DISTRIBUTION OF MARINE BIRDS
ON
GEORGES BANK AND ADJACENT WATERS

Technical Progress Report

Period Covered: 1 January-31 August 1978

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TECHNICAL PROGRESS REPORT

SUMMARY: The work accomplished during the period covered in this technical progress report demonstrates the importance, interest, and necessity of a distribution study of marine birds in the Georges Bank area on a national and international scale. Cooperation was extended by the U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service, U.S. Coast Guard, and by the Canadian Wildlife Service, Halifax, N.S., AtlantNIRO, Kalinin-grad, USSR, and Federal Republic of Germany. Two sampling methods, fixed-area and total bird counts, were effectively employed, which allow comparable data bases with marine bird distribution information being collected in the North Pacific, Bering and Chukchi Seas (Outer Continental Shelf Energy Assessment Program), and in the North Atlantic and Canadian Arctic (CWS and The Seabird Group). A marine bird data retrieval bank is being developed for MBO seabird data at the USFWS Migratory Bird and Habitat Research Laboratory. A food habits bibliography and prey item/bird species summary table for marine birds in the western North Atlantic has been prepared from existing literature. Unpublished NMFS data on zooplankton/ichthyoplankton and ground fish is being made available for possible correlations in distribution of selected prey items with bird species.

INTRODUCTION. Eighteen cruises were undertaken in the western North Atlantic from Cape Hatteras to the Scotian Shelf during the period covered by this report. One additional cruise in July 1978 was in Canadian Atlantic and Low Arctic waters. Although the primary area of interest is Georges Bank, cruises were extended to these other regions because: (1) the entire cruise track was not known at the start of the voyage, e.g. U.S. Coast Guard patrols, or (2) the opportunity was afforded to survey these areas when qualified volunteer observers were available allowing the collection of additional background information on species range, composition and density in adjacent areas. All cruises were on ships-of-opportunity, except MBO cruise no. 7819, 14-28 August 1978, which was a dedicated survey of marine bird distribution and feeding ecology aboard the USSR R/V ALIOT. Lists of dates, vessels, cooperating agencies, ports of departures and observers for MBO cruises were made from January-September 1978 are included in DOE Progress Reports Nos. 1-3. The ships-of-opportunity program has been successful because of the cooperation extended by the National Marine Fisheries, U.S. Coast Guard, AtlantNIRO, Kaliningrad, USSR, and the Canadian Wildlife Service and Coast Guard. These agencies have demonstrated gratifying interest and a sincere willingness to assist in the seabird survey by providing logistical support and background data on bird and prey species.

CENSUS TECHNIQUES. Two primary census techniques have been employed during the course of the study: fixed-area transects and total bird counts. A fixed-area transect census is a count of all birds by species (excluding ship-followers) within a fixed-area, 300m laterally by the distance traveled in 10 minutes cruising time. A transect count provides information on relative population density. The fixed-area transect method exclusively is

being used by several principal investigators in the North Pacific from California to the Chukchi Sea. A total bird count is a count of all birds by species within sight of the ship for a period of 10 minutes. A total bird count includes ship-followers and provides information on relative abundance, i.e. birds seen per 10-minutes. The Canadian Wildlife Service has used this method in Atlantic Canada, Canadian Arctic, and Sargasso Sea (see Brown et al. 1975, Atlas of Eastern Canadian Seabirds; Brown 1977, Supplement to Canadian Seabird Atlas); British and Scottish seabird investigators are using a similar method in the eastern North Atlantic. Both methods require that the ship be moving on a fixed course and at a constant rate, four kts or faster, and that visibility be at least one km. For further information concerning these and other census methods, the reader is referred to the initial DOE proposal for this study, DOE Progress Rept. No. 1 (April 1978), Powers and Ramage 1978, a MBO final unpublished seabird report submitted to USFWS, Office of Biological Services, Newton, MA (in review), and an unpublished MBO report submitted to USFWS, MBHRL, Laurel, MD (February 1978) (see Appendix A).

The utilization of both methods is required adequately to assess the distribution of the major bird species in the Georges Bank area using a ships-of-opportunity program. (1) It allows for comparable data bases with seabird investigators on an international scale. (The range of most species found on Georges Bank extends throughout the Atlantic and Pacific Oceans.) (2) The distribution of certain species (e.g. shearwaters, storm-petrels, al-cids) is best quantified by the fixed-area method, while other species (e.g. gulls) are best described using the total count method. Most gulls (*Larus* spp.) have a propensity to follow ships for long periods of time (e.g. several hours to a day) and the arrival of new individuals from those counted in

prior 10-minute counts cannot usually be made by the observer. Therefore, the inclusion of these birds in density estimates should be treated with caution. (3) Although neither method can control distribution bias from commercial fishing activities or attraction of birds themselves to the survey ship, statistical tests can be applied to the data to determine if there is a significant effect on density because of ship activity. For example, an analysis of data collected on USCG offshore fisheries patrols imply a greater avian population density than are derived from similar data taken on oceanographic survey cruises. Coast Guard cutters on fisheries patrol seek out all vessels, while research ships follow a predetermined cruise track. This type of information demonstrates the importance of utilizing several types of survey ships because marine bird distribution is clumped and often influenced by fishing activities.

Addended to this report is a series of marine bird photographs taken during the period covered by this report (see Appendix B).

BIRD DISTRIBUTION. A narrative summary of species distribution indicating arrival and departure dates, rare bird sightings, and significant bird concentrations is given in the quarterly progress reports. Table 1 indicates the relative density (birds/km²) of all birds recorded in three selected regions (i.e. Georges Bank, Gulf of Maine and Southern New England) by month (Jan-Aug 1978) using fixed-area transects. These areas are defined in DOE Progress Report No. 1. Table 2 indicates the relative abundance (birds seen per 10-minutes) of all birds recorded in the same regions and months using total bird counts. Table 3 indicates the level of effort (i.e. area sampled or number of 10-minute counts) achieved per month and region. Coverage between months was not uniform because the observers did not have control over ship

TABLE 1.

Bird Density by Month (Jan-Aug 1978) in Three Selected
Regions Using Fixed-Area Transects

Region	Relative Density (birds/Km ²)							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Georges Bank	4.25	7.89	3.84	20.62	7.25	75.53	105.28	19.02
Gulf of Maine	29.66	6.57	7.35	9.86	5.45	33.62	23.78	20.88
Southern New England	40.08	9.04	-	4.36	37.84	9.22	2.37	9.52

TABLE 2.

Bird Abundance by Month (Jan-Aug 1978) in Three Selected
Regions Using Total Bird Counts

Region	Relative Abundance (birds seen per 10-minutes)							
	Jan	Feb	Mar	Apr	May	June	Jul	Aug
Georges Bank	35.92	24.94	56.00	166.47	14.00	1,433.14	633.65	21.40
Gulf of Maine	130.46	40.00	12.75	40.93	31.17	78.83	87.11	29.43
Southern New England	175.86	94.17	-	29.45	73.04	50.45	5.12	11.64

TABLE 3.

Level of Effort, Number of 10-Minute Counts and Area Sampled,
Per Month (Jan-Aug 1978) in Three Selected Regions

Month	Georges Bank		Gulf of Maine		Southern New England	
	No. of Counts	Area Sampled (Km ²)	No. of Counts	Area Sampled (Km ²)	No. of Counts	Area Sampled (Km ²)
Jan	12	16.22	59	58.73	21	28.72
Feb	47	40.30	35	40.95	35	47.88
Mar	5	4.17	72	57.82	0	0
Apr	194	181.72	45	44.10	70	68.02
May	19	17.79	70	63.46	21	22.45
Jun	69	68.28	108	103.86	89	87.14
Jul	75	71.58	106	100.66	93	90.81
Aug	81	75.20	74	72.51	75	69.64

scheduling or cruise track.

Several important points are evident from the data presented in Tables 1 and 2. (1) The relatively high density and abundance of birds in January in the Gulf of Maine and Southern New England was a result of large concentrations of fulmars and gulls associated with domestic fishing operations in the Gulf of Maine, and gannets and large gulls with foreign fishing activities along the continental shelf edge in Southern New England. (2) The increase in density and abundance on Georges Bank in April resulted from spring migration when 16 species of coastal and marine birds were recorded in fixed-area transects. Large concentrations of fulmars, gannets and large gulls were found associated with foreign fishing activities on the southern slope of Georges Bank, but also found were high densities of fulmars along the Northern Edge and Northeast Peak of Georges Bank which were not always associated with fishing vessels. This month also marked the exit of alcids, the northward passing of phalaropes and jaegers, and the arrival of shearwaters and storm-petrels. (3) The spectacular densities on Georges Bank in June and July (see MBO cruise report No. 7811 and 7812) mark the complete arrival and summer residence of shearwaters (primarily Greater Shearwater) and storm-petrels which breed in the South Atlantic.

TRANSCRIPTION OF DATA. The U.S. Fish and Wildlife Service Migratory Bird and Habitat Research Laboratory has agreed to keypunch MBO seabird data at no cost to MBO or the DOE. Cruises conducted in the first two quarters of 1978 have been transcribed, verified and keypunched. Eighteen of 24 cruises conducted by MBO in 1977 have been transcribed (Table 4). None of the 15 MBO cruises conducted in 1976 have been transcribed. Although there has been a lag in transcribing MBO seabird data generated prior to the DOE contract, the majority of past data should be transcribed, verified and sub-

TABLE 4.
Progress in Transcription of MBO Seabird Data
Collected in 1977

Cruise No.	Cruise Dates	No. of 10-Min. Watches	Transcribed	Proofed
7701	4-10 Jan	36		
7702	21 Jan-2 Feb	154	X	
7703	26-29 Jan	7	X	X
7704	9-13 Feb	30		
7705	16 Feb-2 Mar	93	X	
7706	16-30 Mar	130	X	
7707	15-21 Mar	50		
7708	30 Mar-10 Apr	143	X	
7709	14-26 Apr	131	X	
7710	30 Apr-13 May	142	X	
7711	24 May-3 Jun	116	X	
7712	31 May-3 Jun	-		
7713	1-13 Jun	113	X	
7714	7-16 Jun	44	X	X
7715	6-20 Jul	155	X	
7716	11-15 Jul	130		
7717	14-28 Aug	40		
7718	6-20 Sept	88	X	X
7719	19-25 Sept	38		
7720	10-29 Oct	112	X	X
7721	16-24 Oct	104	X	
7722	26 Oct-12 Nov	167	X	
7723	2-18 Nov	50		
7724	8-20 Dec	70	X	X

mitted to MBHRL for keypunching in 1978. Another staff member was added on 1 September 1978 for the purpose of transcribing data. That salary is supported with funds previously allocated for computer services. Also, MBO staff interns are volunteering their time in the coding effort.

LITERATURE SEARCH. A complete search of pertinent literature on feeding habits of marine birds in the North Atlantic was undertaken. The results are classified by bird species and author in DOE Progress Report No. 2. A summary chart indicating bird species, prey item, and its importance based on literary evidence and MBO field observations (1976-1978) is presented in Table 5. A food habits bibliography is presented in Table 6.

In a cooperative effort between AtlantNIRO (USSR), NMFS, MBO, and Peabody Museum at Yale University, a cruise dedicated to distribution and feeding ecology of marine birds on Georges Bank and adjacent waters (MBO cruise no. 7819) was undertaken in August. An analysis by AtlantNIRO of the stomach contents of 126 specimens of 9 species collected is expected in 6 - 12 months.

Prior to the end of the contract period (31 December 1978), a summary of NMFS groundfish data by selected species will be initiated. The NMFS is making available this information at no cost. The bird data collected in 1976-1978 is being keypunched in a format compatible with NMFS groundfish data, so that statistical tests for correlations between density and biomass estimates of selected groundfish and bird species are possible. Although NMFS has collected vast quantities of zooplankton/ichthyoplankton data in the study area, no attempt to examine that information in light of bird distribution has been made at this time.

TABLE 5.

A Marine Birds Food Habits Summary Chart Indicating Bird Species,
Prey Item and Importance Based On Literature

	NOFU	COSH	GRSH	SOSH	MASH	LESP	WISP	GANN	GBBG HEGU	BLKI	RAZO	COMU TBMU	COPU
Coelenterata													
Scyphozoa ("Jellyfish")	?												
Hydrozoa (i.e. <i>Vellella</i>)						?							
Ctenophora	?												
Annelida	?								?				
Polychaeta											?	?	
Mollusca									?		?		
Gastropoda													
Nudibranchia										?			
Thecosomata													
Cephalapoda	?	?	+	+	+	?	+	?				?	
<i>Sepia</i>	+							?		?		?	
<i>Loligo</i>		?		+									
<i>Ilex</i>			?										
Arthropoda													
Crustacea				?	?				?	?	?		
Copepoda	?												
<i>Temora</i>						?							
Malacostraca													
Mysidacea											?		
Cumacea	+												
Isopoda	+												
Amphipoda	+					+					?	?	
Euphausiacea			?			+	+					?	
Decapoda													
"Crabs, Shrimp, Prawns"	?	?				+	+			?			
Echinodermata									?	?			

+ Important food source based on literary evidence and to a lesser extent on MBO field observations.

? Food source of unknown importance.

TABLE 5. (continued)

	NOFU	COSH	GRSH	SOSH	MASH	LESP	WISP	GANN	GBBG HEGU	BLKI	RAZO	COMU TBMU	COPU
Chaetognatha	?												
Chordata													
Osteichthyes	+	+	+	+	+	?	?	+	?	+	+	+	+
Clupeidae					+								
<i>Clupea</i>		+			+			+			+	+	+
<i>Brevoortia</i>								?					
Engraulidae								?					
<i>Eugraulis</i>				+	+								
Osmeridae													
<i>Mallotus</i>			+	+				+		+	+	+	
Anguillidae													
<i>Anguilla</i>									?				
Scomberesocidae													
<i>Scomberesox</i>		+	?						?				
Merlucciidae (whiting)													?
Gadidae	?			+			+		?	+			
<i>Gadus</i>								+				+	
<i>Boreogadus</i>												+	
<i>Melanogrammus</i>												+	
Gasterosteidae (sticklebacks)											?		
Scombridae									?				
<i>Scomber</i>								+					
Triglidae (gurnards)								?					
Ammodytidae													
<i>Ammodytes</i>			+	+				+		?	+	+	+
Stichaeidae													
<i>Leptoclinus</i>												?	
Offal (fish offal, trawl escapes, carriion, animal refuge, garbage, etc.)	+		+	+	?		+	+	+	+			
Oily substances (oily offal, etc.)	+	?				+			?				

+ Important food source based on literary evidence and to a lesser extent on MBO field observations.

? Food source of unknown importance.

* Includes eggs

TABLE 6.
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PUBLICATIONS

A. Papers Published

Powers, K.D., and W.T. Ramage. "The effect of the Argo Merchant oil spill on bird populations off the New England coast, 15 December 1976 to January 1977."

Published in symposium proceedings, In the Wake of the Argo Merchant, held at U.R.I., Narragansett, RI, 11-13 January 1978.

Powers, K.D., R.E. Noble, and R.H. Chabreck. "Seed distribution by waterfowl in southern Louisiana."

Published in Journal of Wildlife Management, Vol. 42, No. 3, p. 598-605.

B. Paper to be Published

Powers, K.D., and J. Van Os. "A notable concentration of Greater Shearwaters on Georges Bank."

To be submitted to American Birds in December 1978.

C. Papers Unpublished

Powers, K.D., and J. M. Loughlin. "Pelagic birds of Georges Bank and adjacent waters: a pilot study of census techniques and distribution, February 1976-June 1977."

Final report (USFWS contract No. 14-16-0005-6057) submitted to U.S. Fish and Wildlife Service, Office of Biological Services, Newton, MA. April 1978.

Powers, K.D. "Seabirds and oil pollution."

Presented at annual meeting of Northeastern Bird-Banding Association, Inc., Holyoke, MA. 15-16 September 1978.

Powers, K.D. "Suggestions and comments: an information retrieval system for coastal and marine bird data."

A report in fulfillment of P.O. SFWB 145138 submitted to USFWS Migratory Bird and Habitat Research Laboratory, Laurel, MD. Feb. 1978.

APPENDIX A. Copy of report concerning information system
for coastal and marine birds submitted to USFWS
Migratory Bird and Habitat Research Laboratory.

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SUGGESTIONS AND COMMENTS: An Information
Retrieval System for
Coastal and Marine Bird Data

A Report in Fulfillment of P.O. SFWB 145138
Submitted to the

Migratory Bird And Habitat Research Laboratory
U.S. Fish and Wildlife Service
Laurel, Maryland 20811

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INTRODUCTION

Application of automatic data processing (ADP) to the study of marine birds was initiated by King et al. (1967) in the Smithsonian Institution Pacific Ocean Biological Survey Program (POBSP). The number of birds, time, location, weather, and other biological data (e.g., plumage, age, sex, behavior) were recorded for every bird sighting. Modifying the POBSP technique, the Canadian Wildlife Service in their Programme Integre de Recherches sur les Oiseaux Pleagique (PIROP) adopted a system of 10-minute watches, recording the total numbers of each species seen during each watch (Brown et al. 1975). The PIROP system provides information on relative abundance only (i.e. birds per unit of time), indicating where concentrations of a given species may be found at any given season. Density estimates (i.e. birds per unit area), using 10-minute fixed-area transect counts, are being made by the U.S. Fish and Wildlife Service on the Alaskan Outer Continental Shelf Energy Assessment Program (U.S. Dept. of Commerce and U.S. Dept. of Interior 1975). Any technique for counting birds at sea on shipboard platforms has certain inherent and unavoidable biases, such as ship followers and ship activities, which influence bird abundance around a ship (Bailey and Bourne 1972).

The Manomet Bird Observatory has used the PIROP technique in their seabird studies on Georges Bank, believing that all seabird information collected in the northwest Atlantic should be compatible in format for comparative analysis.

The fixed-area count system used by U.S. Fish and Wildlife Service in Alaska is subjected to ADP and makes possible a sophisticated analysis of

the effects of many environmental factors, both oceanographic and meteorologic, upon the distribution and movements of seabirds in a given area. ADP permits more rapid handling of the large quantities of data collected. The use of density estimates allows more meaningful statistical analysis of the observed distribution patterns of marine bird populations, whereas relative abundance estimates without fixed-area counts can only indicate trends of bird distribution. The distance at which certain species may be sighted (Dixon 1977) will vary with observers and strong winds, rough seas and sun glare.

INPUT

We suggest that (1) relative abundance estimates (i.e. total counts of all birds within sight of the ship) be collected to maintain information comparable with past Manomet Bird Observatory/USFWS work on Georges Bank and ongoing studies conducted by the Canadian Wildlife Service in eastern Canada, Canadian Arctic, and Sargasso Sea; and (2) relative density estimates be initiated to allow more meaningful statistical analysis in the future. The data sheet and codes (see Appendix A) developed by U.S. Fish and Wildlife Service, Office of Biological Services - Coastal Ecosystems, Anchorage, Alaska (Dr. Patrick J. Gould, Project Leader for Pelagic Birds) with certain minor modifications (see Appendix A), allow both types of information to be collected, coded, and stored for computer analysis, in addition to location of marine mammal sightings with behavioral observations.

The USFWS technique of counting birds at sea (Appendix A) entails three different methods: (1) counts within fixed-area transects; (2) counts of birds within sight of the ship but outside the transect boundary; and (3) ship follower counts. The PIROP technique is a total

count of each species within sight of the ship or the sum of each method recorded in the USFWS format. Both techniques use counts of 10-minute duration.

Using USFWS format guidelines for collecting marine bird data at sea, and MBO experience gained during two years of seabird survey work on Georges Bank, we have outlined a retrieval system to accurately assess the population status, habitat requirements, and pelagic distribution of coastal and marine birds on the U.S. Atlantic Outer Continental Shelf (OCS).

RETRIEVAL AND ANALYSIS

Although much is known about coastal and marine birds at their breeding colonies, little quantitative effort has been made toward determining pelagic distributions of birds on the U.S. Atlantic OCS. Therefore, benchmark data on spatial and temporal distributions of birds at sea is of paramount importance. The retrieval system should be capable of determining the amount of effort (i.e. number of watches or transects), mean abundance values by species of the number of birds seen from 10-minute total bird counts with no fixed area, and mean density values by species from 10-minute fixed-area counts. These values will be useful in plotting distribution maps, averaged on a monthly basis, either by square blocks of 10, 20, 30 etc. minutes of latitude and longitude, or by strata. Strata are standard oceanographically defined areas, irregular in size, in the northwest Atlantic as determined by the National Marine Fisheries Service (NMFS) and International Commission for North Atlantic Fisheries (ICNAF). Cross-tabulation tables of effort, abundance and density would be sufficient for map preparation. Blocks or strata in which

effort was made but a species was not observed should be distinct from those blocks in which no effort was made. Cross-tabulation tables may also be used to indicate age distributions of gulls, color phases of fulmars, or distributions of oiled birds.

Birds that follow ships present particular problems in analysis. Individual gulls have been observed ship following for hours and even for days. Fulmars follow ships but often appear to have a regular turnover of new birds as the previous ship-following fulmars move along ahead of the ship. This turnover of fulmars is not, however, apparent in areas of fishing activity. In any event, a total count of all birds within sight of the ship may result in inflated estimates of certain species because the same individuals may be included in several watches. The use of a ship-follower count will allow separate analyses for abundance and distribution of these special cases.

Several alternatives are available for handling ship-follower counts. For example, species and numbers of birds following different types of ships, or similar ships involved in different activities (e.g., fishing, oceanographic, surveillance, etc.) can be tested statistically for significant differences to allow assessments of the species most prone to follow ships. Seasonal and age-related differences in the ship-following propensities of individuals within a species can be examined. As a species, Herring Gulls are more apt to closely follow a vessel steaming in the open ocean. However, within a species immature Great Black-backed Gulls are more prone to closely follow a travelling ship than adults.

Distribution maps can be plotted indicating relative abundance of those ship-following species which may not appear in fixed-area counts, but are obviously widely distributed. The maximum number by species of

ship-followers seen at any one time on a given series of transects, or perhaps two values for the maximum and minimum as above, may be summarized by block or stratum over time. Tests for differences (chi-square) in number of ship followers between areas or strata can be made, and likely will show high densities of ship following species in areas of intensive fishing.

The above are just a few examples of capacities that the retrieval system should have. The system should also be capable of retrieving all sightings of rare or infrequently occurring species or species groups (e.g. murre) with the associated location and environment data recorded when the sighting was made. These sightings may be from any of the station types coded in col. 15 of the "Header Card" (see Appendix A). The distribution of birds (and marine mammals) which are rarely sighted or sighted frequently, but over a short period (e.g., 1-2 months), are best illustrated graphically by plotting all sightings in a given month on maps, or by listing them in an appendix for easy reference.

It is necessary to know whether apparent population changes are real between blocks or strata, or in the same areas but different months or years. It is possible to determine population movements and cyclical phenomena on the basis of differences (i.e. chi-square, G-test, or other non-parametric tests) in abundance estimates. Shifts in populations between months or years may be due to a change in migration routes, shipping lanes, oil rigs, movements of commercial fishing fleets, etc. or to changes in environmental factors. Certain areas, where large concentrations of birds traditionally occur, can be tested against other areas of similar habitat, commercial fishing activities, or petroleum development. The abundance of certain species in larger areas (e.g., Georges Bank, Gulf of Maine, Great South Channel) may appear to be greater in some

years than in others. Therefore, probability statements, based upon numerical estimates of abundance, can be used to determine population trends, species distribution and abundance, and locations of key habitats provided that an adequate data base is available. Information of this nature can superficially provide baseline data for environmental impact evaluations, but more specific studies involving habitat requirements will be necessary to determine why the changes occur.

It is important to know whether apparent correlations between environmental factors and bird distribution are spurious or real. Simple statistical correlations with environmental factors, both oceanographic and meteorologic, provide basic information for graphs or keys to more complex statistical analysis. For example, abundance or density estimates of Northern Fulmars (*Fulmars glacialis*), Cory's Shearwaters (*Puffinus diomedea*) and Greater Shearwaters (*P. gravis*) may be affected by sea-surface temperature. An analysis could be performed on abundance versus sea-surface temperature which would supply material for plotting bar graphs, or for mapping isopleths. The winter ranges of the two shearwaters overlap in warmer sub-tropical waters and the northerly withdrawal of fulmars in summer perhaps correlates with the seasonal warming of ocean surface layers (Brown et al. 1975).

Distributions of other species do not have obvious environmental correlations. Tests of multiple regression can predict species numbers based on different environmental variables and may better indicate habitat requirements. For example, a difference in areas used during the 1977 spring migration of phalaropes, Red (*Phalaropus fulicarius*) and Northern (*Lobipes lobatus*), across New England waters was observed, but reasons for the separation are not clear. Red Phalaropes were exclusively sighted in offshore areas. Northern Phalaropes were recorded in inshore, offshore, and pelagic waters, but apparently preferred areas nearer shore. Both

these shorebirds breed in the Arctic and have circumpolar distributions.

It is important to know whether apparent correlations between the occurrence of species or species groups in guild associations and feeding assemblages are significant. Simple statistics for correlation coefficients among, and factor analysis on numbers of certain species and species groups observed based on 10-minute counts provide information to determine relationships among species. Once a correlation, either positive or negative, has been found between species, further investigation into environmental factors and food habits will provide insight into habitat requirements.

Mutual aid in finding food is considered by some authors (Gannon 1934, Rand 1954) to be a primary factor in the formation of feeding flocks. Sealy (1973) found that certain marine bird species help other species in finding food, and that differentiation of feeding methods between the species increases the effective food supply. Primary sources of potential marine bird food exist at current interfaces (i.e. contact points of unlike water masses) with marine mammal pods and schools of predatory fish which drive nekton to the surface and thus make food available to birds (Ashmole and Ashmole 1976), and in association with commercial fishing operations where trawlers bring benthic and nektonic organisms to the surface and discard offal. The formation and composition of marine bird feeding assemblages at any of these potential food resources offers information concerning general seasonal feeding ecology and location of critical habitats.

Ideally, one would like to be able to predict numbers of birds in an area using environmental parameters. Predictive models may be developed in years to come using information collected on the proposed USFWS format (Appendix A). Systems and population modeling must include those habitat and environmental factors which have the most influence in determining population abundance, distribution, and movements. With the continuation

of present marine bird surveys but over more Atlantic OCS waters, and with specific, long-range studies in the future, such predictive capabilities are possible.

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APPENDIX B. Series of marine bird and mammal photographs
taken during 1978.

FIGURE 1. A light-phased Northern Fulmar (*Fulmarus glacialis*) sitting on the water.

FIGURE 2. A light-phased fulmar in flight.

FIGURE 3. A Greater Shearwater (*Puffinus gravis*) sitting on the water.

FIGURE 4. An adult light-phased Pomarine Jaeger, (*Stercorarius pomarinus*) in flight.

FIGURE 5. An adult Gannet (*Morus bassanus*) in flight.

FIGURE 6. A subadult Gannet about to plunge dive in pursuit of a fish.

FIGURE 7. An immature Iceland Gull (*Larus glaucoides*) ship-following.

FIGURE 8. A possible adult Kumlien's Gull (*L. g. kumlieni*) in flight.

FIGURE 9. A subadult Herring Gull (*Larus argentatus*) visibly oiled on belly.

FIGURE 10. A Thick-billed Murre (*Uria lomvia*) in flight.

FIGURE 11. Great Black-backed Gulls (*L. marinus*) and Herring Gulls fighting for fish offal discarded by a trawler.

FIGURE 12. Gulls (*Larus* spp.) feeding in association with probable Minke Whales (*Balaenoptera acutorostrata*) and Common Dolphins (*Delphinus delphis*).