Annual Report

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Research Unit [illegible] and
330/196
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The distribution, abundance and feeding ecology of birds associated with the Bering and Beaufort Sea pack ice

and

Identification, documentation and delineation of coastal migratory bird habitat in Alaska

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I. Summary of objectives, conclusions and implications with respect to OCS oil and gas development

Both R.U. 3/4 and R.U. 330/196 are concerned with determining bird densities and activities in the Arctic Ocean. R.U. 3/4 is concerned with determining the bird use of coastal habitats in the Beaufort and Chukchi Seas. R.U. 330/196 deals with bird use of the different regions and types of sea ice. Both projects will determine critical habitats for birds.

Field work in past years has shown Chukchi and Beaufort Sea ice to be a major summering area for a number of species. 1975 showed that when little Bering Sea water is entering the Chukchi Sea, the area may be less important.

II. Introduction

This report covers two research units: R.U. 330/196, The distribution, abundance and feeding ecology of birds associated with the Bering and Beaufort Sea pack ice and part of R.U. 3/4, Identification, documentation, and delineation of coastal migratory bird habitat in Alaska. The part of R.U. 3/4 that covers the area south of Cape Prince of Wales will be reported by Paul Arneson, Alaska Department of Fish and Game, Anchorage. The Arctic coast portion of R.U. 3/4 is closely associated with birds and pack ice and NOAA personnel have asked that a common annual report be written.

A. General nature and scope of study

Both R.U. 330/196 and R.U. 3/4 deal with determining densities of birds in the Arctic and in analyzing the habitat that supports these birds. R.U. 330/196 considers bird densities in relation to ice cover and type and a number of oceanographic parameters such as sea surface temperatures and salinity. R.U. 3/4 considers birds primarily in relation to physiographic and faunistic characteristics of the shoreline. Both of the projects assess bird activities in relation to the habitat and determine what organisms the birds are feeding on. Because bird densities are good indicators of the productivity of a region, these projects will ultimately show which areas of the Beaufort and Chukchi Seas are the most biologically productive.

B. Specific objectives

The specific objectives of R.U. 3/4 are:

1. To determine the seasonal density, distribution, critical habitats, migratory routes and breeding locales for bird species in littoral and estuarine habitats in the Chukchi and Beaufort Seas.

2. To describe population dynamics and trophic relationships of selected seabird species at coastal study sites in the Beaufort Sea.

3. Summarize existing literature and unpublished data on bird use of coastal and estuarine habitats in the Beaufort and Chukchi Seas.

The specific objectives for R.U. 330/196 are:

1. To determine the seasonal distribution and abundance of the seabird species associated with the Arctic pack ice off Alaska and to determine the importance of the various regions of the ice (e.g. ice front, consolidated pack, polynias) to bird populations.

2. To develop a predictive model based on ice cover, type and location (the independent variable) and the distribution, abundance, behavior and age classes of birds associated with the pack ice. Such a model will allow the prediction of species and numbers of birds in a given area on the basis of satellite or aerial photos.

3. To determine the feeding habits of the seabird species associated with the pack ice with regard to the relative importance of nekton, macro-plankton, benthos and under-ice biota as food sources and how the relative importance of these food sources varies during the period of ice cover and in the various regions of the ice.

C. Relevance to problems of petroleum development

Because birds are indicators of biological productivity these projects not only determine where birds are most abundant in the Beaufort and Chukchi Seas, they also determine what parts of these two seas are the most biologically productive. Oil drilling and related activities will hopefully be limited to those areas of little biological importance and these projects will be able to determine what those areas are.

Both of these projects involve primarily Arctic waters where biodegradation of oil would be slow and the long term effects on the Arctic ecosystem could be expected to be large. The ice environment has been shown to play a major role in providing food for a number of seabird species. Oil spills on or under the ice would have major impacts on these species. These studies will allow the determination of what these impacts will be. The major use of much of the data provided by these projects will be in the preparation of environmental impact statements and ultimately in providing baseline data for assessing the impact of oil spills.

Because barrier islands will be used for oil drilling platforms, our work on Cooper and other islands is especially pertinent.

III. Current state of knowledge

R.U. 3/4

No delineation of bird habitat in the Beaufort or Chukchi Seas has been done. Bailey (1948) gives a summary of birds found in the Alaskan arctic but does not give a breakdown of bird use by habitat. Andersson (1973) presents a breakdown of species found in habitats at one point on the Beaufort Sea coast.

R.U. 330/196

Observations of birds in the Chukchi Sea in 1970 and Beaufort Sea in 1971 and 1972 have been presented in Watson and Divoky (1972, 1975). The only other paper on birds in the ice is by Frame (1973).

IV. Study area

Positions of field work are given in Sections V and VI of this report.

V. Sources, methods and rationale of data collection

R.U. 3/4

Work on this project was begun in late October 1975 and has included a preliminary delineation of bird habitat and planning for an intensive field season in the spring and summer of 1976. The preliminary delineation of coastal habitat is in the Results section of this report. The field plans for the 1976 field season include the following:

Location	Dates	Purpose
Barrow	April-May	Observe migration in area of offshore lead
Wales	early June	Observe migration and coastal habitat use
Point Hope	mid-June	Observe migration and coastal habitat use

Point Lay	late-June	Observe migration and coastal habitat use
Kasegaluk Lagoon (small boat trip)	July	Census breeding populations; assess bird use of coastal habitat
Wainwright to Barrow (small boat trip)	early August	Census breeding populations; assess bird use of coastal habitat
Demarcation Bay	late June	Census breeding populations; assess bird use of coastal habitat
Prudhoe Bay to Oliktok Pt.	early July	Census breeding populations; assess bird use of coastal habitat
Cooper Island	mid-June to August	Study breeding biology and feeding ecology of species breeding on island and determine use of island by non-breeding birds
Prudhoe Bay	June to August	Observe migration; census breeding populations and assess bird use of coastal habitats
DEWline sites along Chukchi and Beaufort coasts	June to September	Observe migration and assess bird use of coastal habitats
Barrow	June to September	Census birds along the Chukchi and Beaufort coasts by air and foot

All observers will be provided with standard forms for recording migration, breeding biology and coastal habitat use. Migration will be recorded on a birds per unit time basis. Use of coastal habitats will be recorded on transects with densities of birds per area of habitat being obtained. While much of the work will be a general survey of large sections of coast, certain coastal transects (at Barrow, Prudhoe and DEWline sites) will be studied from June through September and will provide replicate sampling and changes in use through time.

R.U. 330/196

Data for this research unit was gathered in the following localities:

Dates	Location	Activity
16-30 May	DISCOVERER Seward to Adak (Bering Sea)	Pelagic observations and and specimen collecting (Divoky)
24-27 June	Barter Island	Waiting for Fish and Wildlife plane to arrive for offshore aerial census; plane did not arrive; some land based observations made (Divoky and Boekelheide)
30 June-23 July	Cooper Island via helo and float plane	Observe breeding activities and migration (Divoky and Boekelheide)
30 July-13 August	USCGC GLACIER Nome to Barrow (Chukchi Sea)	Pelagic observations (Divoky and Boekelheide)
13-29 August	USCGC GLACIER off Barrow	Pelagic observations (Boekelheide)
22-28 August	Anchorage	Waiting for good weather for P2V Beaufort Sea flight; flight scrubbed (Divoky)
1-5 September	Cooper Island (via float plane)	Observe breeding activities and migration (Boekelheide)
6-18 September	Barrow	Observe migration (Divoky and Gibson)
28 September-21 October	Barrow	Wait for BURTON ISLAND; mission scrubbed (Divoky)

Cruise tracks for the cruises are given in Figs. 1 and 2. Methods of data collection are as follows:

Pelagic observations - observations are made from the flying bridge while the ship is underway during daylight hours. Observations are made for at least 30 minutes each hour (two 15 minute intervals). Observations at stations are made at irregular intervals. Birds are identified to species, counted, ages determined when possible and their activity (flying, sitting on water, sitting on ice, etc.) is noted. Detailed notes on behavior are taken when warranted. Oceanographic and meteorological data are obtained from the ship's log. Data on ice type and cover is gathered by the bird observer. Transect observations are used to derive density figures on a km^2 basis. Station observations provide relative numbers but not densities.

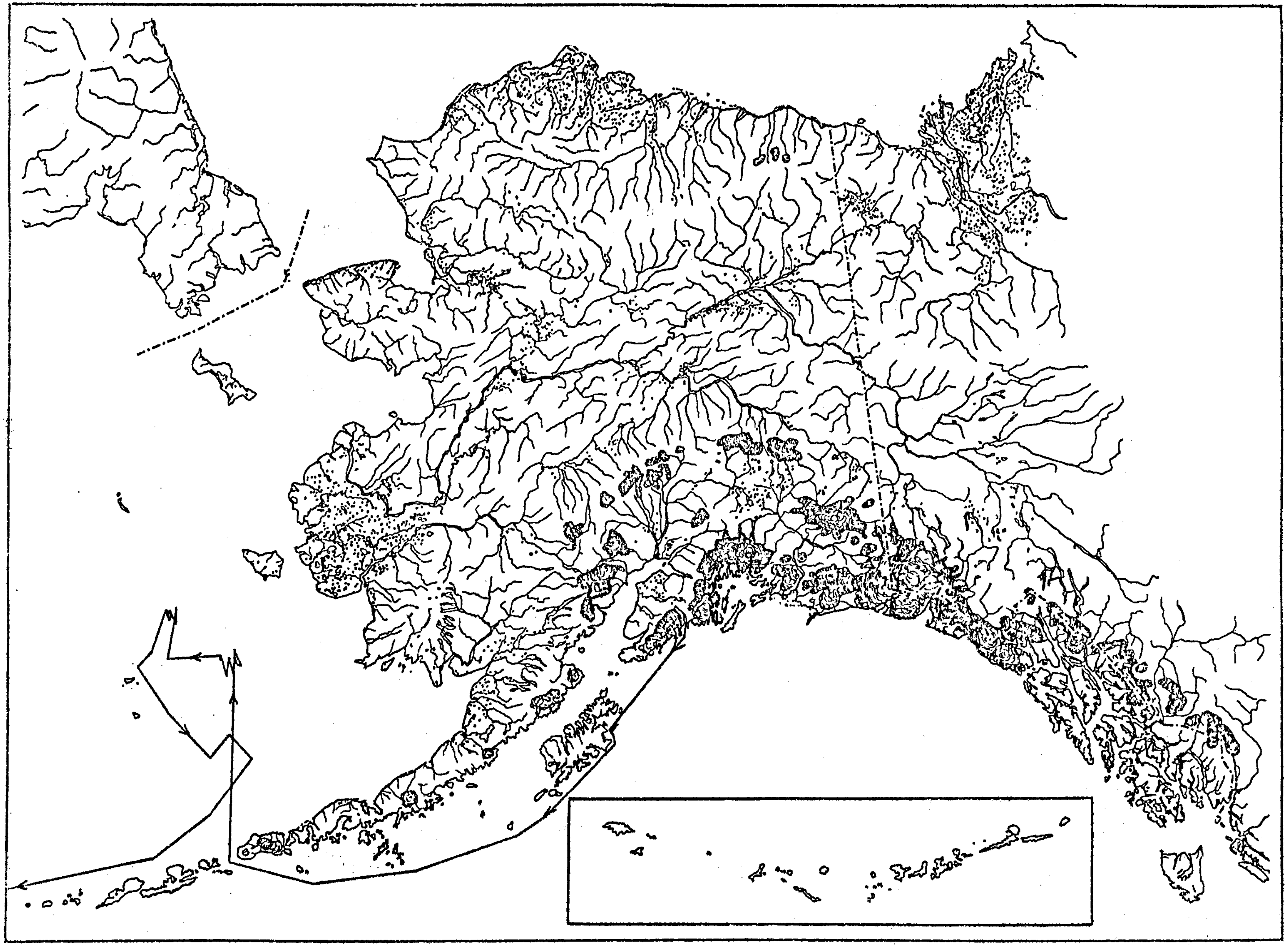

Fig. 1. Cruise track of DISCOVERER
16-30 May 1975

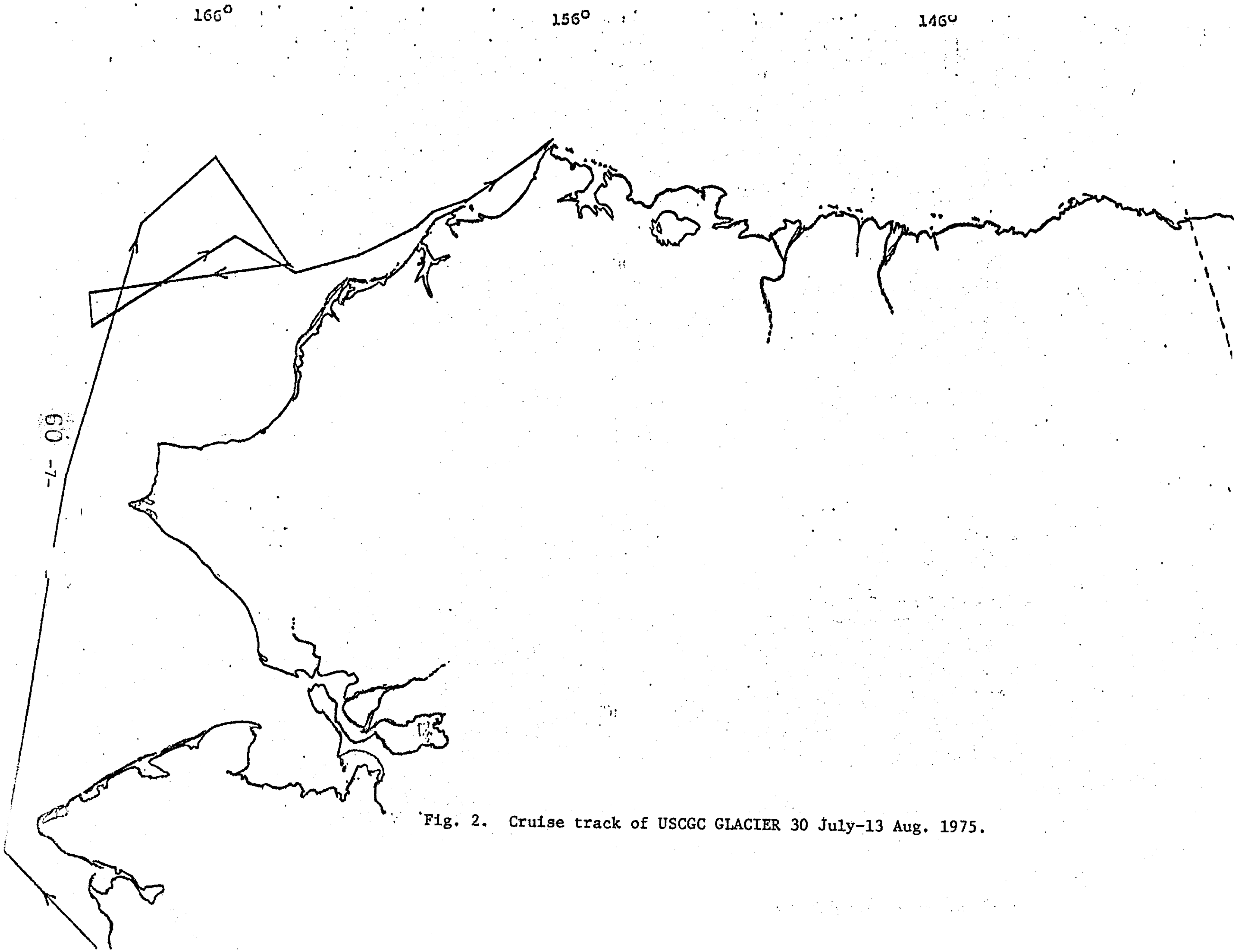

Fig. 2. Cruise track of USCGC GLACIER 30 July-13 Aug. 1975.

Cooper Island breeding activities - When Cooper Island was first visited on 29 June it was completely surrounded by ice except for a 5m moat immediately adjacent to the island. Cooper Island was chosen as a study site because it is surrounded by ice until late in the season and still supports a relatively large number of breeding birds. Our purpose in visiting Cooper was to obtain information on breeding chronology and success and to determine where the breeding birds feed during breeding. Because we saw that most tern flights were either to the north or south of the island, watches were conducted to determine the number of flights in each direction per hour. Nesting was studied by locating all nests on the island and visiting them every two days to determine final hatching dates and hatching success. Later visits to the island provided information on fledgling success. Plankton tows were taken near the island.

Migration observations - numbers, movements and feeding activity of migrant birds were observed whenever possible. This was frequently done incidentally to other land-based work but some information of birds per unit time were obtained.

Specimen collecting - birds were collected with a shotgun. Stomach contents were preserved in formalin and the bird's body frozen for later examination. Some collections of zooplankton were conducted to observe densities of prey.

The following data were obtained:

DISCOVERER Cruise

Number of 15 minute transect observations	104
Number of station observations	30
Specimens collected:	
Black-legged Kittiwake	4
Glaucous-winged Gull	6
Glaucous Gull	1

Cooper Island

Number of hours of observations of movements of migratory and breeding birds	110
Nests studied:	
Arctic Tern	51
Black Guillemot	18
Oldsquaw	9
Sabine's Gull	4
Specimens collected:	
King Eider	2
Oldsquaw	4
Black-legged Kittiwake	1
Glaucous Gull	1
Arctic Tern	1

GLACIER Cruise

Number of 15 minute transect observations	489
Number of station observations	15

VI and VII. Results and discussion

In order to delineate coastal bird habitat between Cape Lisburne and Demarcation Point, the coastline was broken down into 15 divisions. An attempt was made to have each division be as homogeneous as possible.

Landforms and habitat characteristics of importance to marine birds were listed and measured in order to assess the importance of the region to birds. Measurements were obtained from USGS maps. Habitat information was obtained from the Joint State-Federal Land Use Planning Commission maps. The following characteristics are measured for each region:

miles of coastline - this is a rough measure of the size of a region. It ignores convolutions of the shoreline and thus is not the same as miles of mainland coast.

barrier islands or spits - these are primarily sand or gravel because they are usually separated from the mainland tundra and thus have fewer predators. They are important breeding and loafing sites for a number of species. When the miles of seaward coastline or barrier islands is subtracted from the miles of seaward aspect of barrier island, a rough estimate of the miles of protected coastline can be obtained.

lagoons or protected waters - these waters are important for birds for a number of reasons. Lagoons are usually subjected to less ice scour than unprotected waters. Rivers frequently empty into lagoons and thus have estuarine conditions Depth of lagoons is important since deeper ones could be expected to have a richer benthic fauna due to less ice scour.

rivers - rivers provide open water early in the summer and the overflow of rivers are important to the arrival of birds in many areas. Rivers are also important sources of nutrients and river mouths would be expected to have higher productivity. This is especially important in summer when surface nutrients in the Arctic are low. Delta islands, numerous in rivers with a large coastline, are also important to breeding birds. Barrier islands in close proximity to rivers are more important than ones away from rivers.

nearshore bottom topography - the distance from the mainland to the five and ten fathom contour show how shallow inshore waters are and give an indication of how important the area may be to benthic feeders. Areas having a large shoal would be expected to be important feeding areas.

coastal relief - the distance from the shoreline to the 50 and 100 foot contour provide information on the drainage of the mainland adjacent to the coast. Low sections of mainland would be expected to have wet tundra and numbers of breeding water birds.

coastal habitat - this provides specific information on the mainland habitat adjacent to the coast. Wet tundra will have larger numbers of waterbirds than moist tundra. Alpine tundra would have few, if any, waterbirds.

Fig. 3 shows the 15 divisions. Tables 1-15 list the landforms in each division and a preliminary analysis of the region's importance to seabirds. Areas with barrier islands, rivers and lagoon areas are of most importance to birds. Areas without these features would have less bird use.

R.U. 330/196

DISCOVERER Cruise

Data formats for processing pelagic observations have just been obtained and no specific results are available for the pelagic aspects of this study. No concentration of birds was found at the ice front as has been found in winter. Black-legged Kittiwakes and Glaucous-winged Gulls were the most abundant birds found in and near the ice. Observations made during the last days of the cruise showed that a diverse assemblage of birds was associated with a "warm" water plume flowing north through Unimak Pass.

GLACIER Cruise

Observations made while the ship steamed north past King Island, Fairway Rock and Cape Lisburne provided information on the locations and movements of feeding flocks going and coming from these colonies. Physical oceanographic conditions in the Chukchi were atypical and the birds observed reflected this. In normal years the water flowing north through the Bering Strait has a major effect on the Chukchi Sea. Bering Sea water usually extends as far north as Barrow and in some years into the Beaufort Sea. In 1975 the Bering Sea water was hard to locate even as far south as Cape Lisburne. These oceanographic conditions were reflected by low densities of birds throughout most of the Chukchi and the absence of many species that typically summer in the Chukchi. These include shearwaters, puffins and a number of other alcids. Ross' Gull, which is usually associated with ice and Arctic waters but does not usually occur in the Chukchi until late September, was observed in early August.

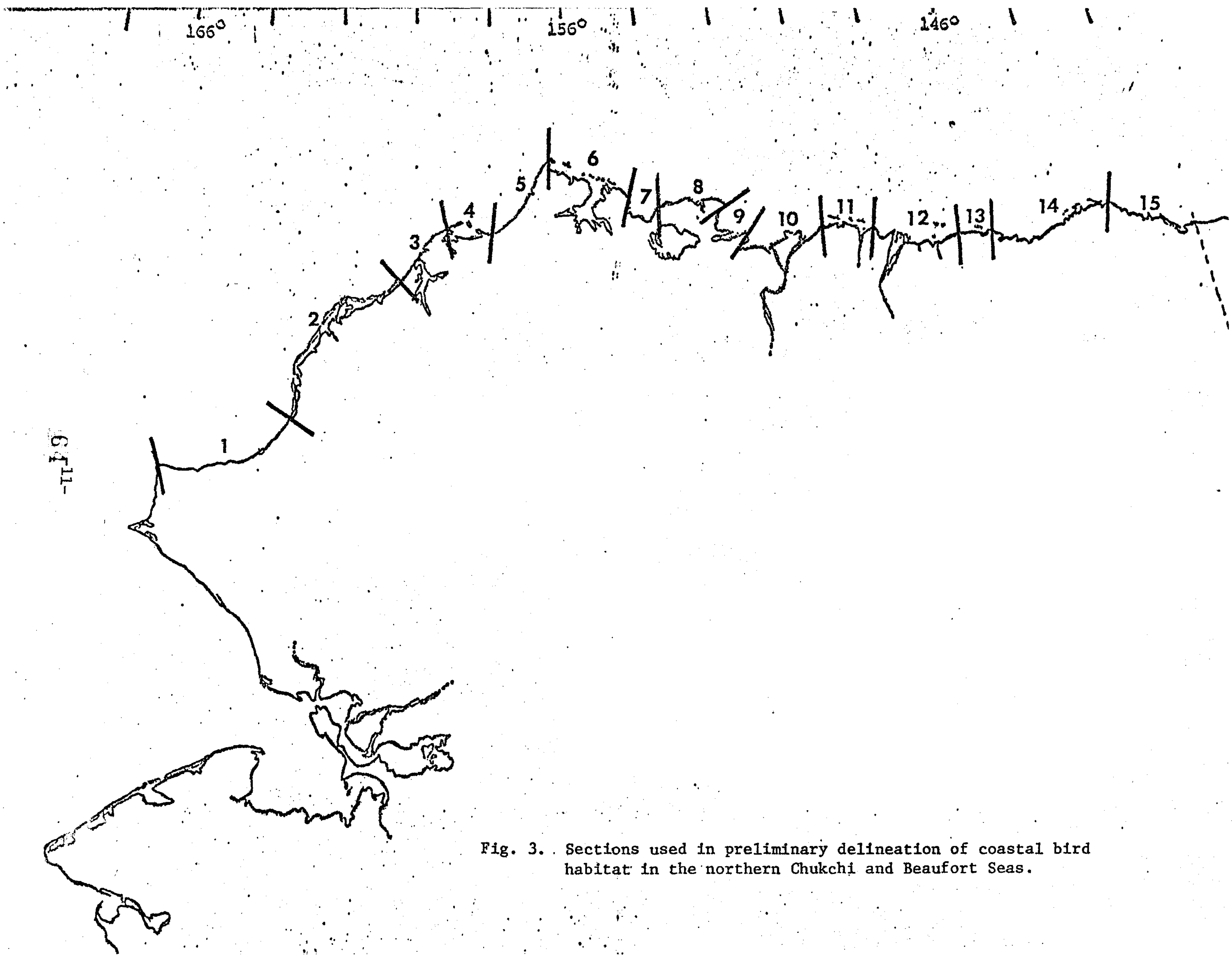

Fig. 3. Sections used in preliminary delineation of coastal bird habitat in the northern Chukchi and Beaufort Seas.

Table 1. Cape Lisburne to Kasegaluk Lagoon - Sect. 1.

Miles of seaward aspect
84 mi.

Barrier islands or spits
none

Lagoons or protected waters

name	area (mi^2)	
Ayugatak	1.88	completely enclosed
Agiak	0.48	" "
Omalik	0.68	" "
Total	3.04	

Rivers
none, however has at least 25 small streams

Nearshore bottom topography
(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
5-7 mi.	10-15 mi.

Coastal relief
(avg. distance mainland shore to contour)

500 foot hills 2 mi. inland

Coastal habitat
Alpine and moist tundra.

Comments

Cape Lisburne is known to have 1 to 2 million breeding cliff nesting seabirds (J. C. Bartonek, pers. comm.), but the remainder of the area is probably of little importance to breeding birds. This is due to the lack of wet tundra, and barrier and delta islands. All of the coastal migrants that breed in the Beaufort and northern Chukchi Seas pass through the region in migration. The importance of the region as a feeding and resting site is not known, however. The inshore waters are shallow enough to provide a large feeding area for benthic feeding species, but since ice scour may be extensive, benthic populations may be small. The completely enclosed lagoons may be of importance since they are the only protected waters in the region.

Table 2. Kasegaluk Lagoon - Sect. 2

Miles of seaward aspect

120 mi.

Barrier islands or spits

name	area (mi^2)	seaward coast (mi)
"southern spit"	2.85	12.75
Naokok to Kukpowruk Pass	1.75	14.6
Pt. Lay Island	2.18	19.6
Akunik to Utukok Pass	2.05	15.0
Solivik Island	3.0	19.0
"Icy Cape Island"	1.62	16.4
Akoliakatat to to Pingorarok Pass	1.4	11.5
"Northern spit"	0.83	9.5
Total	15.6	118.35

Lagoons or protected waters

name	area (mi^2)	depth (ft)
Kasegaluk	360	6

Rivers

name	mi. coastline
Kukpowruk R. and Epizetka R.	4.0
Kokolik R.	1.6
Utukok R.	4.8

Nearshore bottom topography

(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
5 mi.	12 mi.

Blossom shoals (3-4 fathoms) extend 6-8 mi. NW of Icy Cape.

Coastal relief

(avg. distance mainland shore to contour)

50 ft.	100 ft.
1-3 mi.	5-16 mi.

decreasing topographical relief toward Icy Cape.

Coastal habitat

Moist tundra; wet tundra at mouth of Utukok R. and Avak Inlet.

Comments

This is probably the most important section of coast in the northern Chukchi Sea. Almost nothing is known about bird use of this area, however. The barrier islands are important breeding sites for eiders (William Wiseman, pers. comm.). The extensive lagoon area is probably a major molting area for eiders and oldsquaw. The rivers provide many delta islands and are the only major rivers emptying into the northeastern Chukchi Sea (excluding those that enter into Wainwright Inlet).

Table 3. Wainwright - Sect. 3
(Kilimantavi to Atavik)

Miles of seaward aspect
37.6 mi.

Barrier islands or spits
None, however spits are present on each side of Wainwright Inlet (both 2.5 mi^2, 6 mi coastline)

Lagoons or protected waters

name	area (mi^2)	depth (ft.)
Wainwright Inlet	90	6-1/2

Rivers

name	mi. coastline
Sinaruruk R. (protected)	2.8 mi. long inlet
Kungok, Kuk, Ivisaruk and Alatakrok Rivers enter into Wainwright Inlet complex.	

Nearshore bottom topography
(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
1/2 mi.	1-3 mi.

Coastal relief
(avg. distance mainland shore to contour)

50 ft.	100 ft.
1-9 mi.	22-30 mi.

Coastal habitat
Moist tundra.

Comments
Most of this area appears to be of low quality bird use. There are a few breeding areas, and the bottom drops off quickly providing little feeding area. Wainwright Inlet may be an important feeding and resting area, however, and studies are needed to determine the Inlet's importance.

Table 4. Peard Bay - Sect. 4.

Miles of seaward aspect

28 mi.

Barrier islands or spits

name	area (mi²)	seaward coast (mi)
"west spit"	1.66	5.6
Pt. Franklin	1.79	8.2
Seahorse Is. (largest has 20' elevation)	0.1	1.5
"east spit"	0.34	5.4
Total	3.79	20.7

Lagoons or protected waters

name	area (mi²)	depth (ft.)
Peard Bay	23	20'
Kugrua Bay	8.4	10-12'

Rivers

name

Kugrua River enters Kugrua Bay

Several small streams enter bay

Nearshore bottom topography

(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
5-7 mi.	10 mi.

Coastal relief

(avg. distance mainland shore to contour)

50 ft.	100 ft
1/2 mi.	20 mi.

Coastal habitat

Moist tundra bordering coast and the Kugrua R.; wet tundra bordering east and west ends of Kugrua Bay.

Comments

This is one of the few bays along the northern Chukchi coast. The barrier islands are known to support breeding colonies of Arctic Terns and Black Guillemots. The shallow well protected bay may be an important feeding and resting site. In 1975 the bay was completely ice free in August when surrounding waters were covered with ice.

Table 5. Tachinisok Inlet to Pt. Barrow - Sect. 5.

Miles of seaward aspect
60 mi.

Barrier islands or spits
none

Lagoons or protected waters
none

Rivers

name

Walakpa River enters into 4-1/2 mi. long Walakpa Bay.

10-12 small streams

Nearshore bottom topography
(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
.5-1.0 mi.	1-5 mi.

Coastal relief

mod. bluffs (25'-90') present, furrowed by numerous small streams. Almost no beaches adjoin bluffs.

closest 100' elevation, 33 mi. inland.

Coastal habitat

Moist tundra present as a 2 - 2-1/2 mi. wide wide band adjacent to coast. Wet tundra begins 2-1/2 mi. inland.

Comments

Very little suitable habitat for breeding seabirds is available in this region. Resting and feeding areas are few due to the lack of barrier islands, and the very narrow band of shallow water adjacent to the shore.

Table 6. Pt. Barrow to Cape Simpson - Sect. 6.

Miles of seaward aspect

53 mi.

Barrier islands or spits

name	area (mi^2)	seaward coastline (mi)
Doctor Island	.02	.25
Deadman's Is.	0.125	1.3
Tapkaluk Is. complex	0.7	7.8
Cooper Is.	0.6	3.8
Martin Is.	0.28	5.0
Sanigarvak Is.	0.075	1.6
Igalik Is.	0.17	2.0
Kulgurak Is.	0.18	3.25
Tulimanik Is.	0.15	2.5
Total	2.31	27.50

Lagoons or protected waters

name	area (mi^2)	depth (ft.)
Elson	100	9'
Admiralty Bay	225	8-10'
Inaru, Meade Topagoruk, Chipp and Alaktak R. enter Admiralty Bay		
Fatigue Bay (extensive mud flats)	5.6	

Rivers

(see Lagoons, Admiralty Bay)

Nearshore bottom topography

(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
5 mi.	16 mi.

Coastal relief

(avg. distance mainland shore to contour)

50 ft.	100 ft.
43 mi.	60 mi.

Coastal habitat

Wet tundra.

Comments

Although this region has a number of barrier islands, they are all ice bound until late in the season due to the lack of major rivers emptying near the islands. This makes them less important to breeding birds than islands further to the east. The protected waters are extensive, but only one section, Admiralty Bay, has input from rivers. Productivity in areas away from rivers could be low. The low wet tundra on the mainland is important breeding habitat for water birds.

7. Smith Bay - Sect. 7.

Miles of seaward aspect	Barrier Islands or Spits	Lagoons or protected waters
38 mi.	none	none

Rivers name	Rivers mi. coastline	Nearshore bottom topography (avg. distance mainland shore to coastline) 5 fathoms	Nearshore bottom topography (avg. distance mainland shore to coastline) 10 fathoms	Coastal relief (avg. distance mainland shore to coastline) 50 ft.	Coastal relief (avg. distance mainland shore to coastline) 100 ft.
Ikpikpuk and Piasuk R.	18.4 mi.	12 mi.	25 mi.	27 mi.	35 mi.

Coastal habitat

Wet tundra.

Comments

The delta islands of the Ikpikpuk and Piasuk River provide breeding habitat. Although the bay is not protected by barrier islands, it is isolated enough from the ocean to have many of the characteristics of a lagoon. The wide shoal in the bay and the input of river water probably makes the area important for feeding.

Table 8. Drew Point to Cape Halkett - Sect. 8

Miles of seaward aspect

44 mi.

Barrier islands or spits

name	area (mi^2)	seaward coast (mi)
"Pitt Pt. Island"	.04	1.0
Pogik Bay Complex	0.7	2.55
Total	.74	3.55

Lagoons or protected waters

name	area (mi^2)
Pogik Bay	7
small shallow lagoon near Kokruagarok	

Rivers

no rivers, few small streams

Nearshore bottom topography
(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
4 mi.	24 mi.

Coastal relief
(avg. distance mainland shore to contour)

50 ft.	100 ft.
32 mi.	36 mi.

Coastal habitat

Wet tundra.

Comments

The lack of islands makes the area unsuitable for certain species of birds, but the large amount of wet tundra makes it important to other species. The lack of protected waters and rivers makes it unsuitable for extensive feeding.

Table 9. West Harrison Bay - Sect. 9.
(Cape Halkett to Atigaru)

Miles of seaward aspect

38 mi.

Barrier islands or spits

name	area (mi^2)	seaward coast (mi)
Eskimo Is.	.13	1.25
	.34	1.5

(tundra islands; bluffs up to 20 ft. in height)

Lagoons or protected waters

name	area (mi^2)	depth (ft.)
Kogru R. -a series of connected "lakes" that form a 10 mi. long, 18 mi^2 lagoon; entrance depth, 4 ft, but deeper inside.		

Rivers

name	mi coastline
None	
Few small streams	

Nearshore bottom topography
(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
6 mi.	25 mi.

Pacific Shoal - 8 mi. SE Cape Halkett; 3-5 ft. deep and 5 mi. in north-south length.

Coastal relief
(avg. distance mainland shore to contour)

50 ft.	100 ft.
5 mi.	15 mi.

Coastal habitat

Wet tundra.

Comments

Suitable breeding habitat is found only on the mainland. The wide shallow bay could be an important feeding area.

Table 10. Colville River - Sect. 10.
(Atigaru Pt. to Oliktok Pt.)

Miles of seaward aspect

56

Barrier islands or spits

name	area (mi^2)	seaward coast (mi)
Thetis Is.	.14, .05	1.4, 1.25

Lagoons or protected waters

name	area (mi^2)	depth (ft.)
None		

Rivers

name	mi. coastline
Colville R.	32.0

Nearshore bottom topography
(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
8 mi.	22 mi.

Extensive bars and shoals to the E and SE of Atigaru Pt.

Coastal relief
(avg. distance mainland shore to contour)

50 ft.	100 ft.
4 mi.	12 mi.

Coastal habitat

Wet tundra.

Comments

The Colville delta provides numerous delta islands. The river provides open water early in the summer and nutrients throughout the open water period. Bird use of the shoreline area would be expected to be high.

Table 11. Oliktok Pt. to Pt. McIntyre - Sect. 11.

Miles of seaward coast

37.6

Barrier islands or spits

name	area (mi²)	seaward coast (mi)
Spy Is.	.18	3.4
Leavitt Is.	.1	1.6
Pingok Is.	1.6	7.1
Bertoncini Is.	.08	.5
Bodfish Is.	.25	.8
Cottle Is.	.35	4.3
Long Is.	.4	7.0
Egg Is.	.05	1.2
Stump Is.	.16	2.75
Total	3.17	28.65

Lagoons or protected waters

name	area (mi²)	depth (ft.)
Simpson Lagoon	100	6
Gwydyr Bay		3-5

Rivers

name	mi. coastline
Ugnuravik R.	-
Sakonowyak R.	-
Kuparuk R.	6.4

Nearshore bottom topography
(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
4 mi.	11 mi.

Coastal relief
(avg. distance mainland shore to contour)

50 ft.	100 ft.
13 mi.	20 mi.

Coastal habitat

Wet tundra, except moist tundra at Oliktok Pt. and south, and adjacent to Kuparuk R. almost to coast.

Comments

An important region for birds. Birds nest in numbers on the barrier islands and on the mainland tundra. Post-breeding use of the lagoon is high.

Table 12. Pt. McIntyre to Bullen - Sect. 12.

Miles of seaward aspect

46 mi.

Barrier islands or spits

name	area (mi^2)	seaward coast (mi)
Gull Is.	.01	.3
Reindeer Is.	.07	1.6
Argo Is.	.02	.5
Niakuk Is.	.03	.75
Howe Is.	.3	.3
Duck Is.	.02	.3
Foggy Is.	.06	2.0
Cross Is.	.19	2.6
Dinkum Is.	.01	.22
Narwhal Is.	.13	2.2
Jeanette to Karluk Is. complex	.12	3.4
Lion Pt.	.06	1.2
Tigvariak Is.	1.37	2.0
Pole Is.	.22	3.0
Belvedere Is.	.15	3.9
Total	2.76	24.3

Lagoons or protected waters

name	area (mi^2)
Prudhoe Bay	30
Foggy Is. Bay	45
Mikkelsen Bay	35
Total	110

4 mi. wide, 18-27 ft deep channel between mainland and barrier islands.

Rivers

name	mi. coastline
Putuligayuk R.	-
Sagavanirktok R.	16.8
Kadleroshilik R.	-
Shaviovik R.	5.5

Nearshore bottom topography
(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
11 mi.	17 mi.

Coastal relief
(avg. distance mainland shore to contour)

50 ft.	100 ft.
6 mi.	10 mi.

Coastal habitat

Wet tundra.

Comments

The barrier islands are far offshore and are probably visited only infrequently by fox. The lagoon has a deep channel that supports a rich benthic fauna (Peter Barnes, pers. comm.). The Sagavanirktok River provides numerous delta islands.

Table 13. Bullen to Brownlow Pt. - Sect. 13.

Miles of seaward aspect

24 mi.

Barrier islands or spits

name	area (mi²)	seaward coast (mi)
Bullen Pt.	.03	1.0
Pt. Gordon	.06	1.75
Challenge Is.	.04	.07
Alaska Is.	.15	3.7
Duchess Is.	.12	1.8
North Star Is.	.08	1.5
Flaxman Is.	1.33	7.0
Pt. Thompson	.04	1.3
Total	1.85	18.75

Lagoons or protected waters

name	area (mi²)	depth (ft.)
"Challenge-Flaxman lagoon"	60	10

Rivers

name	mi. coastline
Staines (branch of Canning R.)	4.0

Nearshore bottom topography

(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
4 mi.	6 mi.

Coastal relief

(avg. distance mainland shore to contour)

50 ft.	100 ft.
6.5 mi.	8.5 mi.

Coastal habitat

Wet tundra.

Comments

The barrier islands and lagoons provide high bird use areas. The mainland wet tundra is not extensive and is found only in close proximity to the coast.

Table 14. Brownlow Pt. to Jago River - Sect. 14.

Miles of seaward aspect

78.4

Barrier islands or spits

name	area (mi^2)	seaward coast (mi)
Canning R. complex	.48	9.35
Collinson Pt.	.10	2.0
Anderson Pt. complex	.50	5.9
Arey Is.	.53	7.25
Barter Is.	6.10	4.6
Bernard Spit	.45	5.2
Total	8.16	34.3

Lagoons or protected waters

name	area (mi^2)	depth (ft.)
"Canning R. lagoon"	9.5	6
"Anderson Pt.	6.5	6
Arey Lagoon	15.0	6
Kaktovik Lagoon	7.0	10
Total	38.0	

Rivers

name	mi. coastline
Canning R. (excluding Staines R. branch), Tamayariak R.	4.0
Katakturuk R.	1.5
Sadlerochit R.	1.0
Hulahula R., Okpilak R.	5.0
Numerous small streams	

Nearshore bottom topography
(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
4 mi.	7.5 mi.

Coastal relief
(avg. distance mainland shore to contour)

50 ft.	100 ft.
1.5 mi.	3 mi.

Coastal habitat

Wet tundra - Canning R. delta; Sadlerochit R. delta; Hulahula R. to Barter Is.
Moist tundra - Camden Bay.
Sadlerochit R. to Hulahula R.

Comments

The western part of this region contains the Canning River, and has a variety of habitats for breeding birds including delta islands, barrier islands, and wet tundra. The remainder of the area has high coastal relief and few islands. The Hulahula and Okpilak River delta provides delta islands, however.

Table 15. Jago River to U.S./Canada Border - Sect. 15.

Miles of seaward aspect

68 mi.

Barrier islands or spits

name	area (mi^2)	seaward coast (mi)
Jago spit	.25	3.8
Tapkaurak spit	.36	7.25
"Pokok Lagoon spit"	.45	4.5
Angun Lagoon (Humphrey Pt. to Angun Pt.	.30	5.0
Nuvagapak Lagoon complex	.40	7.0
Egaksrak Lagoon complex	.28	3.7
Icy Reef	1.14	16.5
Demarcation Pt.	.25	2.5
Total	3.43	50.3

Lagoons or protected waters

name	area (mi^2)	depth (ft.)
Jago	21	10
Tapkaurak	8	6
Oruktalik	3.5	6
Pokok	57.24	6
Pokok Bay	1.7	10
Angun	3.5	9
Beaufort-Nuvagapak	10.5	6
Egaksrak	14.0	6
Siku	9.0	6
Demarcation Bay	17.0	15
Total	89.1	

Rivers

name	mi. coastline
Jago R.	6
Aichilik-Egaksrak R.	6.4
Kongakut R.	10.0
Numerous small streams	

Nearshore bottom topography
(avg. distance mainland shore to contour)

5 fathoms	10 fathoms
1.0 mi.	3.5 mi.

Coastal relief
(avg. distance mainland shore to contour)

50 ft.	100 ft.
2 mi.	4 mi.

Coastal habitat

Moist tundra along entire coast, except wet tundra at Jago R. and its mouth, mainland adjacent to Beaufort Lagoon, and east side of Demarcation Bay.

Comments

The large river deltas and barrier islands make the area suitable for breeding birds. Coastal habitat drier than further west and less suitable for large numbers of breeding water birds. The Mackenzie River probably plays a major role in influencing conditions in the section.

Cooper Island

Arctic Terns on Cooper Island fed primarily on the mainland during the pre-hatching stage of incubation. Table 16 shows that between 10 and 17 July approximately two birds per hour flew to and from the mainland. No open water was present between the island and the mainland and we assumed that all birds flying south of the island were feeding on tundra ponds. One bird collected as it flew back to the island had insects in its stomach. Flights on the north side of the island were much less common. Between 0800 and 1800 no tern flights were observed on the north side of the island during the pre-hatching period. No similar phenomenon was observed on the south side of the island. This will be studied further in 1976 to determine if a mid-day period of inactivity on the north side is a regular occurrence.

Observations during hatching (Table 17) show that flights both to the north and south increase after hatching. Arctic cod become an important food item at this time with more than half of the birds returning from the north carrying fish.

In addition to flying to the mainland for insects, terns also fed in the lagoon south of the island. While no specimens were collected, it appeared that the terns were feeding on amphipods. It is of interest that no terns flying to the island from the south were observed carrying Arctic cod. This indicates that the ice in the lagoon does not support Arctic cod populations as does the ice outside of the islands.

In order to assess the potential importance of the moat surroundi the island surface and bottom plankton tows were taken at a number of stations on 11 July. The volumes taken in these tows are shown in Fig. 4. An aerial photo of the moat is shown in Fig. 5. Mysids made up over 90 percent of the volume of the tows. They were most common in the bottom tows and few were taken on the south side. Small numbers of amphipods were taken in most tows and these were occasionally common at the surface unlike mysids. On the basis of these tows and from observations of birds feeding in the moat, it is concluded that the moat is of little importance as a feeding area, except for irregular feeding on small surface amphipods. Large benthic isopods which occur in the moat but were not taken in tows appear to be the only food items in the moat that may be of regular importance to birds.

Information on breeding chronology and nesting success on Cooper Island were gathered so they can be compared with years in which ice cover differs. The 1975 information proved quite interestir by itself, however. Hatching success was high for both Black Guillemots and Arctic Terns (Tables 18 and 19). Both species had hatching success greater than any previously published findings. Black Guillemots also had a very high fledging success. No data is available on Arctic Tern fledging success but survival of Arctic Tern young after one week was high.

Table 16. Cooper Island 1975. 10,12-17 July - Pre-hatching period Arctic Tern flights.

	North Side		South Side	
Time	Flights North	Flights South	Flights North	Flights South
0-0100	0	0	0	0
0100-0200	0	0	0	0
0200-0300	0	1F	0	0
0300-0400	2	1,2F*	2	1
0400-0500	0	3,1F	1	1
0500-0600	2	2	1	3
0600-0700	0	2	2	0
0700-0800	0	2,1F	0	4
0800-0900	0	0	0	0
0900-1000	0	0	2	3
1000-1100	0	0	2	4
1100-1200	0	0	1	6
1200-1300	0	0	2	7
1300-1400	0	0	7	3
1400-1500	0	0	1	2
1500-1600	0	0	4	0
1600-1700	0	0	2	2
1700-1800	0	0	1	0
1800-1900	1	0	0	1
1900-2000	0	1	10	5
2000-2100	1	2	10	3
2100-2200	0	1	0	0
2200-2300	0	2	0	0
2300-2400	0	1	2	4
Totals	6 .25/hr.	22 (5 w/fish) .92/hr.	50 2.08/hr.	49 2.04/hr.

*F indicates bird carrying fish.

Table 17. Cooper Island 1975. 18-22 July - During Hatching, Arctic Tern flights.

	North Side		South Side	
Time	Flights North	Flights South	Flights North	Flights South
0-100				
0100-0200				
0200-0300				
0300-0400				
0400-0500				
0500-0600				
0600-0700				
0700-0800				
0800-0900				
0900-1000	8	1	24	16
1000-1100	11	6	7	11
1100-1200	7	1,7F*	6	0
1200-1300				
1300-1400				
1400-1500	0	3	6	5
1500-1600				
1600-1700	1	3,4F	6	0
1700-1800 (2 watches)	2 & 11	3,3F & 9,1F	5 & 6	3 & 0
1800-1900				
1900-2000	11	5,8F	2	2
2000-2100				
2100-2200				
2200-2300	0	5F	0	1
2300-2400				
Totals	51 5.66/hr	59 (28 w/fish) 6.6/hr.	62 6.9/hr.	38 4.2/hr.

*F indicates bird carrying fish.

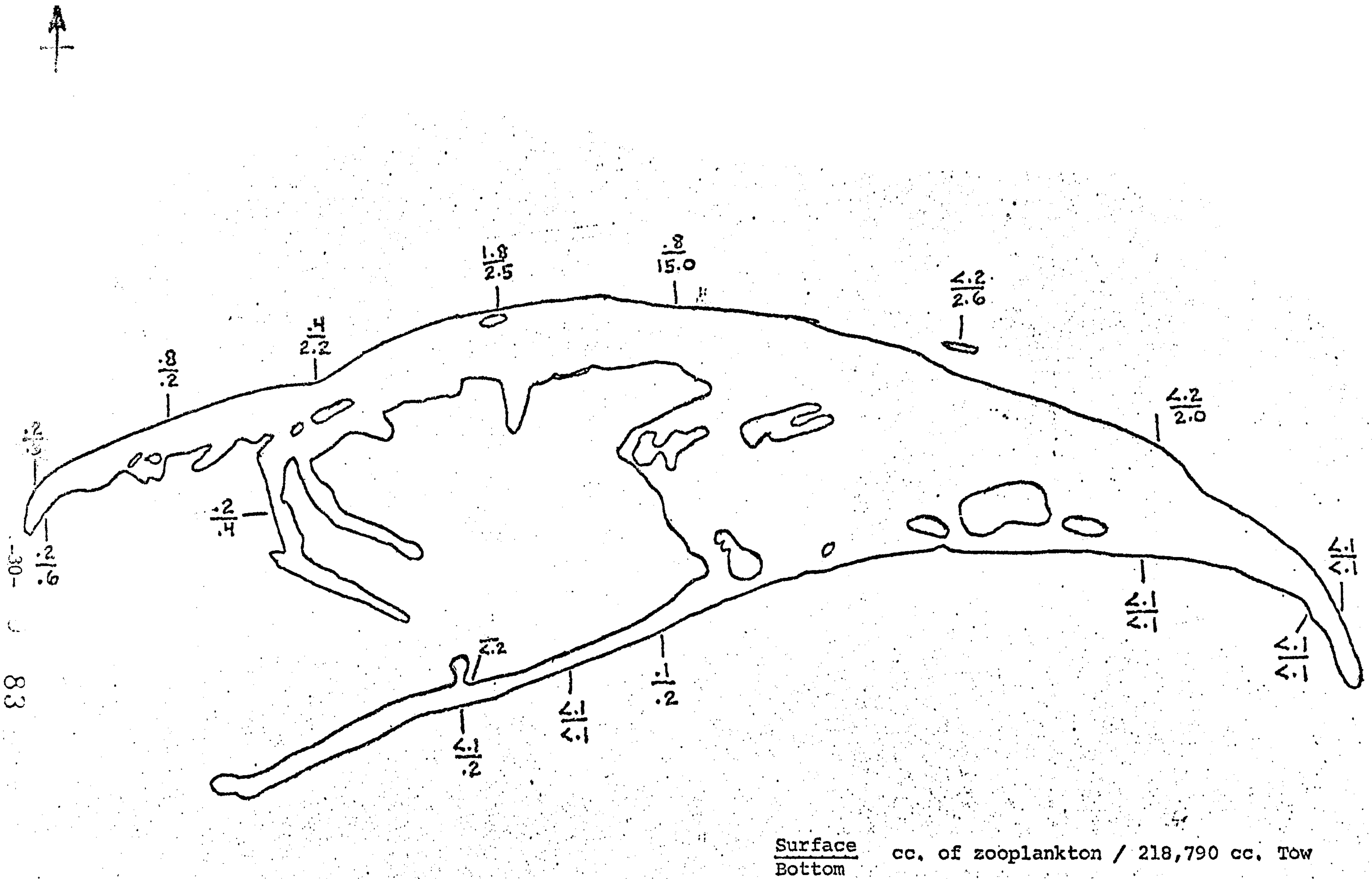

Fig. 4. Cooper Island, Beaufort Sea 11 July 1975.

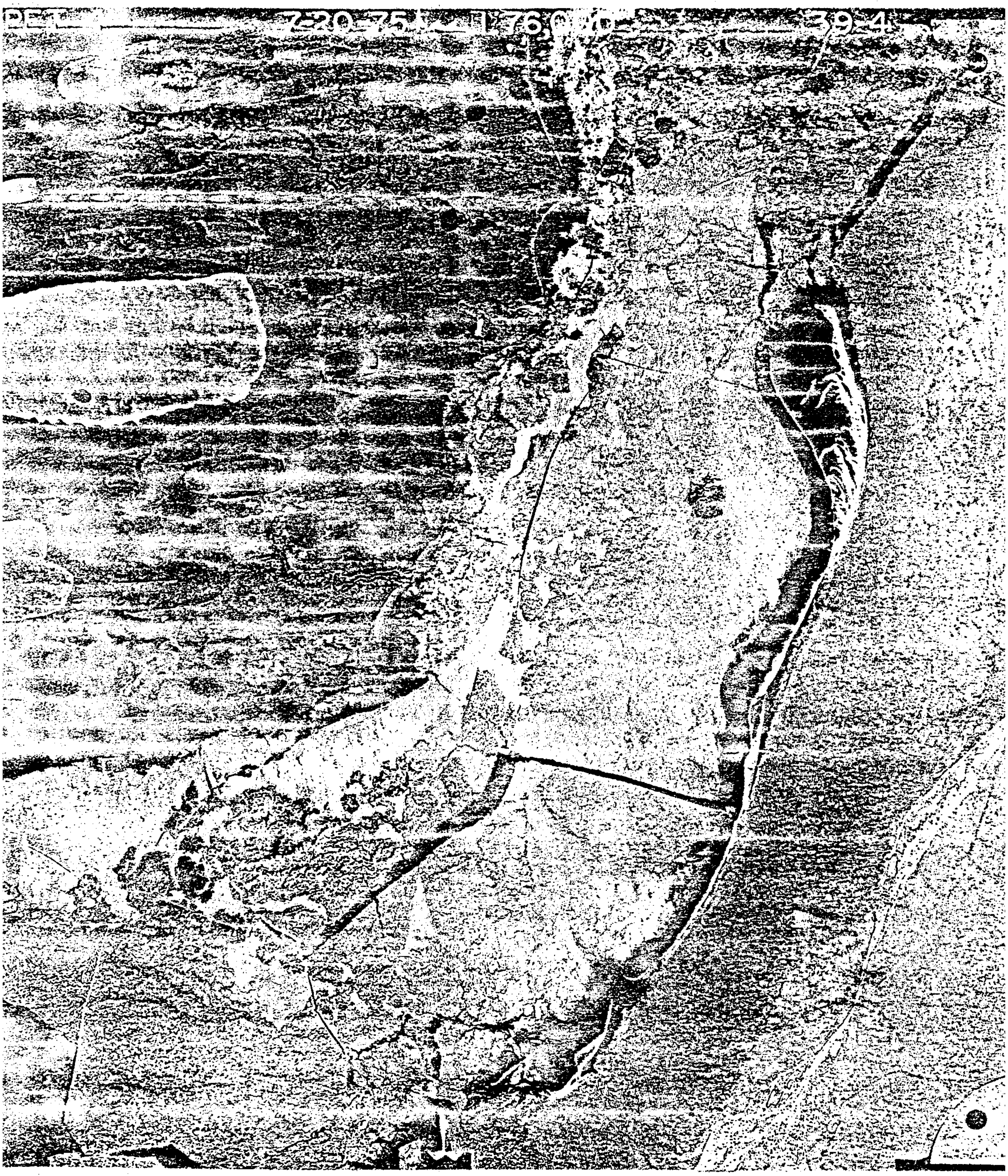

Fig. 5. Cooper Island aerial photograph, 20 July 1975.

Table 18. Black Guillemot breeding data, Cooper Island, Beaufort Sea, 1975.

Number of nests: 17
Average clutch size: 1.8

Approximate dates of laying:

	July								
	1	3	5	6	10	15	17	21	22
No. of eggs	10	6	4	1	1	5	1	2	1

Approximate dates of hatching:

	July		August						
	29	31	2	3	7	12	14	18	19
No. of eggs	10	6	4	1	1	5	1	2	1

Hatching and Fledging Success

No. of eggs: 31
No. of dead eggs: 1
No of eggs hatched: 30 (96.78%)
No. of young hatched/nest: 1.77
No. of young fledged: 25 minimum (80.7%)
29 maximum (93.6%)

Table 19. Arctic Tern breeding data, Cooper Island, Beaufort Sea, 1975.

Number of nests: 51
Average clutch size: 1.9

Approximate dates of laying (calculation based on 22 days incubation):

	June						July	
	23	25	27	28	29	30	1	2
No of eggs	1	11	20	2	28	15	3	3

Approximate dates hf Hatching (includes projected dates):

	July							
	15	17	19	20	21	22	23	24
No. of eggs	1	11	20	2	28	15	3	3

Hatching Success
- No. of eggs: 97
- No. of dead eggs: 7
- No. of young died in hatching: 7
- No. of eggs hatched: 83 (85.6%)
- No. of young hatched/nest: 1.6

Number of young alive after first week: 67 individuals
1.3/nest

Barrow

Observations of birds feeding at the shoreline at Barrow in mid-September provided information on food during migration. Red Phalaropes, Sabine's Gulls and Ross' Gulls were all feeding on an assemblage of invertebrates found at the water's edge. The stomach contents of Ross' Gulls collected at Cooper Island and Barrow are included in a paper on the feeding habits of Ivory and Ross' Gulls to be published in the next issue of Condor. A copy of the manuscript is attached to this report.

VIII. Conclusions

R.U. 3/4

The preliminary delineation of coastal bird habitat in the northern Chukchi and Beaufort Sea presented in this report show that certain areas would be expected to have little bird use while other areas will have intensive bird use. Field work being conducted in 1976 will determine how important each of the areas is. Once the relative importance of each area and the habitats within an area are determined, specific results of petroleum related impacts can be determined.

R.U. 330/196

No specific information from the at-sea observations made in 1975 is yet available. The Bering Sea May observations provided information on birds in the ice during a time that has not been studied before. From the 1975 data it is obvious that by May the species that winter in the Bering Sea pack ice have moved north and have been replaced by birds that breed and summer in the Bering Sea.

Observations made in the Chukchi Sea in August provide information from an anomolous year when bird densities were low and certain species were absent from the Chukchi. Information such as this will allow more accurate determinations of what population changes are due to oceanographic effects and which are the result of petroleum related factors.

Breeding and feeding data obtained on Cooper Island demonstrated how important the ice and its associated fauna is to certain species. The Arctic cod associated with the ice is the apparent reason why nesting success was so high for Black Guillemots and Arctic Terns. It was also demonstrated that while tundra ponds on the mainland are important to Arctic Terns during the pre-hatching period, the area north of the island becomes important after the chicks hatch.

IX. Needs for futher study

R.U. 3/4

Because no field work has been done on this project it is impossible at this time to suggest future topics for study. This season's field work will undoubtedly provide the basis for directing future studies.

R.U. 330/196

Pelagic observations made over the past six years provide information on birds in the pack ice in the Bering Sea in winter and in the Chukchi and Beaufort Seas in summer and fall. The period between October and March has had almost no observations, however. Aerial or small boat surveys are needed during this period.

For those periods and areas where the species and relative numbers of birds are known the most pressing need is an understanding of what the birds are feeding on so that the relative importance of organisms under the ice, in the water column and on the bottom can be determined.

Observations made in 1975 show that barrier islands may be most important as loafing areas. While 1975 work stressed the birds breeding on Cooper Island, in 1976 much time will be spent on the island's role as a loafing and feeding site.

X. Summary of fouth quarter activities

A. Ship or laboratory schedule

1. Field trip schedule

12-14 January	Divoky attends OCS coastal-littoral workshop in Seattle
9-10 February	Divoky attends pre-cruise meeting at PMC in Seattle

2. Data analyzed and methods

a. Number and types of samples

26 plankton tows.

b. Types of analyses

Volume of each order in tow were determined; average size of organisms in each group were determine(

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THE PELAGIC FEEDING HABITS OF IVORY AND ROSS' GULLS

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Little information is available on the pelagic feeding habits of the Ivory Gull (Pagophila eburnea) and Ross' Gull (Rhodotethia rosea). This paper reports the food found in the stomachs of 13 Ivory and 24 Ross' Gulls collected from an icebreaker in the Chukchi Sea and 7 Ross' Gulls collected from shore near Point Barrow, Alaska. Observation on the feeding behavior of these two species in the Chukchi, Beaufort and Bering Seas are also presented and the importance of sea ice as a feeding area is discussed.

Specimens were collected in the eastern Chukchi Sea between 24 September and 9 October southwest of Point Barrow and north of Cape Lisburne (for specific localities see Watson and Divoky 1972). With one exception, all birds were collected at the edge of the pack ice, either in leads or in the brash ice just south of the consolidated pack. Sea surface temperatures ranged from -1.8° to 1.7°C. A single Ross' Gull was collected in an ice free area with a sea surface temperature of 3.1°C. Seven Ross' Gulls were collected from shore in 1975; 2 at Cooper Island 32 km east of Point Barrow on 4 September and 5 at Point Barrow between 9 and 18 September. Pack ice was visible 2 to 3 km from shore and grounded ice floes were present on some of the shoreline. Sea surface temperatures ranged from 1.5° to 0°C at both these localities.

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Ross' Gulls were observed in the Chukchi Sea in summer and fall and Beaufort Sea in fall; Ivory Gulls in the Beaufort Sea in summer, Chukchi Sea in fall and Bering Sea in winter. Terms used to describe feeding methods are from Ashmole and Ashmole (1967:70-71).

IVORY GULL

Juvenile arctic cod (Boreogadus saida) was the primary food in Ivory Gull stomachs (Table 1), usually indicated by the presence of otoliths. The otoliths ranged from 1 to 6.5 mm, corresponding to fish of approximately 40 to 140 mm total length. Two benthic tunicates found in one stomach must have been taken after they floated to the surface. A single amphipod, Apherusa glacialis, was present in one stomach. Potentilla sp. seeds were present in two stomachs.

Ivory Gulls were observed feeding by hovering and contact dipping. Most fed within 2 to 3 m of the ice. They were observed sitting on the water only three times, but were not feeding. When the ship was breaking ice in the Beaufort and Chukchi Seas, the propellers frequently washed arctic cod onto ice floes. These were eaten by Ivory and other gulls. In the Bering Sea, Ivory Gulls fed on small, unidentifiable items washed onto the ice by natural waves (Fig. 1). In the Chukchi Sea flocks of these Gulls were twice seen flying over surfacing whales and may have been feeding on items brought to the surface by them. Garbage thrown on the ice was often scavenged, natural refuse only rarely. In the Chukchi

Sea in fall a single Ivory Gull was observed picking at walrus (Odobenus rosmarus) feces on an ice floe.

It frequently is stated that the Ivory Gull depends on the carcasses and feces of pack ice mammals for much of its food (Salomonsen 1950:290-292; Dement'ev et al. 1969:467; Lovenskiold 1964:271). Seals killed by polar bears (Ursus maritimus) are thought to be a major food source (Summerhayes and Elton 1928). Thus, Birkenmajer (1972) attributed the decline of the Ivory Gull population on Spitsbergen to a declining polar bear population. Kurotshkin (1970) explained the high mobility of the Ivory Gull's jaw on the basis of a staple winter diet of frozen polar bear, seal and walrus feces.

Little evidence from the western Arctic supports these ideas of the Ivory Gull's dietary dependency. I saw no Ivory Gulls in association with 20 polar bears observed in the Beaufort Sea or the 15 observed in the Chukchi Sea (Watson and Divoky 1972 and Divoky in prep.). Polar bears are common in both these seas in winter but Ivory Gulls leave as the ice edge advances southward into the Bering Sea (Bailey 1948:264). They are found there in the loose ice at the southern edge of the pack in the general vicinity of St. Matthew Island (Irving et al. 1970; Divoky in prep.). This is outside the range of the polar bear which now rarely occurs south of St. Lawrence Island (Jack W. Lentfer pers. comm.).

Evidence suggesting that pinnipeds supply a major food source in the western Arctic also is lacking. The walrus would provide the most constant and readily available food source because it hauls out on the ice more frequently than other pinnipeds and leaves ice floes covered with feces. While Ivory Gulls in the Chukchi Sea in fall commonly were seen in areas where walrus feces were plentiful on the ice, only one instance of scavenging on the feces was recorded. Although Ryder (1957) observed Ivory Gulls in the Bering Sea in February feeding among walruses on ice floes, I found them in the Bering Sea in February and March to be well south of the large concentrations of walrus (Divoky in prep.). Ryder also observed Ivory Gulls, as well as Black-legged Kittiwakes (Rissa tridactyla) and Glaucous Gulls (Larus hyperboreus), feeding on seal carcasses. Seals probably provide little food except in April and May when all the pack ice pinnipeds are whelping and placentas may be a major food source as they are in parts of the eastern Arctic (Tuck 1960:104-105).

Zooplankton may be an important food item in the spring when Ivory Gulls move north into the Chukchi Sea (Bailey 1948:247). During that season Brower found Ivory Gulls to be more common at Barrow during westerly winds when they fed on an "invertebrate scum" floating on the water's surface (Bailey 1948:248).

Stomachs of Ivory Gulls from the eastern Arctic contain primarily fish and invertebrates. Manniche (1910) found mainly fish bones and crustaceans although he also found insects in the stomach of one summer bird and a piece of seal flesh in another. The stomach of a gull collected off Greenland (Cottam 1936) contained primarily invertebrates, including 115 Thysanoessa inermis, 5 Apherusa glacialis and traces of arctic cod and copepods. An Ivory Gull shot at a glacier face was full of Thysanoessa sp. (Hartley and Fisher 1936). Jackson (1899:419-420) found "shrimps", fish, pelecypod shells and brown algae in the stomachs of nine birds. Only small crustaceans were present in the birds examined by Kumlien (1879).

Fish and invertebrates are probably the primary food during breeding. Bateson and Plowright (1959) saw mostly fish and crustaceans being fed to young. The two birds collected contained only arctic cod. Montague (1926) found fish and carrion in the stomachs of birds collected at breeding sites.

Although scavenging by Ivory Gulls has been recorded often in the eastern Arctic (e.g. Lovenskiold 1964:271-272), there is no evidence that such scavenging provides most of the diet throughout the year. Much of the scavenging observed was on garbage and carrion provided by man. Many species of gull will use such refuse, but there is no evidence that scavenging by birds not associated with man is as frequent. Apparently the Ivory Gull's habit of rarely sitting on the water has reinforced the view that it is unable to obtain food from the water and that scavenging on carrion and feces constitutes the bulk of its feeding activity. Montague (1926) surmised that fishes found in Ivory Gull stomachs were not obtained from the water but were picked up after being dropped by other birds. As this paper and previously published reports on stomach contents show, the Ivory Gull does obtain much of its food from the water.

The role that pack ice mammals play in providing food for the Ivory Gull cannot be ascertained until regular observations of feeding activity are made throughout the year in various regions; however the species certainly is not as dependent on pack ice mammals as previous authors have stated. Rather the Ivory Gull appears to feed primarly on fish and invertebrates associated with the ice and to a lesser extent on the feces and carcasses of mammals found at the pack ice edge.

ROSS' GULL

Juvenile arctic cod were found in 79 percent of the Ross' Gull stomachs collected at sea (Table 1). Otolith size was the same as in the Ivory Gull. Because otoliths persist in the stomach for some time the relative importance of arctic cod as a food item is probably exaggerated. Amphipods were an important part of the diet in the Chukchi Sea, being present in 54 percent of the stomachs. Apherusa glacialis was the most abundant amphipod; one stomach contained 160, six contained between 40 and 90 and three contained less than 5. Three Anonyx nugax, two probable Gammarus locusta and one Atylus bruggeni also were found. Four stomachs contained ventral setae of an echiuroid worm. Echiuroids are benthic organisms and are too large to be a food item for Ross' Gull even if they floated to the surface. Walrus and bearded seal (Erignathus barbatus) feed on echiuroids (John J. Burns pers. comm.) and it seems likely that Ross' Gulls ingested the spines while feeding on feces. The setae are highly chitinized and could pass through a pinniped digestive tract and remain intact. One stomach contained five setae. A piece of coleopteran exoskeleton present in one of the stomachs apparently had persisted from the breeding season when insects are the primary food (Buturlin 1906). Previous accounts of the pelagic feeding habits of the Ross' Gull are rare. Collett and Nansen (1900) found the crustacean Hymenodora glacialis and arctic cod in eight birds and Gammarus locusta in one.

Ross' Gulls collected from shore were feeding primarily on a diverse assemblage of invertebrates (table 2). Arctic cod though present in 57 percent of the stomachs was usually only represented by single skeletal elements. This differed from birds collected at sea which frequently contained whole fish. Apherusa glacialis was present in 71 percent of the stomachs though the number per stomach was less than birds collected at sea; one stomach contained 35 and the rest had less than 20 each. Chaetognaths though present in only 29 percent of the stomachs were numerous in each there being 75 in one and 40 in the other. The other invertebrates present in the stomachs were each represented by less than five individuals. Sedge seeds present in one stomach were being fed upon at the shoreline as indicated by a number of seeds present in the esophagus.

At sea, Ross' Gulls fed primarily within 2-3 m of ice usually by hovering and surface feeding. In more open water birds usually plunged to the surface. When plunging to the surface little submersion of the body would occur. Ross' Gulls were not attracted to the ship's garbage. The only scavenging I observed was by a single bird feeding on walrus feces on an ice floe.

Ross' Gulls observed feeding near shore were usually in or near flocks of surface feeding Red Phalaropes (Phalaropus fulicarius) and Sabine's Gull (Xema sabini). Such flocks were usually within 3 m of the shoreline. Ross' Gulls associated with these flocks would feed by contact dipping, plunging to the surface and wading at the water's edge. In such situations Ross' Gulls appeared to be minimizing the amount of time their plumage was in contact with the water. Birds plunging to the surface would take flight a few seconds after hitting the water. Birds wading in the water would avoid depths where they would have to swim. Such behavior probably accounts for Dement'ev et al. (1969:487) and Salomonsen (1972) stating that Ross' Gulls rarely, if ever, sit on saltwater. My observations at sea, however, show that sitting on water is not uncommon.

DISCUSSION

Observations made during the period when the Ivory and Ross' Gulls were collected at sea showed both species to be found more frequently at the edge of the ice pack than in the open water south of it (Divoky 1972; Watson and Divoky 1972). The apparent reasons for this was the abundance and availability of prey organisms associated with ice. Arctic cod and *Apherusa glacialis* are both part of an under-ice fauna that may be an important food source for several species of arctic seabirds.

The under-ice biota is poorly known, and only fragmentary information is available on its component species. Phytoplankton blooms occur in and on the underside of sea ice (Apollonio 1961). At least in areas with multi-year ice the phytoplankton associated with the ice supports an under-ice zooplankton community. Amphipods are a major part of this community and are found either swimming in the water directly below the ice or clinging to its undersurface. Some amphipod species are found under the ice only in winter and are dispersed by meltwater in spring (Mohr and Geiger 1968). Others, including *Apherusa glacialis*, are found under the ice throughout the year (MacGinitie 1955). Although the arctic cod is found in open water away from the ice (Alverson and Wilimovsky 1966; Quast 1974), it is common under the ice where it evidently feeds on under-ice organisms.

The lack of techniques for quantitatively sampling the under-ice fauna precludes comparison of prey densities between ice and open water areas. Observations and sampling in the Chukchi Sea at the time the birds were collected does, however, allow some comments about the two areas. Trawling in open water south of the pack ice showed that arctic cod were uncommon in the upper 11 of water (Quast 1974). Conversely, observations showed arctic cod were common in the surface waters next to ice floes. Vertical plankton tows showed zooplankton to be scarce in the water column both next to the ice and in open water (B. L. Wing in prep.). That these plankton tows failed to sample the organisms associated with the ice is indicated by their failure to catch Apherusa glacialis which was so common in stomachs of Ross' Gulls from the same areas.

The prey organisms associated with the ice are probably easier for birds to locate than surface organisms in open water. The ice acts as a windbreak, and surface waters on the lee side are relatively calm, providing increased visibility. Also, arctic cod swimming over underwater ice shelves are highly visible from above.

Although the ice associated fauna is the major food source in fall for the Ivory and Ross' Gull, the latter species is also seen at the shore at Barrow (Gabrielson and Lincoln 1959:463) where chaetognaths, crab zoea and other invertebrates are abundant. Ivory Gulls do not utilize this food source and only are occasionally seen from land at Barrow (Bailey 1948:247-248).

While both species are found primarily at the ice edge in the Chukchi Sea in fall they differ in their association with ice during the remainder of the year. Ivory Gulls are dependent on ice during the breeding season. Breeding colonies are usually close to the pack ice or glaciers. Glacier faces provide a concentration of organisms at the water's surface due to upwelling of nutrient rich waters (Hartley and

Fisher 1936; Hartley and Dunbar 1938). The importance of the ice to the Ivory Gull during the breeding season is suggested by the observation of Dalgety (1932) that the average clutch size was smaller in a year with little ice than it was in a year with more ice. Montague (1926) believed that adult birds fly to the pack ice for food for their young. Traditional breeding colonies of the Ivory Gull may be deserted as a result of ice disappearing from the area (Birkenmajer 1972).

In contrast to the Ivory Gull the Ross' Gull has no association with the pack ice during breeding but nests on river deltas where the primary food is insects. Immediately after breeding, however, Ross' gulls move north to the pack ice (Buturlin 1906).

During the winter both species are associated with the pack ice but occupy ecologically distinct areas. Ross' Gulls apparently winter primarily in the Arctic Ocean (Bailey 1948:252) with only a small number passing through the Bering Strait (Fay and Cade 1959). Ivory Gulls, however, winter primarily at the ice edge in the Bering Sea with few, if any, individuals remaining in the Arctic Ocean. Most of the ice in the Arctic Ocean is multi-year ice and is capable of supporting a well-developed under ice fauna. Almost all of the ice in the Bering Sea is first year ice and while it supports an in and under ice plankton bloom (McRoy and Goering 1974) it does not have time to develop ice associated zooplankton and arctic cod populations. Thus, while Ross' Gulls probably feed on the under ice fauna during the winter Ivory Gulls winter in an area where the fauna is not present.

Primary productivity in the Bering Sea in winter is low except for the phytoplankton bloom occurring in the ice and one occurring in the surface waters at the southern edge of the ice (McRoy and Goering 1974). Because the bloom occuring in the ice is not available to grazing zooplanktons the ice edge bloom is the only food source available to zooplankton near the water's surface. While no sampling of fish or zooplankton associated with this bloom has been conducted it seems likely that organisms supported by the bloom provide food for the Ivory Gull. This would explain the association of Ivory Gulls with the southern edge of the Bering Sea ice (Divoky in prep.). In spring when the ice begins to melt the phytoplankton in the ice is released into the water making the ice edge bloom less important.

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TABLE 1. Frequency of occurrence of food items in stomachs of Ivory Gulls and Ross' Gulls collected in the Chukchi Sea in fall.

Food Items	Ivory Gull no.	Ivory Gull % Freq.	Ross' Gull no.	Ross' Gull % Freq.
(Sample size)	(13)		(24)	
Arctic cod (*Boreogadus saida*)	12	92	19	79
Amphipods	1	8	13	54
Apherusa glacialis	1	8	10	42
Anonyx nugax			1	4
Gammarus locusta			1	4
Atylus bruggeni			1	4
Unidentified			2	8
Echiuroid worm (*Echiurus echiurus*)			4	17
Pyurid ascidian	1	8		
Coleoptera			1	4
Plant material	3	23		
Phaeophyceae (brown algae)	1	8		
Potentilla sp. seeds	2	15		
Ship's refuse	1			

TABLE 2. Frequency of occurrence of food items in stomachs of Ross' Gulls collected from land near Point Barrow, Alaska in early September.

Food Items	No.	% Freq.
Sample size	(7)	
Arctic cod (*Boreogadus saida*)	4	57
Amphipods	5	71
Apherusa glacialis	5	71
Onisimus litoralis	1	14
Chaetognaths	2	29
Copepods	2	29
Mysids	1	14
Euphausids	1	14
Decapods	1	14
Polychaetes	1	14
Cyperaceae seeds	1	14

Environmental Assessment of the Alaskan Continental Shelf

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