terns accounted for only 61% of the birds seen. Shearwaters, petrels, and their allies in Gulf of Mexico subunits accounted for less than 1% of the marine birds seen, but comprised 11% of the marine birds seen in the MIFL subunit. Pelicans and their allies accounted for less than 10% of the birds in Gulf of Mexico subunits, but accounted for 17% of the birds in the MIFL subunit.

The number and diversity of shearwaters, petrels, and their allies were greatest in the MIFL subunit, possibly because the MIFL subunit is closer to migration routes of shearwaters that nest on islands in the Atlantic Ocean.

Marine Mammals

The higher number of mammal species in the MIFL subunit than in Gulf of Mexico subunits has two possible explanations. One is that the MIFL subunit is closer to the migratory routes from the North Atlantic, an area of concentration for a greater variety of species. Species whose occurrence in the MIFL subunit may be explained by this hypothesis are the Right Whale and Minke Whale. The other explanation is that animals are resident and more abundant in the MIFL subunit and therefore more likely to be seen. The Pygmy Sperm Whale, Cuvier's Beaked Whale, and False Killer Whale have been reported from the Gulf of Mexico, but during this study were only identified in the MIFL subunit.

The greater number of marine mammals in the MIFL subunit than in the Gulf of Mexico subunits may in part be a result of more abundant food resources in the area. The Gulf Stream passes through the subunit causing mixing through convergences (Jacobson 1974) and increasing productivity (Watson 1966; Dustan et al. 1981). Currents occur within the Gulf of Mexico subunits but do not cause mixing to the extent of the Gulf Stream.

The composition of marine mammals in the BTEX and MIFL subunits, which have extensive areas of deep water (Figures 2 and 5), was distinctively different from that of the MILA and NAFL subunits, which have large areas inside the 100-m isobath (Figures 3 and 4). Deep-water cetaceans such as Sperm Whales, Short-finned Pilot Whales, Risso's Dolphin, beaked whales, Minke Whales, False Killer Whales, and Pygmy Killer Whales were absent or rare in the MILA and NAFL subunits. The Sperm Whales and Short-finned Pilot Whales that were seen in the MILA and NAFL subunits occurred near the offshore boundaries of the subunits. During surveys offshore of the NAFL subunit, Risso's Dolphins were sighted in water 420 to 1,530 m in depth. The BTEX and MIFL subunits had fewer Bottlenose Dolphins, and the dolphins were closer to shore than in the MILA and NAFL subunits. *Stenella* spp. were present in all subunits, but occurred in greatest numbers in the eastern Gulf of Mexico (NAFL) and Atlantic Ocean (MIFL). This suggests that water depth alone does not control the distribution of these species.

SEASONAL OVERVIEW

The northern Gulf of Mexico and the Atlantic waters of the southeastern United States are subject to less obvious seasonal changes than other marine environments of the continental United States. The waters off southeastern United States are moderated, especially in winter months, by the Gulf Stream current carrying warm waters from the Gulf of Mexico and the Caribbean Sea. The Gulf of Mexico is a relatively closed system subject to some temperature oscillations but bounded by areas with mild winters and hot summers. The shallow coastal waters of the northern Gulf experience the most marked cooling due to the influence of adjacent terrestrial climates and to the inflow of cold, fresh water from the Mississippi River and tributaries.

Temperature gradients in the Gulf of Mexico generally exist between inshore and offshore waters with inshore waters cooler in winter and warmer in summer than adjacent waters farther offshore (Leipper 1954). Temperature gradients off the Atlantic coast of Florida differ, having warmer waters of the Gulf Stream at varying distances from shore and cooler waters both landward and seaward of the main Gulf Stream.

A variety of seasonal categories can be identified within the fauna of the study area, but details of seasonal movements are largely unavailable for most species. The data collected in this study spans a single year; thus, the seasonal trends observed must be considered as tentative ones requiring confirmation during other years.

Seasonal changes in the distribution of species and in the use of an area can be summarized as follows: (1) species present year-round, (2) species using the area for a portion of the year, and (3) species traveling through the area (whether on a seasonal schedule or not). A large portion of the fauna is present in the study area year-round, but several distinctions can be made in discussing seasonality of year-round inhabitants. An asynchronous species may use the study area throughout the year, but have lower densities in fall and winter than in other seasons. The White Pelican is asynchronous in Texas with some individuals nesting there and others migrating to inland nesting areas.

The ability to determine whether an uncommon species has migrated out of the area or is resident but in such low numbers that it is undetected depends upon having reliable data spanning several years. The information on many species in the study area is not complete enough at present to make such a distinction. Consequently, only the most obvious examples of seasonal occurrence are included in the present discussion.

The present data available for most turtles and marine mammals are inadequate to define transient use of the study area. The long migrations of birds often involve rapid movement through areas with only minimal utilization of habitats for feeding and nesting.

TURTLES

Loggerhead Turtles are probably asynchronous in the NAFL and MIFL subunits. Some individuals are present only during warmer months to exploit feeding or nesting sites, whereas others are present as active or dormant individuals even during the coldest months. Seasonal and geographic relationships will remain confused and speculative, until better data exist on the movements of neonate, juvenile, and reproductive classes of marine turtles.

Leatherback Turtles are frequently thought to be highly migratory (Pritchard 1976; Hendrickson 1980). Concentrations of Leatherbacks may increase in fall or winter periods as a result of immigration from more northern waters (Shoop et al. 1981), but the peak in abundance during this study was in August.

Green Sea Turtles occur in the study area year-round but may be largely inactive in cool months. The stunning of Green Sea Turtles by cold weather on the east coast of Florida has been reported by Ehrhart (1977) and Ehrhart and Lee (1981).

As noted above, differences in the occurrence and abundance of marine turtles in response to season are particularly confused. Kemp's Ridley Turtle, which was sighted only in low numbers, was present during June and October off Texas, during August and October in the eastern Gulf of Mexico, and during October and April in the Atlantic off Florida. Whether the species migrates seasonally within the Gulf or occurs in low numbers year-round can only be determined with additional data.

BIRDS

The most conspicuous bird species that are year-round inhabitants of the study area include: Brown Pelicans, Laughing Gulls, Royal Terns, Bridled Terns, and Magnificent Frigatebirds. Several species restricted to coastal habitats are also present throughout the year (e.g., Least Terns and Black Skimmers). The American White Pelican is a year-round resident in South Texas because of the nesting colony near Laguna Madre, but it is a winter migrant in all other areas. Adults of the American White Pelican leave the study area earlier in the spring than do nonbreeding juveniles.

Magnificent Frigatebirds nest within the study area only in the southern extreme of Florida and occur in all months in this area. Frigatebirds sometimes nest asynchronously and therefore vary in their occurrence near roosts and feeding areas away from the nesting area.

Brown Pelicans, Laughing Gulls, Bridled Terns, and Royal Terns are apparently most abundant in winter months when populations are augmented by birds from areas to the north. Such winter aggregations range from only slight changes in the numbers of Brown Pelicans to large changes in the numbers of Royal Terns, which migrate from the northern parts of the Atlantic coast to Florida and the Caribbean.

The bird fauna in the study area includes many migrants. Wintering birds include Common Loons, Cory's Shearwaters, Northern Gannets, Herring Gulls, Ring-billed Gulls, and Bonaparte's Gulls. Most of these birds leave the study area to nest farther north. Stragglers and nonbreeding Cory's Shearwaters may be present year-round especially in the western Gulf, but the predominant portion of the population is present only during winter. Concentrations of Bonaparte's Gulls were most frequently seen in the northern Gulf of Mexico during February.

Some tropical species with distributions to the south occasionally use the study area, especially during summer. These species include Brown Boobies, Masked Boobies, tropicbirds, and Brown Noddies.

Greater Shearwaters prefer cold waters and tend to migrate rapidly through most of the warm waters of the study area. Phalaropes are also transients in the study area. Franklin's Gull is an inland species that uses the study area only during migration to and from southern regions. A large number of land and shore birds migrate across the Gulf and along coastal waters (Table 60).

MAMMALS

The Bottlenose Dolphin is conspicuous in all months throughout the study area but may move farther from shore in winter. Detailed studies of individual herds in Texas (Shane 1980; Gruber 1981) and in Florida (Irvine et al. in press) also suggest that the local distribution of Bottlenose Dolphins changes seasonally.

The West Indian Manatee exhibits pronounced seasonal movements within Florida with the distribution shifting south in response to cooler temperatures and north with returning warm weather. The southward migration of manatees is sometimes shortened or suspended in some areas by the species' use of hot water discharges from industrial facilities and artesian springs (Hartman 1979c).

The Spotted Dolphin and other Stenella spp. are probably year-round residents nearshore and offshore in the study area, but may move over large distances seasonally. The Sperm Whale has been encountered in the Gulf of Mexico in nearly all months of the year, but it is unclear whether the same individuals are present year-round or whether a population is present which migrates asynchronously. Risso's Dolphin and the Short-finned Pilot Whale are probably present year-round, but like other marine mammals, local distributions may change in response to seasonal variants.

Several marine mammals (the Minke Whale, Sperm Whale, and Right Whale) were noted during cooler months in the Atlantic off Florida, but were absent during other periods. These animals which migrate along the Atlantic coast would be expected to be seasonally present in the MIFL survey subunit. The only Sperm Whale noted in the eastern Gulf was seen during February. However, Sperm Whales were most commonly encountered in waters off Texas during the warmer months of June, August, and October. Beaked whales were also present off Texas during June and August, but were not observed there in other months. Right Whales migrate north along the Atlantic coast of Florida during winter months, often accompanied by calves. The time these whales spend in the area and the ecological variables influencing their distribution during this period are unknown.

ECOLOGICAL OVERVIEW

An ecological overview focuses on the interactions of physical and biological factors that influence the distribution and abundance of organisms (Krebs 1972). The fauna and habitats within outer continental shelf waters are here defined in terms of distance from shore and water depth. The ability to occupy inshore, nearshore, and offshore habitats varies with the ecological habits of the species. Depth and distance from shore may affect habitat use directly or may affect the species indirectly by influencing food resources, currents, and other environmental variables related to depth and distance from shore.

The habitat limits used here are adapted from Wynne-Edwards (1935, 1964), who separated marine birds into three faunas on the basis of dependence on land for food and resting areas. The present discussion focuses on inshore, nearshore, and offshore habitats. The inshore zone extends from the mean high water mark to approximately 6 km (1 to 11 m in depth) from shore. This zone includes the surf zone, tidal flats, and coastal lagoons, barrier islands, associated marshes and passes, and coastal waterways. The characteristics of the inshore habitat vary greatly within the study area. The BTEX and MIFL subunits have prominent barrier islands with associated lagoons and waterways. The MILA and NAFL subunits have complex coasts with numerous shallow water bays, coastal islands, and vegetated shores with few dunes and other sand habitats.

The nearshore zone begins 6 km from shore and extends to the continental shelf break arbitrarily set as the 200-m isobath in this study. The nearshore zone varies greatly in size depending upon the slope of the continental shelf. Most of the NAFL subunit consists of nearshore habitats since the continental shelf extends beyond the outer limits of the subunit. In contrast, the nearshore zone in the MIFL subunit is quite narrow because the shelf break is within 61 km of the coast. The nearshore zone of the subunits off Louisiana and Texas are intermediate in size (Figures 2 through 5).

The offshore zone occurs from the edge of the continental shelf seaward. It includes the continental slope, rise, and the abyss. Although the offshore habitat extends over a large area of the earth's surface, it supports a complex and specialized marine fauna little of which is known.

Certain species are primarily restricted to either the inshore, nearshore, or offshore ecological zone, but others occupy two or more zones for at least a limited part of the life cycle or annual cycle, or under special ecological conditions (Figure 167).

INSHORE FAUNA

The inshore zone is important to many species of birds and turtles, which nest in adjacent terrestrial habitats. The inshore zone is rich in nutrients derived from freshwater inflow and the decomposition of vegetation. Primary productivity is therefore highest inshore and decreases seaward. The shallow waters of marshes and lagoons are nursery grounds for numerous fish and invertebrates such as menhaden

Figure 167. Distribution of species in the inshore, nearshore and offshore zones of the study area based on literature reports and aerial survey data. Solid lines represent known occurrences; dotted lines represent minor occurrences (such as during migration); dotted lines with question mark (?) indicates possible occurrence based on literature.

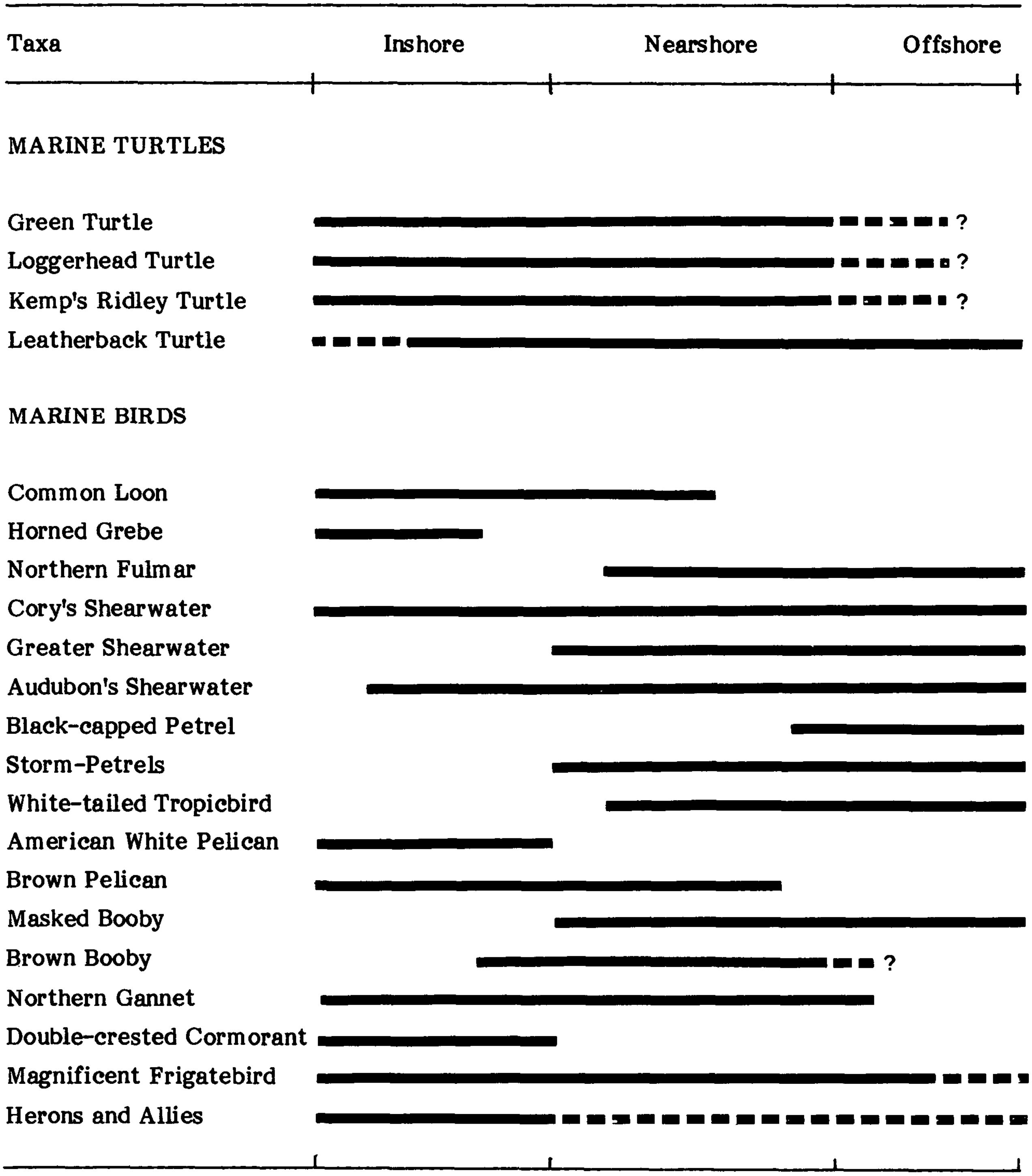
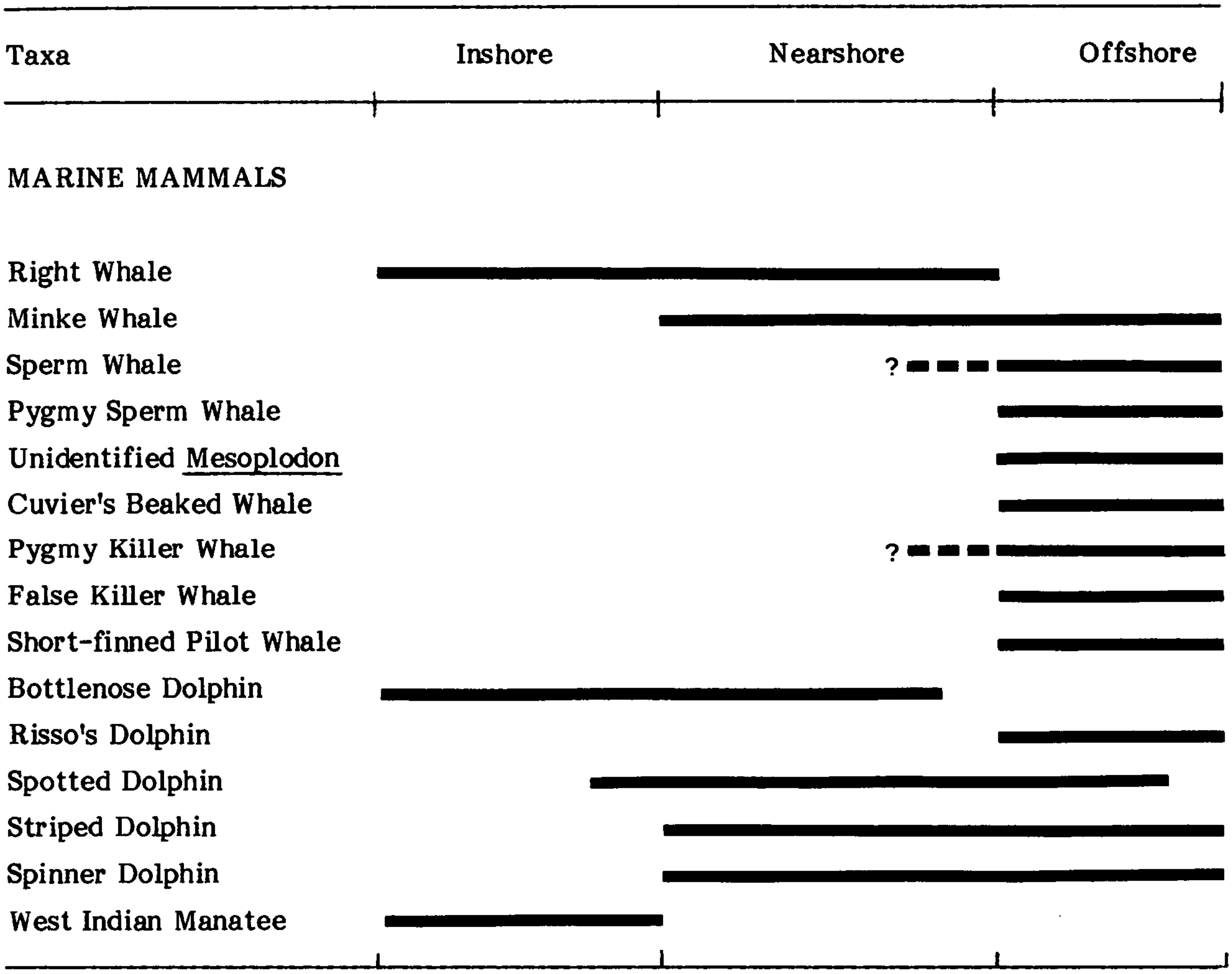


Figure 167. Continued.

Figure 167. Concluded.



(Brevoortia spp.) and penaeid shrimp. The sea grasses (e.g., Thallasia testudinum) provide food, shelter, and stable attachments for developing juveniles as well as for adults of many organisms. These vertebrates and invertebrates in turn provide a seasonally abundant food source for many larger species of the inshore fauna. The surf zone, despite its well-mixed and nutrient-rich water, is too turbid for substantial primary production to take place. It does serve to deposit decaying animal and vegetable matter onto the beach, thus providing a food source for carrion-feeders such as gulls, frigatebirds, and intertidal invertebrates.

Marine turtles are most frequently seen in the inshore area during the nesting season. Loggerhead Turtles were abundant in this zone off eastern Florida from April to September. Loggerhead Turtles were seen commonly in inshore waters off both coasts of Florida during this study. Leatherback Turtles have been seen feeding on jellyfish in the surf zone near Port Aransas, Texas (Leary 1957) and other areas of the Gulf of Mexico.

Although little is known about the habitats and activity of juvenile turtles, individuals have been found in the calm waters of the lagoon systems of the inshore zone. Ehrhart (1977) reported over 100 Green and Loggerhead juveniles in Mosquito Lagoon, Florida. Green Turtles are occasionally caught by fishermen in the shallows of Laguna Madre in Texas (Hildebrand 1979). The use of this area by juvenile and adult turtles is not completely understood, but the inshore waters may provide important sources of food.

Wading birds, such as the Great Blue Heron, other herons and egrets, White Ibis, and Roseate Spoonbill utilize the shallow lagoons and marsh areas of the inshore zone. The herons and egrets forage for small fish in clear water and scavenge along beaches. The spoonbill and ibis forage for invertebrates in muddy substrates and water. Willets and other shorebirds feed on invertebrates along the shore at the edge of the surf zone. Least Terns and Brown Pelicans plunge in clear waters for small fish and invertebrates. Double-crested Cormorants feed by diving after fish. Laughing Gulls feed in a variety of ways: by surface-seizing prey in the lagoons, marshes, and the rougher waters of the inshore zone; by scavenging along the shore for carrion; and by kleptoparasitizing other birds.

Many marine birds such as cormorants, pelicans, terns, and gulls nest near the inshore zone. These birds roost and preen on sandbars and in low vegetation near the water. Several species of birds may share a sandbar and later feed on the same fish school.

Few marine mammals commonly occur in the inshore zone. Within the study area, only the West Indian Manatee, Right Whale, and Bottlenose Dolphin were observed there. Manatees inhabit both fresh and salt water deeper than 1 m (NFWL 1980c). In marine habitats, they are known to subsist on various types of sea grasses (Hartman 1979b).

During their migrations along the east coast of the United States, Right Whales often can be seen from the beach (Caldwell and Caldwell 1974). In more northern waters, they feed on concentrations of copepods and euphausiid crustaceans (Caldwell and Caldwell 1974; Leatherwood et al. 1976; Winn et al. 1979). It is not known if Right Whales feed in the turbid inshore waters along the southeast Atlantic coast. During this survey two Right Whales, a mother and calf, were seen in the turbid waters beyond the surf line. A herd of Bottlenose Dolphins was nearby.

Bottlenose Dolphins are often seen in inshore waters. They frequent lagoons, estuaries, and rivers in search of prey (Caldwell and Caldwell 1972; Wells et al. 1980). They often forage alone or in small groups on scattered fish. Bottlenose Dolphins feed on a variety of prey items found in inshore waters including mullet (Mugil spp.), menhaden, shrimp (Penaeus spp.), and squid (Loligo spp.). Bottlenose Dolphins usually feed in water 1 m or more in depth, but also have been observed herding a fish school out of the water onto a sandbar (Hoese 1971). The dolphins then partially beached themselves, ate the fish, and retreated into the water.

NEARSHORE FAUNA

Most continental shelf areas are highly productive because the waters are shallow and well-mixed with current patterns that retain nutrients (Gross 1972). Many species of marine turtles, birds, and mammals are abundant in the nearshore zone, perhaps in response to food availability. Loggerhead Turtles feed on benthic organisms in shallow waters of the shelf. Sea grass beds in the Gulf of Mexico compose suitable feeding habitat for Green Turtles (Hirth 1971; USDOI 1976). Large concentrations of jellyfish (the major prey item of Leatherback Turtles) were observed in the area and could explain the nearshore distribution of the Leatherbacks.

Bird species characteristic of the nearshore fauna are: Laughing Gulls, Royal Terns, Audubon's and Cory's Shearwaters, Northern Gannets, Brown Pelicans, and Magnificent Frigatebirds (Figure 167).

Of these birds, gulls, terns, and pelicans must spend some time out of the water preening and roosting and are thus restricted in their distribution. However, oil rig platforms apparently are suitable as resting sites and provide new foraging areas due to the fish assemblages associated with the biofouling communities on the structures. Use of these platforms can help extend the distribution of these birds into nearshore and offshore areas by reducing energy expenditure for flying between foraging and resting areas. Brown Boobies and Magnificent Frigatebirds are also known to use artificial platforms for resting. It is not known just how important resting platforms at sea are to birds; yet on three occasions, Loggerhead Turtles, floating at the surface, were used as a resting platform by three different species of birds.

Some marine birds use the nearshore zone for only part of the year. During the winter, the nearshore zone is used extensively by Laughing Gulls. However, Royal and Common-group Terns which are in nearshore waters in summer seem to occur farther offshore in winter. Changes in distribution of prey species may induce changes in the birds' distribution.

Many birds of the nearshore fauna feed in mixed aggregations or flocks. Flocks can range from simple aggregations involving one or a few species to complex associations involving many bird species; large pelagic fish, such as tuna; various shark species, including whale sharks; and marine mammals. Descriptions of these feeding associations are included in the accounts of the individual species involved.

The feeding strategies of the marine birds of the nearshore zone vary even within mixed feeding aggregations (see Ashmole 1971). For example, the Magnificent Frigatebird and Laughing Gull seize prey at the surface by dipping and surface seizing, respectively. Royal Terns and Brown Pelicans surface-plunge to obtain prey a few centimeters to 0.5 m under the surface. Deep plunging birds, such as the Northern Gannet and Masked Booby seize prey a meter or more below the surface, and shearwaters, such as Audubon's, plunge under the water and then swim in pursuit of prey. Gannets can pursue prey by swimming to depths of 15 m. Cory's Shearwater doesn't go so deep. Some shearwaters feed even deeper than the gannets or boobies. Common Loons can dive 30 m or more in pursuit of prey. In a feeding aggregation, these various strategies allow the birds to exploit a fish school from below as well as above.

Different marine bird species are associated with characteristic water types defined by temperature and salinity (Brown 1981). For example, Cory's Shearwaters are associated with warm waters off the eastern North Atlantic whereas Greater Shearwaters are found over colder waters.

Within their preferred habitats, marine birds are distributed primarily on the basis of prey concentration. Small scale oceanographic phenomena, such as convergences, fronts, and upwellings tend to concentrate prey species by trapping plankton and other small organisms (Brown 1981). Convergences are often visible from aircraft and detectable by sudden changes in sea surface temperature or water color. Frequently sargassum is also trapped by convergences. Marine birds were often noted near convergences where prey may be concentrated. In one instance, about 5,000 Bonaparte's Gulls were floating on and flying along a convergence covering a linear distance of 7 km. Several phalaropes and a Common Loon were also seen in the area. Since most marine birds can feed only in the upper layers of the ocean, they exploit prey when it is concentrated near the surface by convergences, upwellings, and current boundaries.

Several small cetaceans are characteristic of the nearshore fauna: the Bottlenose, Spotted, Striped, and Spinner Dolphins. Bottlenose Dolphins generally occurred closer to shore than the other dolphin species. They frequently occurred in the inshore zone as well as in the shoreward portions of the nearshore zone. The Spotted, Spinner, and Striped Dolphins occurred farther from shore in the nearshore zone and into the offshore zone. For example, in the NAFL subunit, Bottlenose Dolphins averaged 77 km from shore, but Spotted Dolphins, Striped Dolphins, and Spinner Dolphins averaged over 100 km from shore. In the NAFL subunit, the distribution of the Spotted, Striped, and Spinner Dolphins appeared similar. In the MIFL subunit, the distribution of Spotted and Striped Dolphins was quite different. The Spotted Dolphins occurred primarily in the nearshore zone (average distance from shore less than 70 km), and the Striped Dolphins occurred primarily in the offshore zone (average distance from shore over 100 km). The differences in the distribution of the dolphins in the NAFL and MIFL subunits could be related to a difference in available food sources.

Dolphins feed on small fish, squid, and crustaceans (Mitchell 1975a). Often dolphins are found in feeding associations with birds and fish. Dolphins were also observed near convergences, but less frequently than birds.

OFFSHORE FAUNA

The offshore zone is relatively nutrient-poor. Consequently, the phytoplankton growth and primary productivity are lower than in other zones. In general, there is less mixing of waters in this area and fewer nutrients are available to foster productivity as compared with continental shelf waters. However, there are areas of upwelling along the continental shelf in the study area, especially on the edge of the Loop Current along the continental shelf break off Southwest Florida. Upwelling brings cold, nutrient-rich waters to the surface where they can support phytoplankton growth. Those areas are potentially rich food sources for a variety of marine organisms. Squid, a principal food for several marine mammals, aggregate in large numbers near areas with upwelling (Marcuzzi and Pilleri 1971).

The offshore zone is less productive than the continental shelf waters of the nearshore and inshore zones; therefore, marine birds and mammals offshore tend to frequent areas with high concentrations of prey. These include sea mounts, shelf edges, and other areas with complex bottom topography where upwelling occurs (Dustan et al. 1981). A variety of species (Sperm Whales, Beaked Whales, Pilot Whales, and Risso's Dolphin) were noted near the edge of the continental shelf in the BTEX subunit. Areas of convergence and divergence also tend to concentrate prey. The deep scattering layer consists of associated masses of plankton and invertebrates that migrate vertically in a daily cycle. The plankton migrates down in daylight to depths of more than 800 m and up at night to depths of less than 200 m (but not to the surface). Many cetaceans and pelagic fish prey on species in this layer.

The Leatherback Turtle is the only marine turtle thought to be distributed primarily in offshore waters (Pritchard 1976). In this survey, Leatherback Turtles were only occasionally seen in offshore waters and were more abundant in nearshore areas. They possibly feed on jellyfish that are associated with the deep scattering layer (Hendrickson 1980). It is speculated that hatchling sea turtles use the offshore zone by taking advantage of the cover offered by sargassum (Witham 1980). Because Loggerheads feed primarily on benthic organisms, their presence offshore is probably related to migration.

The marine birds most characteristic of the offshore fauna are phalaropes (Red and Northern), storm petrels, Masked Boobies, Sooty Terns, and tropicbirds (Figure 167). Phalaropes and other birds, which feed on plankton and other small prey, can feed efficiently only when their prey is concentrated. Phalaropes are attracted to concentrations of zooplankton caused by upwellings, which are usually well offshore and patchy in distribution (Murphy 1936; Gross 1972). Phalaropes and storm petrels are, therefore, similarly distributed.

Some birds, such as Greater Shearwaters and Black-capped Petrels, among others, feed nocturnally on squid, fish, and siphonophores associated with the deep scattering layer (Barham 1963; Banse 1964; Clarke 1966; Brinton 1967; Nafpaktitis 1968 cited by Ashmole 1971).

Many birds, such as tropicbirds and Masked Boobies, require clear non-turbid water to see prey items. Clear water is most common in the offshore zone, but can also be found in neritic waters. Consequently, the Masked Booby and White-tailed Tropicbirds, once thought to be primarily offshore species, may also be part of the nearshore fauna.

Sooty Terns are surface-seizers and often rely on tuna schools or other large predatory fish and marine mammals to chase small fish and squid to the surface. Sooty Terns were observed in both the nearshore and offshore zone, but are known to occur mostly far offshore (Watson 1966). They were often seen in association with cetaceans such as Striped and Spotted Dolphins, Risso's Dolphin, and unidentified whales.

Mammals characteristic of the offshore fauna in the study area are the Sperm Whale and other Physeteridae, beaked whales (Ziphius and Mesoplodon spp.), the smaller whales, such as Short-finned Pilot Whales, False Killer Whales, Pygmy Killer Whales, Risso's Dolphin, and the Stenella spp., including Spotted Dolphins, Spinner Dolphins, and Striped Dolphins.

Most of the mammals of the offshore fauna feed heavily on squid. Squid-eaters generally have a characteristic reduction of maxillary teeth (as in Sperm Whale), an anterior emphasis in the distribution of teeth in both jaws (as in the Pilot Whale), or partial or complete loss of all functional teeth (as in many Ziphiidae) (Gaskin 1976). Most odontocetes are opportunistic feeders. Therefore, even though beaked whales appear to be squid eaters, they take mesopelagic and demersal fish in certain seasons (Pike 1953, cited by Gaskin 1976; Tomilin 1967). Both the Pilot Whale and the False Killer Whale feed on squid (Sergeant 1962a; Fraser 1937, cited by Gaskin 1976) supplemented by fish. Pseudorca has been known to steal fish from fishermen's lines off Florida (see Species Accounts) and perhaps also feeds on smaller cetaceans (Perryman and Foster 1980).

Off the coast of southern Texas over a period of 20 months, three Pilot Whale sightings occurred within 11 km of each other (Figure 135). Whether these sightings represent a resident population of the same animals or different animals attracted to a unique ecological or oceanographic feature is unknown. Risso's Dolphins were consistently in waters over the continental slope and may also be attracted to critical ecological or oceanographic features.

Members of the offshore fauna may, at times, penetrate into the nearshore zone. For example, Pilot Whales and Risso's Dolphins are known to follow squid onto the continental shelf at certain times of the year (Norris and Prescott 1961; Sergeant 1962b; Leatherwood and Reeves 1978; Leatherwood et al. 1980). During this study one Sperm Whale was observed over the shelf off western Florida. The occurrence of this deepwater species over the shelf could be in response to prey distribution and upwelling along the slope in this area.

The smaller cetaceans, such as Spotted, Spinner, and Striped Dolphins, feed on small fish and squid. They all have a long, slender rostrum and many teeth adapted for grasping small fish. Spotted Dolphins and tuna feed in aggregations on epipelagic prey during the day (Perrin et al. 1973). The Spinner Dolphins, however, feed on mesopelagic fishes at night, perhaps in the deep scattering layer. Large fish-dolphin feeding aggregations seem to be important in concentrating food for offshore birds in the Pacific and seem to have the same effect in the study areas.

EFFECTS OF OCS DEVELOPMENT ON MARINE VERTEBRATES

Gas and oil activities on the outer continental shelf are diverse, and require many onshore operations. However, this discussion will focus on activities in OCS areas that would most directly affect the marine fauna: geophysical surveying, exploratory drilling, production drilling, pipeline construction, and the aerial and marine traffic that services these offshore operations.

Probably the most conspicuous alteration to the marine environment during the production phase is the presence of support structures for drilling and production platforms. Generally, the structure is permanently attached to the ocean floor. The mechanics of drilling involve the use of drilling fluids, which are pumped down the hollow center of the drill pipe to the drill bit (Gallaway 1981). Drilling fluids are largely barite and bentonite clays in water-based colloidal suspensions. Small amounts of drilling fluids and small cuttings from the bore hole are returned to the surface and discharged into the sea after being separated by a process designed to retrieve the fluids for reuse. Periodically during the drilling process, larger amounts of drilling fluids are dumped into the water. Although drilling fluids have detrimental effects on bottom communities, fluids are rapidly diluted and rendered nontoxic at short distances from the release site (Gallaway 1981).

Briny water, derived from the geological formations and separated from the hydrocarbon products, is an another effluent from the production platform (Gallaway 1981). These produced waters are characterized by the presence of alkane, aromatics, volatiles, sulfur, and biocides (Middleditch and West 1980) and are toxic to marine organisms (Zein-Eldin and Keney 1979; Energy Resources Company Incorporated 1980). The sulfur in produced waters may provide one of several mediums by which hydrocarbons are transported to bottom sediments (Gallaway 1981).

Oil and petroleum derivatives are, of course, the main product of OCS operations. These products find their way into the marine environment via several known pathways. The most publicized pathways are catastrophic oil well blowouts, pipeline breaks, and tanker spills which may introduce millions of barrels of oil into the marine ecosystem. Ships and tankers are reported to contribute 26 times as much oil pollution as OCS structures (Ohlendorf et al. 1978). The damage caused by oil spills varies with location, local geography, amount and type of oil, weather conditions, and the types of flora and fauna in the area. Hydrocarbons may be found in measurable amounts in sediments 5 years after a spill (Sanders et al. 1980). Dispersants used to neutralize or clean up spills are often more destructive to marine organisms than the oil (George 1970, cited by Swedmark et al. 1973). Although large amounts are occasionally introduced by OCS activities, 66% of the oil found in coastal waters originate from terrestrial sites, and only 1.3% of the oceanic hydrocarbon load result from OCS production (NAS 1975).

Near production areas hydrocarbons are found in low levels in the sediments (Blumer et al. 1971, cited by Swedmark et al. 1973; Sanders et al. 1980) and in the water column, and are assimilated into the food web by some marine organisms that concentrate near OCS structures (Varanasi and Malins 1977; Gallaway 1981).

Construction, drilling, and oil spills are not the only disturbance OCS development introduces into the marine environment. Marine and air traffic is heavy between production areas and land bases. Ships generally carry equipment and supplies to production sites, while aircraft commonly are used to move personnel. The effect of OCS traffic on marine organisms is uncertain. Trash associated with construction, production, and shipping increases in areas of OCS development and activities, and can affect marine organisms that ingest nondigestible or toxic substances.

Pollution and petroleum assimilation capacities of the different trophic levels are unknown, but must be determined to predict future loading and long-term impacts. Direct effects on vertebrate populations usually occur because of breakdown in lower trophic levels, and then changes usually occur rapidly (see discussion in Gallaway 1981).

The production platform, like any artificial reef, provides a hard substrate for biofouling communities (Gunter and Geyer 1955; Gallaway 1981). Fouling organisms are the primary producers around production platforms (Gallaway 1981). Larvae of fouling organisms are food sources for small planktonic fishes and nektonic invertebrates (Fotheringham 1977) that in turn attract larger organisms.

Organisms concentrated around production platforms are exposed to unusually high levels of drilling fluids, hydrocarbons, and briny (produced) waters. The drilling fluids, produced waters, and hydrocarbons have detrimental effects on the fouling communities close to discharge sources. Concentrations of drilling fluids may block the light and directly smother corals (Gallaway 1981). Produced waters lower biomass levels and production rates of biofouling communities close to discharge pipes (Gallaway 1981). Larval Brown Shrimp and other crustaceans are especially sensitive to produced waters (Gallaway 1981). Low levels of hydrocarbons may accumulate in marine organisms with long-term effects that are difficult to assess. After exposure to large concentrations of oil, as in spills and blowouts, plankton and invertebrates may retain measurable concentrations of hydrocarbons for long periods (Varanasi and Malins 1977). Eggs and larval stages are particularly susceptible (Hay 1977). Bivalves are sensitive; and mortality may occur quickly or gradually, depending on the metabolic rate of the organism to the toxic substances (Swedmark et al. 1973). In some circumstances, spills and cleansing operations may result in the disappearance of macroscopic species (Konig 1968; Reish 1970 cited by Swedmark et al. 1973).

Marine fish are attracted to OCS structures by the presence of food and cover (Gallaway 1981). The numbers of some species of fish may increase because there is more available habitat in areas with OCS structures (Gallaway 1981). True reef species may increase in numbers, whereas less specific fish may simply use OCS structures opportunistically as feeding sites. Fish that cluster around OCS structures and assimilate hydrocarbons include mullet (Shipton et al. 1970, cited by Connel et al. 1975), sheepshead (Gallaway 1981), and others. McCain et al. (1978) reported that sole assimilated hydrocarbons from oiled sediments. Most fish probably accumulate petroleum derivatives through the food web (i.e., lower trophic levels in the biofouling community), but transfer pathways are uncertain. Some species may be able to clear hydrocarbons from their system, if ambient levels decrease (see review by Sharp 1979). The effects of chronic levels of hydrocarbons in fish may be difficult to identify, but decreased immune response and overall resistance to disease are suspected (see review by Hodgins et al. 1977). Small fish may suffer sublethal impairments (Johnson 1977; Stein et al. 1978) that may render them less able to escape predation. Flounder are known to suffer liver and gonad damage after exposure to hydrocarbons, resulting in abnormal reproduction behavior (Whipple et al. 1978). Resident sheepshead around OCS structures in the northern Gulf of Mexico are heavily parasitized by nematodes, while transients are not (Gallaway 1981). Mullet exposed to chronic low levels of oil develop fin rot (Minchew and Yarbrough 1977), because chronic exposure alters the bacteria on the fish allowing growth of pathogens (Gilles et al. 1978). Dispersants used to clean up oil spills also are toxic to fish (Swedmark et al. 1973).

Deleterious effects of hydrocarbons (i.e., acute exposure and bioaccumulation) on marine invertebrates and fish suggest that continued or increased marine pollution could result in dramatic changes in marine communities. Major population changes in lower trophic levels would not only have adverse effects on commercial and sport fisheries, but would also upset the marine ecosystem by removing food resources of higher trophic levels including marine turtles, birds, and mammals. Such ecological changes can occur slowly and may go unnoticed without detailed long-term studies. These subtle changes can be monitored by studying the more conspicuous higher trophic levels that depend on fish and marine invertebrates for food because changes are magnified at higher trophic levels. Brown Pelicans in Louisiana and California responded to high levels of a contaminant that had accumulated as a result of the large number of fish a pelican eats. This study of marine turtles, birds, and mammals provides some baseline data that can be used to monitor population levels of conspicuous marine predators. Population changes or absences observed in future studies would indicate environmental stress. Such studies could probably detect problems such as the one with Brown Pelicans before they reach critical levels.

From the viewpoint of a population, changes in population size, age structure, movements, and habitat quality are important criteria for evaluating impacts. Species are made up of one or more populations. Impacts on species must be judged using the same criteria as for populations as well as the number, size, and distribution of populations.

The present study was designed to provide critically needed information on populations and their distribution, size, ecology, and seasonality. This information will be used to evaluate known effects on individuals. In some cases the need for further research into the factors that influence survival, growth, and reproduction of individuals of especially sensitive populations and species will also be discussed.

VULNERABILITY OF POPULATIONS AND INDIVIDUALS

Vulnerability of Populations

Indices of population vulnerability in the four survey subunits were compiled using biological characteristics presented in the species accounts (Table 64). A population's vulnerability was estimated by considering status, distribution, reproduction seasonality, and abundance in each subunit. Criteria were developed to rank the relative importance of each subunit to the existence of the populations or species. For example, if the total score for a species is higher in one subunit than in others, environmental perturbations in this subunit would be more likely to seriously impact the population or entire species. A

Table 64. Vulnerability of animal populations to oil and gas development and other environmental perturbations in the four survey subunits. Coding of numbers is explained in text. A = status, B = distribution, C = reproduction, D = abundance, E = seasonality, T = total.

Species	BTEX						MILA						NAFL						MIFL						TOTAL
	A	B	C	D	E	T	A	B	C	D	E	T	A	B	C	D	E	T	A	B	C	D	E	T	
Green Turtle	4	2	4	0	0	10	4	2	2	0	0	08	6	2	4	2	6	20	6	2	6	4	6	24	62
Loggerhead Turtle	4	2	4	0	0	10	4	2	4	0	0	10	4	2	6	4	6	22	4	2	8	4	6	24	66
Kemp's Ridley Turtle	6	6	6	2	0	20	6	6	4	2	0	18	6	6	4	2	0	18	6	6	2	0	0	14	70
Leatherback Turtle	6	2	2	2	2	14	6	2	2	4	2	16	6	2	2	4	4	18	6	2	6	4	4	20	68
Common Loon	0	2	0	0	4	06	0	2	4	2	4	12	0	2	4	6	4	16	0	2	4	2	4	12	46
Horned Grebe	0	2	0	0	0	02	0	2	0	2	4	08	0	2	0	2	4	08	0	2	2	2	4	10	28
Northern Fulmar	0	2	0	0	0	02	0	2	0	0	0	02	0	2	0	0	0	02	0	2	0	0	0	02	08
Cory's Shearwater	0	2	4	2	4	12	0	2	4	0	0	06	0	2	4	0	0	06	0	2	4	4	4	14	38
Greater Shearwater	0	2	2	0	2	06	0	2	2	0	2	06	0	2	4	0	2	08	0	2	4	0	2	08	28
Manx Shearwater	0	2	2	0	2	06	0	2	0	0	0	02	0	2	0	0	0	02	0	2	2	0	2	06	16
Audubon's Shearwater	0	2	4	2	4	12	0	2	4	2	4	12	0	2	4	2	4	12	0	2	6	4	4	16	52
Black-capped Petrel	0	6	0	0	0	06	0	6	0	0	0	06	0	6	0	0	0	06	0	6	2	0	2	10	28
Leach's Storm Petrel	0	2	2	0	2	06	0	2	2	0	2	06	0	2	0	0	0	02	0	2	2	0	2	06	20
Band-rumped Storm Petrel	0	4	2	0	2	08	0	4	0	0	0	04	0	4	0	0	0	04	0	4	2	0	2	08	24
Wilson's Storm Petrel	0	2	2	2	4	10	0	2	2	2	4	10	0	2	2	2	4	10	0	2	2	2	4	10	40
White-tailed Tropicbird	0	2	4	0	2	08	0	2	4	0	2	08	0	2	4	0	2	08	0	2	4	0	2	08	32
Red-billed Tropicbird	0	2	0	0	0	02	0	2	0	0	0	02	0	2	0	0	0	02	0	2	0	0	0	02	08
American White Pelican	0	2	6	6	6	20	0	2	4	2	4	12	0	2	4	0	4	10	0	2	4	2	4	12	54
Brown Pelican	6	2	6	0	6	20	6	2	6	0	6	20	6	2	8	4	6	26	6	2	8	4	6	26	92
Masked Booby	0	4	4	4	4	16	0	4	4	4	4	16	0	4	4	4	4	16	0	4	4	4	4	16	64
Brown Booby	0	4	4	0	4	12	0	4	4	0	4	12	0	4	4	4	6	18	0	4	4	0	4	12	54
Northern Gannet	0	2	4	2	4	12	0	2	4	4	4	14	0	2	4	2	4	12	0	2	4	2	4	12	50
Double-crested Cormorant	0	2	6	2	6	16	0	2	4	2	6	14	0	2	8	6	6	22	0	2	8	6	6	22	74
Magnificent Frigatebird	0	2	4	2	4	12	0	2	2	4	4	12	0	2	8	4	6	20	0	2	4	4	6	16	42
Great Blue Heron	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	64
Little Blue Heron	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	64
Cattle Egret	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	64

Table 64. Continued.

Species	BTEX						MILA						NAFL						MIFL						TOTAL
	A	B	C	D	E	T	A	B	C	D	E	T	A	B	C	D	E	T	A	B	C	D	E	T	
Reddish Egret	0	6	8	6	6	26	0	6	6	6	6	24	0	6	6	6	6	24	0	6	4	2	4	16	90
Great Egret	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	64
Snowy Egret	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	64
Louisiana Heron	0	2	6	4	6	18	0	2	6	4	6	18	0	2	6	4	6	18	0	2	6	4	6	18	72
American Bittern	0	2	2	0	6	10	0	2	6	0	6	14	0	2	6	0	6	14	0	2	6	0	6	14	52
White Ibis	0	6	6	2	6	20	0	6	6	2	6	20	0	6	6	2	6	20	0	6	6	2	6	20	80
Blue-winged Teal	0	2	6	2	4	14	0	2	2	2	4	10	0	2	2	2	4	10	0	2	2	2	4	10	44
Lesser Scaup	0	2	2	2	4	10	0	2	2	2	4	10	0	2	2	2	4	10	0	2	2	2	4	10	40
Surf Scoter	0	2	0	0	4	06	0	2	0	0	4	06	0	2	0	0	4	06	0	2	2	0	4	08	26
Willet	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	64
Red Phalarope	0	2	2	2	4	10	0	2	2	2	4	10	0	2	2	2	4	10	0	2	2	2	4	10	40
Wilson's Phalarope	0	2	0	0	0	02	0	2	0	0	0	02	0	2	0	0	0	02	0	2	0	0	0	02	08
Red-necked Phalarope	0	2	2	2	4	10	0	2	2	2	4	10	0	2	2	2	4	10	0	2	2	2	4	10	40
Pomarine Jaeger	0	2	2	2	2	08	0	2	2	2	2	08	0	2	2	0	2	06	0	2	2	2	2	08	30
Parasitic Jaeger	0	2	2	2	4	10	0	2	2	2	4	10	0	2	2	2	4	10	0	2	2	2	4	10	40
Long-tailed Jaeger	0	4	0	0	0	04	0	4	0	0	0	04	0	4	0	0	0	04	0	4	0	0	0	04	16
Great Black-backed Gull	0	2	0	0	0	02	0	2	0	0	0	02	0	2	0	0	0	02	0	2	4	0	4	10	16
Herring Gull	0	2	4	2	4	12	0	2	4	2	4	12	0	2	4	2	4	12	0	2	4	2	4	12	48
Ring-billed Gull	0	2	4	2	4	12	0	2	4	2	4	12	0	2	4	2	4	12	0	2	4	2	4	12	48
Laughing Gull	0	2	6	2	6	16	0	2	8	2	6	18	0	2	6	2	6	16	0	2	6	2	6	16	66
Franklin's Gull	0	2	4	2	4	12	0	2	4	0	4	10	0	2	0	0	0	02	0	2	0	0	0	02	26
Bonaparte's Gull	0	2	4	0	4	10	0	2	4	2	4	12	0	2	4	0	4	10	0	2	4	0	4	10	42
Black-legged Kittiwake	0	2	0	0	0	02	0	2	0	0	0	02	0	2	0	0	0	02	0	2	0	0	0	02	08
Gull-billed Tern	0	2	8	4	4	18	0	2	6	2	4	14	0	2	0	0	0	02	0	2	0	0	0	02	36
Forster's Tern	0	2	6	2	6	16	0	2	8	6	6	22	0	2	4	2	4	12	0	2	4	2	4	12	62
Common Tern	0	2	4	2	4	12	0	2	6	2	4	14	0	2	4	2	4	12	0	2	4	2	4	12	50
Arctic Tern	0	2	0	0	2	04	0	2	0	0	2	04	0	2	0	0	2	04	0	2	0	0	2	04	16
Roseate Tern	0	4	0	0	0	04	0	4	0	0	0	04	0	4	6	2	4	16	0	4	6	0	2	12	36
Sooty Tern	0	4	6	2	4	16	0	4	6	2	4	16	0	4	8	6	4	22	0	4	6	4	4	18	72

Table 64. Concluded.

Species	BTEX						MILA						NAFL						MIFL						TOTAL
	A	B	C	D	E	T	A	B	C	D	E	T	A	B	C	D	E	T	A	B	C	D	E	T	
Bridled Tern	0	4	4	2	4	14	0	4	4	0	0	08	0	4	4	2	4	14	0	4	6	2	4	16	52
Least Tern	0	2	6	2	4	14	0	2	8	4	4	18	0	2	6	2	4	14	0	2	6	2	4	14	60
Royal Tern	0	2	6	4	6	18	0	2	8	6	6	22	0	2	4	6	6	18	0	2	8	4	6	20	78
Sandwich Tern	0	2	6	2	4	14	0	2	8	6	4	20	0	2	4	2	4	12	0	2	4	2	4	12	58
Caspian Tern	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	0	2	6	2	6	16	64
Black Tern	0	2	4	4	4	14	0	2	4	4	4	14	0	2	4	4	4	14	0	2	4	4	4	14	56
Brown Noddy	0	4	4	0	2	10	0	4	4	0	2	10	0	4	8	4	4	20	0	4	4	0	2	10	50
Black Skimmer	0	2	6	2	4	14	0	2	8	6	6	22	0	2	6	4	6	18	0	2	6	4	6	18	72
Right Whale	6	2	0	0	0	08	6	2	0	0	0	08	6	2	0	0	0	08	6	2	4	4	4	20	44
Minke Whale	2	2	0	0	0	04	2	2	2	0	2	08	2	2	2	0	2	08	2	2	4	4	2	14	34
Sperm Whale	6	2	4	2	4	18	6	2	4	2	2	16	6	2	2	0	2	12	6	2	2	0	2	12	58
Pygmy Sperm Whale	2	2	2	0	2	08	2	0	2	0	2	06	2	2	2	0	2	08	2	2	2	0	2	08	30
Blainville's Beaked Whale	2	2	0	0	0	04	2	2	2	0	2	08	2	2	0	0	0	04	2	2	2	0	2	08	24
Gervais' Beaked Whale	2	2	2	0	2	08	2	2	0	0	0	04	2	2	2	0	2	08	2	2	2	0	2	08	28
True's Beaked Whale	2	2	0	0	0	04	2	2	0	0	0	04	2	2	0	0	0	04	2	2	2	0	2	08	20
Cuvier's Beaked Whale	2	2	0	0	0	04	2	2	0	0	0	04	2	2	2	0	2	08	2	2	2	0	2	08	24
Pygmy Killer Whale	2	2	2	0	2	08	2	2	0	0	0	04	2	2	0	0	0	04	2	2	0	0	0	04	20
False Killer Whale	2	2	2	0	2	08	2	2	0	0	0	04	2	2	0	0	0	04	2	2	4	2	4	14	30
Long-finned Pilot Whale	2	2	0	0	0	04	2	2	0	0	0	04	2	2	0	0	0	04	2	2	0	0	0	04	16
Short-finned Pilot Whale	2	2	4	2	2	12	2	2	4	2	2	12	2	2	2	2	2	10	2	2	4	2	6	16	50
Bottlenose Dolphin	2	2	8	2	6	20	2	2	8	2	6	20	2	2	8	2	6	20	2	2	8	2	6	20	80
Risso's Dolphin	2	2	2	0	2	08	2	2	0	0	0	04	2	2	2	2	6	14	2	2	2	2	6	14	40
Spotted Dolphin	2	6	2	6	6	22	2	6	2	6	6	22	2	6	4	6	6	24	2	6	4	6	6	24	92
Bridled Dolphin	2	6	0	0	2	10	2	6	0	0	2	10	2	6	0	0	2	10	2	6	0	0	2	10	40
Short-snouted Spinner Dolphin	2	4	2	0	2	10	2	4	0	0	0	06	2	4	0	0	0	06	2	4	2	0	2	10	32
Striped Dolphin	2	2	4	0	2	10	2	2	2	0	2	08	2	2	4	2	4	14	2	2	4	2	4	14	46
Spinner Dolphin	2	4	2	0	2	10	2	4	2	0	2	10	2	4	4	0	2	12	2	4	2	0	2	10	42
West Indian Manatee	6	6	0	0	0	12	6	6	0	0	0	12	6	6	8	6	6	32	6	6	8	6	6	32	88

species with a higher total score across all subunits than a related species would be judged to be more vulnerable to environmental hazards in the study area than the latter species. Total scores are less comparable between widely divergent animal groups (e.g., a dolphin and a tern).

Index scores, whether across all subunits or within just one, may not adequately reflect vulnerability of some organisms due to inadequate data available. For example, little is known of the reproductive biology of the Pygmy Sperm Whale or the seasonal occurrence of this species within the study area. Therefore, it received a low score, as did many cetaceans. It is rarely sighted at sea, yet it strands rather frequently, and may be more sensitive to oil and gas effects than the matrix can indicate.

The vulnerability index for populations attempts to assess present conditions within an area and does not reflect historical changes in populations that might influence conservation priorities. For example, the Brown Pelican has been drastically reduced in numbers along the Texas coast. Consequently, the population size was judged to be lower and the reproductive colony smaller in size than in other areas. Such characteristics would usually represent suboptimal habitats of less importance to the survival of the species than those where pelicans were dense. However, pelicans are reduced in Texas because of man's effects on the environment and because of natural conditions. In terms of evaluating the sensitivity of Brown Pelicans to future impacts leading to extinction of the species, the large colonies in Florida and other areas are more important than the already reduced populations in Texas. The vulnerability matrix for populations (Table 64) reflects this difference. However, in terms of protecting species on local or regional levels, the loss of a few Brown Pelicans in Texas would be of greater concern than the same loss in Florida. This distinction is not reflected in the index.

It is necessary to stress that the matrix is designed for comparative purposes only. A total score of 60 for the Magnificent Frigatebird means nothing until it is compared with a score of 48 for the Ring-billed Gull. The difference in values represents a relative difference in the vulnerability of the birds within the study area.

Consideration of all characteristics facilitates evaluation of overall vulnerability of populations. Such information should assist in developing ecological priorities when considering environmental impacts. However, this information should be used with caution due to the limitations of the subjective ranking of objectively determined characteristics. The preceding discussion and accompanying index do not imply that animals in each of the subunits represent distinct populations. However, comparison of characteristics across subunits is valid for management and planning purposes.

The criteria used in evaluating vulnerability for the five population parameters are listed below preceded by the numerical value assigned to each criterion:

A. Status -
    6 Endangered within or near subunit.
    4 Threatened within or near subunit.
    2 Proposed as threatened or endangered within or near subunit or protected by MMPA.
    0 Not endangered or threatened and not protected by MMPA.
B. Distribution -
    6 Distribution of species confined to limited area worldwide.

4 Distribution within United States restricted, but other populations exist in other parts of the world.
2 Ubiquitous or widespread in United States and/or other areas of the world.
0 Species absent or uncommon in subunit and nearby waters.

C. Reproduction -
8 Major reproductive area (on world-wide basis) in or near subunit.
6 Minor reproductive area (on world-wide basis) in or near subunit.
4 Juveniles present in or near subunit.
2 Species occurs, but importance of subunit to reproduction is unknown.
0 Species absent or uncommon in subunit and nearby waters.

D. Abundance -
6 Subunit contains major concentration worldwide.
4 Subunit contains major concentration in U.S. waters.
2 Animals regularly present but not in major concentrations.
0 Species absent or uncommon in subunit and adjacent waters.

E. Seasonality -
6 Present year-round in or near subunit.
4 Present seasonally in or near subunit.
2 Present as transient or for unknown period of time.
0 Absent or uncommon in subunit and nearby waters.

The vulnerability matrix for populations is presented in Table 64.

Vulnerability of Individuals

Another index, limited to bird species, assesses vulnerability of individuals to petroleum contaminants on the basis of attributes of the species (Table 65). King and Sanger (1979) developed a vulnerability index for birds, which facilitated comparisons of species and identified aspects of their behavior, distribution, and ecology that would contribute to their vulnerability to petroleum spills. Water is the primary medium by which petroleum contaminants from OCS activities are dispersed. The vulnerability index for individuals in the Gulf of Mexico and adjacent Atlantic waters was developed to consider the varying degrees of contact birds have with the ocean. Marine mammals and turtles are primarily confined to the ocean whereas birds variously plunge into, rest upon, or nest near ocean waters. Consequently, opportunities for contacting oil in marine waters are similar for mammals and turtles and indices were not calculated.

The information used to assess vulnerability is taken from the literature and summarized in individual species accounts. Several activities are thought to render birds vulnerable to oil: feeding methods, time of feeding, nocturnal and diurnal resting habits, location of the bird during its molt, and seasonal use of the marine environment. The justifications for including these activities are based on varying probabilities of contacting oil in marine waters. Feeding methods affect the degree of contact because some species plunge into the water whereas others may not touch the water except with the tip of the bill. The time of feeding influences the light available and may affect the ability of the bird to detect and avoid the petroleum present. The sites where birds rest during the night and during the day are separated due to possible differences in being able to detect or avoid petroleum under varying light conditions. Variation in the molting of feathers possibly affects the ability to avoid or survive oiling. The degree of use of marine habitats also influences the probability that an individual will contact

Table 65. Index of the vulnerability of marine bird species to floating oil. Coding of numbers is explained in text. Dash means no data available.

Species	Feeding method	Time of feeding	Daytime resting	Nocturnal resting	Molt	Seasonal use of marine habitat	Total
Common Loon	8	0	6	8	8	4	34
Horned Grebe	8	0	6	8	4	4	30
Northern Fulmar	6	0	6	8	0	6	26
Cory's Shearwater	6	2	6	8	0	6	28
Greater Shearwater	8	2	6	8	0	6	30
Manx Shearwater	8	2	6	8	0	6	30
Audubon's Shearwater	8	2	6	8	0	6	30
Black-capped Petrel	6	4	6	8	0	6	30
Leach's Storm Petrel	2	2	6	8	0	6	24
Band-rumped Storm Petrel	2	2	6	8	0	6	24
Wilson's Storm Petrel	6	2	6	8	0	6	28
White-tailed Tropicbird	6	0	6	8	0	6	26
Red-billed Tropicbird	6	0	6	8	0	6	26
American White Pelican	6	0	6	6	0	4[a]	22
Brown Pelican	4	0	6	6	0	6	22
Masked Booby	4	0	6	8	0	6	24
Brown Booby	4	0	2	2	0	6	14
Northern Gannet	8	0	6	8	0	6	28
Double-crested Cormorant	8	0	4	6	0	6	24
Magnificent Frigatebird	2	0	2	2	0	6	12

Table 65. Continued.

Species	Feeding method	Time of feeding	Daytime resting	Nocturnal resting	Molt	Seasonal use of marine habitat	Total
Great Blue Heron	6	0	4	2	0	6	18
Little Blue Heron	6	0	2	2	0	6	16
Cattle Egret	0	0	2	2	0	0	04
Reddish Egret	6	0	4	2	0	6	18
Common Egret	6	0	2	2	0	6[a]	16
Snowy Egret	6	0	2	2	0	6[a]	16
Louisiana Heron	6	0	2	2	0	6[a]	16
American Bittern	0	2	2	2	0	2	08
White Ibis	6	0	4	6	0	6[a]	22
Blue-winged Teal	6	0	6	8	4	2	26
Lesser Scaup	8	0	6	8	4	4	30
Surf Scoter	8	0	6	8	4	4	30
Willet	6	0	4	6	0	6[a]	22
Red Phalarope	6	0	6	8	0	4	24
Wilson's Phalarope	6	0	6	8	0	4	24
Red-necked Phalarope	6	0	6	8	0	4	24
Pomarine Jaeger	0	0	6	8	0	4	18
Parasitic Jaeger	0	0	6	8	0	4	18
Long-tailed Jaeger	0	0	6	8	0	4	18
Great Black-backed Gull	6	0	6	8	0	6	26

Table 65. Concluded.

Species	Feeding method	Time of feeding	Daytime resting	Nocturnal resting	Molt	Seasonal use of marine habitat	Total
Herring Gull	6	0	6	6[b]	0	6	24
Ring-billed Gull	6	0	6	6	0	6	24
Laughing Gull	6	0	6	6	0	6	24
Franklin's Gull	-	2	6	6	0	2	16
Bonaparte's Gull	6	0	6	8	0	4	24
Black-legged Kittiwake	4	0	6	8	0	6	24
Gull-billed Tern	2	0	2	2	0	6[a]	12
Forster's Tern	4	0	4	6	0	6[a]	20
Common Tern	4	0	4	6	0	6[a]	20
Artic Tern	4	0	4	6	0	6[a]	20
Roseate Tern	4	0	4	6	0	6[a]	20
Sooty Tern	0	0	0	0	0	6	06
Bridled Tern	2	0	4	6	0	6	18
Least Tern	4	0	4	6	0	6[a]	20
Royal Tern	4	0	6	6	0	6	22
Sandwich Tern	4	0	4	6	0	6	20
Caspian Tern	4	0	4	6	0	6[a]	20
Black Tern	2	0	4	6	0	4	16
Brown Noddy	2	2	4	6	0	6	20
Black Skimmer	2	2	4	6	0	6	20

[a] some populations utilize marine environment year-round, others do not.

[b] segment of population rest on water at night.

petroleum. The rating for each criterion was subjective, based on reports of how oiling can occur. An excellent review on the subject was presented by Bourne (1976).

The vulnerability index for individuals can be used in several ways. The total value can be used to compare species to determine relative vulnerability of individuals. For example, Common Loons have a higher vulnerability score and apparently are more vulnerable to an oil spill than Laughing Gulls. The individual columns can be used to determine which species would be most likely to contact oil during feeding, nocturnal nesting, or during temporary spills.

This index should be used with caution. The total values, themselves, mean little unless compared with the other totals in this index. Values from this index are not comparable with the vulnerability index for populations, but species with high ratings in both indices warrant specific management concern.

The vulnerability of individuals of seabirds to petroleum spills was evaluated using the following criteria and associated numerical scores:

A. Feeding method -
    8 Swims underwater.
    6 Swims or wades at surface while feeding.
    4 Plunges into water.
    2 Dips into water.
    0 Rarely or does not touch feathers to water while feeding.
B. Time of feeding -
    4 Largely nocturnal.
    2 Crepuscular, or variable.
    0 Largely diurnal.
C. Daytime resting -
    6 On the water.
    4 On floating boards or near surfline on beaches.
    2 On high ground, trees, structures.
    0 In the air.
D. Nocturnal resting -
    8 On water.
    6 On floating boards or near surfline on beaches.
    2 On high ground, trees, structures.
    0 In the air.
E. Molt -
    8 Flightless molt period on water.
    4 Flightless period on land.
    0 No flightless period.
F. Seasonal use of marine habitat -
    6 All year.
    4 More than half of the year.
    2 Less than half of the year.
    0 None of the year.

MARINE TURTLES

Little research has been conducted to study the effects of petroleum on marine turtles (Hall 1980; Frazier 1980). Fritts and McGehee (1981) studied the survival and development of marine turtle embryos when eggs were exposed to sand contaminated with petroleum. The results showed that fresh crude oil caused developmental anomalies and mortality, and that petroleum residues that are weathered are less harmful to developing embryos. Studies have not been performed on the sensitivity of turtles in water to petroleum, but Witham (1978) recorded juveniles of Loggerhead and Green Turtles which were distressed or had died because of petroleum fouling. In some instances turtles had petroleum globules in the mouth and esophagus, suggesting that active ingestion had occurred. Most marine turtles apparently confuse plastic materials floating in the ocean with food items (see review by Mrosovsky 1981; Fritts in press). It appears that plastic sheets and bags and oil globules resemble jellyfish and other medusae enough to be actively ingested by marine turtles. The United States produces one third of the world's litter in oceans (NAS 1975); thus, the problem with plastic and other trash is potentially greatest in U.S. waters.

Hall (1980) suggested that mortality of Green and Kemp's Ridley Turtles occurred as a result of the IXTOC oil spill in the western Gulf of Mexico. However, details are not available on the extent and actual cause of this mortality. It is relevant that even though petroleum was obvious in waters near Rancho Nuevo in 1980, none of the females of Kemp's Ridley that were observed nesting from 20 to 26 June had oil on the carapace, head, or limbs (T. H. Fritts field notes June 1980).

Lights from OCS structures may adversely affect turtles. The detrimental effects of lights near nesting beaches are well known. McFarlane (1963) and Mann (1978) demonstrated that lights near nest sites caused the disorientation of hatchlings and often resulted in turtles not reaching the ocean. Mrosovsky and Shettleworth (1968) showed how neonate turtles orient to the ocean using reflected light from the water, but the response to lights after the young are in the water is less clear. Nesting females may be disturbed by moving lights and human activity on the beach (see review in Frazier 1980), but intense lighting and beach development does not preclude turtle nesting (Mann 1978).

Bustard (1973) and Ridgeway et al. (1969) suggested that marine turtles were sensitive to low-frequency sound and were capable of responding to sound waves conducted by soil and water. Nothing is known about the response of marine turtles to sounds produced by OCS drilling and boat traffic. During this study, turtles often appeared to dive in response to the approach of the aircraft, but it was unclear whether they detected the aircraft by sound or sight.

The toxic and physiological effects of ingestion of petroleum directly or in food items are unknown for marine turtles (see discussion by Frazier 1980). The aquatic plants consumed by Green Turtles, and to a less extent by other marine turtles, are susceptible to being fouled by petroleum settling to the floor of shallow waters. Kemp's Ridley Turtle and the Loggerhead Turtle feed primarily on crustaceans and molluscs, which concentrate hydrocarbons and other marine contaminants (NAS 1975; Hodgins et al. 1977). Hendrickson (1980) noted that Leatherback Turtles feed primarily on coelenterates, which in turn feed on nanoplankton. This food web differs from the web leading to crustaceans and molluscs, and may respond differently to environmental contaminants (Frazier 1980).

Turtles are long-lived animals and accumulate heavy metals, PCB's, and metabolities of pesticides (Hillestad et al. 1974; Thompson et al. 1974, cited by Frazier 1980), although to date, attempts have not been made to measure chronic ingestion of petroleum contaminants by marine turtles.

The life histories of marine turtles are poorly known (see reviews by Carr 1980 and Witham 1980). The lack of information on the habitats, foods, and growth rates of neonates and juveniles is a critical void. Consequently, the detection of oil-related problems and their differentiation from other problems are difficult. Young turtles may occur in deep waters, passively moving with their food sources and dominant currents (Witham 1980), or they may forage on the bottom in shallow coastal waters, as suspected for at least some age groups of Kemp's Ridley Turtles (Carr 1980). The actual habitat used could determine to what degree juvenile marine turtles come in contact with petroleum in the ocean.

The results of the present study and those of Shoop et al. (1981) provide several facts about marine turtles that are important in evaluating petroleum effects. A discussion of these findings follows.

Nearly all marine turtles encountered were on the continental shelf (i.e., in waters of less than 200 m). The correlation between the area of the continental and the area of turtle habitat was particularly marked in southern Texas and eastern Florida, where the narrowness of the shelf appeared to limit the distribution of turtles to a narrow band along the coast. Even the Leatherback Turtle, frequently considered a pelagic species, was largely confined to coastal waters. It is these inshore and nearshore waters that are most suitable for oil and gas development and that will receive the largest quantities of petroleum contamination due to exploration, production, and transportation of petroleum products.

Marine turtles are much less common in waters off Louisiana and Texas than off eastern and western Florida. Clearly marine turtle populations in the western Gulf of Mexico are extremely reduced (Hildebrand 1979; Pritchard and Marquez 1973). Hildebrand (1979) presented evidence that primary habitats and concentrations of Kemp's Ridley Turtle once occurred off Louisiana from Marsh Island to the Mississippi River Delta, and in the Bay of Campeche between Chupilco, Tabasco, and Champoton, Campeche, Mexico. The reason for the decline of ridleys and other turtles in the western Gulf of Mexico is unclear. The mortality of marine turtles in the western Gulf of Mexico appears to be significantly higher than in eastern waters perhaps partially as a result of incidental catch by shrimp trawlers (see discussion in Loggerhead Turtle Species Account). Further population reductions in the western Gulf could mean the extinction of Kemp's Ridley Turtle and the elimination of other species from the area.

If winter dormancy is widespread, dormant turtles buried in bottom sediments in winter may be particularly vulnerable to petroleum settling on the ocean's floor. Turtles that migrate out of the study area in winter may decrease their vulnerability to oil.

The small dark turtles in extreme inshore waters of East Florida during June may have been juvenile Kemp's Ridley Turtles. The sightings during this study were in coastal waters west of the western boundary of the Gulf Stream. The distinction of being in the Gulf Stream and being adjacent to it is important in evaluating the movements, feeding habitats, and vulnerability of young Kemp's Ridleys. These sightings are yet another suggestion that the shallow waters of the Atlantic coast of the United States are a part of the normal range of this species as reported by Carr (1980). Other workers, such as Hildebrand (1979) and Hendrickson (1980), have suggested that ridleys outside the Gulf are lost to the reproductive population as wayward juveniles at the mercy of currents. Consequently, any information on the location, habits, and seasonality of young Kemp's Ridley Turtles will be important to subsequent study of their survival in relation to environmental contaminants and OCS activities.

Whether oil and gas activities in the OCS are affecting the decline and preventing the recovery of marine turtles can only be determined by detailed examination of life history information and subsequent direction of research toward specific life stages, habitats, and conditions under which populations are most influenced.

MARINE BIRDS

Marine birds are more conspicuously affected by petroleum than other marine groups. However habits differ and species or groups of species are affected to varying degrees. Variables include the amount of time spent on the water, prey species, feeding strategies, proximity of nesting sites, and the tendency to roost on the water.

The effects of OCS development on marine birds include direct disturbance, habitat alteration, fouling and assimilation of petroleum. Disturbance results from marine and air traffic, seismic testing, and drilling and could disrupt the normal behavior of marine birds, especially while they rest or feed at sea. Habitat alteration occurs where OCS structures are erected and where OCS activities alter the normal distribution of prey species. Contact with petroleum is the most important impact of OCS development. These effects include oiling of plumage, ingestion of oil, and the contamination of nests, burrows, eggs, and nestlings with oil. Behavior of a species determines the relative likelihood of oiling.

Direct oiling of a bird's plumage usually results in reduced bouyancy and loss of insulation from extreme temperatures (Hartung 1967). Death often results from exposure or exhaustion caused by the increased energy expenditure required for the bird to stay afloat or maintain body temperature (Hartung 1967). Birds often suffer from oil ingested while preening oiled feathers or eating oiled prey. Respiratory and gastro-intestinal irritation, nervous disorders, pulmonary congestion, fluid and electrolyte loss, and absorption of toxic materials leading to organ damage have been attributed to oil ingestion (Bourne 1976).

Sublethal damage as a result of oil ingestion renders birds less likely to survive stressful situations. Hydrocarbons are likely to be stored in the fat and are metabolized only during periods of low food abundance (Hartung and Hunt 1966). Oil carried to the nest often fouls the nest and eggs or young. Oiled eggs and young are often stressed, reducing hatching and fledging success (Miller et al. 1978; White et al. 1979).

The effects of OCS development on populations of different bird species in the study area vary according to the status, distribution, and habits of the species. The species within a family often possess similar morphologies and behaviors; thus, they are often similarly affected by OCS development. For this reason, the following discussion of OCS effects on marine birds seen during this study is organized by family.

The Loons: Gaviidae

The Common Loon is seasonally susceptible to severe effects from OCS development (Tables 64 and 65). The loon is especially vulnerable to spilled oil (Bourne 1976) because it has difficulty taking flight, spends most of its time on the water, and dives for fish. These factors reduce its ability to avoid oil. About 500 loons died as a result of an oil spill from the Delian Appolon in Tampa Bay, reducing the winter population size for several years (Clapp et al. 1982). Based on this information, special consideration for this species should be directed toward the NAFL subunit where large numbers were seen in winter. Bioaccumulation of hydrocarbons is also a potential threat where Common Loons feed near areas of gas and oil development.

The Shearwaters and Petrels: Procellariidae

Most members of this group vary in their abundance seasonally in the study area. Feeding habits vary. The Northern Fulmar, Cory's Shearwater, and Black-capped Petrel feed at the surface, while the Greater Shearwater, Manx Shearwater, and Audubon Shearwater tend to dive beneath the surface for fish. The latter species are therefore more susceptible to oiling. Greater Shearwaters were seen in low numbers irregularly. The Audubon's Shearwater comonly occurs in the study area year-round and nests near the study area, making it the most susceptible species of the group to petroleum effects (Table 65). Few records of oiling are available for the Audubon's Shearwater, but its distribution far from shore may decrease the possibility of finding oiled birds. Transportation of oil to nestlings is possible. These birds were frequently associated with sargassum and current boundaries. Oil often is concentrated at current boundaries, thus increasing the chances for bio-accumulation of hydrocarbons.

The Storm Petrels: Hydrobatidae

Of the three species that occur in the study area, only Leach's Storm Petrel is known to have been fouled by oil (Clapp et al. 1982). However, habits are similar, and all petrel species are equally susceptible. The pelagic distribution of these species may cause oiled birds to go undetected. Wilson's Storm Petrel is the most abundant species of this group in the study area and therefore is most likely to come into contact with petroleum. Storm petrels congregate over convergences where food as well as pollutants are concentrated (Frazier 1980). Small predatory fish in the sargassum community assimilate petroleum hydrocarbons up to 20 times as concentrated as ambient sargassum (Frazier 1980). Storm petrels are noted for accumulating high levels of chlorinated hydrocarbons (Bourne 1976). Chronic low level exposure to hydrocarbons may be the greatest effect OCS development will have on these species (Table 65).

The population of storm petrels within the study area is so small that OCS activities in the Gulf of Mexico and in adjacent waters of the Atlantic Ocean probably will have little impact on the world population (Table 64).

The Tropicbirds: Phaethontidae

Few tropicbirds were seen during aerial surveys. Their pelagic distribution reduces the likelihood of impacts in the study area. Oiled White-tailed Tropicbirds have been reported from Bermuda (Wingate 1978). Their habit of plunging from the air after fish and squid makes them susceptible to direct oiling.

The Pelicans: Pelecanidae

Because of its plunging feeding habits and coastal distribution, the Brown Pelican is highly susceptible to direct oiling. Two Brown Pelicans were killed as a result of a small oil spill in Corpus Christi, Texas (King et al. 1979). Small spills are common in the western Gulf of Mexico (Gallaway 1981), and most mortality resulting from such spills probably goes unnoticed. Oil contamination of nests and eggs by adults is also a potential hazard, especially in Florida (Table 65). The accumulation of pollutants in Brown Pelicans is well documented. Contaminated food may poison birds directly or impair their reproductive capacity (Sowls et al. 1980), as it did in Louisiana from 1950 to 1963. The Brown Pelican nests extensively along the coasts in the study area, consequently nest sites are vulnerable to disruption by onshore activities and support facilities. Population levels of an endangered species like the Brown Pelican are extremely susceptible to further disturbance of reproduction and maintenance. As a result, Brown Pelicans are among the most vulnerable of marine birds in the study area (Tables 64 and 65).

The American White Pelican is largely a winter visitor in the study area and most nesting is outside the study area, although nesting colonies are present on the South Texas coast. Oiling and accumulation of chronic low levels of hyrocarbons are still potential hazards to White Pelicans in coastal areas.

The Gannets and Boobies: Sulidae

The sulids' habit of diving into the water from the air for fish makes them especially vulnerable to direct oiling. During the IXTOC oil spill, eight oiled Masked Boobies washed up on Texas shores (see review by Duncan and Havard 1980). More undoubtedly died but were undetected because of their pelagic distribution (Chapman 1979). Bird mortality data are unavailable for areas adjacent to the spill. An estimated 800 Masked Boobies could have been affected by the IXTOC spill, representing a significant portion of the population in the Gulf of Mexico (see review by Duncan and Havard 1980).

Masked Boobies nest near the Yucatan Peninsula in the eastern Gulf of Mexico, and in the Caribbean Sea (Clapp et al. 1982). Near nesting areas, sulids may contact oil while gathering seaweed for nesting material (Jouanin 1967, cited by Bourne et al. 1978).

Brown and Masked Boobies may be attracted to OCS structures (Clapp et al. 1982). During this study, Brown Boobies were seen perched on the support structure of a beacon in nearshore waters. If boobies become regular visitors to gas and oil platforms, bioaccumulation of hydrocarbons in these birds could pose a serious threat. Signs of eggshell thinning have been discovered for gannets breeding in the Gulf of St. Lawrence (Pearce et al. 1973, cited by Nelson 1978a).

The Cormorants: Phalacrocoracidae

The Double-crested Cormorant, which is the most common cormorant seen in the study area, inhabits coastal waters and feeds on fish. Cormorants are highly susceptible to local oil spills (Bourne 1976). High levels of stored chlorinated hydrocarbons have also been discovered in cormorants (Bourne 1976), making effects of chronic exposure to petroleum derivatives potentially hazardous. Cormorants nest in the study area and oil can be transported to the nest, causing decreased reproductive success. Nesting can be disrupted by land-based support operations of OCS development, causing eggs and nestlings to be abandoned or exposed to environmental extremes. Cormorants are among the most vulnerable of marine birds in the study area (Tables 64 and 65).

The Frigatebirds: Fregatidae

The Magnificent Frigatebird is the only frigatebird frequently seen in the study area. It rarely gets its feathers wet, even while feeding, and therefore it should be minimally susceptible to direct oiling (Tables 64 and 65). Its diet of fish does make it susceptible to accumulations of hydrocarbons, and ingestion of oiled prey. The only nesting colony in North America is within the study area on the Marquesas Keys, near future OCS lease sites off Southwest Florida. OCS pollution in that area would likely contaminate prey, which could influence reproductive success. Support activities, especially aircraft, could disrupt nesting. Disturbed frigatebirds at nesting sites have been reported to injure themselves and dislodge eggs and nestlings from the nest while trying to flee (Bent 1922).

The Phalaropes: Scolopacidae

Three species of phalaropes occur seasonally (February to April) in the study area; and two of these, the Red and Red-Necked Phalaropes, spend much of their time at sea. Phalaropes are noted for feeding on plankton along current boundaries and convergences, where Frazier (1980) indicated pollutants are often concentrated. Phalaropes are expected to accumulate organochlorines; but only one such analysis has been performed, and levels were not high (Bourne 1976). Phalaropes do not nest in the study area. King and Sanger (1979) rated Red-necked and Red Phalaropes among the most vulnerable of the shorebirds in the eastern North Pacific Ocean. This group is of special concern because of its potential for accumulating contaminants from feeding situations.

The Jaegers: Laridae

The jaegers occur at sea in the study area during non-nesting periods. All three species roost on the water and therefore are susceptible to direct oiling. Clapp et al. (1982) reported three records of oiling in the Pomarine Jaeger. Other instances have probably gone undetected because jaegers occur well offshore. Since jaegers scavenge for food and feed at the surface, they may be susceptible to ingestion of oil-fouled prey and carrion. Nesting is extralimital to the study area. Although local numbers may be affected by OCS development in the study area, influences on the worldwide populations would be minimal.

The Gulls and Terns: Laridae

Eighteen species of gulls and terns were identified over marine waters in the study area. Many species are migratory or seasonal: the Ring-billed Gull, Franklin's Gull, Bonaparte's Gull, Black-legged Kittiwake, Bridled Tern, and Black Tern. The Great Black-backed Gull, Herring Gull, Laughing Gull, Gull-billed Tern, Forster's Tern, Common Tern, Roseate Tern, Sooty Tern, Least Tern, Royal Tern, Sandwich Tern, and Brown Noddy can be found in the study area throughout the year and nest in at least a portion of the study area. They constitute the majority of marine birds in the study, and impacts of OCS development should affect greater numbers of gulls and terns than any other group.

Gulls and terns feed at the surface of the water or just beneath it by aerial plunging and commonly roost along the shore on sand bars, in estuaries, and in bays. Some of the gulls roost overnight on the water. These habits make them susceptible to direct oiling. During the IXTOC spill, Royal Terns sitting along the high tide line on Texas beaches were heavily oiled (Chapman 1979). The species (especially the terns) that nest in the study area may suffer from oiled nests, eggs, and nestlings, as well as disruption of breeding sites by increased OCS activity and habitat loss. Many species are scavengers; others feed primarily on fish. These habits make them susceptible to ingestion of oiled prey or carrion and accumulation of hydrocarbons found in fishes. Hazards resulting from accumulation may be compounded, because gulls and terns tend to roost and perch on OCS structures and feed on contaminated fish that congregate around the structures. Some species will suffer to a greater extent than others (Table 64 and 65), but OCS development in the study area will probably impact this group more than any other.

The Skimmers: Laridae

The Black Skimmer breeds in the study area and feeds in coastal waters, bays, and estuaries by skimming the lower bill along the surface of the water. It also roosts near the water's edge. Because of these habits, the Black Skimmer is susceptible to direct oiling, ingestion of oiled prey, accumulation of hydrocarbons, and reduced reproductive success due to contamination of nests, eggs, and nestlings.

MARINE MAMMALS

Knowledge of the effects of OCS oil and gas activities on marine mammals is important to the conservation and management of these animals as required by the MMPA and ESA. Geraci and St. Aubin (1980) presented a detailed review of potential effects of oil development on marine mammals. They pointed out that few scientific data exist, and that for cetaceans, we are presently limited to information from field observations, news accounts, and intuitive comparisions with other mammalian groups.

The major impacts on individual animals considered by Geraci and St. Aubin (1980) included shock waves, noise, collisions, and oil contamination. It should be noted that Geraci and St. Aubin focused only on individual effects and did not extend their discussion to effects on populations.

Shock Waves

Although the evidence available was limited, Geraci and St. Aubin concluded that the effects of seismic tests were a function of the distance from the test site, the nature of the shock wave generated, the size of the animal, and the nature of the site where the test was to be performed. Seismic exploration using explosives was considered most threatening, but the examples cited involved work in 1948 with obsolete techniques and an underground nuclear test in Alaska. Elsewhere blasting may have been responsible for the death or strandings of Minke Whales, beaked whales, pilot whales, and Pygmy or Dwarf Sperm Whales (FAO 1978).

Noise

The effects of noise can be divided into two basic types: physiological damage and behavioral responses. Acoustic confusion and disorientation have been listed as causes of cetacean strandings (see review by Wood 1979). Geraci and St. Aubin reviewed the physiological basis for effects of low frequency noise from petroleum activities. The behavioral responses to noise are variable depending upon species, age, activity, and ecological situation. The behavioral responses to noise may affect group structure and local populations by causing interference with communication between group members, mother-calf pairs, and isolated individuals. Navigation and feeding may also depend upon sound reception and be affected by high levels of artificial ambient noise. Consequently, the overall long-term effects of noise are potentially complex and important.

Collisions

The injury and mortality of animals as a result of collisions with ships, small craft, and structures in marine waters are not limited to OCS activities. The most important consideration is the frequency with which such collisions occur in relation to population levels, age structure, and other factors. The West Indian Manatee is particularly vulnerable to collisions with surface craft primarily because of its preference for shallow waters (Brownell et al. 1980). The number of boats, the speed at which they move, the preferred habitat, and the behavior of the West Indian Manatee all contribute to the exceptional threat of collisions to the endangered population of this species in the southeastern United States (Table 64). The concentrations of manatees in coastal and estuarine waters of southwestern Florida (Irvine and Campbell 1978; Irvine et al. 1981) create a special environmental concern about possible effects of OCS development in the eastern Gulf of Mexico.

Petroleum Contaminants

Most examples of oil contamination affecting marine mammals cited by Geraci and St. Aubin (1980) involved pinnipeds and sea otters. Both of these groups are absent from the study area. However, physiological, morphological, and behavioral differences exist between these animals (pinnipeds and otters) and cetaceans that restrict extrapolation of known effects from one group to the other. Cetaceans lack hair and do not depend upon a hair coat for insulation. Also the smooth skin of cetaceans does not provide as suitable a substrate as hair for oil adhesion (Geraci and St. Aubin 1980). Oil on the skin of a cetacean would be harder to detect than in the matted hair of other mammals even in stranded specimens, and special attention should be given to examining stranded cetaceans for oil.

Most petroleum spills occur in waters on the continental shelf. Consequently, those marine mammals occurring regularly on the shelf are most likely to contact petroleum (Table 64). Although the Bottlenose Dolphin is the most abundant and widespread mammal in continental shelf waters of the southeastern United States, especially in coastal areas, dolphins of the genus Stenella (Spinner, Spotted, and Striped Dolphins) are also present and could occur in proximity to oil spills. Bottlenose Dolphins sighted in this study were restricted to the continental shelf, and consequently the survival of local and regional populations is potentially subject to catastrophic oil spills.

Although long-term effects of oil spills and pollution on cetaceans are still unknown, some evidence indicates that direct effects may not be as great as indirect effects. Bottlenose Dolphins in Texas moved through dense patches of recently spilled oil without obvious ill-effects (Shane and Schmidly 1978; Gruber 1981). Four groups of Bottlenose Dolphins were sighted in or adjacent to oil slicks during the present study. These, however, are the only known sightings of small cetaceans in oil slicks. During the massive oil spill in the Santa Barbara Channel, California, cetaceans were not known to be affected (Brownell 1971). However, contamination of the water column influences cetaceans. The numbers of Bottlenose Dolphins in San Diego Bay, California, and Biscayne Bay, Florida, were significantly reduced as a result of urban development and general pollution (Odell 1976; FAO 1978). The populations in San Diego increased after pollution levels were reduced (FAO 1978). Numbers of Bottlenose Dolphins in the North Sea appear to be reduced because of pollution affecting food resources (Mitchell 1975a; FAO 1978).

The inshore Bottlenose Dolphin population in the southeastern United States consists of a number of subpopulations with relatively discrete ranges (Asper and Odell 1980; Shane 1980; Irvine et al. in press). It is unknown whether a local dolphin herd (Wells et al. 1980), would remain in an area contaminated by a petroleum or chemical spill. The behavioral and ecological consequences of movement into the range of adjacent herds to avoid petroleum are also unclear. Herd dislocations could produce subtle changes in social structure, which would not be reflected in population size for years. Such changes would not be discernable without detailed study.

Striped and Spinner Dolphins (Stenella coeruleoalba and S. longirostris, respectively) occur in deeper waters of the shelf and also range into waters over the continental slope and beyond. If a primary effect of a petroleum spill is degradation of food resources, the Bottlenose Dolphin is more susceptible to such effects than the Stenella spp., which forage widely in deeper waters (Table 64).

As air-breathing vertebrates, marine mammals repeatedly surface. This activity potentially brings them in contact with floating oil, which may adhere to nasal passages, eyes, and the oral area. Whether cetaceans can perceive oil using sonar or visual cues is unknown. The ability to avoid floating oil is, in part, limited by the quantity and nature of the oil as well as the conditions in which it is encountered.

Ingestion of oil will vary widely between species. The species that feed in benthic environments by routing in silt or mud to expose prey may ingest larger amounts of hydrocarbons because a wide variety of petroleum components settle and aggregate in benthic environments (NAS 1975). Contamination of organisms and sediment may be additive over a long period. The presence of hydrocarbons in benthic organisms has been related to the presence of such hydrocarbons in nearby sediments (NAS 1975). Sperm Whales, Pygmy Sperm Whales, and Risso's Dolphins feed on benthic organisms and therefore may be particularly vulnerable to ingestion of oil while feeding.

Most odontocetes (toothed whales) feed on fish, molluscs, and crustaceans in the water column. The ingestion of petroleum components by most toothed whales is not likely, except in play activities and as contamination in food species. Dolphins that feed on fish concentrated near oil and gas structures, and on offal from shrimp trawls near OCS structures, are most likely to ingest fish with elevated hydrocarbon concentrations. Such fish may have higher parasite loads, bacterial infections, and other maladies associated with hydrocarbon pollution; but such factors may not affect marine mammals except under extreme conditions.

Ingestion of petroleum suspended in the water column and floating on the surface is most probable for the mysticetes (baleen whales). The large quantities of water that are filtered by these large whales during feeding may contain petroleum. It is doubtful that sufficient petroleum would be ingested to cause death, but fouling of baleen plates, irritation of buccal membranes, and disruption of absorption of nutrients is likely.

Geraci and St. Aubin (1980) mention the unique skin morphology of cetaceans. Whether differences in sensitivity to petroleum exist between species is unknown. It is likely that the reaction to volatile and refined petroleum products spilled in transport would be more severe than the reaction to crude oil.

CONCLUSIONS

During this study, 88 species were recorded, including 4 species of marine turtles (2,282 individuals), 34 species of marine birds (59,112 individuals), and 15 species of marine mammals (9,369 individuals). Thirty-five species of migratory or land-based birds were also seen.

The most abundant marine turtle in the study area was the Loggerhead Turtle. The 2,009 individual Loggerheads encountered provide a perspective of this species at sea. Loggerheads are largely restricted to continental shelf waters except when migrating. They are present and active in the study area year-round although activity during winter may be reduced. Large numbers occur in the eastern Gulf of Mexico even though major nesting beaches do not exist on adjacent beaches. Loggerheads are rare in the western Gulf of Mexico where most OCS oil and gas activity is centered, but causal factors have not yet been determined. Loggerheads spend time floating at the surface apparently basking. The population of Loggerheads nesting on beaches of the Southeastern United States and occupying adjacent marine habitats is a major one on a world-wide basis.

Other sea turtles seen were the Leatherback Turtle (48 individuals), Kemp's Ridley Turtle (12 individuals), and Green Sea Turtle (11 individuals). The Leatherback was most abundant in nearshore waters off eastern Florida in August.

Of the few individuals of Kemp's Ridley Turtle recorded, most were off Southwest Florida suggesting that the eastern Gulf of Mexico may be an important area for this critically endangered turtle.

The lack of information on the distribution, habits, and sources of mortality for juvenile marine turtles is a major obstacle to evaluation of oil and gas impacts on marine turtles. Research is needed which addresses the ecology of marine turtles away from nesting beaches.

The present low populations of all marine turtles except Loggerheads in the Gulf of Mexico are of special importance in considering environmental effects of oil and gas. Even though oil and gas are not known to have caused the decline of these populations, additional declines could have severe consequences.

Marine birds accounted for nearly 85% of all animals encountered. The majority of the marine birds seen was gulls and terns (89%, 52,840 individuals). Within this group, the most abundant species were the Laughing Gull (9,511 individuals), Bonaparte's Gull (6,483 individuals), Royal Tern (6,031 individuals), and Herring Gull (4,243 individuals). Several species of gulls and terns were seen less commonly even though they were important elements of the bird fauna. Gulls and terns are important subjects for studies of oil and gas impacts on birds because they are abundant, they employ various surface feeding strategies, and they show varying degrees of dependency on marine habitats.

Pelicans and their allies constituted 7% of all marine birds. Brown Pelicans were abundant in Florida waters where they feed in both inshore and nearshore waters. The endangered Brown Pelican is of special concern in the western Gulf where populations are already low due to contaminants.

The shearwaters and petrels accounted for 3% of the marine birds seen. They made up a larger portion of the marine bird fauna in Atlantic waters than they did within the Gulf of Mexico.

The impact of oil and gas activities on birds in OCS areas will depend to a large extent on the habits of the individual species and on a variety of characteristics of local populations.

Of the cetaceans, the Bottlenose Dolphin was most abundant (3,567 individuals); it was present in every survey subunit and in every month. Bottlenose Dolphins are suitable for future studies of petroleum impacts because they are abundant and widely distributed in coastal areas where contact with oil spills and other aspects of petroleum production are most likely to occur.

The Short-finned Pilot Whale (824 individuals), Spotted Dolphin (1,032 individuals), and Striped Dolphin (866 individuals) were relatively common, although the pilot whales were not seen in all subunits. The Sperm Whale, Risso's Dolphin, and Spinner Dolphin occurred in moderate numbers and were recorded in the Western Gulf of Mexico where they were previously unknown or poorly documented.

Of the endangered cetaceans, only the Sperm Whale is present regularly in the Gulf of Mexico. Sperm Whales are largely restricted to deep waters beyond the continental shelf where impacts of petroleum may be minimal.

Of the species identified in this study, several are so poorly known that their status, distribution, and ecology cannot be evaluated adequately. These species include the Beaked Whales, Pygmy Sperm Whale, Pygmy Killer Whale, and False Killer Whale. The inability to consistently distinguish several species of dolphins (Stenella spp.) also limits assessment of this group from aircraft.

The ability to evaluate impacts of oil and gas development on the fauna of OCS areas is limited by the lack of information on the biology of individual species. Only by increasing our knowledge of marine faunas will the most important research directions be identified. The data and conclusions from this study area cover selected areas over a short-time interval. In order to define even major environmental impacts on marine vertebrates additional research will be needed.

The physiological and toxicological reactions of vertebrates (especially cetaceans and marine turtles) to petroleum remain speculative. The ability of researchers and managers to define all possible toxicological limits and long-term responses to the myriad of components in petroleum at present is doubtful. The ability of investigators to obtain adequate experimental animals from representatives of the diverse marine vertebrate fauna is hampered by logistic expenses, populations sizes, and regulatory barriers. Until specific problems are identified concerning ingestion of oil and other oil effects, our knowledge of individual effects must necessarily be based on material obtained from strandings and detailed study of accidental spills.

The monitoring of the overall status and ecological vulnerability of marine turtles, birds, and mammals remains the most basic approach to environmental assessment of these poorly known groups. Such population studies measure the health of populations and not individuals. These studies potentially identify problems by focusing on measures of abundance, group size, relative age structure, and distribution. These attributes vary widely when environmental alteration affects local demes and populations. An understanding of the ecology and overall biology of species is essential for evaluating specific environmental problems related to exploitation of petroleum resources.

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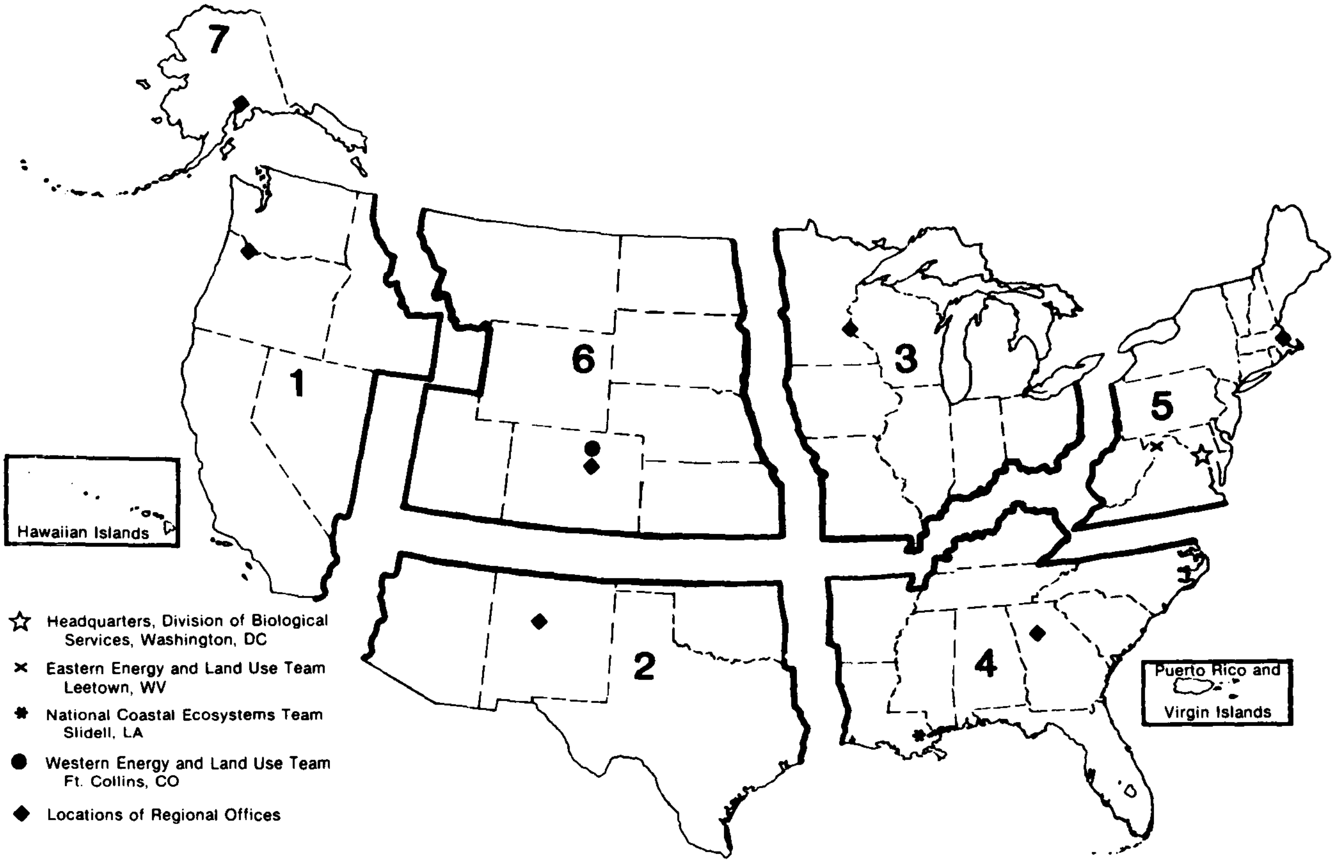

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DEPARTMENT OF THE INTERIOR

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.