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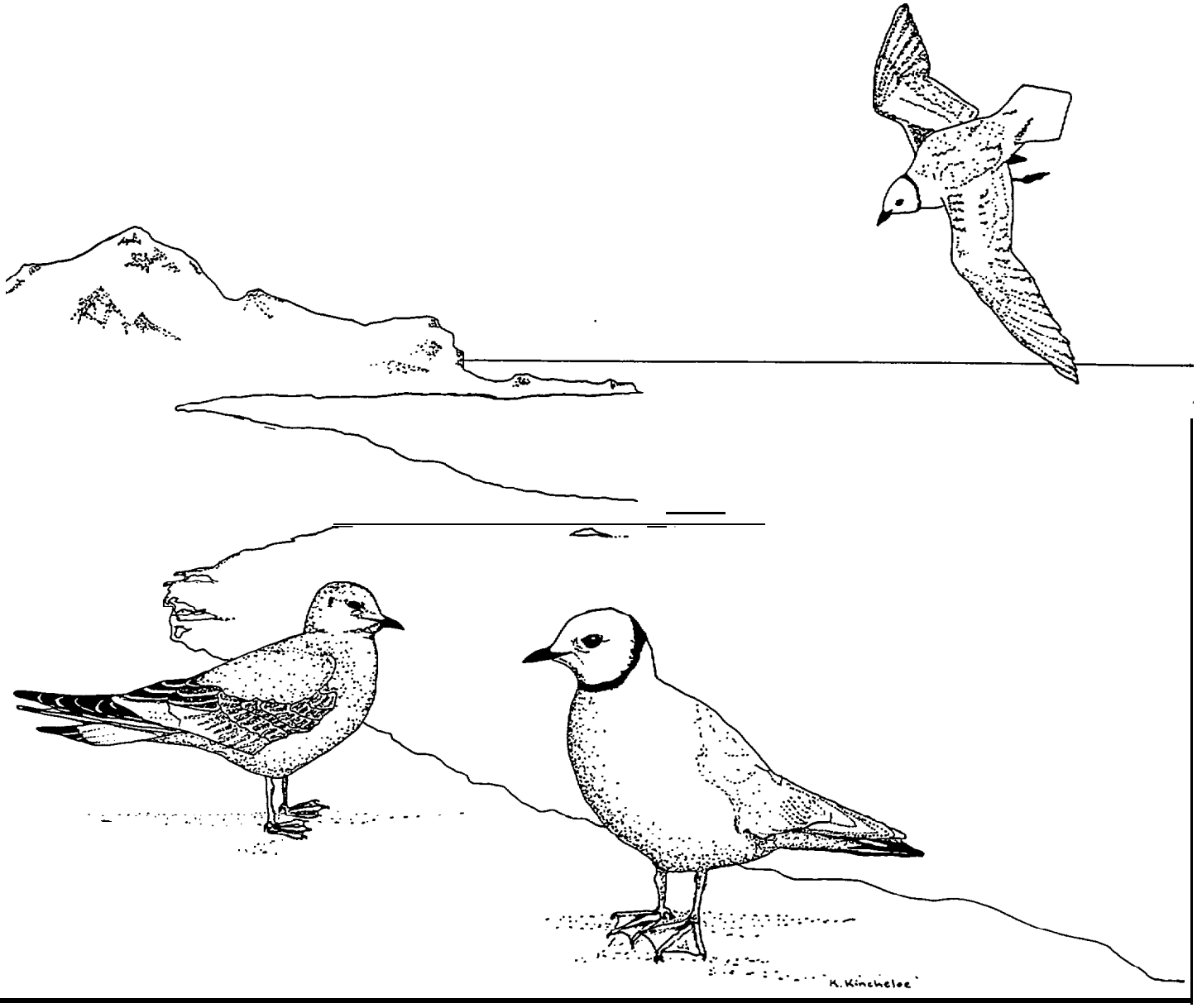
OCS Study
MMS 88-0023

Alaska Fish and Wildlife Research Center

Monitoring Seabird Populations in Areas of Oil and Gas Development on the Alaskan Continental Shelf:

Fall Migration of Ross' Gull (*Rhodostethia* roses) in Alaskan Chukchi and Beaufort Seas

Fins/ Report



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Fall Migration of Ross' Gull (*Rhodostethia rosea*) in Alaskan Chukchi and Beaufort Seas

by

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ABSTRACT

Ross ' Gulls (Rhodostethia rosea) are a major component of the pelagic avifauna of the Alaskan Chukchi and Beaufort seas in fall. Until recently, however, their distribution, abundance, and phenology of occurrence in Alaskan waters was poorly known. Since 1970, a combination of shipboard, aerial, and land-based surveys has revealed the major features of this species' post-breeding movements in Alaska.

Beginning about mid-September, Ross' Gulls move from the Soviet Chukchi to the Point Barrow region, and then into the Beaufort Sea in late September or early October. There is a return movement into the Chukchi in mid- to late October. After returning from the Beaufort, Ross' Gulls stay at the Chukchi ice edge, apparently moving into the Bering Sea as the Chukchi freezes over in November.

The reasons why Ross' Gulls enter the Beaufort Sea in late September to mid-October remain unknown, but coastal densities appear to be related to the availability of zooplankton concentrations. Birds are found in shoreline habitats from the village of Wainwright on the Chukchi coast to Cape Halkett, adjacent to Harrison Bay in the Beaufort. The highest shoreline densities are found from Point Barrow to Tangent Point. During three years of observations at Point Barrow (1984, 1986, and 1987), estimated numbers of migrating Ross' Gulls ranged from 4,500 to 16,000 birds headed east, and 3,500 to 10,000 birds moving west. Although a few birds were seen as early as 21 September in 1987, most of the eastward migration occurred between 29 September and 1 October in all three years. Similarly, the westward migration seems to have ended within a narrow range of calendar dates, 14-19 October, in all three years.

A sizeable movement of Ivory Gulls (Pagophila eburnea) past Point Barrow was seen in one year (1984), but the regularity of Ivory Gull migration in this region remains unclear. A west to east migration and return of Ivory Gulls may occur after mid-October each year, but additional late fall observations in the vicinity of Point Barrow are needed to confirm that possibility.

Population estimates for Alaska (20,000 - 40,000 birds) suggest that in any given year, a large proportion of the world population of Ross' Gulls may reside in the nearshore zone of the Chukchi and Beaufort seas, but

information from Soviet waters during fall is needed to confirm this. Management plans for this species should address the timing of eastward and westward migrations, the proximity to shore of the ice edge and its influence on concentrating Ross' Gulls, and the nature and importance of the birds' presumed prey base in the Beaufort Sea.

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CHAPTER 1. Introduction

1.1 Background and Objectives

Ross' Gull (*Rhodostethia rosea*) is one of the least studied of northern hemisphere seabirds. Known only from scattered collected individuals until late in the last century, it was not observed in numbers until 1881, when a large fall migration was seen at Point Barrow (Murdoch 1885) (Fig. 1.1). Its breeding grounds were not discovered until 1905, when large numbers were found nesting in eastern Siberia on the wet tundra of the Kolyma and Indigirka river deltas (Buturlin 1906) (Fig. 1.1). Little of substance has been added to our knowledge of the distribution of Ross' Gulls since these initial findings. A small number of nesting pairs have been recorded from a number of locations in the eastern and western arctic (Cramp 1983) but nesting in locations away from the Siberian breeding grounds appears to be temporary in nature and always involves small numbers of birds. Point Barrow remains the only location away from the principal breeding area where the species is both regular and abundant. Ross' Gull is one of the few northern hemisphere species whose principal wintering areas remain unknown.

Following the initial observations of a fall passage at Point Barrow, observers have regularly recorded the species there in September and October (Bailey 1948, Gabrielson and Lincoln 1959, Kessel and Gibson 1978). Few accounts of the passage have been detailed in nature and none has included systematic quantitative observations conducted over the duration of the movement. Almost all observers have noted an eastward or northeastward direction of movement, whereas the lack of observations of a return movement to the west has led to speculation that the species winters in the Arctic Basin (Bailey 1948). This hypothesis gained credibility (Blomquist and Elander 1981) from the continued lack of winter observations of substantial numbers of birds, although there are increasing numbers of sightings of vagrants in both the eastern and western subarctic (Bledsoe and Sibley 1985). The belief in an Arctic Basin wintering area has persisted despite the almost complete ice cover and lack of daylight in the region for most of the winter.

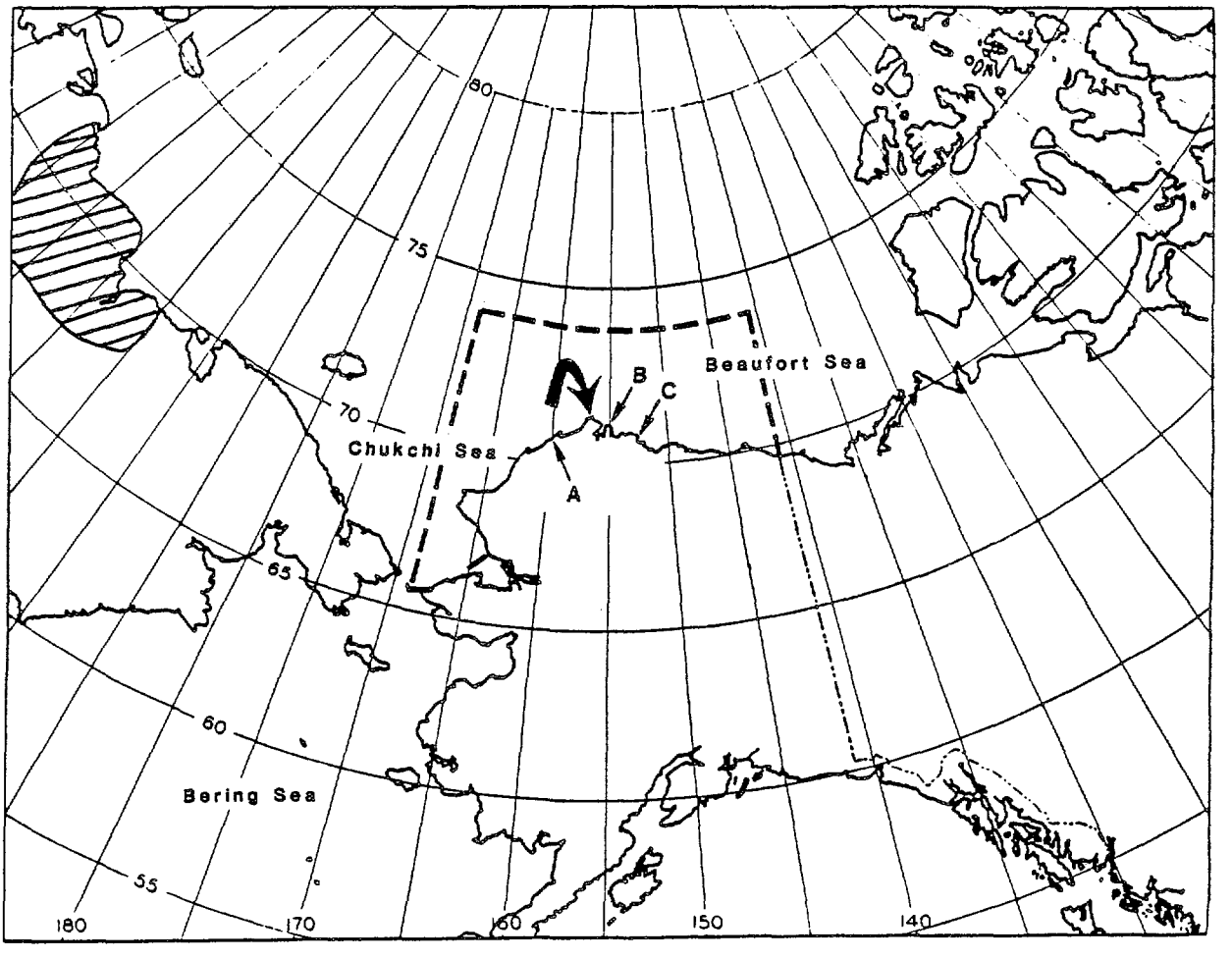

Figure 1.1. Location of Ross' Gull breeding grounds in Siberia (hatched area), study area discussed in this report (enclosed by dotted line), and places mentioned in the text: Point Barrow (large arrow), Wainwright (A), Point Tangent (B), and Cape Halkett (C).

As oil and gas development has proceeded in arctic Alaska over the last two decades, the status of Ross' Gulls in Alaskan waters has been an increasing concern. Population estimates (chapter 2 of this report) suggest that in any given year, a significant proportion of the world population of Ross' Gulls may occur in the nearshore zone of the Beaufort Sea. The species occurs in a relatively narrow band between the pack ice and shore within a six- to eight-week period in the fall, and thus may be particularly vulnerable to oil pollution or other adverse environmental influences in Alaskan waters.

Information on the habitat use and numbers of Ross' Gulls in Alaskan waters has been slow to accumulate since few vessels of opportunity are available during the period of ice formation. Between 1970 and 1986, however, G.J. Divoky and co-workers made observations on Ross' Gulls in late summer and early fall during 19 cruises in the Chukchi and Beaufort seas. Divoky also conducted a number of aerial surveys of Chukchi and Beaufort sea coasts, and made land-based observations of Ross' Gull migration past Point Barrow in 3 years: 1976, 1984, and 1986. Additional observations of fall migration at Point Barrow were made in 1987, under co-sponsorship of the Minerals Management Service and Fish and Wildlife Service. The main objectives of this latter study were:

1. Determine the presence and timing of easterly and westerly migrations of the Ross' Gull at Point Barrow in 1987, with hourly passage rates estimated and peak passage periods identified.

2. Compare results from 1987 with previous surveys of Ross' Gulls in the same region.

3. Dependent upon easterly passage rates and weather conditions, assess the geographic extent and density of Ross' Gulls at feeding areas located by aerial censusing, and determine ambient oceanographic conditions at feeding locales.

This report is thus a compilation of information obtained in 10 years of fieldwork from 1970 to 1987. Data obtained during cruises, land-based

observations, and aerial surveys are presented to provide the first comprehensive account of the chronology, distribution, abundance and movements of Ross' Gulls in the Alaskan Beaufort and Chukchi seas in late summer and fall.

Incidental to the primary focus on Ross' Gull, observers in 1987 also noted the occurrence near Point Barrow of Ivory Gulls (*Pagophila eburnea*), a species that appears to have a fall migration pattern similar to the Ross' Gull, at least in some years. Available information on the numbers and movements of this poorly known species is included in chapter 3.

1.2 Acknowledgments

Divoky's observations from 1970-72 were conducted with support of the Smithsonian Institution. From 1975 to 1978 fieldwork was supported by the Bureau of Land Management (now the Minerals Management Service) through interagency agreement with the National Oceanic and Atmospheric Administration (NOAA), under which a multi-year program responding to the needs of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office. Fieldwork in 1984 and 1986 was conducted through a grant from the National Geographic Society.

Opportunities for shipboard observations were provided by the Coast Guard for the *Glacier*, *Northwind*, and *Polar Star* cruises; NOAA for the *Discover* and *Oceanographer* cruises; and the Naval Arctic Research Laboratory for the *Alumiak* cruises. Logistical support in the Point Barrow area was provided by the Naval Arctic Research Laboratory prior to 1984 and by the North Slope Borough's Department of Wildlife Management in 1984 and 1986. Additional logistical support in 1984 was provided by the Barrow Whaling Captain's Association.

Divoky is grateful for assistance in field work to R. J. Boekelheide, K. Bohuski, D. Forsell, A.E. Good, T. Harvey, J. Sease, G.E. Watson, K. Wilson, D. A. Woodby, and P. Woodman. Haney was assisted by William Maynard during field work in 1987, and Jeri Riffle provided cheerful and efficient help

with the typing. The authors are indebted to Karen Kincheloe for artwork on the cover.

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CHAPTER 2. Fall Distribution, Abundance, and Movements of Ross' Gull: Shipboard, Aerial, and Land-based Studies from 1970 through 1986

2.1 Introduction

Most of the known range of Ross' Gull at sea in the Arctic is seldom visited by biologists. Large numbers of Ross' Gulls were first seen migrating past point Barrow in the fall of 1881 (Murdoch 1885), and the species has since been seen there regularly in September and October (e.g., Gabrielson and Lincoln 1959). However, there was little quantitative information about Ross' Gulls in Alaskan waters prior to studies by G.J. Divoky and co-workers between 1970 and 1986. Divoky's work included censusing at sea from ships in the Chukchi and Beaufort seas, aerial surveys of adjacent coasts, and systematic counts from land at Point Barrow. The purpose of this chapter is to summarize the results of those studies and provide a basis for comparison with the results obtained in 1987.

2.2 Study Areas

For purposes of description, the Alaskan Chukchi and Beaufort seas have been divided into five regions: the southern, central, and northern Chukchi, and the western and eastern Beaufort (Fig. 2.1). The Chukchi divisions were used by Divoky (1987) in an overview of the pelagic avifauna of that sea. For the northern Chukchi and Beaufort seas, the northern limit of the regions are defined by the mean position of the pack ice for the period 16-30 September (Brewer et al. 1977). Ice and sea surface temperatures presented below are also from Brewer et al. (1977). Brief descriptions of each region follow.

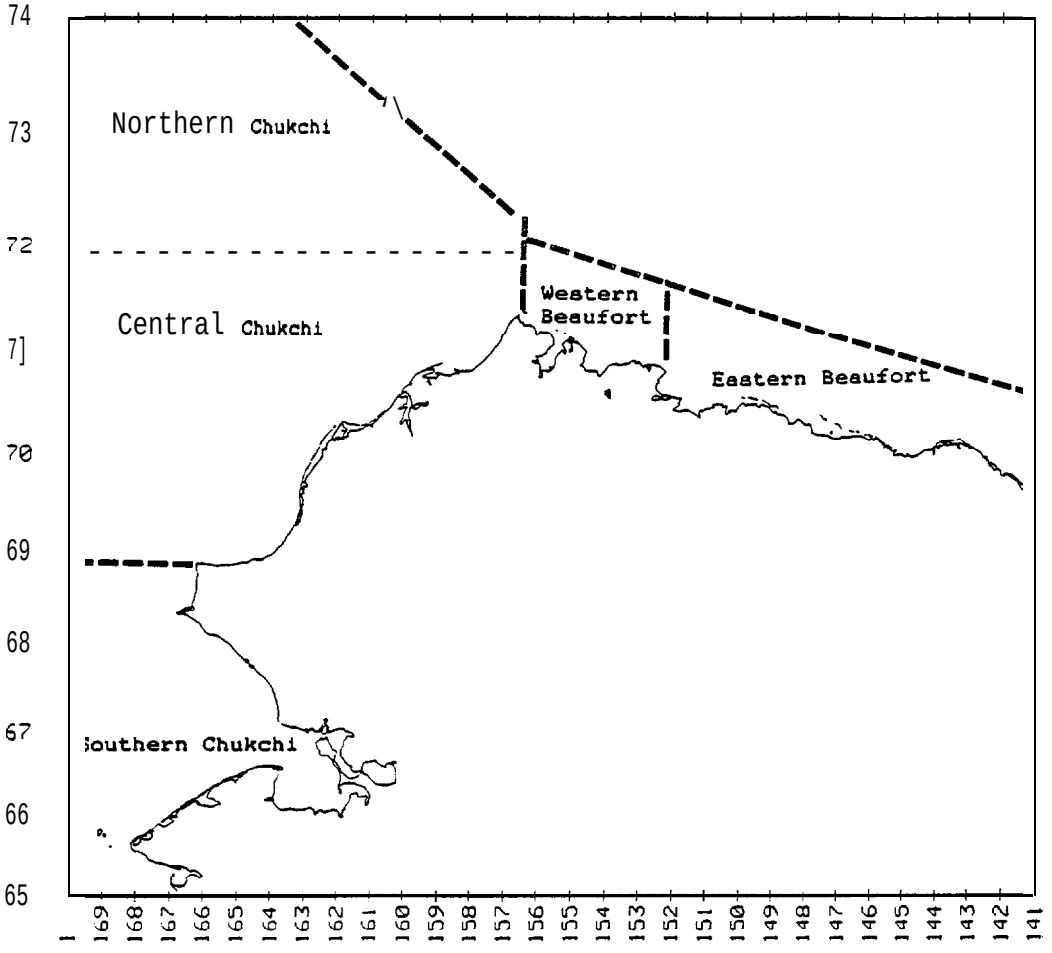

Figure 2.1. Regions of the Alaskan Chukchi and Beaufort Seas discussed in text.

2.2.1. Southern Chukchi Sea - 55,000 sq. km

This region is the most subarctic of the Alaskan sector of the Arctic Ocean. Currents passing north through the Bering Strait can raise summer sea surface temperatures to as high as 15°C. The area is ice free for four to five months of the year with ice decomposing in July and reforming in November. Because ice decomposes and forms rapidly in this region, the ice edge is present for a limited amount of time. All censusing in this region was conducted during the period when ice was absent..

2.2.2. Central Chukchi Sea - 140,000 Sq. km

The influence of subarctic waters in this area is much less than in the southern Chukchi, but still substantial since sea surface temperatures in summer can reach 10°C . The ice edge is present in this region after late July, and in some years it remains in the region until ice begins forming in the fall. In most years the area is ice free during the period of maximum ice retreat in late September. Ice cover is extensive by the end of October.

2.2.3 Northern Chukchi Sea - 33,000 sq. km

This region has little influence from subarctic waters since Bering Sea waters typically split into east and west components before reaching the northern Chukchi. The amount of open water in the region shows high annual variability. Typically the region has extensive open water only in September.

2.2.4 Western Beaufort Sea - 12,000 sq. km

This area is ice covered until late August and the extent of open water south of the pack ice in both this and the eastern Beaufort shows high annual variability. The advection of Bering Sea water into the region can raise sea surface temperatures over 5°C. Ice formation in the western and eastern Beaufort usually occurs in mid-October.

2.2.5 Eastern Beaufort Sea - 32,000 sq. km

Except near input from rivers, this region has sea surface temperatures of less than 5°C. The region usually is little influenced by the Bering Sea intrusion into the Beaufort Sea.

2.3 Data Sources

2.3.1 Cruises

From 1970 to 1986, observations of pelagic birds were made on late summer and early fall cruises in the Chukchi (Divoky 1987) and Beaufort (Divoky 1984) seas (Table 2. 1). The location of cruise tracks by region and time period are shown in Figures 2.2 - 2.8.

2.3.2 Land-based Observations

Incidental observations of approximately two hours per day were conducted at Point Barrow during the Ross' Gull movement in 1976, and systematic observations of migration were conducted in 1984 and 1986 (Table 2.2).

The locations of the Point Barrow observations are shown in Figure 2.9. Observations in 1984 were conducted at Nuwuk at the tip of Point Barrow near the racon tower, approximately 0.5 km southeast of the Point. Observations in 1976 and 1986 were conducted from Birnik, the location of the "shooting station", at the base of the spit leading to the Point. Storm surges in late September 1986 eroded the base of the Point Barrow spit and access to the Point was not possible each day. Concurrent observations conducted at both Nuwuk and Birnik in 1984 found numbers and rates of movements to be similar at both locations.

2.3.3 Aerial Surveys

Aerial surveys of the Chukchi and Beaufort Sea coasts (Table 2.3) were conducted on a regular basis in 1976 from June until October. Linear

Table 2.1. Elates, vessels, and number of observation periods for cruises in the Alaskan Chukchi and Beaufort seas.

Dates of observations	Vessel	15-minute observ. per.	Cruise track
CHUKCHI SEA:			
16-25 Jul. 1981	POLAR STAR	260	Figure 2.2
01-20 Aug. 1975	GLACIER	359	Figure 2.2
07-14 Aug. 1976	"	133	Figure 2.2
07-08 Aug. 1977	"	43	Figure 2.2
24 Aug. - 08 Sep. 1986	OCEANOGRAPHER	215	Figure 2.2
11-22 Sep. 1976	DISCOVERER	141	Figure 2.2
22 Sep. - 01 Oct. 1976	GLACIER	162	Figure 2.4
24 Sep. - 17 Oct. 1970	"	187*	Figure 2.5
07-09 Oct. 1976	"	134	Figure 2.6
	TOTAL : Chukchi Sea - 1,534 = 399 hours		
1534 = 399 hours			
BEAUFORT SEA:			
02 Aug. - 09 Sep. 1972	GLACIER	230*	Figure 2.3
02-26 Aug. 1977	ALUMIAK	202	Figure 2.3
05-29 Aug. 1978	"	259	Figure 2.3
07 Aug. - 05 Sep. 1977	GLACIER	404	Figure 2.3
17 Aug. - 03 Sep. 1976	"	113	Figure 2.3
18 Aug. - 16 Sep. 1971	"	263*	Figure 2.3
19-30 Aug. 1976	AUMIAK	108	Figure 2.3
26 Aug. - 15 Sep. 1978	NORTHWIND	179	Figure 2.3
06-18 Sept. 1976	GLACIER	122	Figure 2.7
01-17 Oct. 1986	POLAR STAR	181	Figure 2.8
	TOTAL : Beaufort Sea - 2,061 = 556 hours		

* 20-minute observation periods

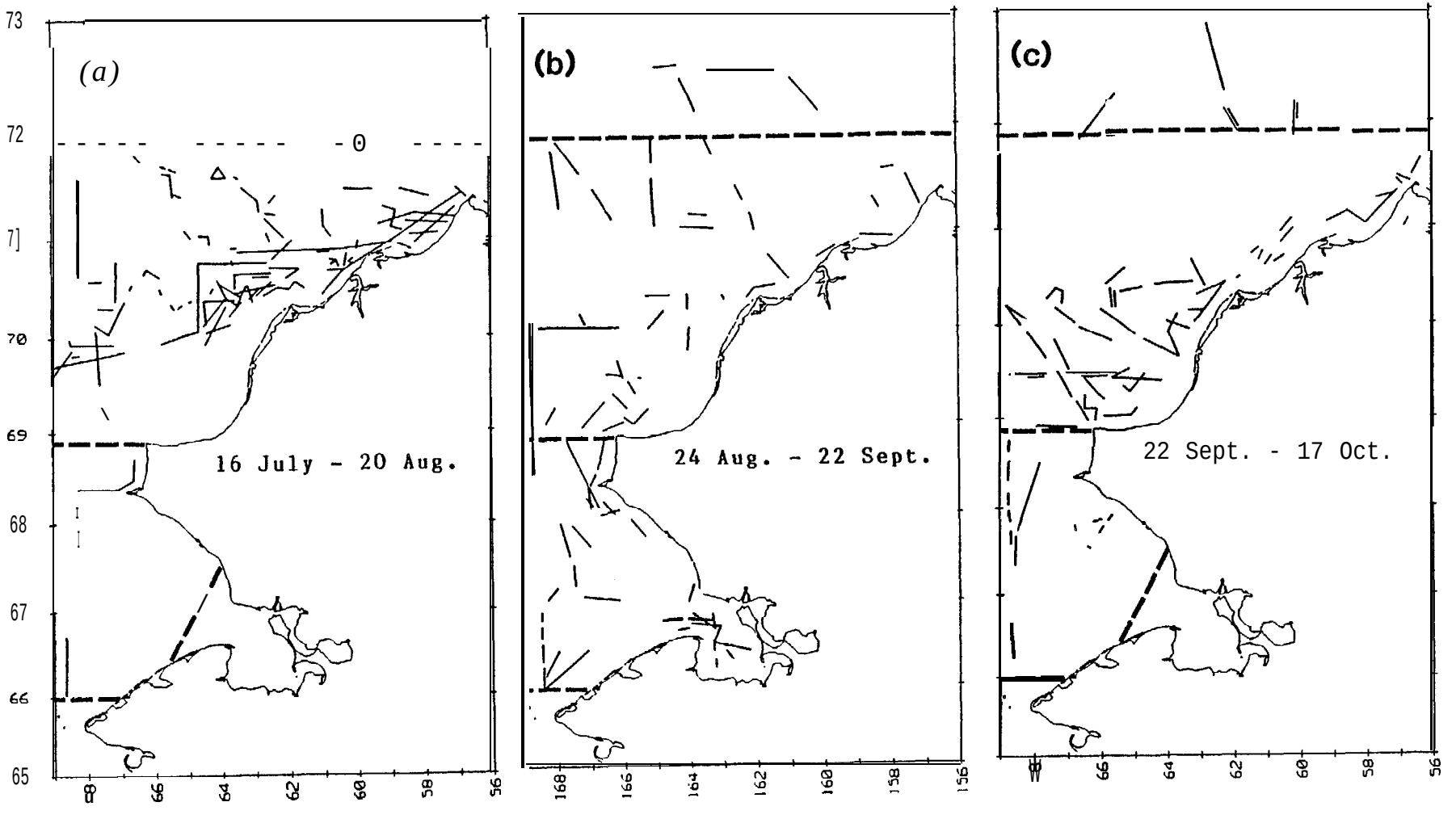

Figure 2.2. Locations of cruise tracks conducted during three time periods in the Chukchi Sea, 1975-81.

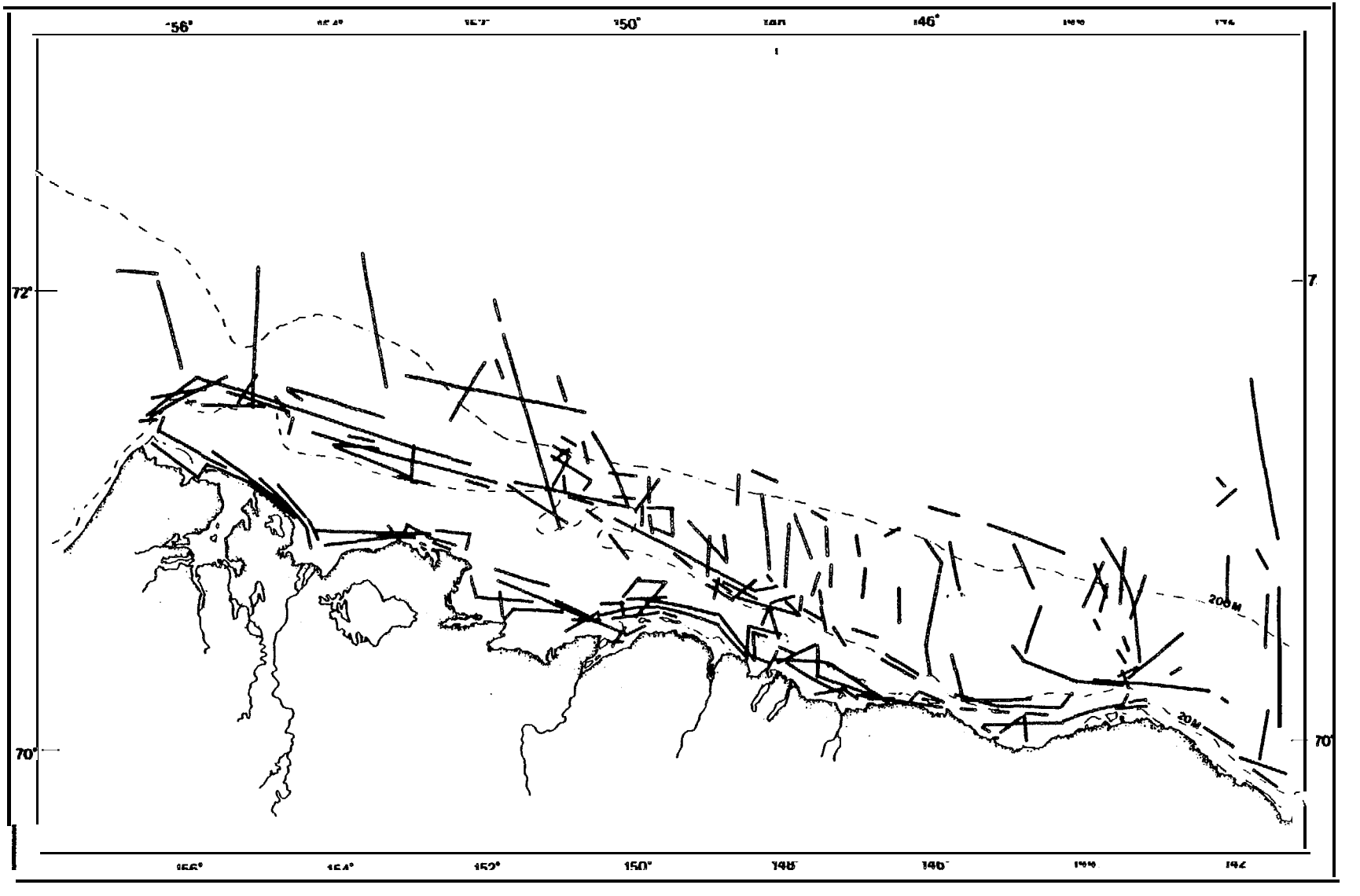

Figure 2.3. Locations of cruise tracks conducted in the Beaufort Sea before the fall arrival of Ross' Gulls in Alaskan waters (2 August - 17 September, 1972-78).

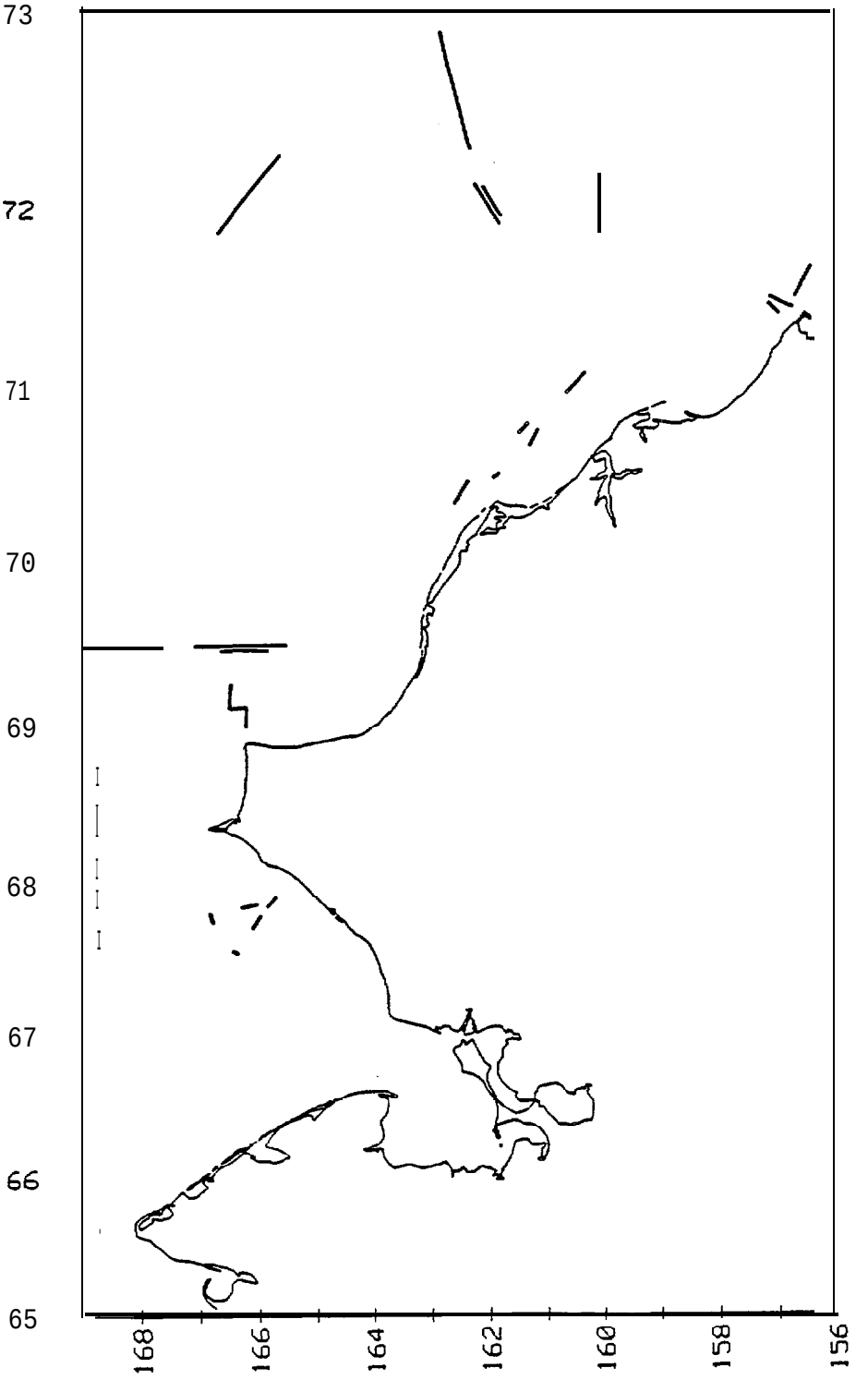

Figure 2.4. Cruise tracks where seabird censusing was conducted from 22 September - 1 October, 1976.

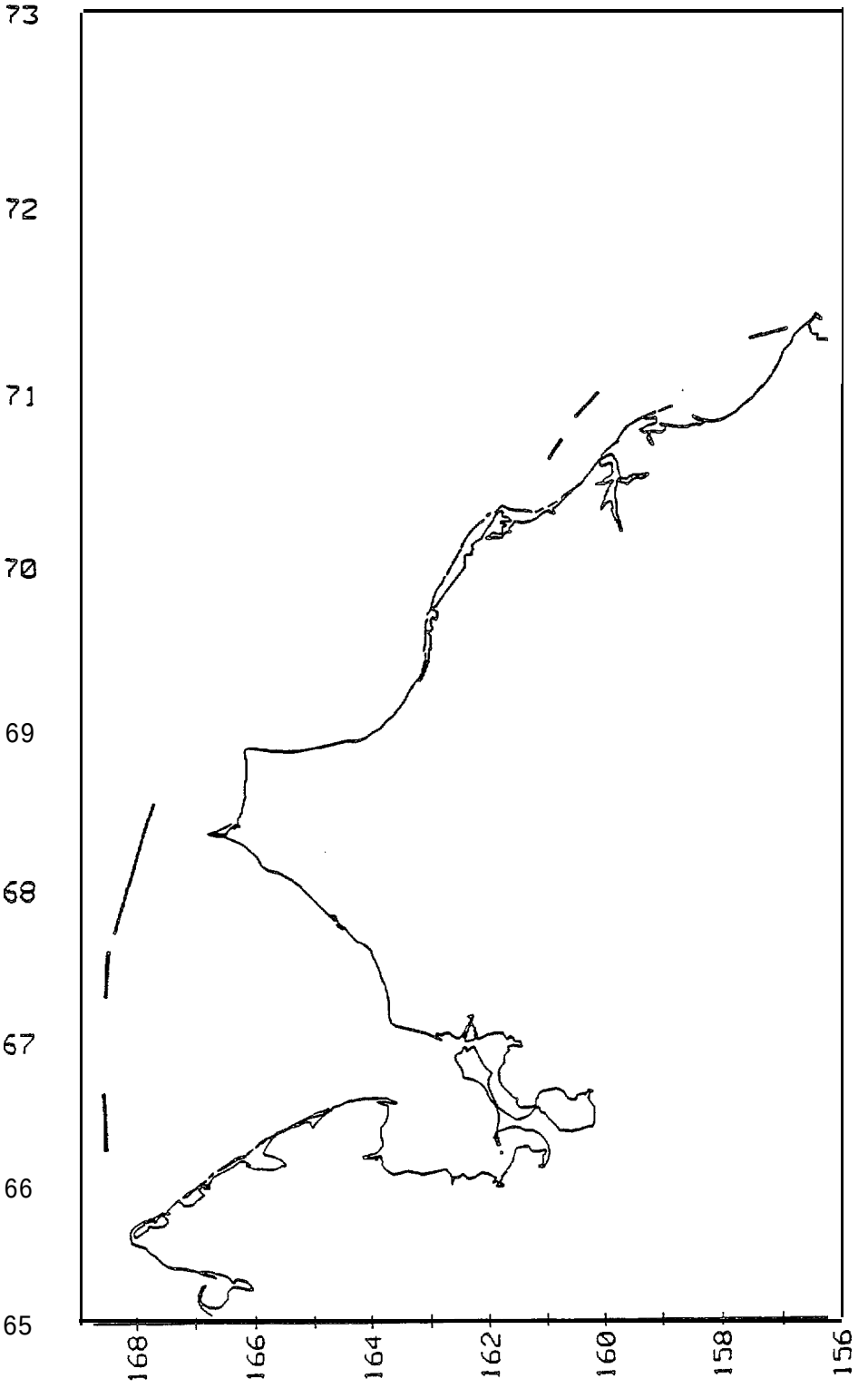

Figure 2.5. Cruise tracks where seabird censusing was conducted from 7 to 9 October, 1976.

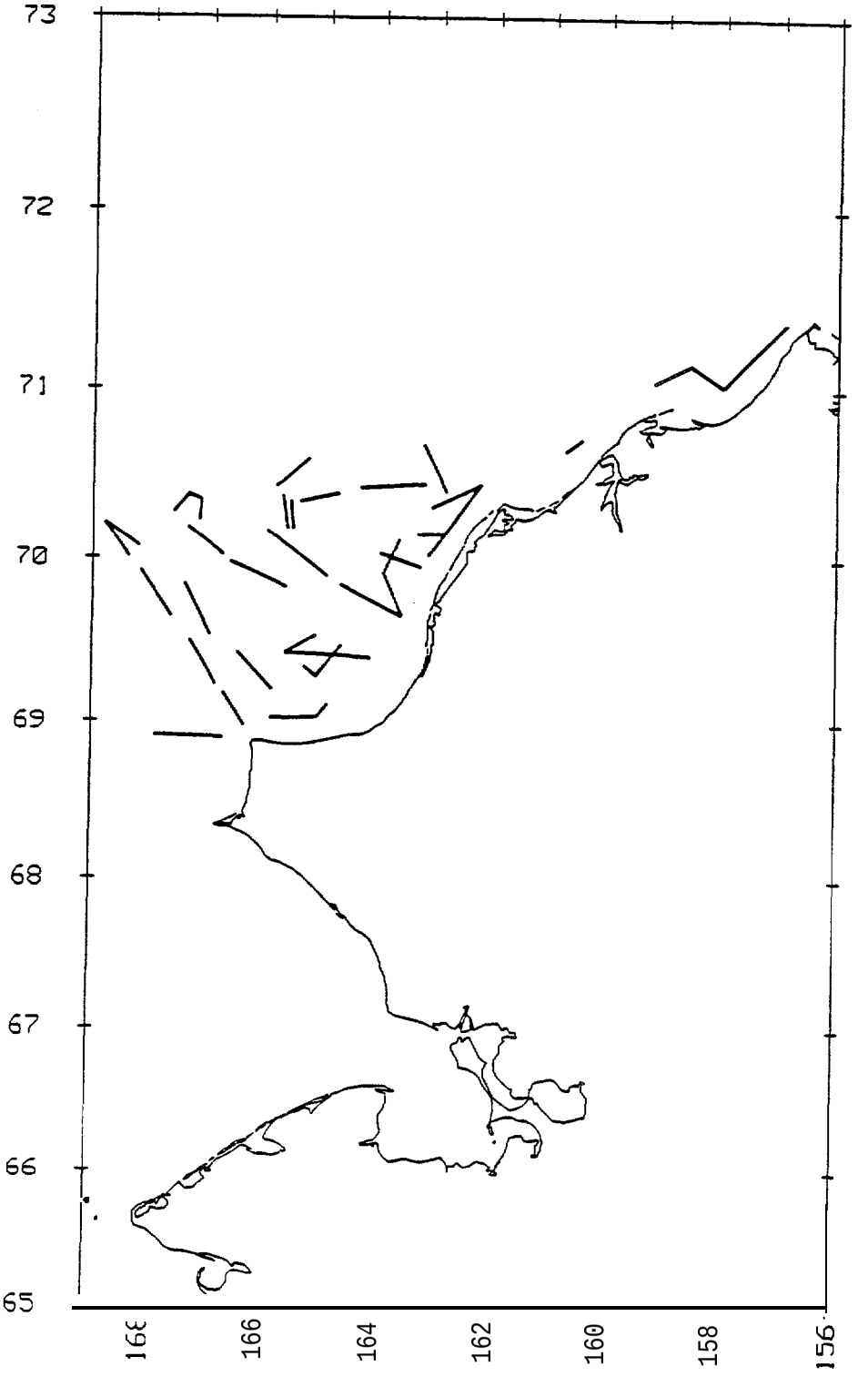

Figure 2.6. Cruise tracks where seabird censusing was conducted from 24 September - 17 October, 1970.

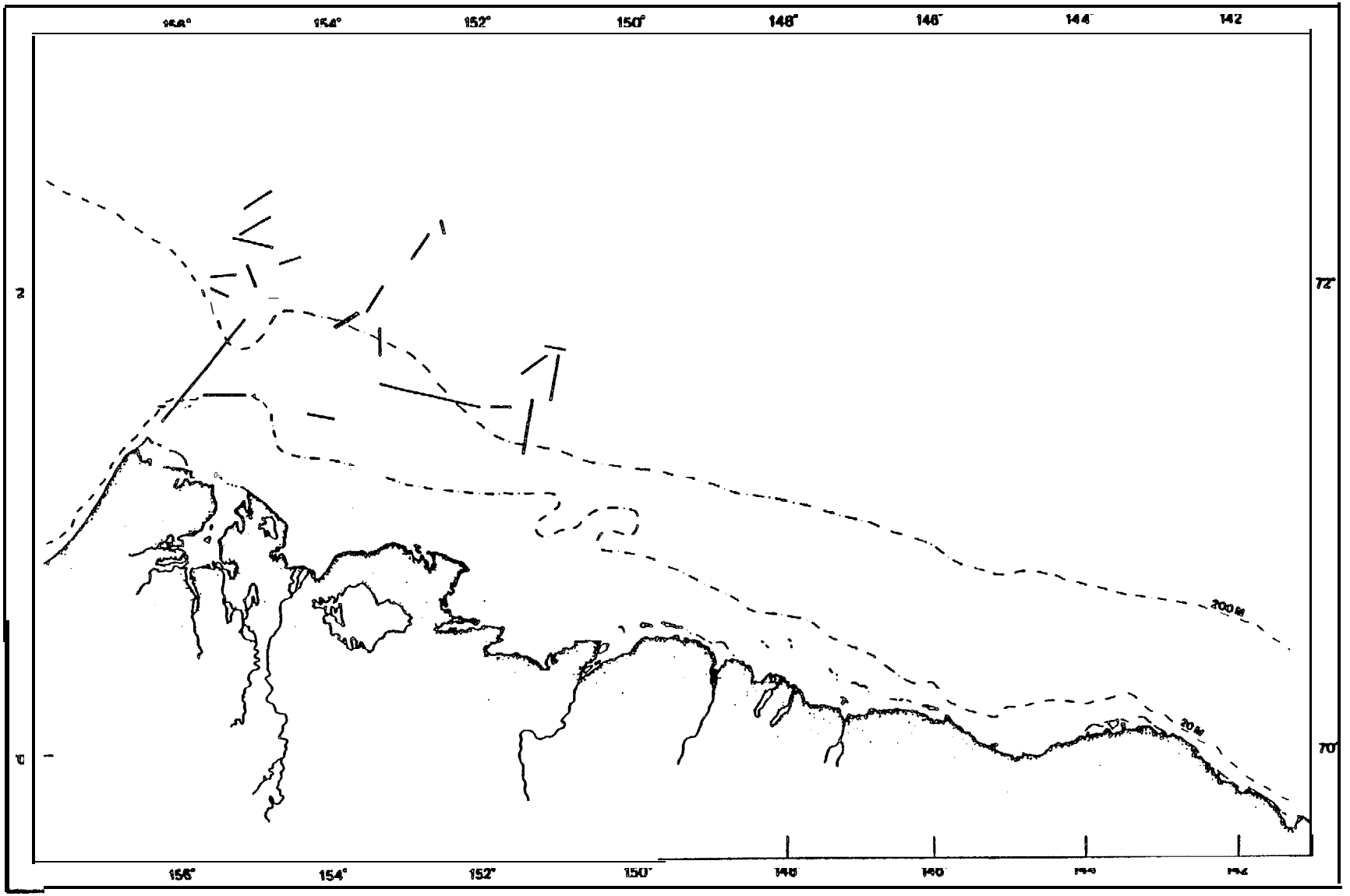

Figure 2.7. Cruise tracks where seabird censusing was conducted from 6 to 17 September, 1976.

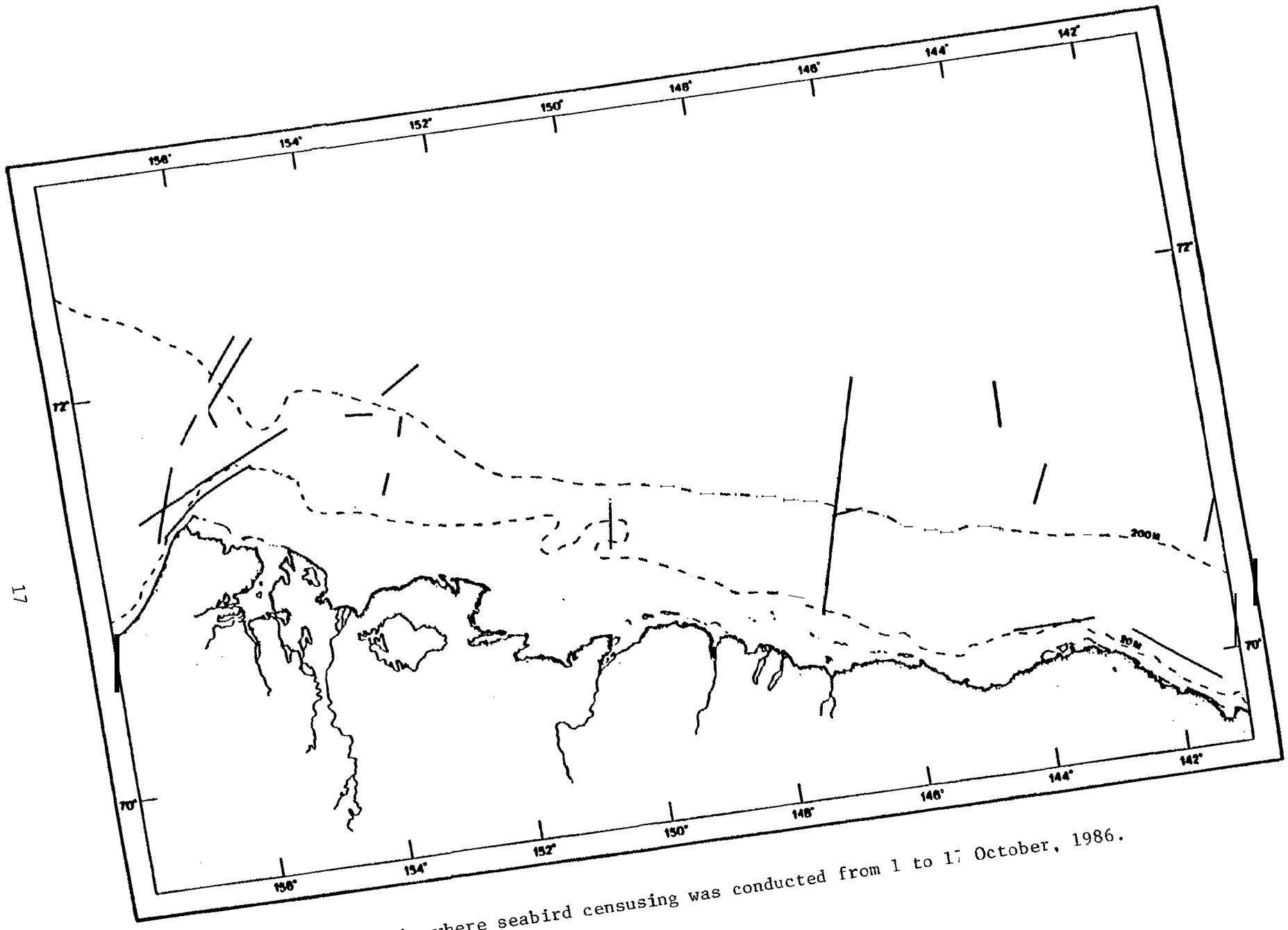

Figure 2.8. Cruise tracks where seabird censusing was conducted from 1 to 17 October, 1986.

Table 2.2. Hours of observation for Ross' Gull migration conducted from Point Barrow in 1976, 1984 and 1986.

		Hours observed		
		1976	1984	1986
September	13		2	
	14		1	
	15		1	
	16		4	
	17		3	
	18		3	
	19		6	
	20		5	
	21		4	
	22		7	
	23		6	1
	24		6	0
	25		6	2
	26		4	4
	27	2	2	5
	28	2	1	6
	29	2	1	5
	30	2	3	6
October	1	2	4	5
	2	2	6	6
	3	2	5	0
	4		7	5
	5	2	5	8
	6	2	7	6
	7		6	5
	8	2	5	6
	9	2	4	6
	10	2	6	6
	11	2	2	6
	12	2	9	5
	13		9	7
	14		9	5
	15	2	4	7
	16		9	7
	17		7	7
	18		5	6
	19		6	
	20		6	
	21		3	
TOTAL HOURS:		30	186	132

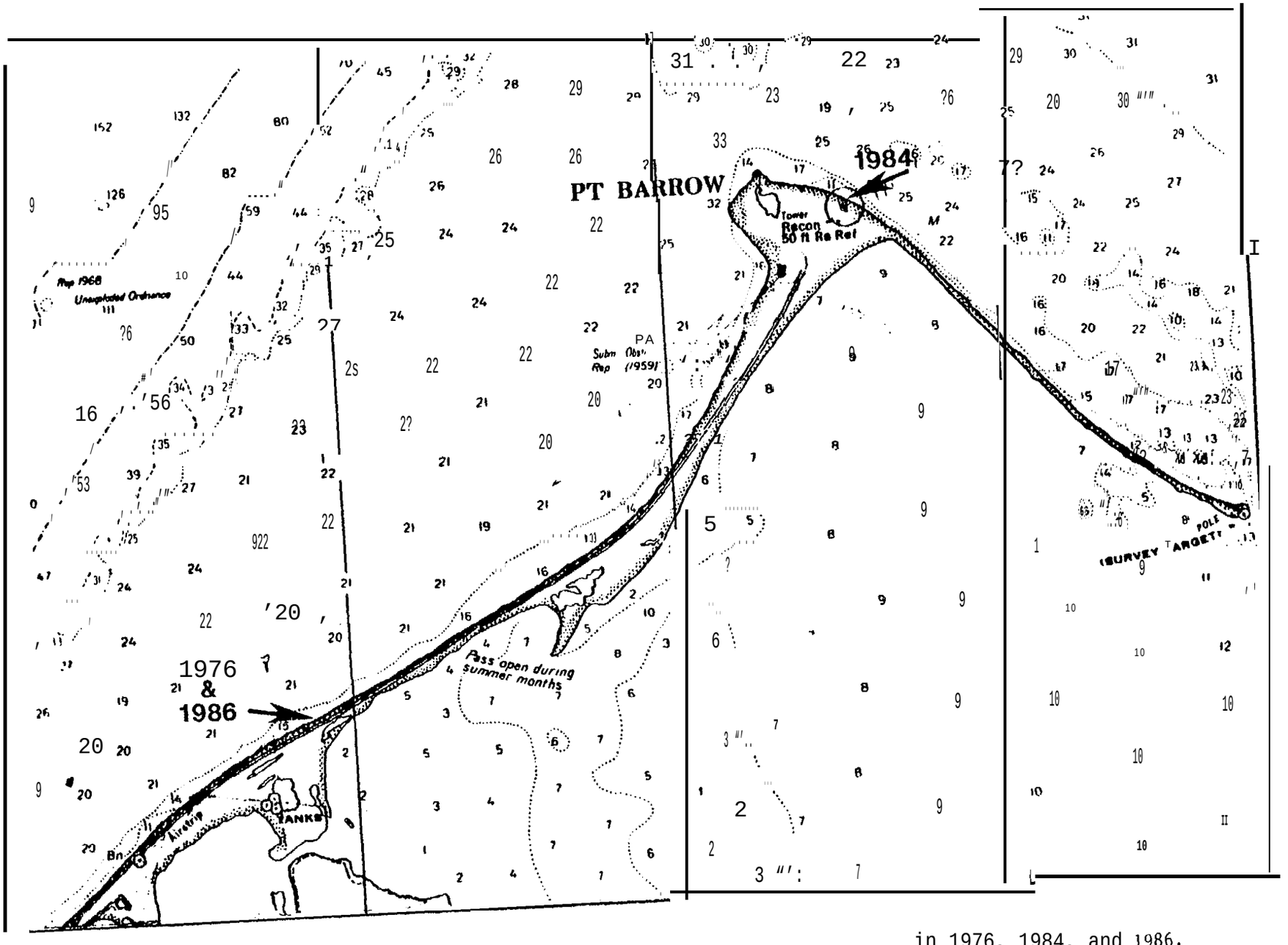

Figure 2.9. Locations where land-based observations were made at Point Barrow in 1976, 1984, and 1986.

Table 2.3. Dates and locations of aerial surveys of the Beaufort and Chukchi coasts in the fall of 1976 and 1984.

Date	Area censused
CHUKCHI SEA:	
1976 11 Sep.	Pt. Barrow to Cape Lisburne
20 Sep.	" "
23 Sep.	Pt. Barrow to Pt. Lay
28 Sep.	Pt. Barrow to Cape Lisburne
13 Oct.	Pt. Barrow to Icy Cape
1984 09 Oct.	Pt. Barrow to Wainwright
11 Oct.	Pt. Barrow to Peard Bay
BEAUFORT SEA:	
1976 07 Sep.	Pt. Barrow to Demarcation Pt.
18 Sep.	Pt. Barrow to Cape Halkett
23 Sep.	Pt. Barrow to Flaxman Is.
04 Oct.	Pt. Barrow to Barter Island
13 Oct.	Pt. Barrow to Tangent Pt.
1984 28 Sep.	Ocean north of Point Barrow
03 Ott.	Plover Islands
10 Oct.	Plover Islands and ocean to north

densities of bird groups encountered are presented in Divoky (1980). The dates and geographic extent of the 1976 aerial censuses conducted when Ross Gulls are in Alaskan waters (September and October) are given in Table 2.3.

Limited aerial censusing was conducted in 1984, usually opportunistically in conjunction with logistic flights (Table 2.3).

2.4 Methods

2.4.1 Shipboard Observations

2.4.1.1 Transects

Censusing from vessels at sea was conducted using methods described in Divoky (1984) and Gould et al. (1982). Observations were made in 15-minute or 20-minute periods when the ship was steaming at more than four knots. These periods are referred to as both "transects" and "observation periods" in this report. Observation periods from cruises conducted from 1970 to 1972 were 20 minutes in length and those from 1975 to 1986 15 minutes in length. One or two individuals observed from the flying bridge of the vessel (average height 18 m above sea level) using 7x or 10x binoculars. All birds to 300 m to one side of the vessel were counted and information on age and activities recorded whenever possible. Flight direction was recorded when an individual or flock was observed in directed flight. The total area censused in each transect was determined and a density of birds per km^2 computed.

The location and ice conditions were recorded for each observation period. Ice condition categories included: no ice (no ice visible - also referred to as open water), visible ice (ice seen during some part of the observation period but not present in the area censused) and ice present (ice encountered in the area censused). When ice was present in the area censused the percent of the water's surface covered with ice was recorded.

Incidental observations of birds seen when the vessel was at oceanographic stations are presented as appropriate to supplement the

transect observations.

2.4.1.2. Migration Watches

Migration watches were conducted from stationary vessels. Observations were made from the flying bridge in periods lasting from 15 minutes to one hour. All birds observed to 300 m were recorded and their flight direction and altitude recorded. Age was obtained whenever possible. Information from migration watches is combined with that on bird movements from transects wherever data from cruises are presented.

2.4.2 Observations From Land

Observations of birds in nearshore waters were conducted from land (Fig. 2.9). These observations were usually conducted in one-hour watches, although shorter watches were conducted when visibility was reduced. All birds within 500 m of shore (both seaward and landward) were recorded as well as information on their direction, distance from shore, and altitude. Movements of birds more than 500 m from shore were recorded only when they appeared to be substantially larger than movements closer to shore.

While the actual direction of flight was recorded for all migrants observed at Point Barrow, only two flight directions are presented: east (leaving the Chukchi and entering the/Beaufort) and west (moving in the opposite direction).

Observations from Point Barrow were made at a height of two to six meters usually made with 7x or 10x binoculars. A 40x telescope was used at those times when much migration was occurring outside of 300 m.

To obtain information on the passage of birds per day those hours when no observations were conducted were estimated to be the average of the preceding and following hours of observation.

2.4.3 Aerial Censusing

Aerial censusing of shoreline and nearshore habitats was conducted from either a Cessna 180 or a Twin Otter flying at 100 knots at an altitude of 150 feet. Two observers recorded on audio tape all birds within 500 m on either side of the flight path. A third person kept track of the plane's location and the habitats being censused. The number of birds per linear kilometer were later computed.

In general, each section of coast was censused twice on a given survey. In areas with barrier islands the initial flight path was down the middle of the islands, with all birds on the south and north side of the island being counted. On the return flight the plane flew down the center of the lagoon. In areas without barrier islands the plane flew 300 m seaward of the beach.

2.4.4 Ice and Meteorological Information

Information on ice conditions recorded at the time of observations (biweekly ice syntheses published by the U.S. Navy, Suitland, MD) was used to study synoptic ice conditions in the western arctic. Information on the average historical ice information is from Brewer et al. (1977). Meteorological information is from the National Climatic Data Center's summaries of the hourly observations obtained at Barrow.

2.5 Results

2.5.1 Shipboard Censusing

Over the several years of this study, considerable sampling effort occurred at sea prior to the arrival of Ross' Gulls in Alaskan waters. Those cruises on which Ross' Gulls were either rare (less than 1% frequency) or not observed (Fig. 2.2 a and b; Fig. 2.3) provide information on the absence of the species, and are mentioned below as appropriate. The cruises discussed in detail, however, are those on which Ross' Gulls were seen more regularly. The frequencies given are the percentages of observation periods

on which Ross' Gulls were observed.

2.5.1.1 Chukchi Sea

2.5.1.1.1 August 1975

Censusing was conducted from 1 to 20 August 1975 as far south as the Bering Strait, with most observations being conducted in and next to the decomposing pack ice north of 69°N in the central Chukchi (Fig. 2.10). Ice was visible or present during 65% of the observation periods. The principal ice edge was between 70° and 71°N, but the area north of the edge had much open water and observations were conducted north to 71°55'N.

A flock of 17 Ross' Gulls was seen on 6 August at 69°45'N, 168°30'W, where pack ice was visible to the north. The density for the transect was 15.8 b/km^2. On the following day, two Ross' Gulls were seen 25 km to the southwest while the ship was on station in an area where no ice was visible. The average density for the cruise was 0004 b/km^2 and the frequency greater than 1%.

2.5.1.1.2 August 1976

Censusing was conducted at the ice edge in the Chukchi Sea east of 164°W (Fig. 2.11). The cruise was just south of the ice edge, with 51% of the transects having ice visible. Single Ross' Gulls, probably the same bird, were seen on two adjacent transects on 11 August at 70°N, 162°30'W in an area of open water approximately 10 kilometers south of the nearest ice. Both transects had a density of 1.2 b/km^2. The average density for the cruise was 0.01 b/km^2 and the percent frequency 1%.

2.5.1.1.3 September 1976

Sampling from 22 September to 1 October 1976 covered a large geographic area (Fig. 2.12). A range of habitats was censused from ice edge and pack ice in the northern Chukchi to open water south of Cape Thompson with sea surface temperatures as high as 7°C.

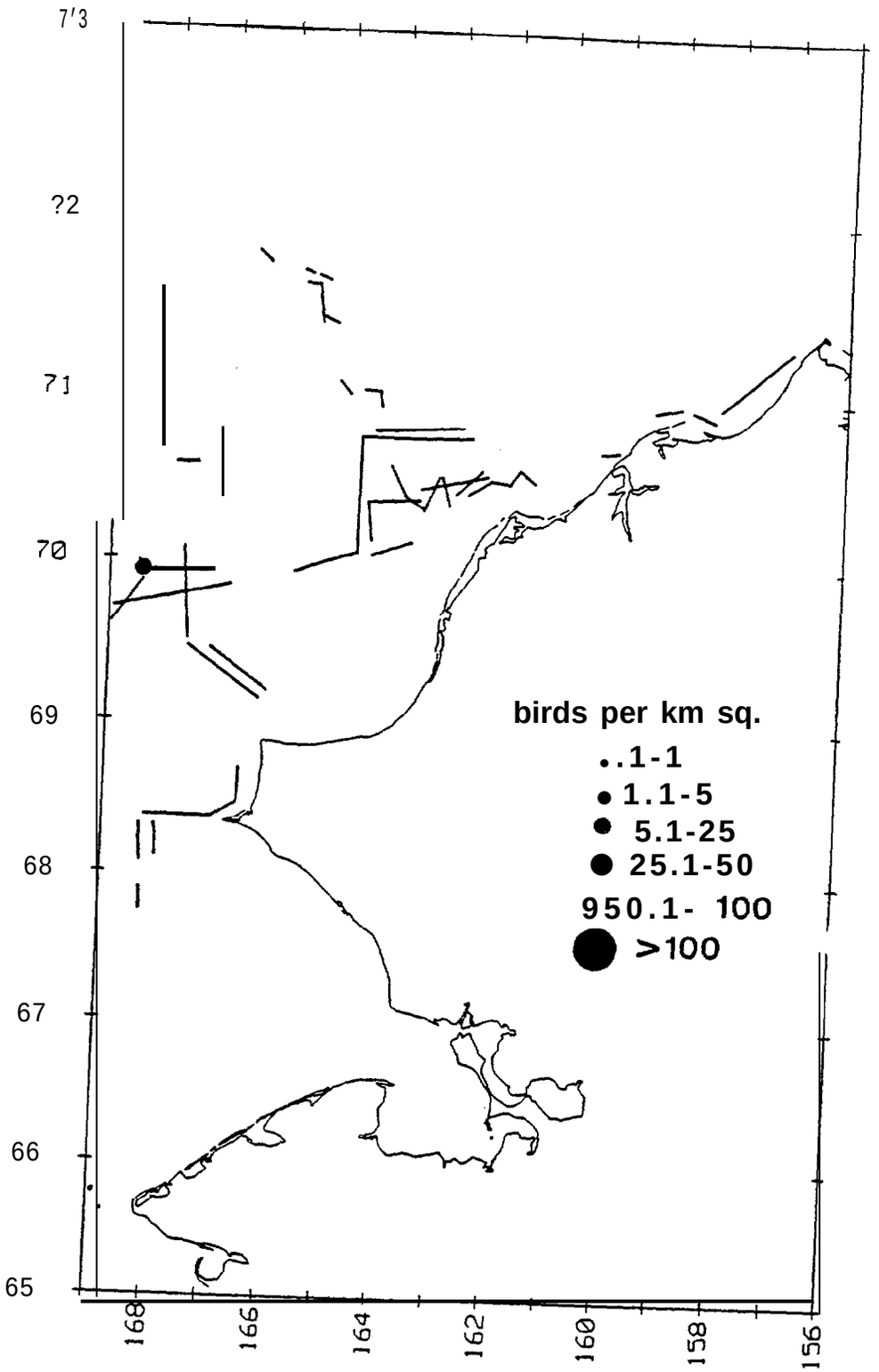

Figure 2.10. Densities of Ross' Gull in the Chukchi Sea from 1 to 20 August 1975.

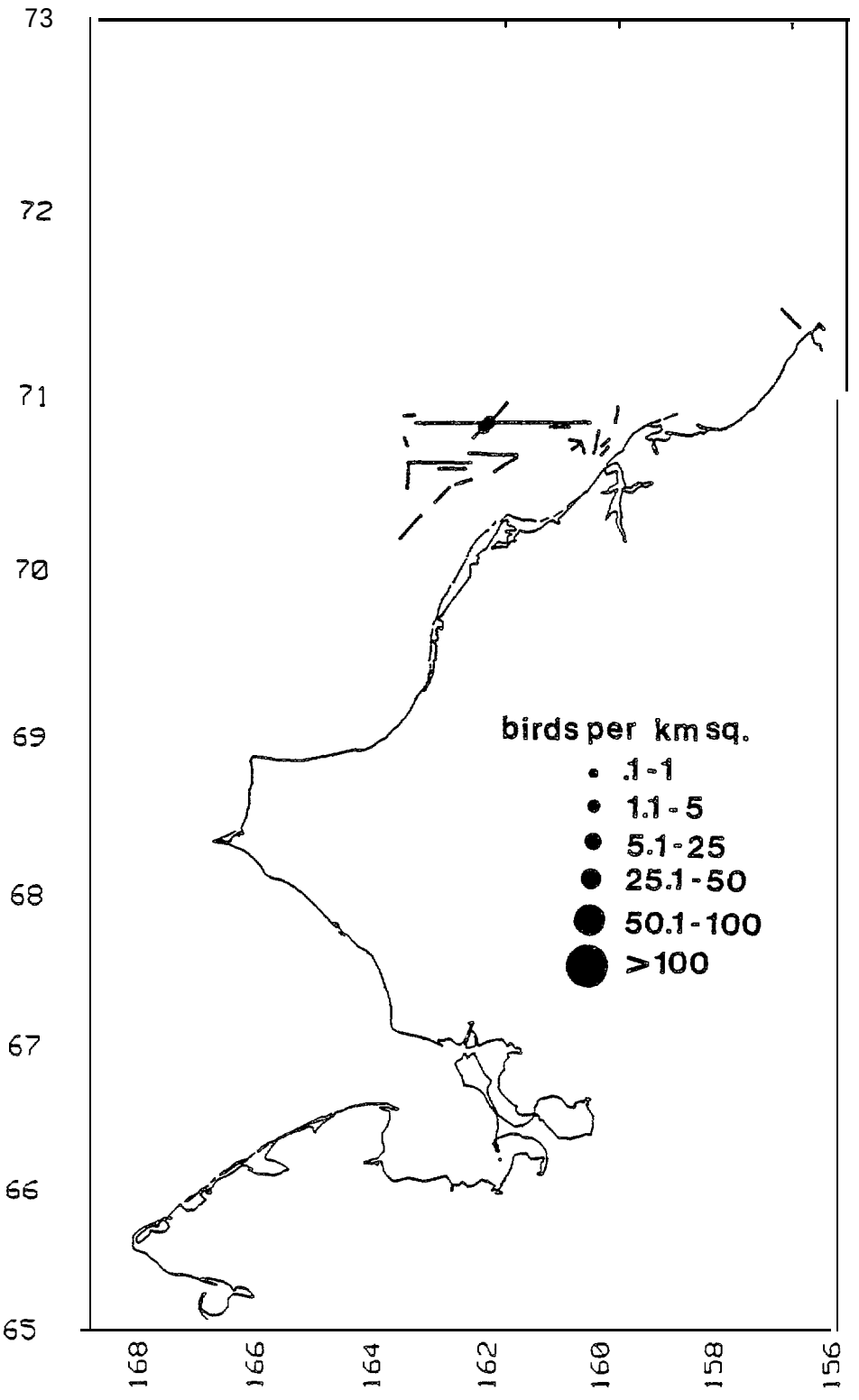

Figure 2.11. Densities of Ross' Gull in the Chukchi Sea from 7 to 14 August, 1976.

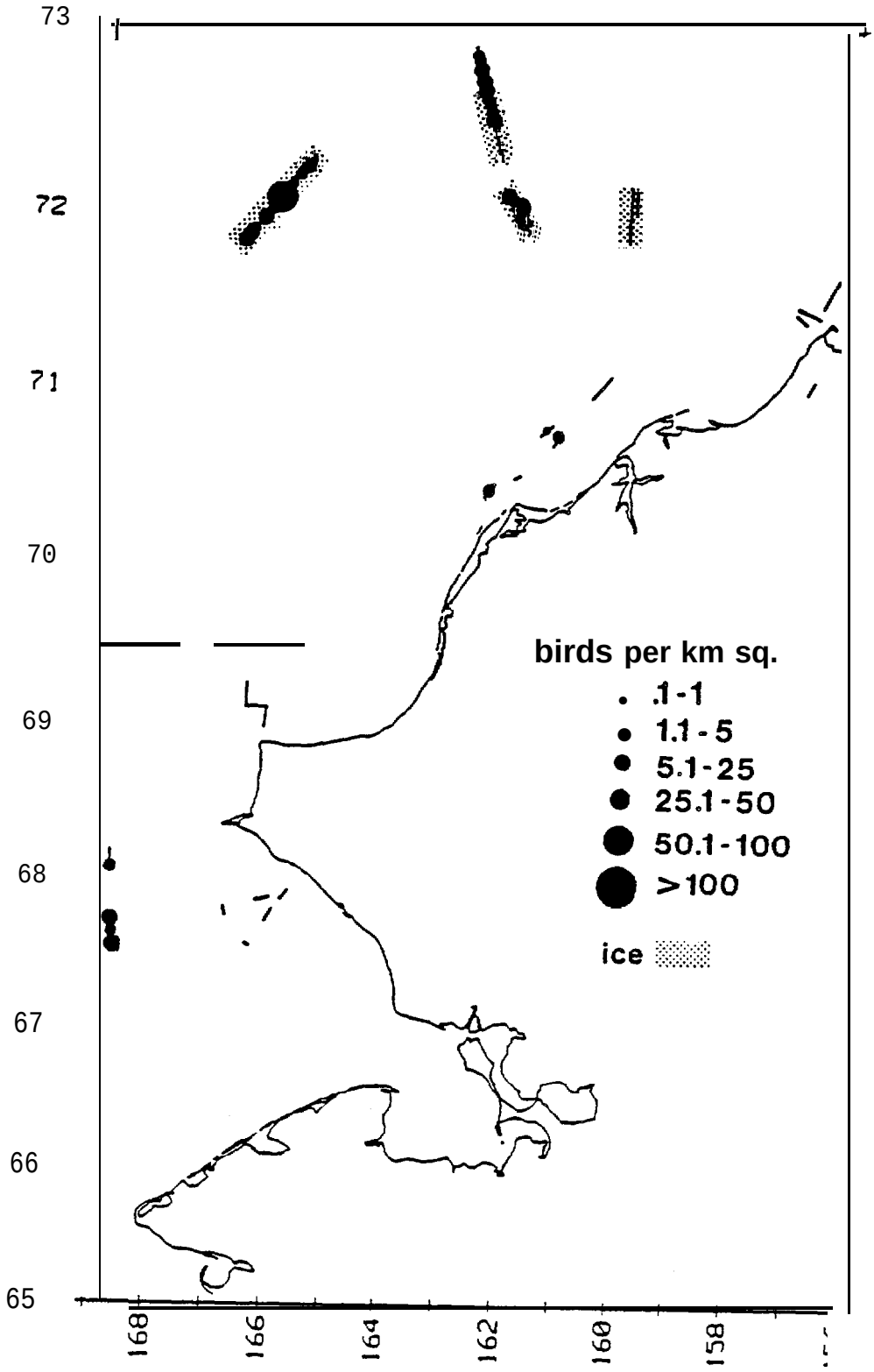

Figure 2.12. Densities of Ross' Gull in the Chukchi Sea from 22 September - 1 October, 1976.

The observations at the ice edge were conducted at the time of maximum ice retreat. Ice was encountered only in the northern Chukchi north of 71°55'N, where 83% of the transects were in or next to ice. While most transects in the ice were in areas with ice coverage of less than 33%, ice cover of 90% was encountered on six of the transects.

Ross ' Gulls were absent the first two days of the cruise in open water northwest of Point Barrow and along the ice edge east of 161°W. The first Ross ' Gulls were seen on 23 September at the ice edge west of 161°W. After that date they were common to abundant at the ice edge in the northern Chukchi, rare in the central Chukchi, and common but localized in the southern Chukchi (Fig. 2.13, Table 2.4).

In the northern Chukchi, Ross' Gulls were found on 40% of the observation periods and averaged 4.0 b/km^2. The absence of the species at the ice edge east of 161°W is surprising given its abundance west of 161°W. The high density of 94.2 b/km^2 was in an area where large numbers of walrus were present on the ice, and Ross' Gulls were associated with the walrus.

The central Chukchi had the lowest average density and frequency of the three regions of the Chukchi. No ice was encountered in this region or in the southern Chukchi. All Ross' Gulls encountered in the central Chukchi were seen west and north of Icy Cape on 1 October.

In the southern Chukchi, on a series of latitudinal transects west and southwest of Point Hope, Ross' Gulls were present in low densities on the southernmost transects on 28 September. None were seen on 27 September directly to the north.

Densities in the ice were consistently an order of magnitude higher than those in open water (Table 2.5), and percent frequency was significantly higher there than in open water. Densities and frequencies were high for all ice coverages sampled.

Flight directions of Ross' Gulls varied between the northern and

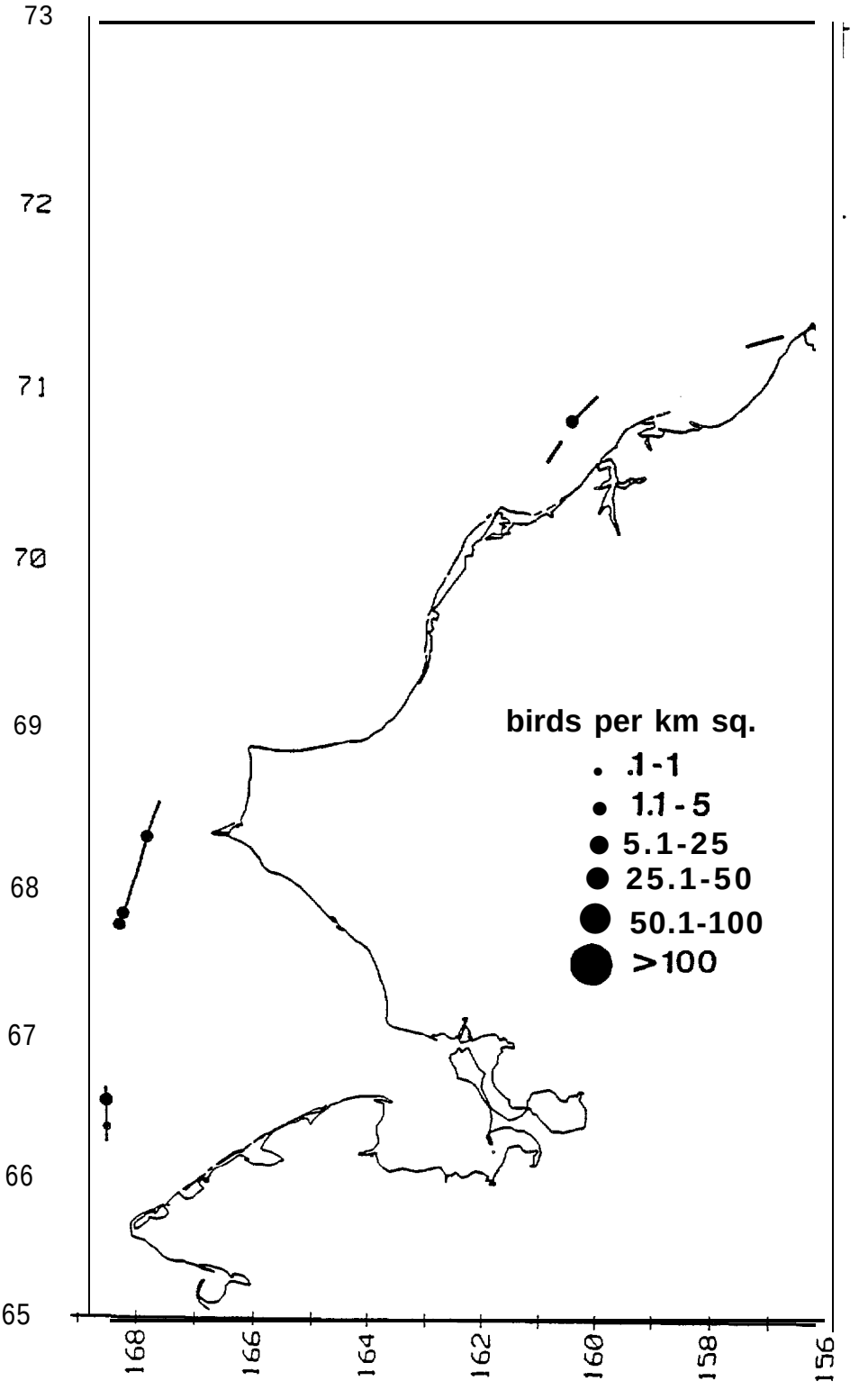

Figure 2.13. Densities of Ross' Gull in the Chukchi Sea from 7 to 9 October, 1976.

Table 2.4. Densities of Ross' Gull in the three regions of the Chukchi Sea from 22 September to 1 October 1976.

Region	Observation periods	Average density Per km^2	Percent frequency	Maximum density Per km^2
Northern Chukchi	61	4.0	40%	94.2
Central Chukchi	62	0.1	5%	3.6
Southern Chukchi	40	0.7	20%	7.9

Table 2.5. Densities of Ross' Gulls in relation to ice cover in the Chukchi Sea from 22 September to 1 October 1976.

Ice	Observation periods	Average density (B/km^2)	Percent freq.	Maximum density (B/km^2)
None	111	.4	14%	7.9
All ice	51	4.4	45%	94.2
Vis.to 10% coverage	11	5.6	64%	29.6
20% coverage	27	2.1	41%	13.0
30% coverage	13	8.2	39%	94.2

southern Chukchi Sea (Table 2.6). Flight direction was recorded for 35% of the 338 Ross' Gulls recorded at the ice edge in the northern Chukchi, and the mean vector was 174°. In the southern Chukchi the mean vector for flight direction was 348°. The large percentage of birds without a flight direction in the northern Chukchi indicates that a majority of the birds were not actively engaged in migration.

2.5.1.1.4 October 1976

Opportunistic observations were made from 7 to 9 October 1976 on a vessel in transit from Point Barrow to the Bering Strait (Fig. 2.13). While the number of observation periods was limited (Table 2.7), the cruise allowed censusing of areas where observations had been made a week earlier. Ice was forming in the Beaufort and northern Chukchi seas during the observations. Ice was present on the Chukchi coast south to Peard Bay, and in the remainder of the Chukchi the ice edge was south of 71°N. Observations in the central Chukchi were in 10% ice cover, or with at least some ice visible, while no ice was seen in the southern Chukchi.

Only one Ross' Gull was seen in the central Chukchi, and two birds were seen west of Peard Bay on 7 October. In the southern Chukchi they were present from west of Point Hope south to the latitude of the Seward Peninsula at 66°30'N. Ross' Gulls averaged 0.3 b/km^2 and had a frequency of 18%.

2.5.1.1.5 September-October 1970

Observations were made from 24 September to 17 October 1970 in transit from Point Barrow southwest to the open water south of the pack ice at the latitude of Icy Cape. Three weeks of additional censusing were conducted north of Cape Lisburne and south of the advancing ice edge (Fig. 2.14). At the beginning of censusing, the ice edge was just north of 70°N and there was a lead paralleling the shore from Point Barrow to Icy Cape. The majority of the Beaufort Sea was ice covered, and ice cover in the nearshore Chukchi was extensive. The ice edge moved south to 69°N during the census period. Sampling in and at the ice edge was extensive, with 78% of the

Table 2.6. Flight direction of Ross' Gull in the northern and southern Chukchi Sea from 22 September to 1 October 1976. n = number of birds.

Region	N	NE	E	SE	S	SW	W	NW
NORTHERN CHUKCHI n=116	9%	3%	16%	8%	41%	3%	18%	0%
Mean direction = 246 degrees Length of mean vector = .23 Angular deviation = 71 degrees								
SOUTHERN CHUKCHI n=33	48%	0%	12%	0%	0%	0%	0%	39%
Mean direction = 30 degrees Length of mean vector = .80 Angular deviation = 36 degrees								

Table 2.7. Densities of Ross' Gull in the central and southern Chukchi Sea from 7 to 9 October 1976.

Region	Observation periods	Average density (per km^2)	Percent freq.	Maximum density (per km^2)
CENTRAL CHUCKHI	12	0.1	8%	1.2
SOUTHERN CHUKCHI	22	0.3	18%	1.8

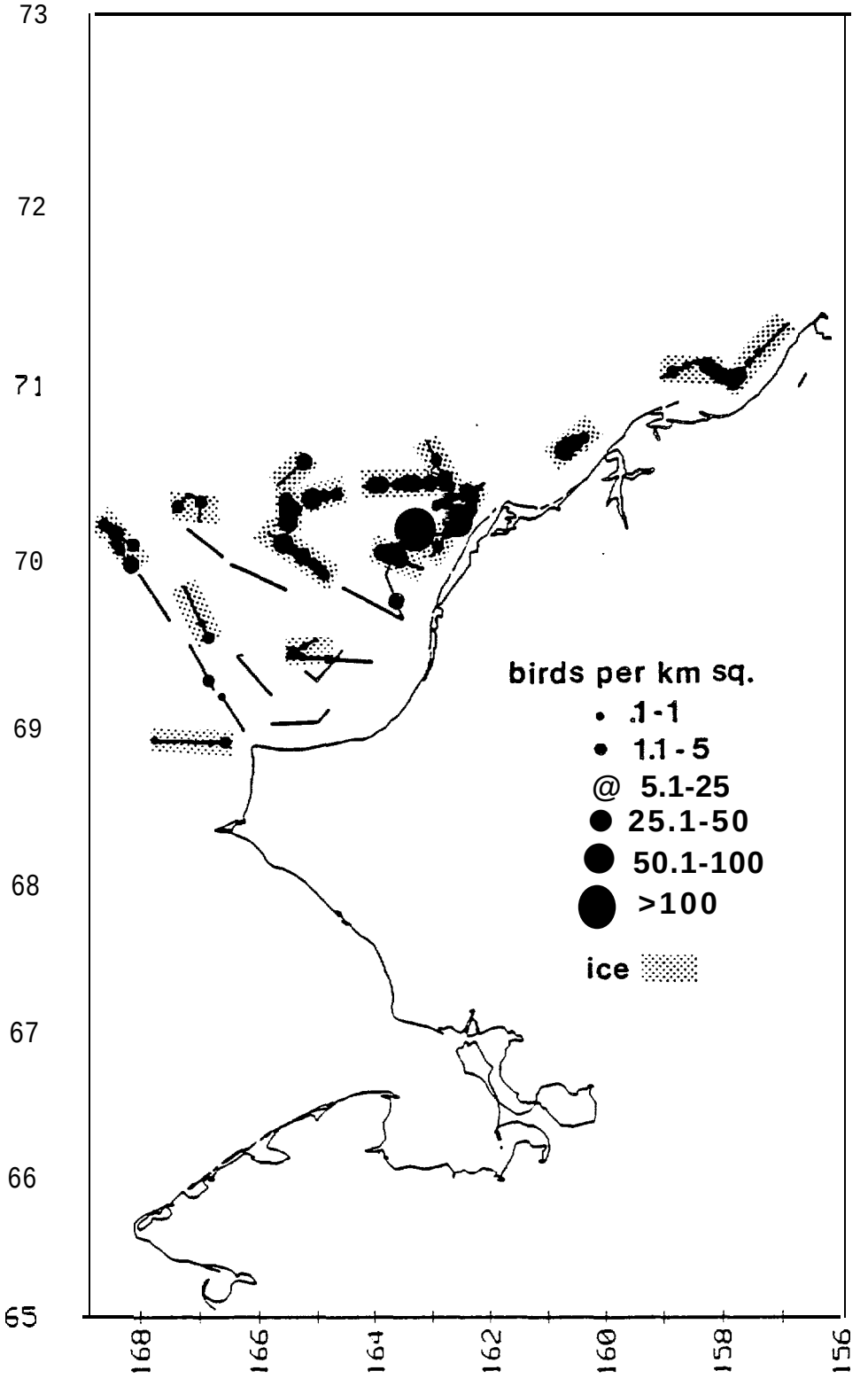

Figure 2.14. Densities of Ross' Gull in the Chukchi Sea from 24 September - 17 October, 1970.

transects in areas with ice (Table 2.8).

Ross' Gulls were present just north of Point Barrow on 22 and 23 September before the start of the cruise and were observed during the entire cruise. They were common in the lead system from Point Barrow south to Icy Cape. At the southern edge of the pack ice, Ross' Gulls were regular from 169°W to the Alaskan Chukchi coast, with densities being highest in the area northwest of Icy Cape and Point Lay. South of the pack ice edge Ross' Gulls were less common.

The average density and frequency of occurrence of Ross' Gulls in ice were approximately three times that found in open water (Table 2.8). Birds were present on almost half of the observation periods in the ice. Transects with ice cover of 20% had densities substantially higher than open water, but transects in other ice coverage had densities similar to open water. An exceptionally high density of 120 b/km^2 was encountered in an area of 20% ice cover just southwest of Icy Cape on 2 October.

No movement indicative of migration was noted for Ross' Gulls on this cruise. Ross' Gulls frequently followed the ship and gathered in the vicinity of the ship when it was stopped on station.

2.5.1.2 Beaufort Sea

2.5.1.2.1 August-September 1971

Observations were made 18 August to 16 September 1971 in decomposing pack ice between Point Barrow and the Canadian border. Ross' Gulls were seen on two of the 263 transects (Fig. 2.15). Both observations were of single birds, resulting in densities of 1.2 b/km^2. One was seen on 11 September north of Harrison Bay, and two were north of Smith Bay on 14 September. The average density for the cruise was 0.001 b/km^2 with a frequency of less than 1%.

Table 2.8. Densities of Ross' Gull in relation to ice cover in the Chukchi Sea from 24 September to 17 October 1970.

Ice Conditions	Observation periods	Average density (per sq. km)	Percent freq.	Maximum density (per sq. km)
None	41	1.3	16%	16.2
All ice	146	4.7	46%	120.0
Vis.to 10% coverage	42	1.8	29%	37,2
20% coverage	69	8.0	58%	120.0
30% coverage	35	1.8	43%	15.3

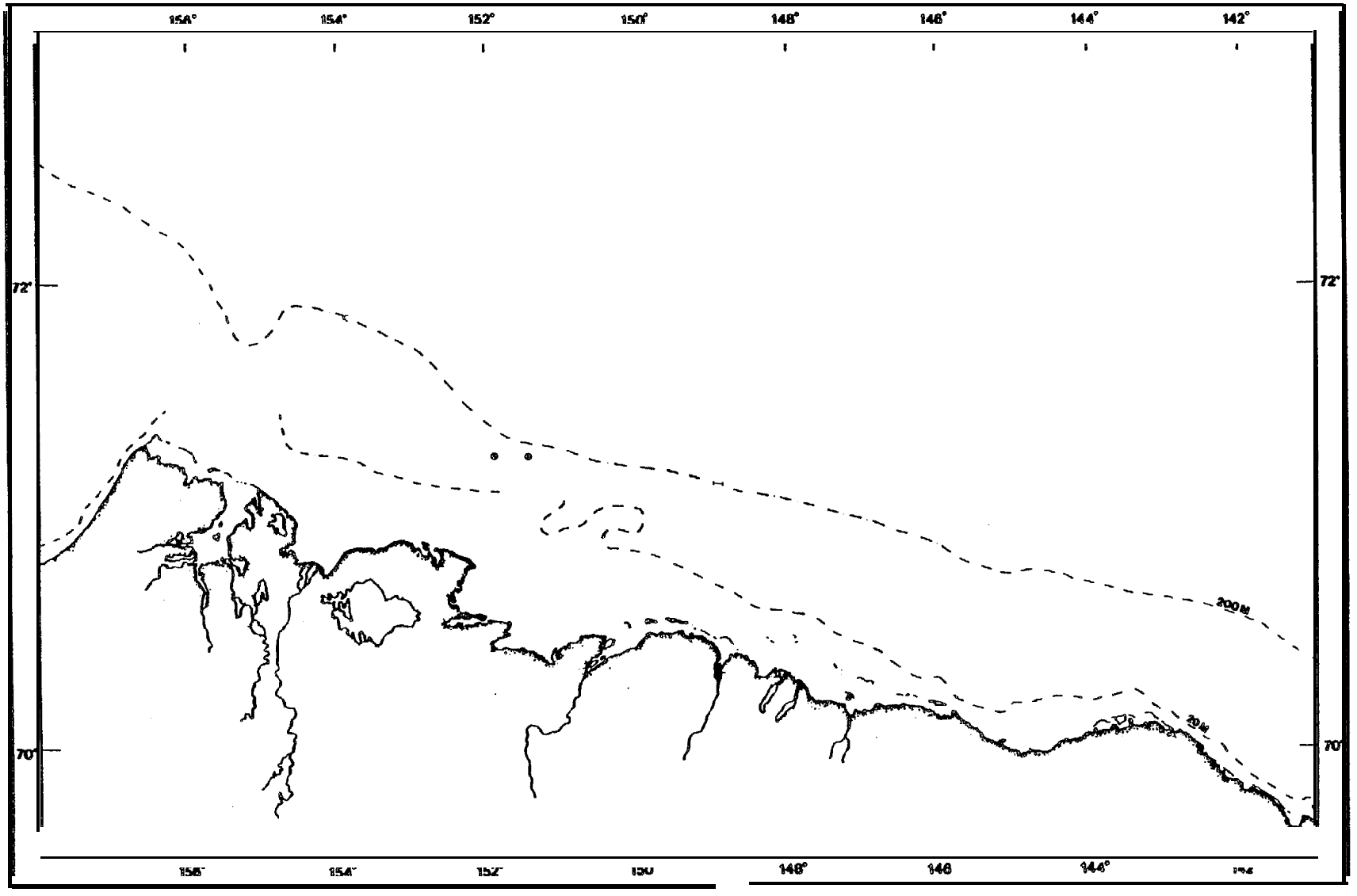

Figure 2.15. Locations of Ross' Gull sightings in the Beaufort Sea from 18 August - 16 September, 1971.

2.5.1.2.2 September 1976

Observations were made 6 to 18 September 1976 in the extreme western Alaskan Beaufort Sea west of 151°W loose pack ice (Fig. 2.16). Ice cover in the Beaufort west of 145°W was 10-50%, whereas east of 145°W the Beaufort was ice free from shore north to 70°30'N. Sixty-five percent (65%) of the transects had ice visible or ice in the transects (Table 2.9). The percent ice cover in the area censused decreased during the sampling period, and the amount of water between the shore and ice edge increased.

The majority of Ross' Gulls were seen in a restricted area between 154° and 156°W and north of 72°N (Fig. 2.16). One bird was seen at 152°W. Average density for the cruise was 0.2 b/km^2, and densities and frequencies were similar for open water and ice (Table 2.9). In ice habitats, densities were highest when ice was visible and lowest when ice was present in the transect.

The first Ross' Gull was seen on 11 September, but most were observed after 13 September. The dates that birds were seen may be due in part to Ross' Gulls being most common in the area that was censused in the latter part of the cruise. It appeared that Ross' Gulls were moving into the area during the first two weeks of September, however, since none were seen on a cruise in the western Beaufort Sea from 17 August to 3 September 1976.

2.5.1.2.3 October 1986

Observations were made 1 to 17 October 1986 from the extreme eastern Chukchi Sea directly adjacent to Point Barrow, east to the eastern boundary of the Alaskan Beaufort at 141°W (Fig. 2.17, Table 2.10). Sampling in the western Beaufort occurred from 1 to 7 October, with censusing in the eastern Beaufort after that date (Table 2.11).

The majority of the Beaufort Sea west of 145°W was ice free north to 72°N (Table 2.11). Ice retreat was pronounced in 1986, and the ice edge in the Chukchi was north of 73°N. Ice cover increased to 80-100% in the majority of the Alaskan Beaufort during the sampling period. Sampling was

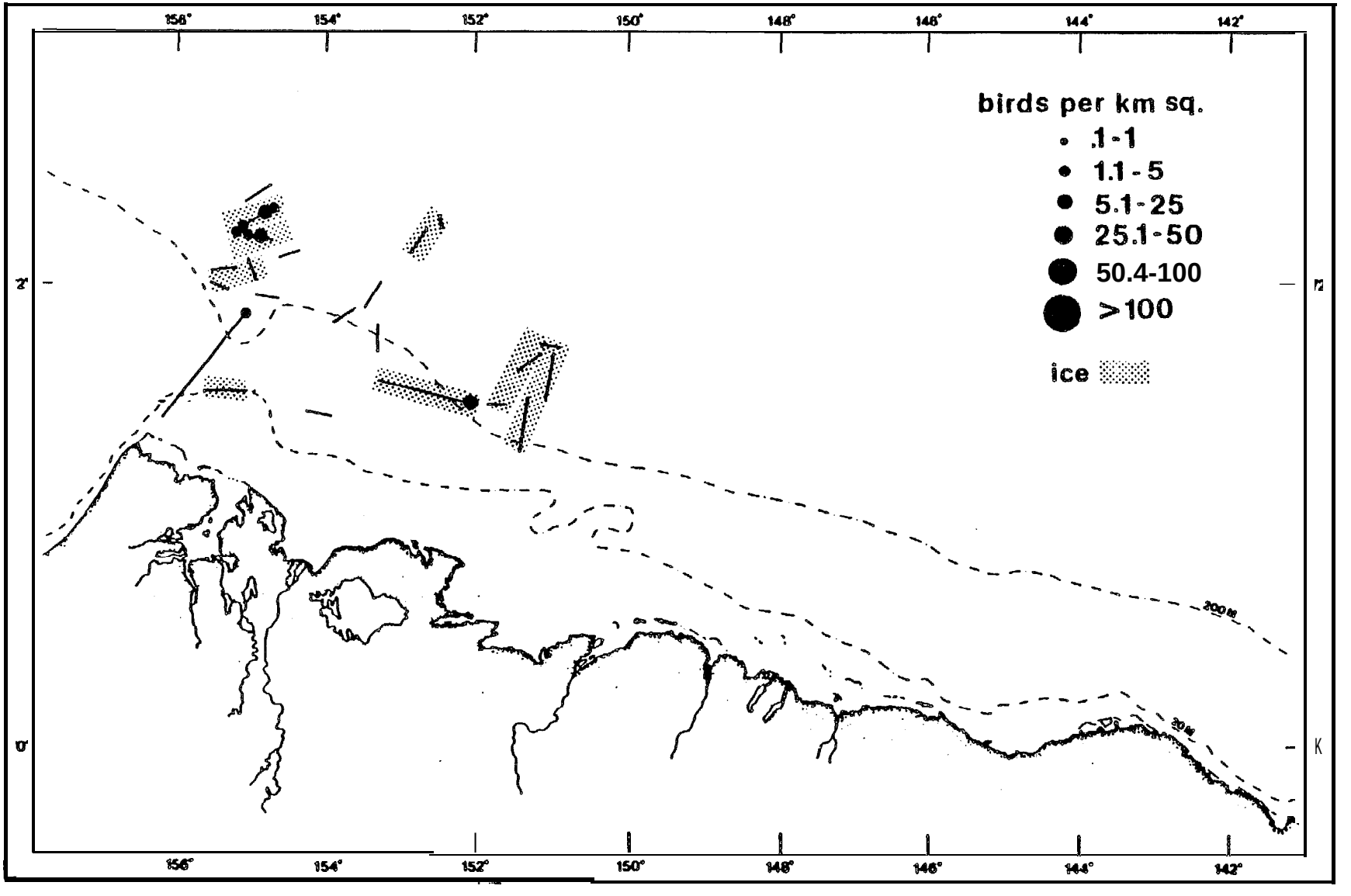

Figure 2.16. Densities of Ross Gull in the Beaufort Sea from 1 to 17 October, 1986.

Table 2.9. Densities of Ross' Gulls in the western Beaufort Sea from 6 to 18 September 1976.

Ice Conditions	Observation periods	Average density (B/km^2)	Percent frequency
None	45	003	7%
Visible	27	0.7	19%
Pres. in transect (10-25% coverage)	56	<0.1	2%

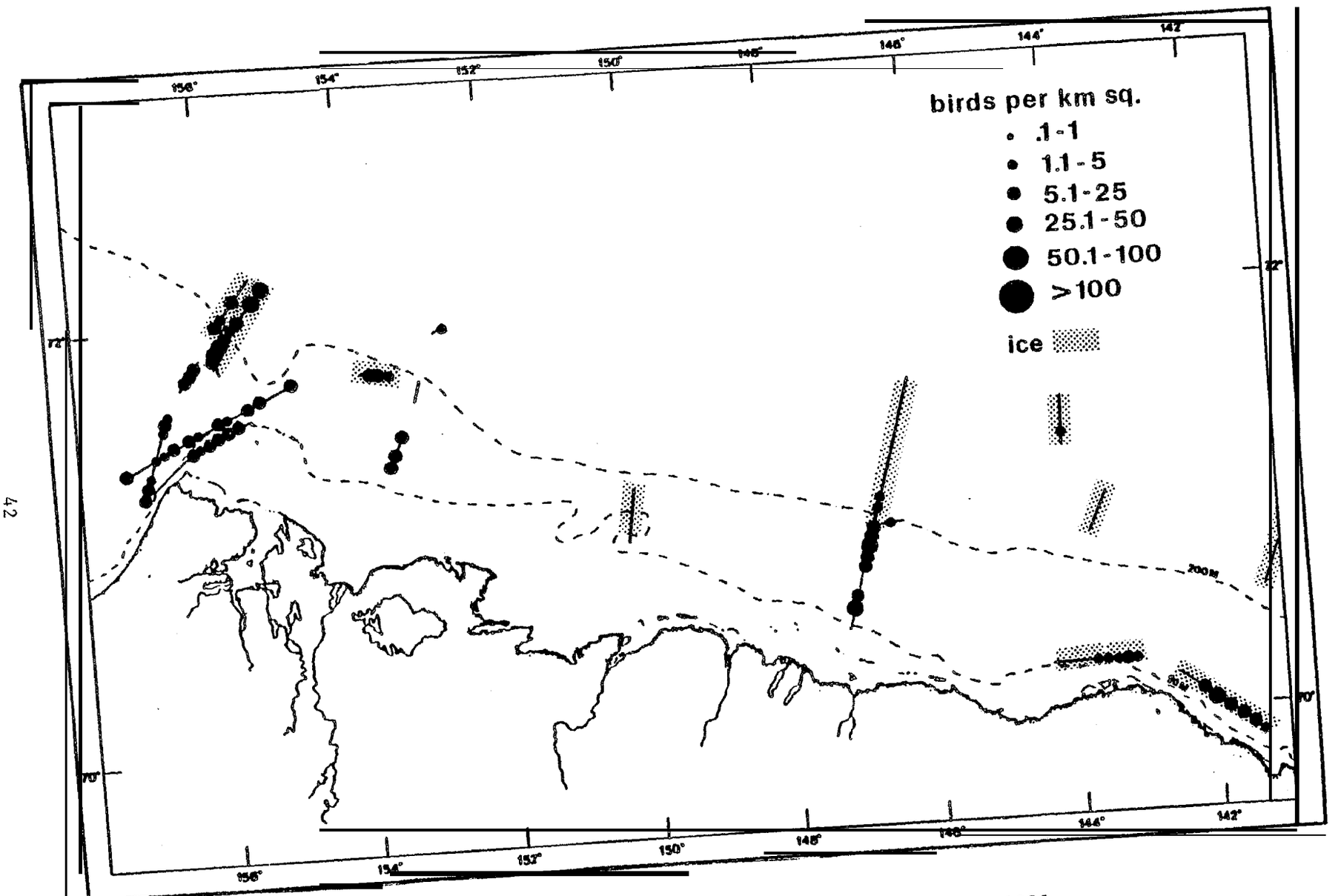

Figure 2.17. Densities of Ross' Gull in the Beaufort Sea from 1 to 18 October, 1986.

Table 2.10. Densities of Ross' Gulls in the Chukchi Sea directly adjacent to Point Barrow and in the two regions of the Beaufort Sea from 1 to 17 October 1986.

Region	Observation periods	Average density (per sq. km)	Percent frequency	Maximum density (per sq. km)
Chukchi	20	0.7	50%	4.2
Western Beaufort	58	1.9	60%	14.4
Eastern Beaufort	92	0.6	24%	8.4

Table 2.11. Densities of Ross' Gulls in the Beaufort Sea from 1 to 18 October 1986.

Ice	Observation periods	Average density (per sq. km)	Percent frequency	Maximum density (per sq. km)
None	59	1.0	46%	2.4
Ice	122	1.0	33%	14.4
Visible	60	1.9	57X	14.4
Pres. in transect (10-25% coverage)	62	0.1	10%	8.4

divided equally between open water, areas with ice visible, and areas in the ice. In the western Beaufort, sampling was conducted south of and at the ice edge, and 56% of the observation periods had ice visible or within the transect. In the eastern Beaufort, sampling was conducted in the newly forming ice north of the 200 m isobath, as well as in the open water south of the forming pack ice, with 82% of the transects in association with ice (Table 2.11).

Ross ' Gulls were present from the start of the cruise on 1 October until 15 October. The highest average densities were in the western Beaufort, where an average of 1.9 b/km^2 were present (Table 2. 10). The lower average density in the eastern Beaufort is the result of transects north of the 200 m isobath where ice cover was 80-90%. Excluding these transects, the densities in the eastern Beaufort averaged 1.4 b/km^2.

Transects adjacent to the ice edge where ice was visible had the highest average densities (1.9 b/km^2), approximately twice what found in open water (Table 2.10). Few birds were seen in areas with ice, primarily because of the extensive ice cover in such areas.

The percentage of birds with a flight direction was 92%. In the western Beaufort, the mean flight direction was 103° and in the eastern Beaufort it was 3° (Table 2.12). Almost 50% of the birds in the western Beaufort were flying eastward, while in the eastern Beaufort the total was only 15%. In the eastern Beaufort, 52% of the migrating Ross' Gulls were flying westward.

2.5.2 Land-based Migrant Watches at Point Barrow

2.5.2.1 September-October 1976

Incidental observations of Ross ' Gull movements were conducted 27 September to 15 October 1976 for one to two hours each day from the time Ross ' Gulls first appeared until freeze-up (Table 2.13). Because the methodology differed from the migration watches in 1984 and 1986, the rates of passage from 1976 cannot be compared with those years. 'The direction of

Table 2.12. Flight directions of Ross' Gulls in the Beaufort Sea from 1 - 17 October 1986. n = number of birds.

Region	N	NE	E	SE	S	SW	W	N W
Western Beaufort	14%	9%	44%	6%	13%	10%	5%	0%
n=140								
Mean direction = 103 degrees								
Length of mean vector = .44								
Angular deviation = 69 degrees								
Eastern Beaufort	23%	1%	14%	0%	10%	6%	35%	11%
n=71								
Mean direction = 3 degrees								
Length of mean vector = .55								
Angular deviation = 54 degrees								

Table 2.13. Observed daily eastward and westward passages of Ross' Gull and daily average wind direction at Point Barrow in late September and early October 1976.

Date	Ross' Gulls East	Ross' Gulls West	Wind direction (oT)
September 27	264	0	60
28	180	0	50
29	96	0	60
30	1740	0	60
October 01	90	17	70
02	177	0	90
03	0	0	40
04			60
05	0	0	70
06	0	0	60
07			80
08			250
09	0	0	310
10	0	279	220
11	0	9	290
12	3	6	240
13			190
14			330
15	1	19	110

the movements is important, however, since these early observations provided the first indication that the eastward movement is followed by a westward movement back to the Chukchi. The eastward movement occurred during an extended period of winds from the northeast and east and the return movement occurred after the wind had shifted to the southwest (Table2.13).

2.5.2.2 September-October 1984

Observations of Ross' Gull migration were conducted from 2 September to 20 October 1984. On 18 September, twelve days before Ross' Gulls were observed, the ice edge in the Alaskan Chukchi was south of 72°N and the majority of the Beaufort Sea was ice covered south to 71°N. Freezing of lagoonal waters began on 1 October, with the water seaward of the beach beginning to freeze on 5 October. At the beginning of the Ross' Gull migration on 1 October the ice edge was at 72°N due north of Point Barrow (and as far north as 73°N in the Chukchi Sea. The western Beaufort Sea was free of ice south of 71°30'N while the eastern Beaufort had patches of 50% ice cover south to 71°15'N. At the end of the migration on 22 October, the Beaufort Sea was 90-100% ice covered and the extreme western Chukchi was frozen to 160°W. The ice edge was at 72°N in the central Chukchi but was close to 71°N adjacent to Siberia and Alaska.

Ross' Gulls were not seen until 30 September but were common after that date until 20 October (Table 2.14). The observed movements (Table 2.14) and projected totals (Table 2.15, Fig. 2.18) show that birds were essentially moving both east and west. When discussing the observations at Point Barrow, a bird going east is considered to be leaving the Chukchi Sea and entering the Beaufort, while a bird moving west is doing the reverse. The majority of the birds flying east flew northeast as they paralleled the Chukchi shore to the tip of Point Barrow; they then continued to parallel the shoreline as they flew southeast into the Beaufort Sea. A small percentage of birds were observed crossing the base of the spit leading to Point Barrow (at the location of observations in 1976 and 1986 in Fig. 2.9). Observations from 1986 show that the number crossing the base of the spit was <10% of the total birds passing by its base. Birds moving westward were flying principally southwest. When no extensive shorefast ice was

Table 2.14. Observed daily eastward and westward passages of Ross' Gulls at Point Barrow in September and October 1984.

Observed East - 1984

Date	Hours of Obs.	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Daily Total	Wind dir.
						time							
Sept. 30	3			36		25				40		101	70
Oct. 1	4			435		184			224	176		1019	70
2	6	8	62	52	195					72	133	522	70
3	5	69	2	0	0						0	71	70
4	7	26	43		17	89			42	26		243	60
5	5		211	124	11	45	36					427	60
6	7	40	91	300				40	0	6	0	477	60
7	6	409	388		231	102				139	22	1291	60
8	5	278	802		222	50		12				1364	70
9	4	46	3		0	0						49	60
10	6		37	21	0	132			24	24	81	319	50
11	2			457				32				489	60
12	9	2281	750	318	165	94	20		35	12		3675	330
13	9		125	18	177	2	0	0	4	0	0	326	320
14	9		235	1	0	0	0	0	0	0	0	236	120
15	4		9	14		32	100	23				178	210
16	9		245	4	0	0	0	0	18	201	8	476	170
17	7	0		0	0	0		0	0		0	0	210
18	5		2	7	0			1		0		10	300
19	6		0	0			1	0		0	0	1	360
20	6		0	0		0	0	0	0			0	40
21	3			0			0	0				0	70

Total observed east = 11,274

Table 2.14 (continued).

Date	Hours of Ohs.	Observed West - 1984 time 900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Daily Total	Wind dir.
Sept. 30	3			0		0				0		0	70
Oct. 1	4			0		0			0	0		0	70
2	6	0	0	0	0					0	0	0	70
3	5	0	0	0	0						0	0	70
4	7	0	0		0	0			1	2		3	60
5	5		0	0	0	1	3	0				13	60
6	7	0	0	0				0	0	0	0	0	60
7	6	0	0		0	0				0	11	11	60
8	5	0	0		0	0		0				0	70
9	4	0	0		0	0						0	60
10	6		0	6	0	0			20		60	86	50
11	2			161				20				181	60
12	9	0	0	0	153	187	154		5	15	16	530	330
13	9		48	193		111	82	33	46	54	67	66 700	320
14	9		0	0	1	154	117	151	138	72	36	669	120
15	4	0	0	0	1			2				3	210
16	9		304	668		67	4	4	0	59	5	24 1135	170
17	7	75		148	137	2?		28	11		140	566	210
18	5		226	245	60			31		8		570	300
19	6		57	57			154	80		73	60	481	360
20	6		43	30		21	31	9	0			134	40
21	3			0			0	0				0	70

Total observed west - 5,082

Table 2.15. Projected total daily eastward and westward passages of Ross' Gull at Point Barrow in September and October 1984.

Date	Hours of Obs.	Total(observed and projected) - East 1984 time 900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Daily Total	Wind dir.
Sept. 30	3	33	33	36	31	25	33	33	33	40	36	331	70
Oct. 1	4	372	372	435	310	184	204	204	224	176	200	2681	70
2	6	8	62	52	195	134	134	134	134	72	133	1056	70
3	5	69	2	0	0	0	0	0	0	0	0	71	70
4	7	26	43	30	17	89	66	66	42	26	13	417	60
5	5		211	124	11	45	36	36	36	36	36	571	60
6	7	40	91	300	170	170	170	40	0	6	0	987	60
7	6	409	388	310	231	102	121	121	121	139	22	1962	60
8	5	278	802	512	222	50	31	12	12	12	12	1943	70
9	4	46	3	1	5	0	0	0	0	0	0	64	60
10	6	29	37	21	0	132	78	78	24	24	81	504	50
11	2	0	0	457	0	0	0	32	0	0	0	489	60
12	9	2281	750	318	165	94	20	0	35	12	0	3675	330
13	9	72	125	18	177	2	0	0	4	0	0	398	320
14	9	117	235	1	0	0	0	0	0	0	0	353	120
15	4	12	9	14	23	32	100	23	61	61	61	396	210
16	9	125	245	4	0	0	0	0	18	201	8	601	170
17	7	0	0	0	0	0	0	0	0	0	0	0	210
18	5	5	2	7	0	1	1	1	0	0	0	17	300
19	6	0	0	0	0	0	1	0	0	0	0	1	360
20	6	0	0	0	0	0	0	0	0	" 0	0	0	40
21	3	0	0	0	0	0	0	0	0	0	0	0	70

Total east = 16,516

Table 2.15 (continued).

Total(observed and projected) - West 1984

	Hours of Ohs.	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Daily Total	Wind dir.
Sept.	30	3	0	0	0	0	0	0	0	0	0	0	0	70
Oct.	1	4	0	0	0	0	0	0	0	0	0	0	0	70
	2	6	0	0	0	0	0	0	0	0	0	0	0	70
	3	5	0	0	0	0	0	0	0	0	0	0	0	70
	4	7	0	0	0	0	0	1	1	1	2	2	6	60
	5	5	0	0	0	0	1	3	0	7	7	7	39	60
	6	7	0	0	0	0	0	0	0	0	0	0	0	60
	7	6	0	0	0	0	0	0	0	0	0	11	11	60
	8	5	0	0	0	0	0	0	0	0	0	0	0	70
	9	4	0	0	0	0	0	0	0	0	0	0	0	60
	10	6	0	0	6	0	0	10	10	20	40	60	146	50
	11	2	0	0	161	0	0	0	20	0	0	0	181	60
	12	9	0	0	0	153	187	154	79	5	15	16	609	330
	13	9	120	48	193	111	82	33	46	5.4	67	66	820	320
	14	9	0	0	0	1	154	117	151	138	72	36	669	120
	15	5	4	0	0	0	1	2	2	2	2	2	12	210
	16	9	484	304	668	67	4	4	0	59	5	24	1619	170
	17	7	75	111	148	137	27	28	28	11	75	140	780	210
	18	5	235	226	245	60	45	45	31	19	8	14	928	300
	19	6	57	57	57	105	105	154	80	75	73	60	823	360
	20	6	36	43	30	36	21	31	9	0	5	5	216	40
	21	3	0	0	0	0	0	0	0	0	0	0	0	70

Total west = 7,069

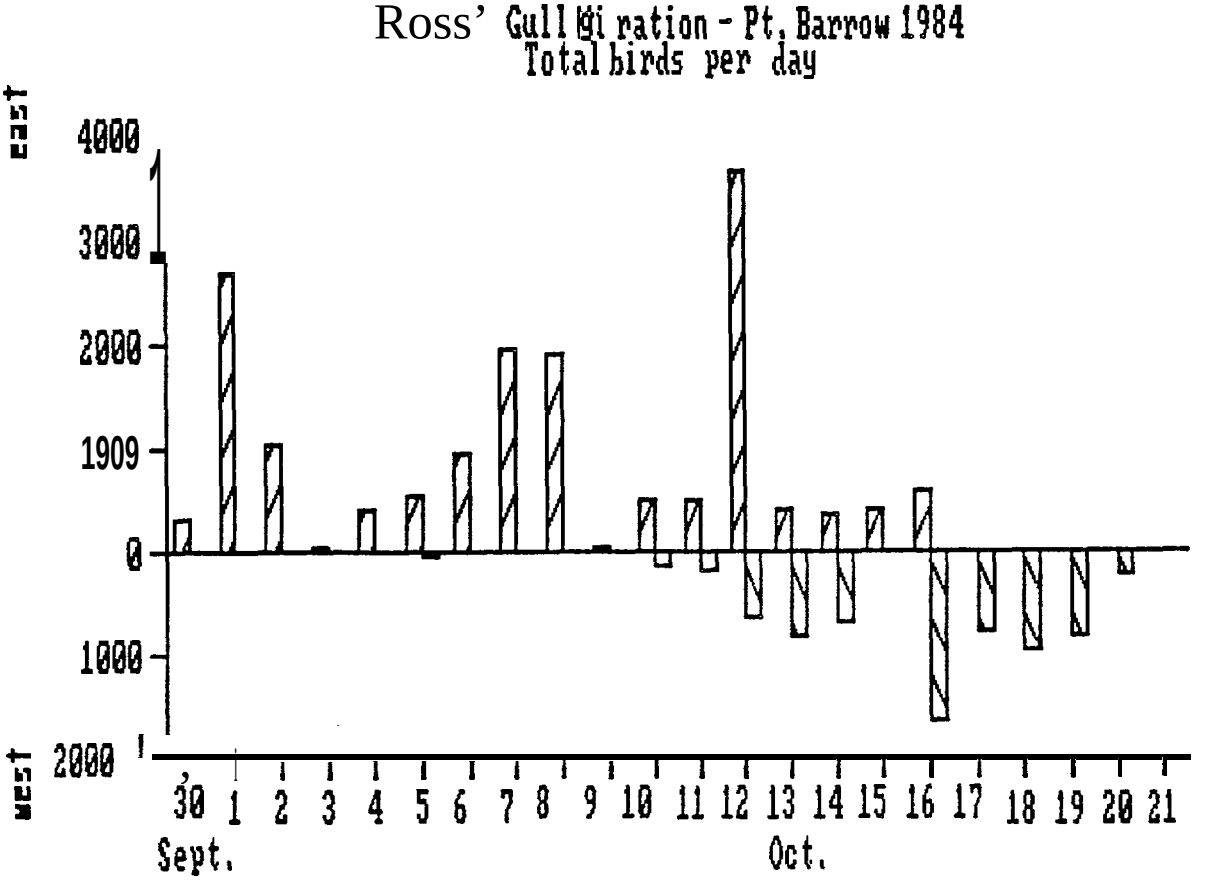

Figure 2.18. Total eastward and westward passages per day (observed and projected) of Ross' Gull at Point Barrow in September and October, 1984.

present, birds approached the tip of Point Barrow from the east or southeast and then followed the Chukchi coast to the southwest.

For the first 12 days of the migration almost all movement was to the east, but after 12 October the net movement was westward, with some eastward movement continuing until 16 October. For the eastward movement, the observed total exceeded 11,000 birds and the projected total was 16,500 (Table 2.15). Because the movement was almost exclusively east for twelve days (30 Sept.-11 Oct.), it is unlikely that the totals for the eastward passage included birds that were being counted twice until 12 October. During this period 10,000 birds were observed flying west, with a projected total of 15,000. Thus the eastward movement at Point Barrow involved a minimum of 10,000 birds and probably approximated 15,000.

The duration and magnitude of the westward movement was substantially less than the eastward movement, with an observed total of 5,000 (Table 2.14) and projected total of 7,000 (Table 2.15). Essentially all of the westward movement occurred after 12 October, and movement was exclusively westward for the last four days of the migration.

Wind conditions during the east and west passages (Table 2.15) show that during the period of exclusive eastward movement, winds blew from the east and northeast with a small angular deviation. During the westward movement the average wind was from the west, but the angular deviation was large and winds also ranged from southeast to north. During both movements the average wind speed was 16 miles per hour.

2.5.2.3 September-October 1986

At the start of observations on 23 September 1986, the ice edge in the Chukchi Sea was north of 73°N. The western Beaufort was ice free north to 72°N, while the eastern Beaufort had scattered patches of ice of 10-30% south of an ice edge at 72°N. The ice edge in the Chukchi and the Beaufort extended from 71-72°N at the end of observations on 18 October. Ice was forming rapidly, and on 21 October the entire Alaskan Beaufort had 80-100% ice cover. In the Chukchi the nearshore zone from Point Barrow to

Peard Bay had 40-60% ice cover, the ice edge was at 71°N, and much of the Soviet Chukchi was ice covered.

Ross' Gulls were not observed until 26 September (Tables 2.16 and 2.17). From that date until 6 October small numbers were seen moving both to the east and west. Movements in both directions increased after 6 October, but were primarily to the west. The movement on 11 October of 2,637 observed and 3,846 projected was the by far the largest during the observation period.

The observed and projected totals for the eastward movement were approximately one quarter that of the westward (Table 2.17, Fig. 2.19). These are estimated passages until 18 October only, since the end of the migration was not observed in 1986.

2.5.3 Aerial Surveys

2.5.3.1 1976 Surveys

No Ross' Gulls were observed on aerial surveys before mid-September. only those coastal sections where the species was encountered are presented (Fig. 2.20), although censusing was conducted from Cape Lisburne to Demarcation Point. No RoSS' Gulls were observed until the 23 September flight (Table 2.18), when they were encountered only in the Beaufort Sea. Numbers were highest in the Plover Islands where the density in birds per linear km doubled from 23 September to 4 October. Both of these censuses extended east to at least Prudhoe Bay but no Ross' Gulls were observed east of Cape Halkett. Nearshore waters froze on 9-10 October causing a decrease in shoreline densities of gulls. Ross' Gulls were encountered on the Chukchi coast later than the Beaufort and only in small numbers.

2.5.3.2 1984 Surveys

Aerial censuses of the extreme western Beaufort Sea and Plover Islands were conducted to determine if any specific feeding aggregations could be located in areas where other surface feeding species congregate in August

Table 2.16. Observed daily eastward and westward passages of Ross' Gulls at Point Barrow in September and October 1986.

Date	Hours of Obs.	Observed East - 1986 time 900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Daily Total	Wind dir.
Sept. 26	4			0	0				0	1		1	330
27	5			0	0	0	0	0				0	90
28	6				0	21	0	0		0	0	21	110
29	5		4	179		3	0			39		225	90
30	6	3	0				0	13	0	2		18	90
Oct. 1	5		5	15		3	14		9			46	150
2	6	11	14			1	0		6	0		32	150
3	0											0	120
4	6			43	13	4	14		6			80	60
5	8		0	0	6	13		0	0	0	0	19	300
6	6		46	64	52		52	52			26	292	220
7	5		0	0	0			118			9	127	270
8	6		0	4	4		0		64	39		111	330
9	6	0	6			0	2	0		0		8	150
10	6		0	0	0	0				0	0	0	2&o
11	7		0	4			14	171	67		15	271	270
12	4		0	2			0				0	2	150
13	7		0	3		2	7	12	20		58	102	40
14	7		18	0	0	0			0	0	0	18	360
15	7		0	2	0	0	0	0	0			2	340
16	7		0	0	0	0			0	0	0	0	180
17	7		0	6	130	0			34	76	3	249	180
18	9		4	5	7				0	0	0	16	240

Total observed east = 1,640

Table 2.16 (continued).

Observed West - 1986

Date	Hours of Obs.	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Daily Total	Wind dir.
Sept. 26	4			0	0				0	0		0	330
27	5			39	20	4	16	0				79	90
28	6				50	0	14	2		44	95	205	110
29	5		0	0		4	6			0		10	90
30	6	80	33				0	15	53	0		181	90
Oct. 1	5		6	17		9	14		0			46	150
2	6	0	0			0	0		4	1	"	5	150
3	0											0	120
4	5			7	17	9	14		0			47	60
5	8		43	78	62	37		60	117	0	15	412	300
6	6		9	17	9		3	17			59	114	220
7	5		233	356	142			134			2	867	270
8	6		191	175	104		37		64	39		610	330
9	6	31	6			2	0	3		3		45	150
10	6		2	11	5	1				4	1	24	240
11	6		1	16			256	357	1647		219	2496	270
12	5		2	10			3	1			0	16	150
13	7		7	105		22	13	147	174		6	474	40
14	5		100	84	118	0			59		28	389	360
15	7		98	20	15	9	0	0	0			142	340
16	7		0	2	0	0			0	0	0	2	180
17	7		0	2	0	0			43	19	101	165	180
18	6		1	0	5				21	71	27	125	240

Total observed east = 6,454

Table 2.17. Projected total daily eastward and westward passages of Ross' Gulls at Point Barrow in September and October 1986.

Date	Hours of Obs.	Total (observed and projected)- East 1986 time 900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Daily Total	Wind dir.
Sept. 26	4	0	0	0	0	0	0	0	0	1	1	2	330
27	5	0	0	0	0	0	0	0	0	0	0	0	90
28	6	10	10	10	10	21	21	0	0	0	0	82	110
29	5	139	95	183	179	94	3	0	24	63	39	819	90
30	6	3	3	0	0	0	0	13	13	2	2	36	90
Oct. 1	5	18	15	20	15	12	17	14	32	9	16	168	150
2	6	11	25	14	7	8	1	0	9	6	0	81	150
3	0	9	9	9	9	1	0	2	3	3	2	0	55	120
4	5	64	64	71	56	17	18	14	16	6	8	334	60
5	8	0	0	0	6	19	13	7	0	0	0	45	300
6	6	106	101	110	116	52	104	104	52	39	65	849	220
7	5	0	0	0	0	0	59	177	118	63	72	489	270
8	6	3	2	4	8	4	2	0	96	103	39	261	330
9	6	6	6	6	3	3	2	2	0	0	0	28	150
10	6	0	0	0	0	0	0	5	5	5	0	15	240
11	6	3	2	4	4	9	23	185	238	56		524	270
12	5	1	1	2	2	1	1	0	0	0	0	8	150
13	7	2	2	3	3	5	9	19	32	20	97	192	40
14	5	22	27	18	0	0	0	0	0	0	0	67	360
15	7	2	1	2	2	0	0	0	0	0	0	7	340
16	7	0	0	0	0	0	0	0	0	0	0	0	180
17	7	3	3	6	136	130	0	25	59	110	79	551	180
18	6	9	9	9	1	2	8	8	8	4	0	0	67	240

Total east = 4,679

Table 2.17 (continued).

Total(observed and projected) - West 1986

Date	Hours of Ohs.	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Daily Total	Wind dir.
Sept. 26	4	0	0	0	0	0	0	0	0	0	0	0	330
27	5	29	29	39	20	4	16	0	8	8	8	161	90
28	6	25	25	25	50	0	14	2	23	44	95	303	110
29	5	0	0	0	2	4	6	14	14	0	7	47	90
30	6	80	33	16	16	16	0	15	53	0	26	255	90
Oct. 1	5	11	6	17	13	9	14	7	0	3	3	83	150
2	6	0	0	0	0	0	0	2	4	1	2	9	150
3	0	0	0	0	0	0	0	0	0	0	0	0	120
4	5	12	12	7	17	9	14	7	0	3	3	84	60
5	8	60	43	78	62	37	48	60	117	0	15	520	300
6	6	13	9	17	9	6	3	17	38	38	59	209	220
7	5	295	233	356	142	138	138	134	67	67	2	1572	270
8	6	183	191	175	104	71	37	51	64	39	62	976	330
9	6	3	1	6	4	4	2	0	3	3	3	59	150
10	6	6	2	11	5	1	2	2	2	4	1	36	240
11	6	8	1	16	136	136	256	357	1647	933	219	3709	270
12	5	6	2	10	6	6	3	1	1	1	0	35	150
13	7	56	7	105	63	22	13	147	174	90	6	683	40
14	5	92	100	84	118	77	77	37	59	44	28	716	360
15	7	59	98	20	15	9.0	0	0	0	0	201	340
1	6	7	0	0	2	0	0	0	0	0	0	2	180
17	7	1	0	2	0	0	15	30	43	19	101	211	180
18	6	1	1	0	5	13	13	13	21	71	27	165	240

Total west = 10,034

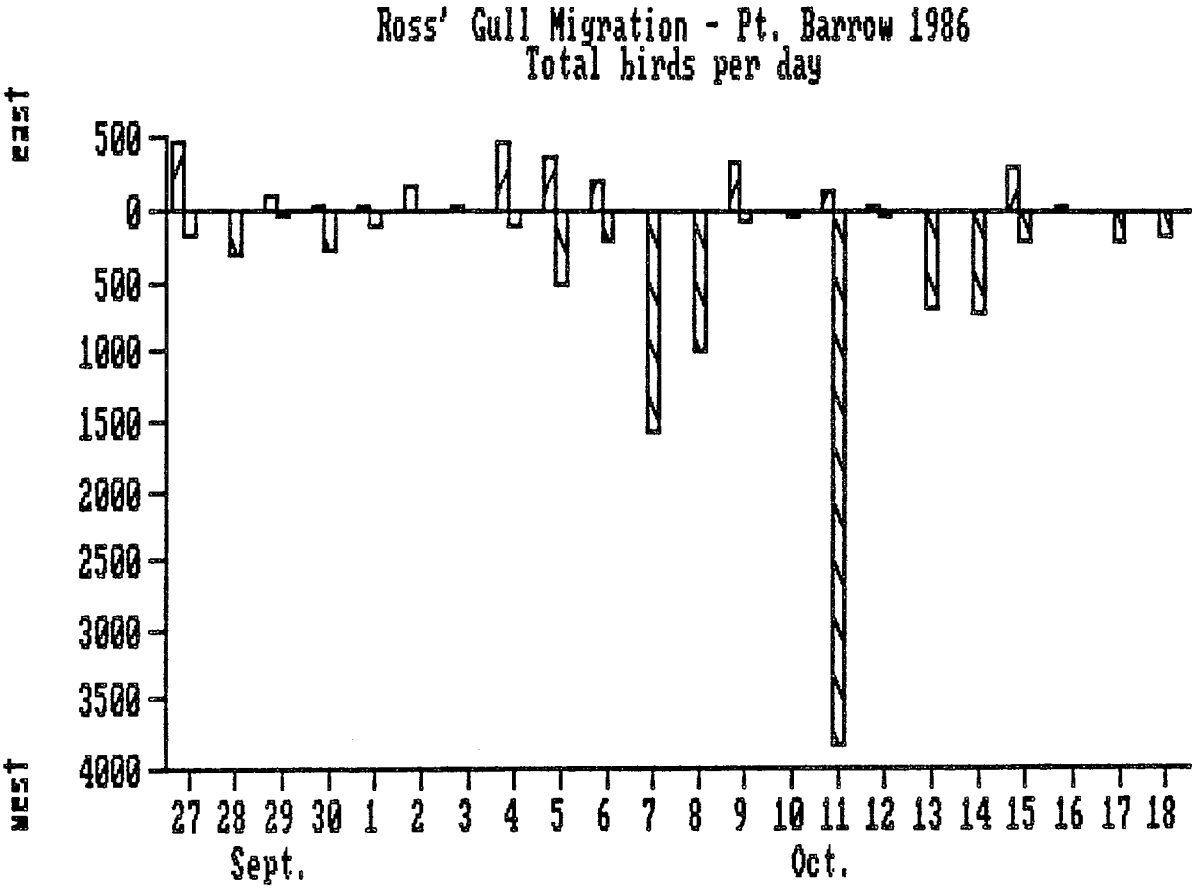

Figure 2.19. Total eastward and westward passages per day (observed and projected) of Ross' Gull at Point Barrow in September and October, 1986.

Table 2.18. Linear densities (birds per linear km) of Ross' Gull between Atanik and Cape Halkett in 1976. See Figure 2.20 for locations of coastal sections.

Date	COASTAL SECTION A	B	C	D	E
7 Sept.			0	0	0
11 Sept.	0	0	–	–	–
18 Sept. -			0	–	–
20 Sept.	0	0	-	-	-
23 Sept.	0	0	12	.1	0
28 Sept.	0	.4	-	-	-
4 Oct.			28	-	<.1
13 Oct.	<.1	<.1	.1	-	-

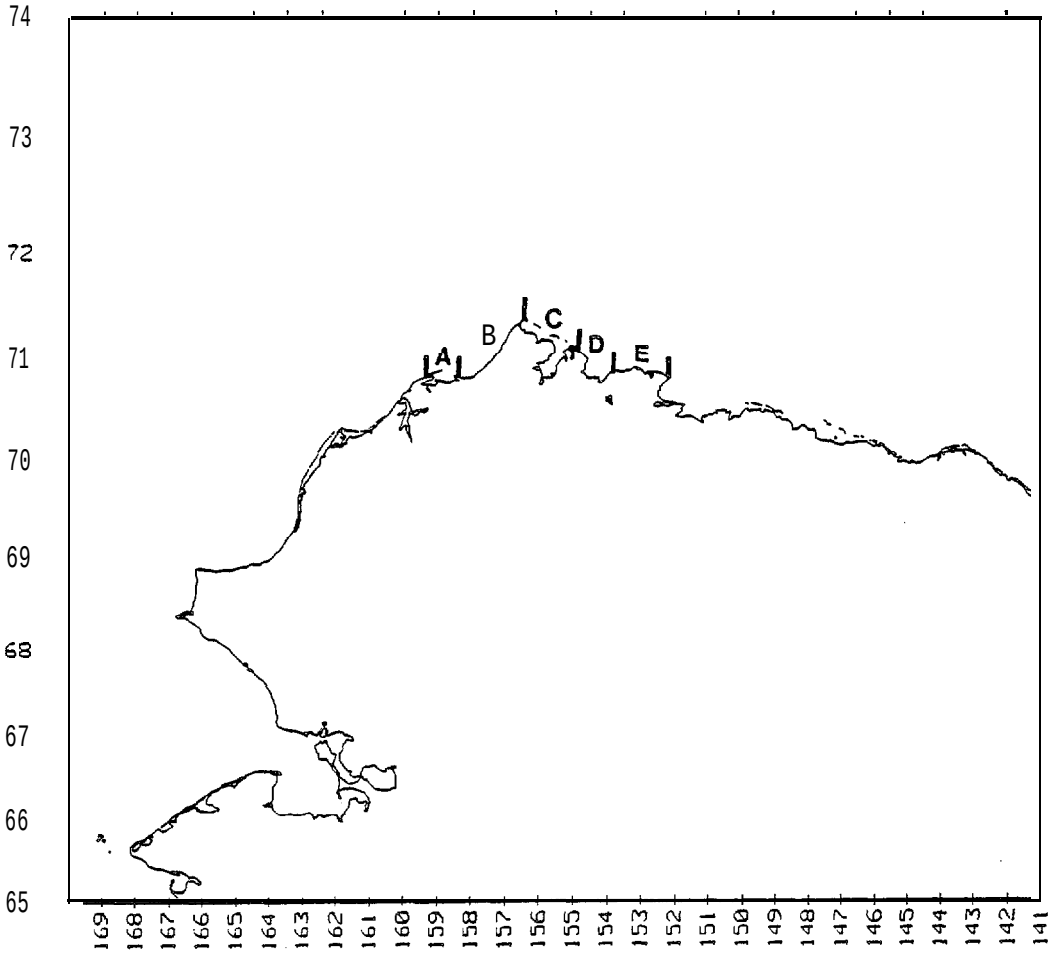

Figure 2.20. Location of coastal sections where Ross' Gulls were encountered on aerial censuses.

and early September (Divoky 1984). No aggregations were encountered.

A census of the Chukchi Sea coast from Point Barrow to Wainwright on 8 October found migrating Ross' Gulls common within 500 m of the beach from Point Barrow to just north of Peard Bay (10 birds per linear km). No Ross Gulls were observed south of the Peard Bay area and it appeared that birds were coming off the Chukchi Sea and encountering the Chukchi coast at Peard Bay. The projected passage at Point Barrow for 8 October was 500 birds.

2.6 Discussion

2.6.1 Timing of Arrival in Arctic Alaska

During the breeding season, from late May to late July, Ross' Gull is apparently an uncommon vagrant in arctic Alaska. Land-based observations from Wainwright to Cooper Island show that single birds or pairs could be expected to be irregular in the pelagic Chukchi and at least the extreme western Beaufort during this period (Bailey 1948, Kessel and Gibson 1978, Divoky unpub.). While most sightings during this period have been in the general region of Point Barrow, this is almost certainly due to the number of observers in that region.

Ross' Gulls departed the breeding grounds shortly after our pelagic observations began in mid-July. Although the breeding area is only 900 nautical miles from Point Barrow, there is a minimum of six weeks between the time of departure from the colonies to arrival in Alaskan waters. This extended period of time implies that Ross' Gulls do not move directly to Alaska from the breeding area. Ice begins forming in the waters north of Siberia west of 175°E from mid- to late-September, two weeks to a month before ice formation usually begins in Alaskan waters. This is approximately the time that Ross' Gulls move to Alaskan waters, and it may be that Ross' Gulls occupy the area north of the breeding ground or the Chukchi Peninsula until freeze-up occurs.

In the Chukchi Sea, during 263 hours of observation from 16 July to 22 September, Ross' Gulls were seen on 3 of 1,151 observation periods. These

three sightings were all in early August, with none being seen from mid-August to mid-September. This indicates that these birds were non-breeding vagrants and did not represent the start of the fall migration. In the Beaufort Sea, 1,758 observation periods (480 hours) were conducted from 2 August to 10 September with no Ross' Gulls being seen.

The extreme paucity of Ross' Gulls in Alaskan waters before the species arrives in numbers in mid- to late-September is somewhat surprising in light of the observations in the Arctic Ocean west of the breeding grounds. In the pack ice between Franz Josef Land and Greenland, Meltofte et al. (1981) found Ross' Gulls to be common in the pack ice from early July to early August . Other summer observations of concentrations in that area of the arctic (Lovenskiold 1963) indicate that nonbreeding Ross' Gulls are probably regular there.

Sampling in mid-September was not extensive but it appears that Ross' Gulls arrived in numbers in Alaskan waters sometime between the end of the first week and the start of the last week in September. On two cruises in 1970 and 1976, we found Ross' Gulls to be common at the ice edge at the start of the last week in September. In two different years (1971 and 1976) Ross ' Gulls were first seen in the Beaufort on 11 September, although both times in small numbers. At Icy Cape, Lehnhausen and Quinlan (1981) had 18 sightings of Ross' Gull between 31 August and 3 September, indicating that early migrants can arrive two weeks earlier than the pelagic observations indicate.

2.6.2 Summary of Occurrence in Arctic Alaska

The period when Ross' Gulls are present in numbers in the Alaskan Chukchi and Beaufort seas is limited to the six to eight week period from mid-September to late October or early November. It appears that Ross' Gulls occupy the Alaskan Beaufort and Chukchi until freeze-up. Based on pelagic observations and migrant watches, Ross' Gulls leave the Beaufort from mid- to late-October when ice cover east of Point Barrow is nearly complete. Ross ' Gulls were present in the Chukchi Sea in late October when our observations ended. If, as proposed in this report, Ross' Gulls move

south with the Chukchi Sea ice edge to the Bering Sea, they would leave the Alaskan arctic when ice cover is nearly complete. This can occur anywhere from late October to early December (Brewer et al. 1977).

2.6.3 Movements

A knowledge of the movements of Ross' Gulls in Alaskan waters is important in interpreting the pelagic densities and other information on the species, as well as assessing the vulnerability of the species in specific regions. While the post-breeding movement from Siberia to Point Barrow has been known since early in this century, the movements of birds in Alaskan waters has been unknown until the acquisition of the information presented in this report.

2.6.3.1 Movement from Siberia to Alaskan Waters

The movement of Ross' Gulls to Alaskan waters has not been well documented, but based on observations at a number of points north of eastern Siberia (Dementev and Gladkov 1969, Pleske 1928) it appears to be a rather direct eastward movement. It is not known if all of the breeding population and newly fledged young move eastward to Alaska when they leave the breeding grounds. The possibility that some birds might move west from Siberia should be considered in light of the numbers of nonbreeders encountered west of the breeding grounds during the breeding season (Meltofte et al. 1981).

The distance from the breeding grounds to Point Barrow is only 900 nautical miles, although it takes Ross' Gulls six to eight weeks to cover the distance. Because Ross' Gulls arrive en masse in late September, with few early migrants being seen, it appears that the species remains in Soviet waters until sometime in September before moving to Alaska. As mentioned above, the Arctic Ocean north of the eastern Siberia begins to freeze in mid- to late-September.

Once in Alaskan waters Ross' Gulls apparently move in a short period of time to the Point Barrow region and western Beaufort Sea. The movement into the Beaufort can occur offshore since in both 1975 and 1976 Ross"' Gulls were

encountered offshore in the western Beaufort before numbers of birds were seen passing Point Barrow.

Pelagic observations in the Chukchi Sea in late September 1976 were conducted at a time when Ross' Gulls were passing east past Point Barrow. These pelagic observations showed that while a directed eastward movement was occurring at Point Barrow, Ross' Gulls were found as far south as 67°30'N in the southern Chukchi and as far north as the ice edge at 72°50'N, with the majority of the birds appearing to be at the ice edge. The percentage of birds at the ice edge recorded as migrating was not large, and the observation of large feeding flocks at the ice edge indicates that birds were not migrating directly through the region. The range of directions of birds at sea (Table 2.6) indicates that birds were not moving directly across the Chukchi to the Beaufort. The mean direction of birds at the ice edge in the northern Chukchi was SSE, and in the southern Chukchi NE. The angular deviation was large in both regions. Both of these mean directions indicate that birds were moving to the central Chukchi and it is possible these birds could have passed into the Beaufort during the period of visible eastward movement which ended on 2 October.

2.6.3.2 Movements at Point Barrow and in the Beaufort Sea

The eastward passage of Ross' Gulls at Point Barrow has been known for over a century and has resulted in much speculation. Unfortunately, up until the present study, essentially all observations were incidental in nature. The first published records of the fall passage were made by Murdoch (1885). From 28 September to 22 October 1881 he found Ross' Gulls sometimes exceedingly abundant. The following year he observed Ross' Gulls from 21 September through 9 October. In 1897 there was only a small passage and it apparently occurred primarily in September (Stone 1900). Bailey was the next to record Ross' Gulls and found them common in the Wainwright area in mid- and late-October 1921. Both Abbott (1929) and Bent (1929) reported on the 1928 migration, when Ross' Gulls appeared on 26 September and were abundant on that and the following date.

There are thus records from 1881, 1882, 1897, 1921, and 1928. Since no

movement occurred in 1897, there are only four years when the Ross' Gull migration was observed. Systematic observations were not conducted in any of these years, and given the incidental nature of the observations, it is not surprising that no return movement to the Chukchi Sea was observed. In addition to these six years, there is the narrative of Brewer (in Bailey 1948), who summarized his observations at Barrow, where he was a resident.

The direction of the movement of Ross' Gulls at Point Barrow is important for a number of reasons. In terms of determining the species' probable wintering area, a completely eastern movement would indicate a wintering area in the Arctic Basin. A eastern movement followed by a westward movement would make a Pacific Basin wintering area most likely. The flight direction is also important in assessing the vulnerability of Ross' Gulls in Alaskan waters. A late westward movement, such as we observed, indicates that the Chukchi is important to the species for an extended period of time, perhaps as much as a month longer than what would be assumed if there was no return from the Beaufort Sea.

The observations presented in this report show that for two of three years (1976 and 1984) the migration at Point Barrow began with an eastward movement followed by westward movement. In all three years (1976, 1984 and 1986) the visible migration ended with a westward movement. In both 1976 and 1984 the observed westward movement was less than the eastward movement, and the difference in the movements visible from land appeared to be due to the formation of nearshore ice causing the westward movement to be offshore or over a broader front in the nearshore.

The extent of the southwest passage after 5 October 1986 and the numbers seen in the pelagic Beaufort in early October, indicate that an unobserved eastward passage had occurred prior to that date. There is little possibility that the passage occurred at Point Barrow prior to the start of our observations on 23 September. Incidental observations made almost daily on the Chukchi Sea beach between the town of Barrow and the base of Point Barrow did not find Ross' Gulls to be present prior to 27 September (J. C. George, pers. comm.), and it appears likely that the migration occurred out of sight of land.

The distance of the ice edge north of Point Franklin (Peard Bay) at the start of migration may be revealing, since Ross' Gulls apparently move from pelagic waters to the Alaskan Chukchi coast between Peard Bay and Point Barrow. If Ross' Gulls moving through the Chukchi Sea eastward from Siberia are primarily at the ice edge, as our pelagic observations indicate, then the eastward movement into the Beaufort may occur out of sight of land when the ice edge is atypically far north at Point Barrow. Three days after Ross' Gulls were first seen at Point Barrow in 1984, the ice edge was 70 nautical miles north of Point Franklin. The distance was 120 nautical miles three days after the first observation in 1986.

The differences in numbers between the eastward and westward movements in 1984 are apparently due to ice conditions and may be important in explaining the fact that previous observers have not seen a westward passage. The eastward passage consisted of birds moving northeast up the Chukchi coast in a rather narrow corridor from the beach to 300 m seaward. The average altitude of flying birds was 7 m and the average distance from land 29 m. The majority of the eastward passage occurred when little or no ice was present in the nearshore zone and migrating birds frequently dipped to the water's surface to feed.

The westward passage in 1984 occurred during a period when ice was rapidly forming and landfast ice extending 300 to 500 m offshore occurred on both the Chukchi and Beaufort coasts in the Point Barrow area. During the westward passage birds were observed flying over a broad front from the base of Point Barrow to the offshore limit of visibility north of the Point. Birds averaged 13 m in altitude and 61 m from shore.

A similar situation occurred in 1976, when a major eastward passage was observed at Point Barrow in late September followed by a smaller return passage. Extensive freezing of the nearshore had occurred between the two movements and observations with a 40x telescope during the minor westward movement indicated that there was a larger movement occurring offshore.

It appears that the extent of the freezing of nearshore waters at Point Barrow could directly influence the extent of the westward migration visible

from land. This would partially explain why so many previous observers have failed to detect a westward passage. Still, the apparent lack of observations of the westward movement is surprising since in each of the four years when systematic observation have been made, a final westward passage was observed. It seems likely that even in years when previous observers noted some westward movement it was so much less than the eastward passage that it was not mentioned.

2.6.3.3 Reasons for the Late Fall Movement

Speculation on the factors causing the movement into the Beaufort are hindered by a lack of information on the percentage of the birds in the Chukchi that enter the Beaufort and a complete lack of information from the Soviet Chukchi. While the movement of Ross' Gulls to and from the Beaufort Sea is well documented in this report, the reason for the movement is less clear.

After Ross' Gulls move to the Chukchi Sea in late September a certain number could be expected to move to the Beaufort Sea before the ice edge advances to south of Point Barrow. The movement to the Beaufort appears to be a directed one, however, and not the result of simple dispersion. The reasons for this movement are not clear but would appear to be related to prey availability. Prey availability at the Chukchi ice edge may not be sufficient to support the numbers of Ross' Gulls that arrive there in mid- to late-September.

The littoral, nearshore and pelagic habitats directly east of Point Barrow and north of the Plover Islands have high densities of surface feeding species from early August to mid-September (Divoky 1984). These densities are the highest for surface feeding species for the northern and central Chukchi and the entire Beaufort (Divoky 1984, 1987). While the aerial censusing of nearshore habitats showed Ross' Gulls to be most abundant in the extreme western Beaufort, the pelagic censusing from 1986 shows Ross' Gulls to be well dispersed throughout the entire Alaskan Beaufort.

A directed eastward movement into the Beaufort Sea in the fall of 1984 was observed for Short-tailed Shearwaters (Puffinus tenuirostris) and Ivory Gulls (Divoky, unpub.), with substantial numbers of the birds in the northern and central Chukchi entering the Beaufort. Well over 100,000 shearwaters were observed flying east past Point Barrow in late September 1984. Less directed eastward movements were observed for Glaucous Gulls (Larus hyperboreus) and Black-1egged Kittiwakes (Rissa tridactyla).

2.6.3.4 Late Fall Movements in the Chukchi Sea

Observations were conducted in the Chukchi Sea in late September and early October 1970, apparently after the return movement of Ross' Gulls from the Beaufort back to the Chukchi. At the beginning of observations the Beaufort Sea was almost completely ice covered and, if Ross' Gulls had entered the Beaufort that year, the majority apparently had already returned to the Chukchi. The observations of Ross' Gulls were notable that year for the lack of directed movement indicative of migration. Flocks were encountered feeding or resting at the ice edge and groups of Ross' Gulls were attracted to the ship, both when it was steaming and when it was stationary. This was the only cruise when ship following was regularly recorded. It appeared that Ross' Gulls were resident at the Chukchi ice edge at this time and were moving south with the advancing ice edge.

During the 1970 cruise, ice was rapidly forming and ice cover in the arctic basin adjacent to the Chukchi was essentially complete. There appeared to be little doubt that Ross' Gulls moved south with the ice edge to the Bering Sea. They are well known at Gambell on St. Lawrence Island in November and December (Fay and Cade 1959, Scaly et al. 1971, Kessel and Gibson 1978) but apparently are not seen in large numbers. This is not surprising since Ross' Gulls would be passing that location at the time of ice formation and could be expected to occur out of sight of land.

2.6.3.5 Possible Wintering Area

The wintering area of the Ross' Gull appears to be in the northwestern Pacific Basin, probably in the area of the Sea of Okhotsk. The November and

December St. Lawrence Island observations indicate that Ross' Gulls move west after passing through the Bering Strait. They are not present in the Alaskan Bering Sea in winter and spring but there are spring observations of regular movements northward in Siberian river valleys between the Sea of Okhotsk and the breeding grounds (Dementev and Gladkov 1969).

2.6.4 Distribution and Abundance

2.6.4.1 Overview

From late September until mid-October Ross' Gulls can be expected anywhere from the extreme western Alaskan Chukchi Sea to the extreme eastern Alaskan Beaufort. After their arrival in the Chukchi, they are found in high densities at the ice edge in that sea. Two cruises had densities over 4 b/km^2 and percent frequencies of 40-45%. Their geographic distribution appears to be dependent on the location of the ice edge. In 1976 it was north of 72°N and in 1970 it was in the central Chukchi near 70°N. Sampling in the open water south of the ice found average densities of 0.1 to 0.7 b/km^2 and frequencies of 8-20%

Censusing in the Beaufort during the period when Ross' Gulls are present is limited, with most observations coming from 1986. It appears that at least in early September Ross' Gulls are restricted to the western Beaufort with densities of 0.2 to 0.3 b/km^2 and frequencies of 7%. In October the species is found throughout the Beaufort, with the western Beaufort having an average density of 1.7 b/km^2 and a frequency of 43%. The eastern Beaufort, where ice coverage was more extensive, had an average density of 0.6 b/km^2 and a frequency of 24%.

Ice appears to play a major role in determining distribution and abundance in the Chukchi, with substantially higher densities and frequencies of Ross' Gulls when ice was present. In the Beaufort, however, densities and frequencies in the ice were similar to open water. This might be due to the limited extent of open water in the Beaufort, which allows birds in open water to be rather close to the ice edge.

During the period when Ross' Gulls occupy the Alaskan arctic they are a major part of the pelagic avifauna. From 22 September on they are the most abundant species in all regions (Fig. 2.1) but the southern Chukchi. At the time when the ice edge is present in the southern Chukchi in late fall they are almost certainly the most abundant species in that region.

2.6.4.2 Southern Chukchi Sea

Observations from the region indicate that Ross' Gulls are present but not as abundant during the initial period of movement to Alaskan waters as later, when most birds appear to be moving eastward at the ice edge. Sampling during this period is limited to 1976, but during that year an average density of 0.5 b/km^2 was found in early October. Ross' Gulls were limited to the area directly north of the Bering Strait and south of the latitude of Point Hope. During the same period, approximately 8,000 Ross' Gulls may be present in an area that is over 200 nautical miles south of the ice edge (Alaskan waters west of 166^{o},30'W and south of 68^{o}N, an area of 16,000 km^2).

The area is one where high densities of phalaropes were found in late September and early October, indicating that densities of zooplankton at the surface were high. Densities of surface feeding species were low in the area until late September however.

If, as proposed in this report, Ross' Gulls move south with the advancing ice edge in late fall, the entire population of Ross' Gulls in the Chukchi Sea passes through this region between late October and December. Ice formation is rapid at this time, however, and it is likely that the birds move quickly south through the region.

2.6.4.3 Central Chukchi

This region has the highest pelagic densities and also the longest period of occupation among the five regions discussed here, although the presence of the ice edge appears to play a major factor in determining the densities and period of occupation. Ross' Gulls are seen moving to the

Point Barrow region, some may remain in the region during the movement into the Beaufort, and after their return to the Chukchi Sea, Ross' Gulls are abundant at the ice edge.

Ross ' Gulls are found in the northern nearshore waters of this region both during the eastward movement to the Beaufort and apparently to a lesser extent, during the return westward movement.

2.6.4.4 Northern Chukchi

The importance of this region to Ross' Gulls could be expected to vary annually depending on the location of the ice edge during maximum ice retreat. In most years, much of the ice edge would be present in this region during the eastward movement, and large numbers of gulls could be expected to occur. In those years when the ice edge is present in the central Chukchi in mid- and late-September, use of the area by Ross' Gulls could be expected to be low. By the time birds return from the Beaufort in mid-October the region is usually ice covered.

2.6.4.5 Western Beaufort

Ross ' Gulls are present in this region from mid-September to mid-October. The area has the highest littoral densities of Ross' Gulls of any region of the Alaskan arctic. Before the arrival of Ross' Gulls , nearshore and pelagic habitats have high densities of surface feeding species (Divoky 1984). The processes that concentrate zooplankton in the vicinity of the Plover Islands apparently persist to freeze-up.

2.6.4.6 Eastern Beaufort

From early August to mid-September this region has low densities of surface-feeding species (Divoky 1984), but Ross' Gulls were common during limited censusing in one year. The average period of occupancy of the region is generally short (two weeks) since ice cover is usually extensive by mid-October.

2.6.5 Age Classes in the Population

Ross ' Gulls are present in Alaskan waters two to four months after the end of the breeding season, when the population consists of adults, juveniles (birds fledged in the previous year) and immatures (birds fledged in the current year). The number of birds present in Alaskan waters thus depends on the breeding success for the two previous breeding seasons, and on winter survival. Ross' Gulls have an average clutch size of 3 eggs, but no information is available on fledging success. A breeding success of 66% would not be out of the ordinary for an arctic larid, and it is conceivable that if two chicks per nest were fledged, half of the birds present in Alaskan waters could be young of the year.

Approximately 50% of all Ross' Gulls observed in 1970 were subadults. Observations at Point Barrow in 1984 were remarkable in that less than 5% of all birds observed were subadults. That year appeared. to be one of extremely low breeding success, and the number of birds passing Point Barrow in some years could be twice the number observed in 1984.

2.6.6 Population Estimates

No population estimate has previously been attempted for Ross' Gulls. Like most tundra-nesting seabirds, adequate censusing of breeding habitats has not been conducted. The rarity of Ross' Gulls on a global basis makes a population estimate of more interest than for widely distributed species. Two data sources are available for population estimates pelagic censusing and migrant watches.

2.6.6.1 Population Estimate from Pelagic Censusing

Pelagic censusing provides information on b /km^2 that can be extrapolated by the area censused to provide a population estimate. Such a technique was used by Gould et al. (1982) for the Bering Sea and Divoky (1987) for the Chukchi. The reliability of such estimates is directly related to the degree of stratification of the area sampled. For this reason, Gould et al. (1982) called their estimates "population estimate

indices."

The information on pelagic distribution and abundance presented in this report that provides the best information for a Ross' Gull population estimate is the 1970 cruise in the Chukchi. This cruise apparently occurred at a time when birds had returned from the Beaufort, and the ice edge was at the latitude of Icy Cape with a minimum distance from the USSR Convention Line to Icy Cape of 220 km. No satellite imagery is available for determining the width of the ice fringe, but on the basis of the shipboard observations the ice edge habitat sampled was a minimum of 20 km in width and as wide as 37 km at some points. Thus, the ice edge habitat was a minimum of 4,400 km^2 and a maximum of 8,140 km^2. Using 4.7 b/km^2 the minimum population present in the area is 20,700 and the maximum 38,000.

2.6.6.2 Population Estimate from Migrant Watches at Point Barrow

The Point Barrow migrant watch in 1984 provides the best estimate of the population entering the Beaufort Sea. The initial movement from 30 September to 12 October was 14,750 birds projected eastward, with only 1,000 projected westward (600 of these on 12 October). There is little chance that the eastward movement included birds that had returned to the Chukchi and were counted twice, so that a minimum of 15,000 Ross' Gulls moved into the Beaufort Sea during the initial period.

The actual number of Ross' Gulls entering the Beaufort is certainly much higher, because it would include birds passing east for the first time after 12 October as well as birds that moved into the Beaufort out of sight of land. In 1986, sampling in the western Beaufort found an average density of 1.9 b/km^2. Assuming an area of 12,000 sq. km, an estimated 23,000 Ross' Gulls were present in the Beaufort Sea during that period.

The percentage of the world's population of Ross' Gulls that visits Alaskan waters is not known. It appears that a substantial part of the nonbreeding population is present in the vicinity of Franz Josef Land in summer, although it is possible that these birds could move east later in the year (Meltofte et al 1981). The percent of the breeding population and

birds of the year that move east to Point Barrow is also unknown. Finally, it is unknown what percentage of the birds that move into the Chukchi enter Alaskan waters. Thus the estimates for Alaskan waters should be considered a minimum estimate for the world's population and would need to be increased by the numbers found outside of Alaskan waters in the fall.

2.7 Conclusions

1. Ross ' Gulls are a regular and major component of the pelagic avifauna of the Alaskan Chukchi and Beaufort seas in fall. Prior to mid-September they are present irregularly in extremely small numbers in the Chukchi Sea and do not become common in Alaskan waters until mid- to late-September.

2. During the period when Ross' Gulls are present in Alaskan waters, they move from the Soviet Chukchi to the Point Barrow region, and then into the Beaufort Sea in late September or early October. There is a return movement into the Chukchi in mid- to late-October. The percentage of Ross' Gulls in the Chukchi that enter the Beaufort is unknown. After returning from the Beaufort, Ross' Gulls stay at the Chukchi ice edge, apparently moving into the Bering as the Chukchi freezes over in November.

3. Ross ' Gulls make extensive use of the Chukchi for two to three months between September and November. Densities are highest at the Chukchi ice edge in late September and early October. Low densities are present in open water south to the Bering Strait.

4. For reasons not yet known, Ross' Gulls enter the Beaufort Sea from late September to mid-October and remain until ice cover is nearly complete. Ross ' Gulls are equally common at the ice edge and in open water in the Beaufort, with densities lower than at the Chukchi ice edge.

5. Ross ' Gulls are found in shoreline habitats from the village of Wainwright on the Chukchi coast to Cape Halkett, adjacent to Harrison Bay in the Beaufort. The highest shoreline densities are found from Point Barrow to Tangent Point. Coastal densities appear to be related to the abundance

and availability of zooplankton concentrations.

6. The population of Ross' Gulls in Alaskan waters in fall is somewhere between 20,000 and 40,000 birds, with the number entering the Beaufort between 15,000 and 25,000.

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CHAPTER 3. Fall Migration of Ross' Gull Near Point Barrow: Land-based Observations in 1987 and Synthesis

3.1 Introduction

Numbers of Ross' Gulls during fall may exceed 20,000 along the Beaufort Sea coastline (Chapter 2). Because of the narrow corridor between the coastline and ice edge occupied by the species, the birds may be especially vulnerable to accidental environmental contamination during the fall staging period. However, a lack of published information on the timing and magnitude of fall migration has precluded development of any mitigating management strategy.

The number of Ross' Gulls occurring near Point Barrow in September and October appears to be highly variable in different years. In 1976 and 1984, for instance, more than 16,000 gulls were observed moving eastward, whereas fewer than 5,000 were seen in 1986 (Chapter 2). Thus, fall passage of the species near Point Barrow is known to vary in intensity, and possibly in timing as well. Studies in 1987 focused on the within-season phenology of fall migration, the diurnal pattern of migration, and factors affecting easterly and westerly passage rates. The occurrence of Ivory Gulls was noted during the same surveys. The results of these studies are presented in this chapter and compared with earlier surveys. We offer conclusions concerning the status, phenology, and distribution of Ross' Gulls in arctic Alaska based on all work conducted to date.

3.2 Methods

3.2.1 Land-based Observations

From 19 September through 15 October, 1 to 6 hours of observations were conducted daily by one of two observers (J.C. Haney or W. Maynard) between approximately 0830 h and 1700 h at either the base of Barrow Spit or at Point Barrow itself. observation points were the same as those used by Divoky in 1976, 1984, and 1986 (Fig. 2.9). A few observations were made opportunistically at other points along the Point Barrow spit; such records

are identified in a complete listing of field data provided as Appendix 1.

Observations on most days were continuous, but they were broken into 10-min segments to allow a finer scale analysis of the data. A lunch break of about 2 hr was taken in the middle of the day by the observers. Data recorded included number of birds, age if known, flight direction if the birds were flying, and any other behavior seen. Gulls were recorded within 500 m in either direction from the beach, as in Divoky's studies.

Flight directions were recorded with reference to a 12-point rosette on which a heading of 12 indicated flight in a northeasterly direction (parallel to the beach at the base of the spit). The large majority of birds followed the shoreline while moving past Point Barrow, but a few flew overland near the base of the spit. In either case, the net direction of movement of Ross' Gulls in the area could be clearly categorized as either easterly (moving from Chukchi to Beaufort Sea) or westerly (moving from Beaufort to Chukchi waters). For the purpose of analysis, headings of 12 or 3 (and adjacent values) were considered easterly movement at the base of the spit, whereas headings of 6 or 9 (and adjacent values) were considered westerly movement. Headings recorded at Point Barrow itself were typically around 3 and 9 for easterly and westerly movements respectively.

3.2.2 Aerial Observations

Aerial observations were conducted on two days (September 28 and October 11) on a not-to-interfere basis during bowhead whale surveys. The bird observer recorded any Ross' gulls seen as the survey plane, an Office of Aircraft Services' Grumman Goose, flew at 120 kt, at an altitude of 1,000' to 1,500'.

3.2.3 Data Analysis

The net directional movement of Ross' gulls was estimated for each day by calculating the daily average number of birds per hour for gulls flying eastward and westward. These figures were then multiplied times 10, the approximate number of hours of daylight during the observation period, to

estimate birds per day flying in each direction. This resulted in daily passage rates for comparison with those obtained by Divoky in two previous years. Net daily directional" movement was obtained by subtracting the smaller of the two figures (east and west passage rates) from the larger.

The National Weather Service collects standard climatological data at Barrow (Local Climatological Data, Monthly Summary, September and October 1987, NOAA, National Climatic Data Center, Asheville, NC). These data were used to assess possible climatic influences on the migration of Ross' gulls at Point Barrow.

3.3 Results

3.3.1 Nearshore Occurrence and Movements of Ross' Gull

Ross' gulls were seen on 19 of 35 observation days (Table 3.1). A single gull was seen on the first day of observations, September 19, but it was not until September 30 that birds began appearing in large numbers. Net numbers of Ross' gulls per day (bpd) moving in an easterly direction increased sharply from 97 bpd on 30 September to 2,754 bpd on 1 October (Fig. 3.1a). The latter value based on sightings of 1,653 birds (48% of all Ross' gulls counted during the study) in 6 h of observations (Table 3.1), the largest daily movement in either direction during the study. The heavy movement continued through 2 October, when 990 bpd were estimated flying eastward.

From 3 October through 9 October, birds were seen flying in both directions (Fig. 3.1a,b) and there was no clear trend in directional movement. However, an obvious migration to the west began and peaked on 11 October; 620 birds were counted flying to the west in 2.5 h of observation, which extrapolated to a projected westward movement of 2,468 bpd. Although the net movement continued westward at about 100 to 300 bpd for three days after that date, some birds also continued flying eastward through the last day of observations, 15 October.

Projected total directional movements (Table 3.1) indicated that about

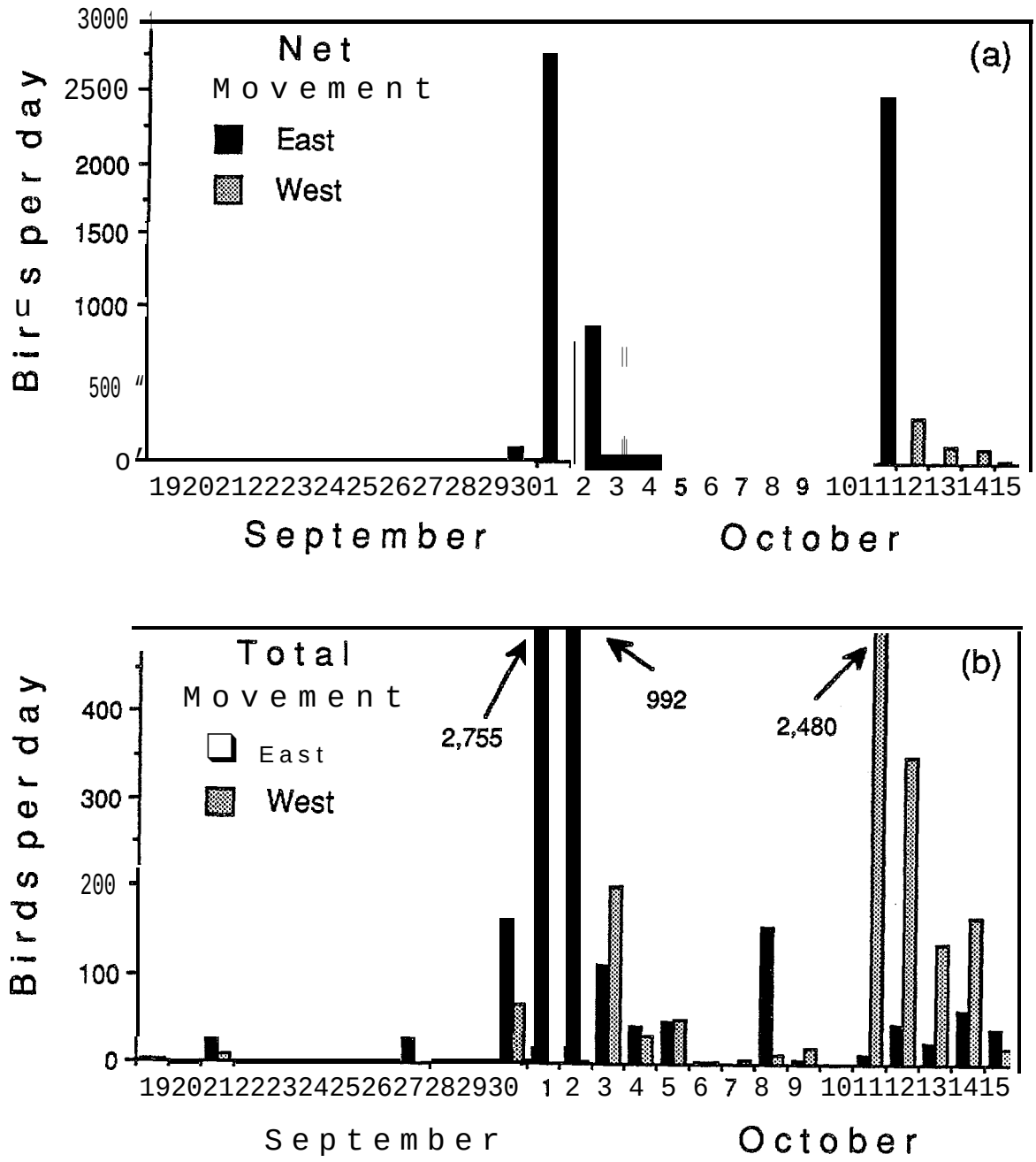

Figure 3.1. Migration of Ross' Gulls (birds per day) past Point Barrow in 1987: (a) net directional movement, and (b) projected total movement.

Table 3.1. Observed and estimated total movements of Ross' Gulls at Point Barrow, 1987. (Page 1 of 4)

Date & hours observed	Age	Direction of movement: East — Number per: Total	Hour	day	West — Number per: Total	Hour	day	Net numbers: East	West
Sep 19 5.9	Adult	1	0.2	2	1	0.2	2		
	Juv								
	Unk								
	Total	1	0.2	2	**1**	0.2	2		
Sep 20 2.2	Adult								
	Juv								
	Unk								
	Total								
Sep 21 6.3	Adult	14	2.2	22	3	0.5	5	17	
	Juv	1	0.2	2	2	0.3	3		1
	Unk								
	Total	15	2.4	24	5	**0.8**	8	16	
Sep 22 4.7	Adult								
	Juv								
	Total								
Sep 23 4.4	Adult								
	Juv								
	Unk								
	Total								
Sep 24 3.0	Adult								
	Juv								
	Unk								
	Total								
Sep 25 5.3	Adult								
	Juv								
	Total								
Sep 26 2.3	Adult								
	Juv								
	Unk								
	Total								

Table 3.1. Observed and estimated total movements of Ross' Gulls at Point Barrow, 1987. (Page 2 of 4)

Date & hours observed	Age	Direction of movement: East — Number			West — Number			Net numbers	
		Total	per: Hour	per: day	Total	per: Hour	per: day	East	West
Sep 27 3.7	Adult	10	2.7	27				27	
	Juv								
	Unk								
	Total	**10**	**2.7**	**27**				**27**	
Sep 28 4.2	Adult	1	0.2	2				2	
	Juv								
	Unk								
	Total	**1**	**0.2**	2				**2**	
Sep 29 1.2	Adult								
	Juv								
	Unk								
	Total								
Sep 30 3.8	Adult	62	16.3	163	3	0.8	8	155	
	Juv				22	5.8	58		58
	Unk								
	Total	**62**	**16.3**	**163**	**25**	6.6	66	**97**	
Ott 1 6.0	Adult	938	156.3	1,563	1	0.2	1	1,562	
	Juv	119	19.8	198				198	
	Unk	596	99.3	993				993	
	Total	**1,653**	**275.5**	2,755	**1**	**0.2**	**1**	2,754	
Ott 2 5.0	Adult	263	52.6	526	1	0.2	2	524	
	Juv	88	17.6	176				176	
	Unk	145	29.0	290				290	
	Total	**496**	**99.2**	992	**1**	0.2	2	990	
Ott 3 4.7	Adult	41	8.7	87	72	15.3	153		81
	Juv	10	2.1	21	16	3.4	34		13
	Unk	1	0.2	2	6	1.3	13		11
	Total	52	**11.1**	**111**	**94**	20.0	200		89
Ott 4 2.8	Adult	5	1.8	18	2	0.7	7	11	
	Juv	7	2.5	25	7	2.5	25		
	Unk								
	Total	**12**	**4.3**	**43**	**9**	**3.2**	**32**	**11**	

Table 3.1. Observed and estimated total movements of Ross' Gulls at Point Barrow, 1987. (Page 3 of 4)

Date & hours observed	Age	Direction of movement: East — Number per: Total	Hour	day	West — Number per: Total	Hour	day	Net numbers: East	West
Ott 5 4.5	Adult	16	3.6	36	17	3.8	38		2
	Juv	5	1.1	11	6	1.3	13		2
	Unk								
	Total	21	4.7	47	**23**	5.1	**51**		4
Ott 6 2.7	Adult	1	0.4	4	1	0.4	4		
	Juv								
	Unk								
	Total	1	0.4	4	1	0.4	4		
Ott 7 3.3	Adult								
	Juv				2	0.6	6		6
	Unk								
	Total				2	0.6	6		6
Ott 8 4.0	Adult	30	7.5	75	3	0.8	8	67	
	Juv	19	4.8	48	1	0.3	3	45	
	Unk	13	3.3	33				33	
	Total	62	15.5	155	4	1.0	10	145	
Ott 9 3.2	Adult				2	0.6	6		6
	Juv	2	0.6	6	4	1.3	13		7
	Unk								
	Total	2	0.6	6	6	**1.9**	19		13
Ott 11 2.5	Adult	3	1.2	12	404	161.6	1,616		1, 604
	Juv		0.0	0	209	83.6	836		836
	Unk		0.0	0	7	2.8	28		28
	Total	3	1.2	12	620	248.0	2,480		2,468
Ott 12 3.7	Adult	10	2.7	27	54	14.6	146		119
	Juv	7	1.9	19	36	9.7	97		78
	Unk				40	10.8	108		108
	Total	17	4.6	46	130	35.1	**351**		305
Ott 13 2.2	Adult	3	1.4	14	15	6.8	68		54
	Juv	2	0.9	9	15	6.8	68		59
	Unk								
	Total	5	2.3	23	30	13.6	136		**113**

Table 3.1. Observed and estimated total movements of Ross' Gulls at Point Barrow, 1987. (Page 4 of 4)

Date & hours observed	Age	Direction of movement: East — Number per: Total	Hour	day	West — Number per: Total	Hour	day	Net numbers: East	West
Ott 14	Adult	20	5.4	54	40	10.8	108		54
3.7	Juv	2	0.5	5	21	5.7	57		52
	Unk	1	0.3	3				3	
	Total	**23**	**6.2**	**62**	**61**	**16.5**	**165**		**103**
15-Oct	Adult								
0.5	Juv	2	4.0	40	1	2.0	20	20	
	Total	2	**4.0**	**40**	**1**	**2.0**	20	20	
TOTALS				4,514			3,553	3,596	3,101

1,000 more Ross' Gulls flew eastward (ea. 4,500) than westward (ea. 3,500) past Point Barrow. Observed net directional movement also showed about 500 birds moving eastward. Thus, it seems likely that the return migration to the west continued to some degree after 15 October.

3.3.2 Diurnal Patterns

Hourly passage rates exhibited marked variation within days during the two primary periods of movement past Point Barrow. In both instances, however, the overall pattern can be characterized as a strong pulse of birds moving east or west, with most of the passage occupying little more than one day. The eastward movement appeared to begin and increase gradually during the day on 30 September, it continued strongly over the following day, and tapered off from morning to evening on 2 October (Fig. 3.2). Hourly rates were not uniform during the peak day (1 October), because high rates of passage during morning and afternoon hours were separated by a mid-day lull in activity. Hourly rates before noon (0800-1100) averaged significantly higher than afternoon rates (1300-1700) when all observations during those two periods were combined ($P < 0.05$; t-test with two-tailed significance test). Subsequent westerly passage was similarly synchronized, with most of the birds moving past Point Barrow on the evening of 11 October (Fig. 3.3).

Outside of the two periods just described, sightings of Ross' Gulls were made at various times of day during the weeks from 19 September through 15 October (Appendix 1). However, the small numbers observed on most days were insufficient to reveal dirunal patterns comparable to those illustrated in Figures 3.2 and 3.3. To test whether gulls were more likely to be seen at some hours of the day than others, the percentage of sampling effort during each hour of the day was compared with the distribution of Ross' Gull sightings (flying birds only), using data from all days except 30 September-1 October and 11-12 October. In general, the temporal distribution of gull sightings, both total numbers and frequency of occurrence appeared to track the distribution of sampling effort (Fig. 3.4). A chi-squared test of the goodness of fit (frequency of occurrence versus sampling effort) was marginally significant ($\chi^2 = 17.4$, 9 df, $P < 0.05$).

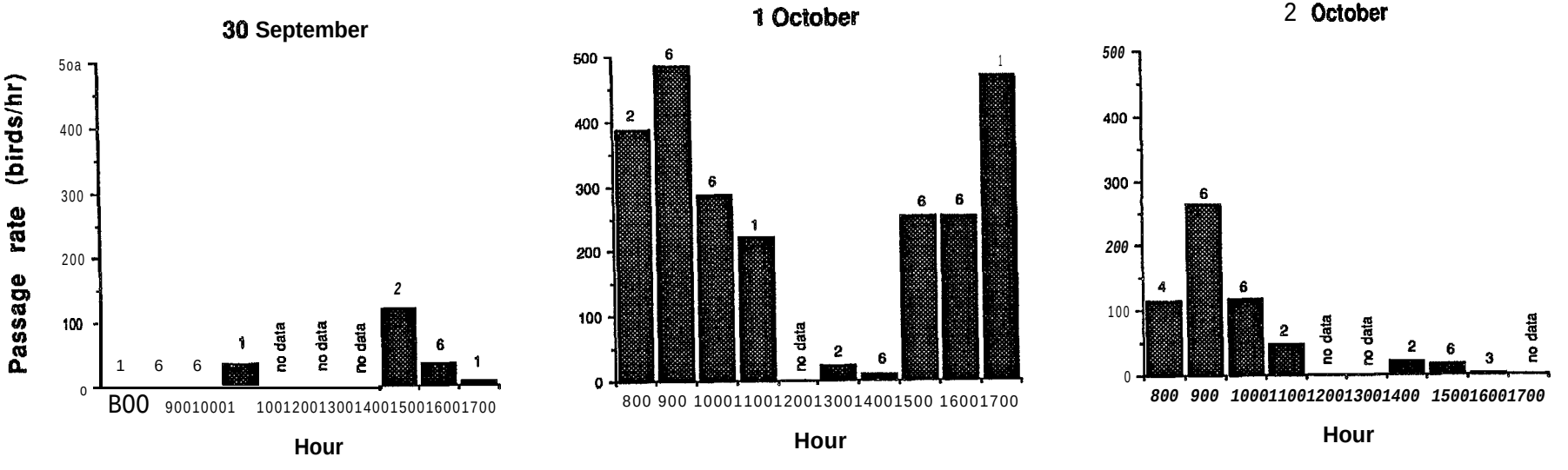

Figure 3.2. Hourly rates of birds flying east past Point Barrow from 30 September to 2 October, 1987.

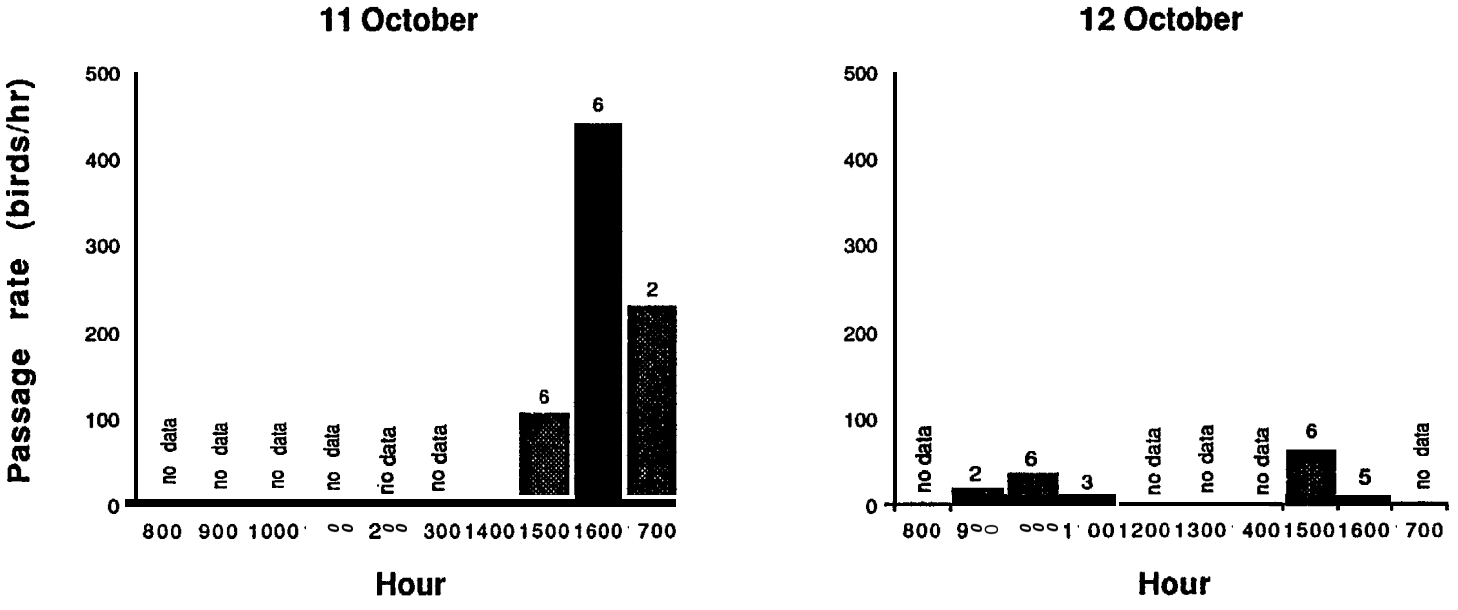

Figure 3.3. Hourly rates of birds flying west past Point Barrow on 11 October and 12 October, 1987.

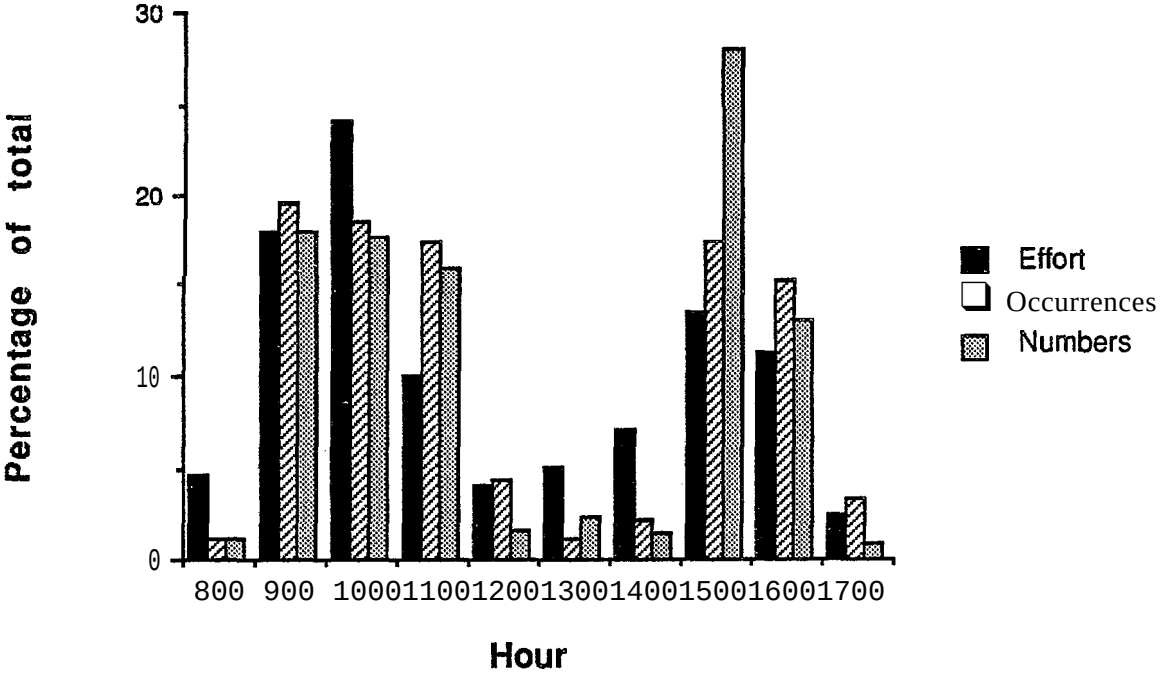

Figure 3.4. Distributions of sampling effort and of birds sighted at different hours of the day between 19 September and 15 October, 1987.

3.3.3 Weather Conditions and Ross' Gull Movements

Climatological data for Barrow (Table 3.2) indicate fairly typical conditions during the study. Temperatures ranged from the low 300's F at the start of September to 10-20 'F at the end of October (Fig. 3.5).

Figure 3.6 shows daily wind speed and direction vectors for September and October 1987 and corresponding net directional movement of Ross' gulls. The heavy eastward movement of gulls noted on October 1 followed about a week of E and NE winds of 15-30 mph, indicating that the birds were flying into the wind. However, the peak of return migration to the west from 11-14 October was also accompanied by easterly winds (Fig. 3.6), so no clear preferences among migrating birds for either following winds or headwinds were evident during this study.

Relationships between Ross' Gull movements and weather were further examined by computing partial correlations between flying birds (numbers east, numbers west, and total observed per day) and each of the variables listed in Table 3.2. Partial correlations removed any effect of seasonal temperature trends (Fig. 3.5) by controlling for day. No significant correlations were found between gull numbers and wind speed or direction. Movements also were largely unrelated to air temperatures, except that the relationship between birds flying east and daily maximum air temperature was significant ($r = -0.49$, 23 df, $P < 0.05$).

3.3.4 Aerial Surveys

Flight time during two whale surveys in which Haney participated was 6 h 20 min on 28 September and 3 h 45 min on 11 October. Both surveys traversed ice-free waters of the Chukchi Sea to the north and east of Barrow. Five Ross' Gulls were seen in four locations, as follows:

Date	Number of Birds	Position
September 28	1	70°53'N, 159°W
September 28	2	70°58'N, 159°W
October 11	1	71°45'N, 161°51'W
October 11	1	71°36'N, 161°52'W

Table 3.2. Climatological data, Point Barrow, Alaska, September - October, 1987.

Date, 1987	Temperature, °F			Resultant Wind	
	Max	Min	Ave	Dir.	Speed
Sep 1	35	31	33	7	10.5
Sep 2	32	28	30	7	12.8
Sep 3	31	27	29	5	16.7
Sep 4	37	27	32	27	5.7
Sep 5	38	31	35	25	9.8
Sep 6	45	29	37	12	10.2
Sep 7	46	33	40	17	1.0
Sep 8	36	23	30	30	10.7
Sep 9	27	23	25	30	4.7
Sep 10	38	25	32	17	17.5
Sep 11	35	24	30	36	2.7
Sep 12	34	23	29	27	16.4
Sep 13	35	27	31	24	17.0
Sep 14	34	22	28	28	15.5
Sep 15	26	15	21	19	12.4
Sep 16	32	14	23	18	8.0
Sep 17	17	29	19	14	17.1
Sep 18	30	19	25	36	2.9
Sep 19	30	13	22	7	10.4
Sep 20	35	25	30	7	5.0
Sep 21	31	24	28	33	9.9
Sep 22	27	23	25	5	14.2
Sep 23	32	26	29	8	29.4
Sep 24	33	31	32	9	25.4
Sep 25	32	24	28	6	15.8
Sep 26	27	23	25	5	19.3
Sep 27	26	21	24	6	13.9
Sep 28	28	19	24	7	11.9
Sep 29	31	26	29	8	9.3
Sep 30	28	22	25	6	14.1

(continued)

Table 3.2. continued.

Date, 1987	Temperature, "F			Resultant Wind	
	Max	Min	Ave	Dir.	Speed
Ott 1	24	20	22	6	19
Ott 2	23	19	21	7	20.7
Ott 3	28	19	24	7	22.9
Ott 4	32	28	30	9	15.4
Ott 5	32	16	24	16	4.5
Ott 6	22	13	18	19	6.7
Ott 7	30	13	22	11	4.9
Ott 8	28	23	26	14	5.9
Ott 9	30	21	26	22	5.2
Ott 10	29	19	24	7	6.8
Ott 11	30	27	29	8	16.6
Ott 12	30	27	29	10	16.1
Ott 13	29	24	27	11	20.4
Ott 14	30	20	25	10	19.9
Ott 15	33	16	25	13	6.4
Ott 16	32	11	22	19	9.5
Ott 17	27	5	16	12	10.3
Ott 18	29	21	25	11	13.4
Ott 19	28	23	26	8	10.4
Ott 20	30	20	25	2	9.1
Ott 21	30	25	28	4	8.9
Ott 22	29	26	28	4	12.7
Ott 23	30	25	28	8	10.5
Ott 24	30	23	27	9	14.7
Ott 25	29	18	24	24	8.4
Ott 26	25	17	21	30	16.5
Ott 27	20	15	18	32	9.4
Ott 28	16	14	15	20	3.6
Ott 29	22	4	13	18	3.9
Ott 30	21	8	15	8	6.9
Ott 31	19	10	15	5	12.0

(Page 2 of 2)

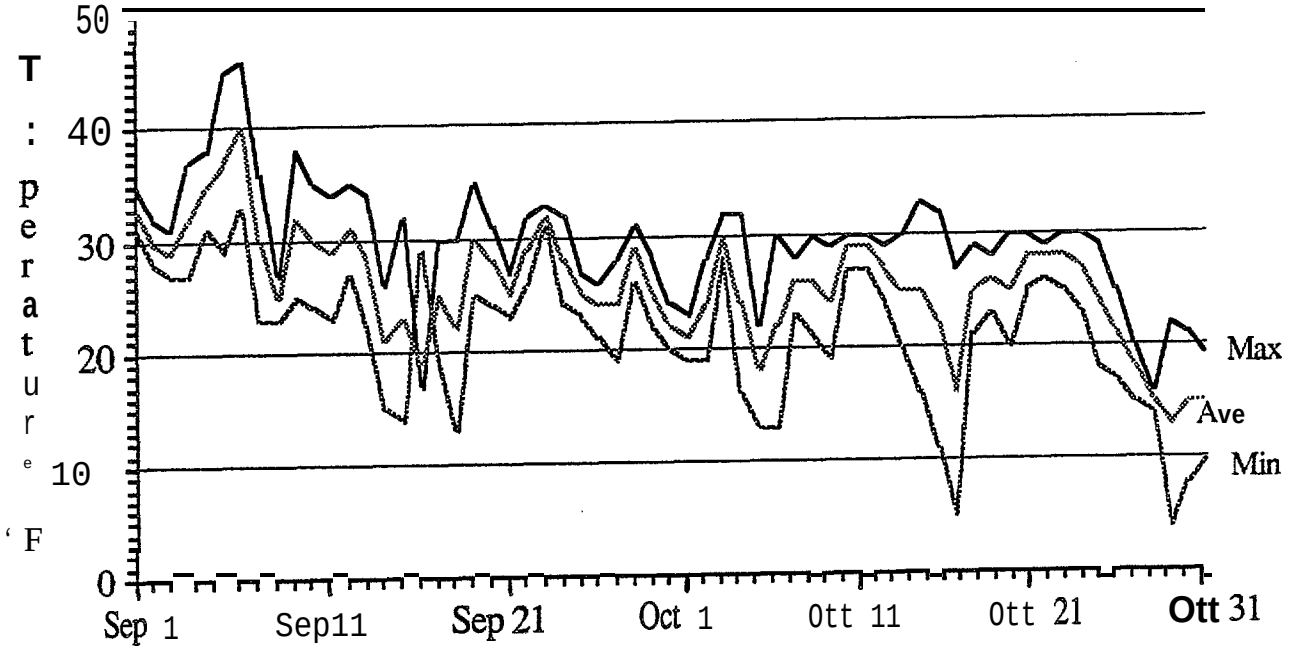

Figure 3.5. Air temperatures at Pt. Barrow, Alaska, 1987. Data from National Weather Service, "Local Climatological Data, Monthly Summary, September and October 1987.

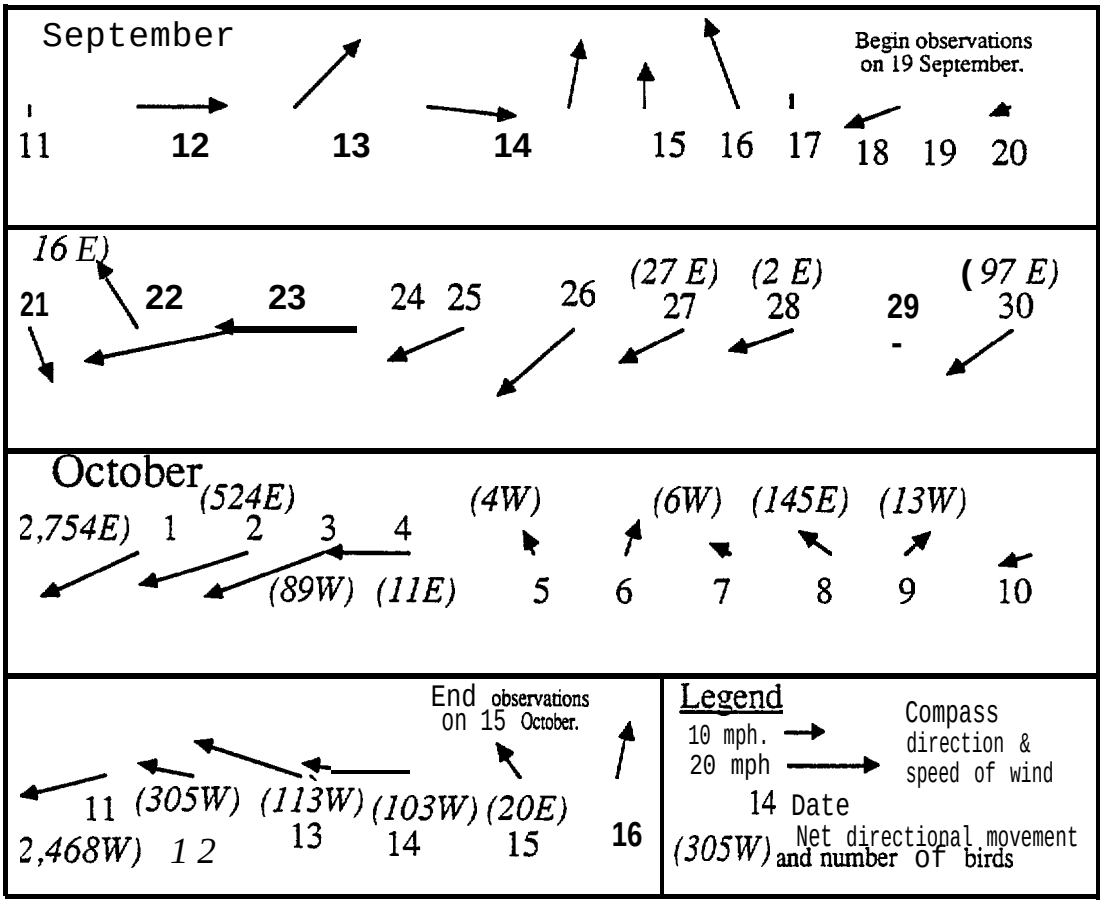

Figure 3.6. Net directional movement of Ross ' Gulls and corresponding daily wind speed and direction vectors at Point Barrow, September - October, 1987.

The scarcity of birds offshore during these flights did not encourage the use of additional aircraft time for Ross' Gull surveys in 1987.

3.3.5 Observations of Ivory Gulls

Only 10 Ivory Gulls were seen during the study, mostly as single individuals flying either northeast or southwest along the shoreline of the Point Barrow spit (Table 3.3). The two birds observed on 4 October were resting on large blocks of ice washed up on the beach at the spit after a wind storm. On 30 September 1987, one Ivory Gull was seen feeding with Red Phalaropes (Phalaropus fulicaria), Black-1egged Kittiwakes (Rissa tridactyla), and approximately one thousand Ross' Gulls within 10-20 m of shoreline behind the surf. Probable prey i terns included benthic invertebrates such as isopods, amphipods, and polychaetes displaced by the storm swells. No other Ivory Gulls were observed feeding during the study, nor were any Ivory Gulls encountered further offshore during the aerial surveys. All birds observed during this study were first year birds.

3.4 Discussion

3.4.1 Timing and Magnitude of Migration Past Point Barrow

The present studies showed that about 4,500 Ross' gulls flew east past Point Barrow, mostly on 1-2 October, and about 3,600 gulls flew west 10 days later. The great majority of movement in both directions took place on one day each. After the first day of Ross' Gull sightings, birds were seen flying in both directions, and some birds were still moving eastward on the last day of observations. Thus, it is likely that the westward migration continued for some period past these field studies.

Divoky's observations of Ross' Gull movements at Point Barrow in 1984 and 1986 (Chapter 2), and the observations made in 1987, constitute 3 Years of data that may be compared directly. Except for a few birds seen as early as 21 September in 1987, in all three years, the eastward migration occurred in earnest between 29 September and 1 October. Similarly, although it appears that the 1987 observations may not have included the last of the

Table 3.3. Observations of Ivory Gulls near Point Barrow, Alaska, between 19 September and 15 October 1987.

Date	Number	Time (AST)	Heading	Year Class	Location
09-28-87	1	1545	NE	1	1 mile N of base of spit
09-30-87	1	0840	SW	1	bight east of Racon tower
09-30-87	1	1100	E	1	Racon tower
10-02-87	1	1055	none	1	base of spit
10-04-87	2	1240	none	1	bight east of Racon tower
10-05-87	1	0905	NE	1	base of spit
10-05-87	1	1015	SW	1	base of spit
10-05-87	1	1625	NE	1	base of spit
10-12-87	1	1105	SW	1	base of spit

westward migrants, in all three years the westward migration seems to have ended within a narrow range of calendar dates, 14-19 October.

Further comparisons among the three years show other similarities, but differences as well (Table 3.4). Observations in 1984 and 1986 indicated from 10,000 to 16,000 birds migrating over several days, while the 1987 migration involved only about 4,500 birds and peaked sharply on one or two days only for both eastward and westward movements. These data are open to individual interpretation, but it is evident that the timing and duration of migrations in 1984 and 1986 were similar, although half again as many birds were seen in 1984 as in 1986. Nineteen-eighty-four (1984) also stood out with a projected 1,000 or more birds moving east on seven of the 17 days that the migration lasted (Fig. 3.7). Nineteen-eighty-seven (1987) was different from both 1984 and 1986 because far fewer birds were seen and the duration of both the eastward and westward movements was about two days. A large pulse of westward migrants was seen on a single day in 1987.

The three years of land-based migration data available greatly increase our knowledge of Ross' Gull migration in arctic Alaska, and they prove that Ross' Gulls return west past Point Barrow rather than overwintering in the arctic basin, However, considering the variability among the years in numbers of birds seen and in the duration of the movements, these studies should be regarded as only a beginning toward understanding the movements and ecology of Ross' Gulls in arctic Alaska. In particular, we still have only tentative ideas about the differences between shoreline and ice edge components of the migration and the influence of distance offshore of the pack ice on overall migration dynamics.

As discussed earlier (Chapter 2), it is still unknown why Ross' Gulls undertake what seems to be a rather lengthy migration into the Beaufort Sea, only to backtrack a short time later. The suggestion that availability of prey in the Beaufort is the main reason for Ross' Gulls moving there seems plausible. Furthermore, it is reasonable to assume that the gulls gain energetically and nutritionally from their brief visit to the Beaufort. A simple way to test this assumption may be to collect Ross' Gulls during their peak movements in both directions, and then measure and compare their

Table 3.4. Comparison of eastward and westward migrations of Ross' Gulls at Point Barrow, Alaska in 1984, 1986, and 1987.

Year	Eastward Migration				Westward Migration			
	Begin	End	Days	Birds	Begin	End	Days	Birds
1984	Sep 30	Ott 16	17	16,516	Ott 09	Ott 19	11	7,069
1986	Sep 29	Ott 17	19	4,679	Ott 05	Ott 18	14	10,034
1987	Ott 01	Ott 02	2	4,514	Ott 11	Ott 12	2	3,553

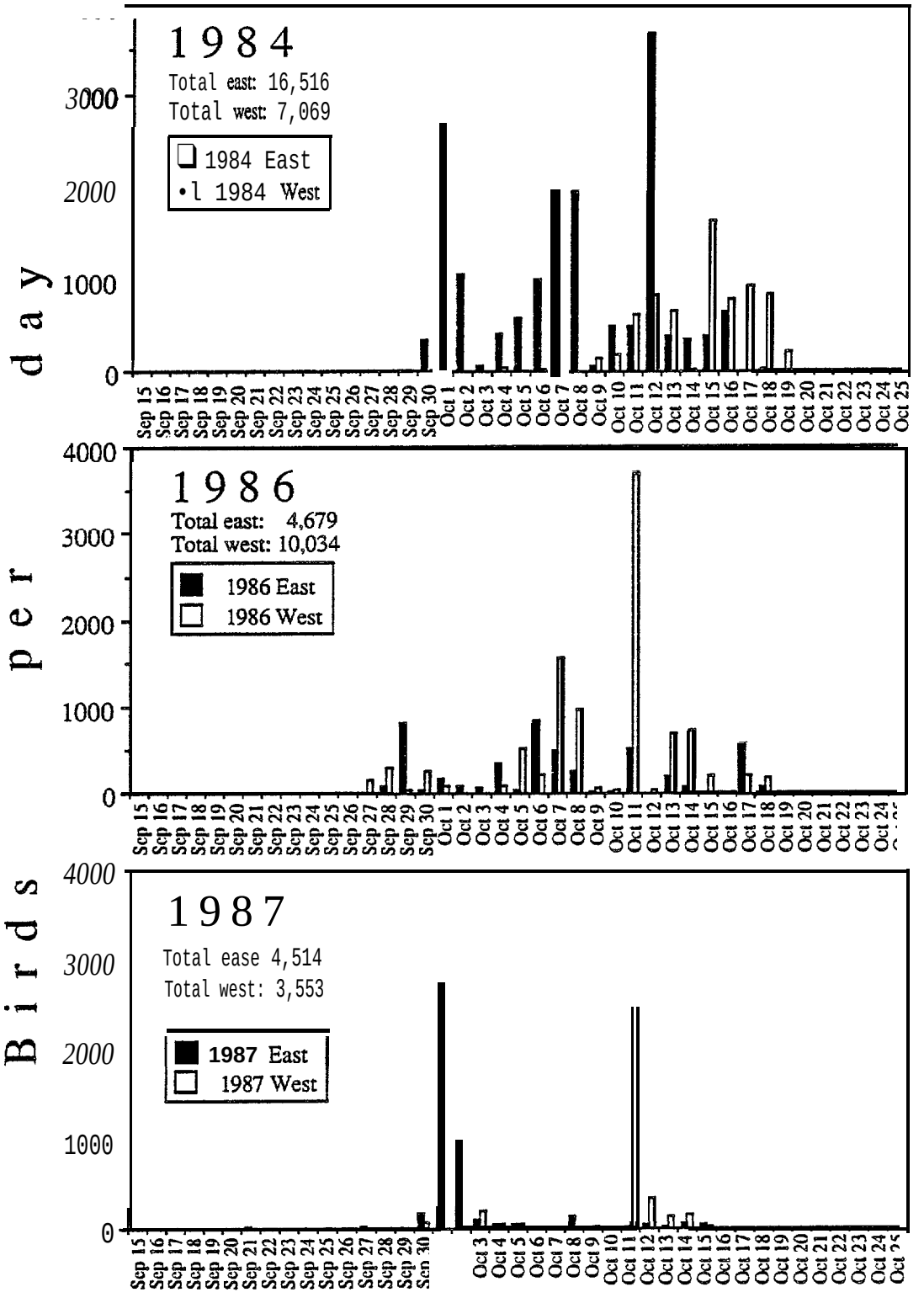

Figure 3.7. Projected total easterly and westerly passage rates for Ross' Gulls during 3 years at Point Barrow.

nutritional states. The nature of the species' prey base in the Beaufort is another important question that needs to be addressed.

3.4.2 Ross' Gull Movements in Relation to Time of Day and Weather

The distribution of sightings of Ross' Gull in 1987 (frequency of occurrence in each daylight hour) differed significantly from the distribution of sighting effort (Fig. 3.4) suggesting a diurnal periodicity in gull movements. It must be recognized, however, that significance tests are in this instance compromised by the inherent lack of independence in the data. Flocking behavior results in sightings that are temporally clumped, and the general agreement between observed and expected distributions depicted in Figure 3.4 is substantial evidence for uniform activity during daylight hours.

Winds were predominantly from the east during both easterly and westerly movements of Ross' Gulls in 1987. Together with the wind direction data presented by Divoky for 1984 and 1986 (Chapter 2), it appears that there is no clear relationship between flight direction of Ross' Gulls and wind direction.

There was limited evidence for a relationship between numbers of gulls moving east and maximum daily air temperatures in 1987. However, because the easterly migration was so concentrated in ony a couple of days, the possibility exists that this relationship was merely fortuitous. Thus, more evidence will be needed to show conclusively whether Ross' Gull movements are in any way related to either time of day or weather.

3.4.3. Occurrence of Ivory Gulls in the Nearshore Zone at Point Barrow

Observations of Ivory Gulls in 1987 were of scattered first-year individuals totaling 10 birds in all. Thus it cannot be said that Ivory Gulls used the area around Point Barrow to any significant degree during the study period. In contrast to these findings, a notable migration of Ivory Gulls past Point Barrow occurred in 1984, as is clear from the following account (Divoky, pers. observations):

> Few Ivory Gulls were seen before 12 October. Single birds were seen on 5 and 7 October. They were regular from 12 October until observations ceased on 22 October with 181 birds being observed. This was followed by five days of small movements to both the east and west. On 19 October a major westward movement of 369 birds was observed with 316 birds passing in a two hour period. On 21 and 22 October, when ice cover was almost complete, small numbers of Ivory Gulls continued to move west past the Point.

No similar migration had been documented in any year prior to 1984 (Divoky 1984), so the regularity of Ivory Gull migration in this region remains unclear. It is possible that substantial numbers of Ivory Gulls pass by Point Barrow in many or all years, but the timing has been so late that this migration has been generally missed by bird observers in the area. This could be the explanation for the rarity of Ivory Gull sightings in 1987, since studies were terminated on 15 October. If this conjecture is correct, it may mean that both Ross' and Ivory Gulls undergo a bidirectional migration past Point Barrow annually, or nearly so, while the two species' use of the area is almost completely nonoverlapping in time.

3.4.4 Summary and Conclusions Concerning Ross' Gull Migration in Arctic Alaska

The studies reviewed in this report indicate that Ross' Gulls occur occur in variable, but sometimes large numbers, for several weeks in the fall between the shores of the Chukchi and Beaufort seas and the ice edge. Three years of comparable data show that an eastward movement of gulls past Point Barrow peaks around the end of September, and a return movement to the west peaks about two weeks later. Projected total numbers of Ross' Gulls that migrated varied among years, and ranged from totals of 4,514 to 16,516 birds headed east, and 3,553 to 10,034 birds moving to the west. Population estimates for Alaska (20,000–40,000 birds) suggest that in any given year, a large proportion of the world population of Ross' Gulls may reside in the nearshore zone of the Chukchi and Beaufort seas, but information from Soviet waters during fall is needed to confirm this.

It was found that Ross' Gulls occur only as uncommon migrants in Alaska from late May through late July. A minimum of six weeks pass from the time birds leave their Siberian nesting grounds until they arrive in numbers in

the Chukchi Sea in mid- to late-September. Data indicate that Ross' Gulls arrive in substantial numbers in Alaskan waters sometime between the end of the first week and the start of the last week in September. Birds seem to be particularly abundant when ice extends to near the shore, such as Divoky encountered in September-October 1970.

After their arrival in numbers in the Chukchi, a large portion of the Ross' Gull population moves east past Point Barrow into the Beaufort Sea. The gulls appear to stay only briefly in the Beaufort, although some birds may reside there for up to a month. Thus, the Beaufort Sea, particularly in the vicinity of the Plover Islands, is an important foraging area for Ross' Gulls. As the Beaufort Sea begins freezing, the gulls return west past Point Barrow. This return migration to the west is a major finding of the present work, and it is the first conclusive evidence that Ross' Gulls do not winter in the arctic basin in numbers as was formerly believed (Bailey 1948).

Where the Ross' Gull population goes after that, however, remains largely conjecture. It seems likely that after their movement westward past Point Barrow, a good portion of the population continues southward through the Chukchi and Bering seas to winter in the Sea of Okhotsk, south of eastern Siberia (Fig. 3.8). Birds have frequently been sighted in spring, flying northward in Siberian river valleys, from the direction of the Sea of Okhotsk, toward their nesting grounds (Dementiev and Gladkov 1969).

Three major habitats are used extensively by Ross' Gulls while they are in arctic Alaskan waters: 1) their coastal migration corridor - a zone within 300 m of shore; 2) the western Beaufort Sea, especially in the vicinity of the Plover Islands; and 3) ice edge habitat wherever it occurs in the Chukchi and Beaufort seas. Also, based on Haney's observations at Point Barrow in 1987, it appears that the bight immediately west of Point Barrow proper (Fig. 2.9) is an important loafing and feeding area for Ross' Gulls .

Shipboard and aerial surveys showed that many Ross' Gulls feed and migrate at the ice edge, a factor that presumably has a significant

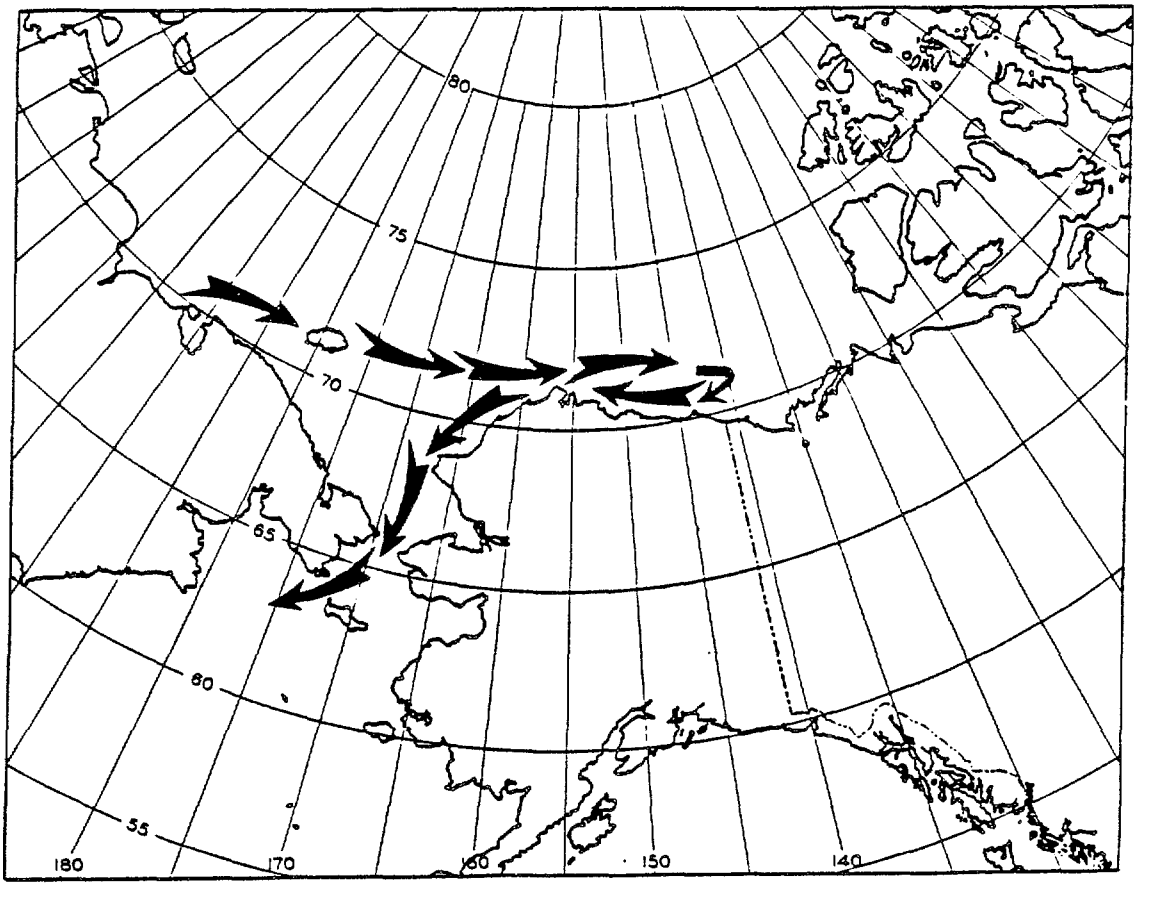

Figure 3.8. General pattern of migration of Ross' Gull in Alaskan waters from September through November.

influence on the number of birds observed from shore. During years when the ice edge is relatively far offshore, fewer birds may migrate close to shore. Conversely, the occurrence of ice close to shore would have the effect of concentrating the gulls and bringing them in closer proximity to oil and gas development activities. Thus, in those years when the ice pack is close to shore, Ross' Gulls would seem to be particularly susceptible to possible oil pollution or other adverse events.

It would appear that management plans for this species should address the timing of eastward and westward migrations, the proximity to shore of the ice edge and its influence on concentrating Ross' Gulls, and the nature and importance of the species' presumed prey base in the Beaufort Sea.

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Appendix 1. Ross ' gull migration data., Pt. Barrow, Sept-Ott 1987.

Rec.					Adults			Juveniles			Unidentified		
#	Date	Start	Stop	Location	#	Bhv	Dir	#	Bhv	Dir	#	Bhv	Dir
1	Sep 19	825	835	Base of Spit									
2	Sep 19	835	845	Base of Spit									
3	Sep 19	845	855	Base of Spit									
4	Sep 19	855	905	Base of Spit									
5	Sep 19	905	915	Base of Spit									
6	Sep 19	915	925	Base of Spit									
7	Sep 19	925	935	Base of Spit									
8	Sep 19	935	945	Base of Spit									
9	Sep 19	945	955	Base of Spit									
10	Sep 19	955	1005	Base of Spit									
11	Sep 19	1005	1015	Base of Spit									
12	Sep 19	1015	1535	Base of Spit									
13	Sep 19	1535	1545	Pt Barrow									
14	Sep 19	1545	1555	Pt Barrow									
15	Sep 19	1555	1605	Pt Barrow									
16	Sep 19	1605	1615	Pt Barrow									
17	Sep 19	1615	1625	Pt Barrow									
18	Sep 19	1625	1635	Pt Barrow	1	fly	1						
19	Sep 19	1635	1645	Pt Barrow									
20	Sep 19	1645	1655	Pt Barrow									
21	Sep 19	1655	1705	Pt Barrow	1	fly	5						
22	Sep 19	1705	1715	Pt Barrow									
23	Sep 19	845	915	Pt Barrow									
24	Sep 19	915	945	Pt Barrow									
25	Sep 19	945	1015	Pt Barrow									
26	Sep 19	1015	1045	Pt Barrow									
27	Sep 19	1050	1120	Pt Barrow									
28	Sep 19	1515	1525	Base of Spit									
29	Sep 19	1525	1536	Base of Spit									
30	Sep 19	1536	1546	Base of Spit									
31	Sep 19	1546	1556	Base of Spit									
32	Sep 19	1556	1606	Base of Spit									
33	Sep 19	1606	1617	Base of Spit									
34	Sep 19	1617	1627	Base of Spit									
35	Sep 19	1627	1637	Base of Spit									
36	Sep 19	1637	1648	Base of Spit									
37	Sep 19	1648	1658	Base of Spit									
38	Sep 19	1658	1708	Base of Spit									
39	Sep 19	1708	1718	Base of Spit									
40	Sep 19	1718	1728	Base of Spit									
41	Sep 20	930	940	Base of Spit									
42	Sep 20	1120	1130	Base of SPit									
43	Sep 20	1130	1140	Base of Spit									
44	Sep 21	830	840	Base of Spit									
45	Sep 21	840	850	Base of SPit									
46	Sep 21	850	900	Base of Spit									
47	Sep 21	900	910	Base of Spit									
48	Sep 21	910	'920	Base of Spit									
49	Sep 21	920	930	Base of Spit									
50	Sep 21	930	940	Base of Spit									
51	Sep 21	940	950	Base of Spit									

Appendix 1. Ross' gull migration data, Pt. Barrow, SePt-Ott 1987.

Rec.					Adults			Juveniles			Unidentified		
#	Date	Start	Stop	Location	#	Bhv	Dir	#	Bhv	Dir	#	Bhv	Dir
52	Sep 21	950	1000	Base of Spit									
53	Sep 21	1000	1010	Base of Spit									
54	Sep 21	1010	1020	Base of Spit									
55	Sep 21	1020	1030	Base of Spit									
56	Sep 21	1030	1040	Base of Spit	1	fly	7	1	fly	7			
57	Sep 21	1040	1050	Base of Spit									
58	Sep 21	1050	1100	Base of Spit									
59	Sep 21	1100	1110	Base of Spit									
60	Sep 21	1305	1315	Base of Spit									
61	Sep 21	1315	1325	Base of Spit									
62	Sep 21	1325	1335	Base of Spit									
63	Sep 21	1335	1345	Base of Spit	10	fly	12						
64	Sep 21	1345	1355	Base of Spit									
65	Sep 21	1355	1405	Base of Spit									
66	Sep 21	1405	1415	Base of Spit									
67	Sep 21	1415	1425	Base of Spit									
68	Sep 21	1425	1435	Base of Spit									
69	Sep 21	1435	1446	Base of Spit	1	fly	6	1	fly	6			
70	Sep 21	1446	1456	Base of Spit	1	fly	6						
71	Sep 21	1456	1506	Base of Spit									
72	Sep 21	1523	1533	Base of Spit	4	feed	12						
73	Sep 21	1620	1630	Base of Spit									
74	Sep 21	1630	1640	Base of Spit									
75	Sep 21	1640	1650	Base of Spit									
76	Sep 21	1650	1700	Base of Spit									
77	Sep 21	1700	1710	Base of Spit				1	fly	12			
78	Sep 21	1710	1720	Base of Spit									
79	Sep 21	1720	1730	Base of Spit									
80	Sep 21	1730	1740	Base of Spit									
81	Sep 21	1740	1750	Base of Spit									
82	Sep 22	820	845	see notes									
83	Sep 22	850	900	Base of Spit									
84	Sep 22	900	910	Base of Spit									
85	Sep 22	910	920	Base of Spit									
86	Sep 22	920	930	Base of Spit									
87	Sep 22	930	940	Base of Spit									
88	Sep 22	940	950	Base of Spit									
89	Sep 22	950	1000	Base of Spit									
90	Sep 22	1000	1010	Base of Spit									
91	Sep 22	1010	1020	Base of Spit									
92	Sep 22	1020	1030	Base of Spit									
93	Sep 22	1030	1040	Base of Spit									
94	Sep 22	1040	1050	Base of Spit									
95	Sep 22	1050	1100	Base of Spit									
96	Sep 22	1100	1110	Base of Spit									
97	Sep 22	1110	1120	Base of Spit									
98	Sep 22	1450	1500	Base of Spit									
99	Sep 22	1500	1510	Base of Spit									
100	Sep 22	1510	1520	Base of Spit									
101	Sep 22	1520	1530	Base of Spit									
102	Sep 22	1530	1540	Base of Spit									

Appendix 1. Ross' **gull migration** data, Pt. Barrow, Sept-Oct 1987.

Rec					Adults			Juveniles			Unidentified		
#	Date	Start	stop	Location	#	Bhv	Dir	#	Bhv	Dir	#	Bhv	Dir
103	Sep 22	1540	1550	Base of Spit									
104	Sep 22	1550	1600	Base of Spit									
105	Sep 22	1600	1610	Base of Spit									
106	Sep 22	1610	1620	Base of Spit									
107	Sep 22	1620	1630	Base of Spit									
108	Sep 22	1630	1640	Base of Spit									
109	Sep 22	1640	1650	Base of Spit									
110	Sep 22	1650	1700	Base of Spit									
111	Sep 23	835	845	Base of Spit									
112	Sep 23	845	855	Base of Spit									
113	Sep 23	855	905	Base of Spit									
114	Sep 23	905	915	Base of Spit									
115	Sep 23	915	925	Base of Spit									
116	Sep 23	925	930	Base of Spit									
117	Sep 23	930	940	Base of Spit									
118	Sep 23	940	950	Bass of Spit									
119	Sep 23	950	1000	Base of Spit									
120	Sep 23	1000	1010	Base of Spit	1	fly	12	1	fly	12			
121	Sep 23	1010	1020	Base of Spit									
122	Sep 23	1020	1030	Base of Spit									
123	Sep 23	1030	1040	Base of Spit									
124	Sep 23	1040	1050	Base of Spit	1	feed	12						
125	Sep 23	1050	1100	Base of Spit									
126	Sep 23	1055	1056	Bight area	1	fly	?	2	fly	?			
127	Sep 23	1430	1440	Base of Spit									
128	Sep 23	1440	1450	Base of Spit									
129	Sep 23	1450	1500	Base of Spit									
130	Sep 23	1500	1510	Base of Spit									
131	Sep 23	1510	1520	Base of Spit									
132	Sep 23	1520	1530	Base of Spit									
133	Sep 23	1530	1540	Base of Spit									
134	Sep 23	1540	1550	Base of Spit									
135	Sep 23	1550	1600	BaSe of Spit									
136	Sep 23	1600	1610	Base of SPit	1	fly	9	1	fly	9			
137	Sep 23	1610	1620	Base of SPit									
138	Sep 23	1620	1630	Base of SPit									
139	Sep 24	830	840	Base of Spit									
140	Sep 24	840	850	Base of Spit									
141	Sep 24	850	900	Base of Spit									
142	Sep 24	900	910	Base of Spit									
143	Sep 24	910	920	Base of Spit									
144	Sep 24	920	930	Base of Spit									
145	Sep 24	930	940	Base of Spit									
146	Sep 24	940	950	Base of Spit									
147	Sep 24	950	1000	Base of Spit									
148	Sep 24	1000	1010	Base of Spit									
149	Sep 24	1010	1020	Base of Spit									
150	Sep 24	1020	1030	Base of Spit									
151	Sep 24	1030	1040	Base of Spit									
152	Sep 24	1040	1050	Base of Spit									
153	Sep 24	1050	1100	Base of Spit									

Appendix 1. Ross' gull migration data, Pt. Barrow, Sept-Ott 1987.

Rec.					Adults			Juveniles			Unidentified		
#	Date	Start	stop	Location	#	Bhv	Dir	#	Bhv	Dir	#	Bhv	Dir
154	Sep 24	1100	1110	Base of Spit									
155	Sep 24	1110	1120	Base of Spit									
156	Sep 24	1120	1130	Base of Spit									
157	Sep 25	900	1100	Pt Barrow	4	rest		1	feed				
158	Sep 25	845	855	Base of Spit									
159	Sep 25	855	905	Base of Spit									
160	Sep 25	905	915	Base of Spit									
161	Sep 25	915	925	Base of Spit									
162	Sep 25	925	935	Base of Spit									
163	Sep 25	935	945	Base of Spit									
164	Sep 25	945	955	Base of Spit									
165	Sep 25	955	1005	Base of Spit									
166	Sep 25	1005	1015	Base of Spit									
167	Sep 25	1015	1025	Base of Spit									
168	Sep 25	1025	1035	Base of Spit									
169	Sep 25	1035	1045	Base of Spit									
170	Sep 25	1045	1055	Base of Spit									
171	Sep 25	1055	1105	Base of Spit									
172	Sep 25	1105	1115	Base of Spit									
173	Sep 25	1115	1125	Base of Spit									
174	Sep 25	1320	1330	Base of Spit									
175	Sep 25	1330	1340	Base of Spit									
176	Sep 25	1340	1350	Base of Spit									
177	Sep 25	1350	1400	Base of Spit									
178	Sep 25	1400	1410	Base of Spit									
179	Sep 25	1410	1420	Base of Spit									
180	Sep 25	1420	1430	Base of Spit									
181	Sep 25	1430	1440	Base of Spit									
182	Sep 25	1440	1450	Base of Spit									
183	Sep 25	1450	1500	Base of Spit									
184	Sep 25	1500	1510	Base of Spit									
185	Sep 25	1510	1520	Base of Spit									
186	Sep 25	1520	1530	Base of Spit									
187	Sep 25	1530	1540	Base of Spit									
188	Sep 25	1540	1550	Base of Spit									
189	Sep 25	1550	1600	Base of Spit									
190	Sep 26	840	850	Base of Spit									
191	Sep 26	850	900	Base of Spit									
192	Sep 26	900	910	Base of Spit									
193	Sep 26	910	920	Base of Spit									
194	Sep 26	920	930	Base of Spit									
195	Sep 26	930	940	Base of Spit									
196	Sep 26	940	950	Base of Spit									
197	Sep 26	950	1000	Base of Spit									
198	Sep 26	1000	1010	Base of Spit									
199	Sep 26	1010	1020	Base of Spit									
200	Sep 26	1020	1030	Base of Spit									
201	Sep 26	1030	1040	Base of Spit									
202	Sep 26	1040	1050	Base of Spit									
203	Sep 26	1050	1100	Base of Spit									
204	Sep 26	1500	1615	Pt Barrow	9	feed		2	feed				

Appendix 1. Ross' gull migration data, Pt. Barrow, Sept-Oct 1987.

Rec.						Adults		Juveniles			Unidentified		
#	Date	Start	Stop	Location	#	Bhv	Dir	#	Bhv	Dir	#	Bhv	Dir
205	Sep 27	1035	1045	Pt Barrow									
206	Sep 27	1045	1055	Pt Barrow									
207	Sep 27	1055	1105	Pt Barrow									
208	Sep 27	1105	1115	Pt Barrow									
209	Sep 27	1115	1125	Pt Barrow									
210	Sep 27	1125	1135	Pt Barrow									
211	Sep 27	1135	1145	Pt Barrow	6	fly	2						
212	Sep 27	1145	1155	Pt Barrow	2	fly	4						
213	Sep 27	1155	1205	Pt Barrow									
214	Sep 27	1205	1215	Pt Barrow									
215	Sep 27	1215	1225	Pt Barrow									
216	Sep 27	1225	1235	Pt Barrow									
217	Sep 27	1235	1245	Pt Barrow									
218	Sep 27	1245	1255	Pt Barrow									
219	Sep 27	1255	1305	Pt Barrow	4	fly	3						
220	Sep 27	1305	1315	Pt Barrow									
221	Sep 27	1315	1325	Pt Barrow									
222	Sep 27	1325	1335	Pt Barrow									
223	Sep 27	1335	1345	Pt Barrow									
224	Sep 27	1345	1355	Pt Barrow									
225	Sep 27	1355	1405	Pt Barrow									
226	Sep 27	1405	1415	Pt Barrow	12	feed		2	feed				
227	Sep 27	1430	1445	near NARL	3	feed	12	1	feed	12			
228	Sep 28	830	831	mid-Spit	3	fly	3						
229	Sep 28	840	850	Pt Barrow									
230	Sep 28	850	900	Pt Barrow									
231	Sep 28	900	910	Pt Barrow									
232	Sep 28	910	920	Pt Barrow									
233	Sep 28	920	930	Pt Barrow									
234	Sep 28	930	940	Pt Barrow									
235	Sep 28	940	950	Pt Barrow									
236	Sep 28	950	1000	Pt Barrow	1	fly	3						
237	Sep 28	1000	1010	Pt Barrow									
238	Sep 28	1010	1020	Pt Barrow									
239	Sep 28	1020	1030	Pt Barrow									
240	Sep 28	1030	1040	Pt Barrow									
241	Sep 28	1040	1050	Pt Barrow									
242	Sep 28	1050	1100	Pt Barrow									
243	Sep 28	1100	1110	Pt Barrow									
244	Sep 28	1110	1120	Pt Barrow									
245	Sep 28	1130	1131	1 mi S Pt	2	fly	12	1	fly	12			
246	Sep 28	1135	1136	mid-spit	1	feed							
247	Sep 28	1525	1535	Pt Barrow									
248	Sep 28	1535	1545	Pt Barrow									
249	Sep 28	1545	1555	Pt Barrow									
250	Sep 28	1555	1605	Pt Barrow									
251	Sep 28	1605	1615	Pt Barrow									
252	Sep 28	1615	1625	Pt Barrow									
253	Sep 28	1625	1635	Pt Barrow									
254	Sep 28	1635	1645	Pt Barrow									
255	Sep 28	1645	1655	Pt Barrow									

Appendix 1. Ross' gull migration data, Pt. Barrow, Sept-Ott 1987.

Rec.					Adults			Juveniles			Unidentified		
#	Date	Start	stop	Location	#	Bhv	Dir	#	Bhv	Dir	#	Bhv	Dir
256	Sep 29	915	925	Pt Barrow									
257	Sep 29	925	935	Pt Barrow									
258	Sep 29	935	945	Pt Barrow									
259	Sep 29	945	955	Pt Barrow									
260	Sep 29	955	1005	Pt Barrow									
261	Sep 29	1005	1015	Pt Barrow									
262	Sep 29	1015	1025	Pt Barrow									
263	Sep 29	1025	1035	Pt Barrow									
264	Sep 29	1035	1045	Pt Barrow									
265	Sep 29	1045	1055	Pt Barrow									
266	Sep 29	1055	1105	Pt Barrow									
267	Sep 30	840	841	Pt Barrow	2	fly	12						
268	Sep 30	850	900	Pt Barrow									
269	Sep 30	900	910	Pt Barrow									
270	Sep 30	910	920	Pt Barrow									
271	Sep 30	920	930	Pt Barrow									
272	Sep 30	930	940	Pt Barrow									
273	Sep 30	940	950	Pt Barrow									
274	Sep 30	950	1000	Pt Barrow									
275	Sep 30	1000	1010	Pt Barrow									
276	Sep 30	1010	1020	Pt Barrow									
277	Sep 30	1020	1030	Pt Barrow									
278	Sep 30	1030	1040	Pt Barrow									
279	Sep 30	1040	1050	Pt Barrow	2	fly	3	1	fly	3			
280	Sep 30	1050	1100	Pt Barrow									
281	Sep 30	1100	1110	Pt Barrow	6	fly	2						
282	Sep 30	1115	1145	along spit	64			10					
283	Sep 30	1400	1500	Pt Brw bight	720	feed	12	180	feed	12			
284	Sep 30	1545	1555	Pt Barrow	8	fly	3	1	fly	3			
285	Sep 30	1545	1555	Pt Barrow	1	fly	2						
286	Sep 30	1555	1605	Pt Barrow	21	fly	3	8	fly	3			
287	Sep 30	1605	1615	Pt Barrow				1	fly	9			
288	Sep 30	1615	1625	Pt Barrow	3	fly	3	2	fly	3			
289	Sep 30	1625	1635	Pt Barrow									
290	Sep 30	1635	1645	Pt Barrow	7	fly	3	3	fly	3			
291	Sep 30	1645	1655	Pt Barrow	12	fly	3	6	fly	3			
292	Sep 30	1655	1705	Pt Barrow	1	fly	3						
293	Sep 30	1705	1715	Pt Barrow	1	fly	6						
294	Sep 30	1705	1715	Pt Barrow	1	fly	3						
295	Sep 30	1705	1715	Pt Barrow	2	fly	9						
296	Ott 1	845	855	Base of Spit	47	fly	12	9	fly	12			
297	Ott 1	845	855	Base of Spit	16	fly	1						
298	Ott 1	855	905	Base of Spit	50	fly	12	4	fly	12			
299	Ott 1	855	905	Base of Spit				3	fly	3			
300	Ott 1	905	915	Base of Spit	65	fly	12	4	fly	12			
301	Ott 1	915	925	Base of Spit	18	fly	1	3	fly	3			
302	Ott 1	915	925	Base of Spit	14	fly	12	1	fly	12			
303	Ott 1	925	935	Base of Spit	23	fly	12	2	fly	12			
304	Ott 1	935	945	Base of Spit	29	fly	12	2	fly	12			
305	Ott 1	935	945	Base of Spit	16	fly	11	1	fly	11			
306	Ott 1	945	955	Base of Spit	21	fly	11	4	fly	11			

Appendix 1. Ross' gull migration data, Pt. Barrow, Sept-Ott 1987.													
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Rec.					Adults			Juveniles			Unidentified		
#	Date	Start	stop	Location	#	Bhv	Dir	#	Bhv	Dir	#	Bhv	Dir
307	Ott 1	945	955	Base of Spit	115	fly	12	17	fly	12			
308	Ott 1	945	955	Base of Spit	1	fly	6						
309	Ott 1	955	1005	Base of Spit	127	fly	12	19	fly	12			
310	Ott 1	955	1005	Base of Spit	4	fly	11						
311	Ott 1	1005	1015	Base of Spit	19	fly	11	4	fly	11			
312	Ott 1	1005	1015	Base of Spit	71	fly	12	5	fly	12			
313	Ott 1	1015	1025	Base of Spit	99	fly	12	17	fly	12			
314	Ott 1	1015	1025	Base of Spit	2	fly	11						
315	Ott 1	1025	1035	Base of Spit	26	fly	12	3	fly	12			
316	Ott 1	1025	1035	Base of Spit	3	fly	1						
317	Ott 1	1035	1045	Base of Spit	8	fly	12	3	fly	12			
318	Ott 1	1045	1055	Base of Spit	4	fly	12						
319	Ott 1	1055	1105	Base of Spit	22	fly	12	1	fly	12			
.320	Ott 1	1105	1115	Base of Spit	31	fly	12	6	fly	12			
321	Ott 1	1345	1355	Base of Spit									
322	Ott 1	1355	1405	Base of Spit	8	fly	12						
323	Ott 1	1405	1415	Base of Spit									
324	Ott 1	1415	1425	Base of Spit	2	fly	12						
325	Ott 1	1425	1435	Base of Spit	3	fly	12						
326	Ott 1	1435	1445	Base of Spit	2	fly	12						
327	Ott 1	1445	1455	Base of Spit									
328	Ott 1	1455	1505	Base of Spit	3	fly	12						
329	Ott 1	1505	1515	Base of Spit	5	fly	12						
330	Ott 1	1515	1525	Base of Spit	8	fly	12						
331	Ott 1	1525	1535	Base of Spit	4	fly	12				115	fly	1
332	Ott 1	1525	1535	Base of Spit	1	fly	11						
333	Ott 1	1535	1545	Base of Spit	1	fly	12				48	fly	12
334	Ott 1	1535	1545	Base of Spit							34	fly	1
335	Ott 1	1545	1555	Base of Spit	7	fly	12	1	fly	12	26	fly	2
336	Ott 1	1555	1605	Base of Spit							118	fly	1
337	Ott 1	1605	1615	Base of Spit	1	fly	12				83	fly	1
338	Ott 1	1605	1606	Pt Brw bight							346		
,339	Ott 1	1615	1625	Base of Spit	4	fly	12	1	fly	12	33	fly	12
340	Ott 1	1615	1625	Base of Spit							18	fly	11
341	Ott 1	1625	1635	Base of Spit	4	fly	12	3	fly	12			
342	Ott 1	1625	1635	Base of Spit	3	fly	4						
343	Ott 1	1635	1645	Base of Spit	16	fly	12				33	fly	1
.344	Ott 1	1645	1655	Base of Spit	8	fly	1	1	fly	1			
345	Ott 1	1645	1655	Base of Spit	14	fly	12				4	fly	12
346	Ott 1	1655	1705	Base of Spit							28	fly	12
347	Ott 1	1705	1715	Base of Spit	17	fly	12	5	fly	12	56	fly	12
348	Ott 2	825	835	Base of Spit	13	fly	12	2	fly	12			
349	Ott 2	835	845	Base of Spit	7	fly	12	3	fly	12			
350	Ott 2	845	855	Base of Spit	15	fly	12	6	fly	12	15	fly	1
351	Ott 2	855	905	Base of Spit	7	fly	12	1	fly	12	8	fly	12
352	Ott 2	905	915	Base of Spit	2	fly	12	1	fly	12	20	fly	12
353	Ott 2	915	925	Base of Spit	12	fly	12	2	fly	12	16	fly	12
354	Ott 2	915	925	Base of Spit	8	fly	11						
355	Ott 2	925	935	Base of Spit	32	fly	12	9	fly	12	30	fly	12
356	Ott 2	935	945	Base of Spit	6	fly	12	23	fly	12	37	fly	12
357	Ott 2	945	955	Base of Spit	29	fly	12	1	fly	12	5	fly	12

Appendix 1. Ross ' gull migration data, Pt. Barrow, Sept-Ott 1987.

Rec.					Adults			Juveniles			Unidentified		
#	Date	Start	stop	Location	#	Bhv	Dir	#	Bhv	Dir	#	Bhv	Dir
358	Ott 2	955	1005	Base of Spit	23	fly	12	6	fly	12			
359	Ott 2	1005	1015	Base of Spit	25	fly	12	10	fly	12			
360	Ott 2	1005	1015	Base of Spit				2	fly	11			
361	Ott 2	1015	1025	Base of Spit	25	fly	12	2	fly	12			
362	Ott 2	1025	1035	Base of Spit	13	fly	12	3	fly	12			
363	Ott 2	1035	1045	Base of Spit	8	fly	12	1	fly	12			
364	Ott 2	1045	1055	Base of Spit	10	fly	12	6	fly	12			
365	Ott 2	1055	1105	Base of Spit	10	fly	12	3	fly	12			
366	Ott 2	1105	1115	Base of Spit	4	fly	12	1	fly	12	10	fly	11
367	Ott 2	1115	1125	Base of Spit	1	fly	12						
368	Ott 2	1435	1445	Base of Spit	1	fly	12	1	fly	12			
369	Ott 2	1445	1455	Base of Spit	3	fly	12				2	fly	12
370	Ott 2	1505	1515	Base of Spit				2	fly	12			
371	Ott 2	1515	1525	Base of Spit	2	fly	6	2	fly	12			
372	Ott 2	1515	1525	Base of Spit	2	fly	12	3	fly	11			
373	Ott 2	1525	1535	Base of Spit									
374	Ott 2	1535	1545	Base of Spit	3	fly	12				2		1
375	Ott 2	1545	1555	Base of Spit	2	fly	12						
376	Ott 2	1555	1605	Base of Spit	1	fly	12						
377	Ott 2	1605	1615	Base of Spit									
378	Ott 2	1615	1625	Base of Spit									
379	Ott 2	1625	1635	Base of Spit	1	fly	12						
380	Ott 2	1600	1630	Pt Brw Bight							347	feed	
381	Ott 2	1600	1630	Pt Brw Bight	48	rest		9	rest				
382	Ott 3	900	930	Base of spit							110		
383	Ott 3	900	910	Base of spit									
384	Ott 3	910	920	Base of spit	3	fly	12	4	fly	12			
385	Ott 3	910	920	Base of spit				1	fly	6			
386	Ott 3	920	930	Base of spit	1	fly	12						
387	Ott 3	930	940	Base of spit									
388	Ott 3	940	950	Base of spit	1	fly	12						
389	Ott 3	940	950	Base of spit	3	fly	6						
390	Ott 3	950	1000	Base of spit	3	fly	8						
391	Ott 3	1000	1010	Base of spit							6	fly	9
392	Ott 3	1010	1020	Base of spit									
393	Ott 3	1020	1030	Base of spit	3	fly	8						
394	Ott 3	1030	1040	Base of spit									
395	Ott 3	1040	1050	Base of spit	5	fly	12				1	fly	12
396	Ott 3	1050	1100	Base of spit									
397	Ott 3	1100	1110	Base of spit	10	fly	12						
398	Ott 3	1100	1110	Base of spit	5	fly	6						
399	Ott 3	1110	1120	Base of spit	2	fly	12						
400	Ott 3	1110	1120	Base of spit	1	fly	6						
401	Ott 3	1120	1130	Base of spit	4	fly	12	1	fly	12			
402	Ott 3	1120	1130	Base of spit	3	fly	6						
403	Ott 3	1130	1140	Base of spit	1	fly	6						
404	Ott 3	1505	1515	Base of spit	6	fly	6	3	fly	6			
405	Oct 3	1505	1515	Base of spit	2	fly	12						
406	Ott 3	1515	1525	Base of spit	23	fly	6	5	fly	6			
407	Ott 3	1525	1535	Base of spit	1	fly	6	1	fly	6			
408	Ott 3	1535	1545	Base of spit	10	fly	6	2	fly	6			

Appendix 1. Ross' gull migration data, Pt. Barrow, Sept-Ott 1987.

Rec.					Adults			Juveniles			Unidentified		
#	Date	Start	stop	Location	#	Bhv	Dir	#	Bhv	Dir	#	Bhv	Dir
409	Ott 3	1545	1555	Base of spit	4	fly	6	1	fly	6			
410	Ott 3	1545	1555	Base of spit	2	fly	9	1	fly	9			
411	Ott 3	1545	1555	Base of spit				3	fly	12			
412	Ott 3	1545	1546	Pt Barrow							218		
413	Ott 3	1555	1605	Base of spit	3	fly	12						
414	Ott 3	1605	1615	Base of spit	4	fly	12	1	fly	12			
415	Ott 3	1605	1615	Base of spit	2	fly	6						
416	Ott 3	1615	1625	Base of spit	1	fly	6	1	fly	6			
417	Ott 3	1615	1625	Base of spit	2	fly	12						
418	Ott 3	1625	1635	Base of spit	3	fly	12						
415	Ott 3	1625	1635	Base of spit	1	fly	6						
420	Ott 3	1635	1645	Base of spit	1	fly	12						
421	Ott 3	1645	1655	Base of spit									
422	Ott 3	1655	1705	Base of spit	2	fly	6	1	fly	6			
423	Ott 3	1655	1705	Base of spit	1	fly	7	1	fly	15			
424	Ott 3	1715	1716	Pt Barrow							218	?	
425	Ott 4	1020	1030	Base of spit									
426	Ott 4	1030	1040	Base of spit									
427	Ott 4	1040	1050	Base of spit									
428	Ott 4	1050	1100	Base of spit									
429	Ott 4	1100	1110	Base of spit									
430	Ott 4	1110	1120	Base of spit	1	fly	12						
431	Ott 4	1120	1130	Base of spit				1	fly	12			
432	Ott 4	1130	1140	Base of spit	4	fly	12	5	fly	12			
433	Ott 4	1140	1150	Base of spit	1	fly	6	2	fly	6			
434	Ott 4	1150	1200	Base of spit	1	fly	6	3	fly	6			
435	Ott 4	1200	1210	Base of spit									
436	Ott 4	1210	1220	Base of spit									
437	Ott 4	1220	1230	Base of spit									
438	Ott 4	1230	1240	Base of spit				1	fly	6			
439	Ott 4	1240	1241	Pt Barrow	21			34					
440	Ott 4	1240	1250	Base of spit				1	fly	6			
441	Ott 4	1250	1300	Base of spit				1	fly	12			
442	Ott 4	1300	1310	Base of spit									
443	Ott 5	855	905	Base of spit	2	fly	12	1	fly	12			
444	Ott 5	855	905	Base of sPit	1	fly	8	1	fly	6			
445	Ott 5	905	915	Base of spit	6	fly	6	3	fly	6			
446	Ott 5	905	915	Base of spit	1	fly	12						
447	Ott 5	915	925	Base of spit	1	fly	11						
448	Ott 5	925	935	Base of spit									
449	Ott 5	935	945	Base of spit	1	fly	6						
450	Ott 5	945	955	Base of spit	1	fly	6						
451	Ott 5	955	1005	Base of spit	1	fly	12						
452	Ott 5	1005	1015	Base of spit	2	flv	6						
453	Ott 5	1015	1025	Base of spit	2	fly	12	2	fly	12			
454	Ott 5	1025	1035	Base of spit									
455	Ott 5	1035	1045	Base of spit	1	fly	12						
456	Ott 5	1045	1055	Base of spit	1	fly	6						
457	Ott 5	1055	1105	Base of spit									
458	Ott 5	1105	1115	Base of spit									
459	Oct 5	1115	1125	Base of spit									

Appendix 1. Ross' gull migration data, Pt. Barrow, Sept-Ott 1987.

Rec.					Adults			Juveniles			Unidentified		
#	Date	Start	Stop	Location	#	Bhv	Dir	#	Bhv	Dir	#	Bhv	Dir
460	Ott 5	1515	1525	Base of spit	2	fly	6	1	fly	6			
461	Ott 5	1525	1535	Base of spit									
462	Ott 5	1535	1545	Base of spit	1	fly	6						
463	Ott 5	1545	1555	Base of spit									
464	Ott 5	1555	1605	Base of spit									
465	Ott 5	1605	1615	Base of spit									
466	Ott 5	1615	1625	Base of spit									
467	Ott 5	1625	1635	Base of spit	6	fly	12	1	fly	12			
468	Ott 5	1635	1645	Base of spit	2	fly	12	1	fly	12			
469	Ott 5	1645	1655	Base of spit									
470	Ott 5	1655	1705	Base of spit	2	fly	6						
471	Ott 5	1705	1715	Base of spit				1	fly	6			
472	Oct 6	945	955	Base of spit	1	fly	12						
473	Oct 6	955	1005	Base of spit									
474	Ott 6	1005	1015	Base of spit									
475	Ott 6	1015	1025	Base of spit									
476	Oct 6	1025	1035	Base of spit									
477	Ott 6	1035	1045	Base of spit									
478	Ott 6	1045	1055	Base of spit									
479	Ott 6	1055	1105	Base of spit									
480	Ott 6	1105	1115	Base of spit	1	fly	6						
481	Ott 6	1115	1125	Base of spit									
482	Ott 6	1200	1300	Br'vl-->NARL	291	feed		227	feed		518		
483	Ott 7	905	915	Base of spit									
484	Ott 7	915	925	Base of spit									
485	Ott 7	925	935	Base of spit									
486	Ott 7	935	945	Base of spit				2	fly	6			
487	Ott 7	945	955	Base of spit									
488	Ott 7	955	1005	Base of spit									
489	Ott 7	1005	1015	Base of spit									
490	Ott 7	1015	1025	Base of spit									
491	Ott 7	1025	1035	Base of spit									
492	Ott 7	1035	1045	Base of spit				1	fly	12			
493	Ott 7	1045	1055	Base of spit									
494	Ott 7	1055	1105	Base of spit									
495	Ott 7	1450	1500	Base of spit									
496	Ott 7	1500	1510	Base of spit									
497	Ott 7	1510	1520	Base of spit									
498	Ott 7	1520	1530	Base of spit									
499	Ott 7	1530	1540	Base of spit									
500	Ott 7	1530	1531	Pt Barrow	4								
501	Ott 7	1540	1550	Base of spit									
502	Ott 7	1550	1600	Base of spit									
503	Ott 7	1600	1610	Base of spit									
504	Ott 7	1610	1620	Base of spit									
505	Ott 7	1620	1630	Base of spit									
506	Ott 7	1630	1640	Base of spit									
507	Ott 7	1640	1650	Base of spit									
508	Ott 8	910	920	Base of spit									
509	Ott 8	920	930	Base of spit									
510	Ott 8	930	940	Base of spit				2	fly	12	1	fly	12

Appendix 1. Ross' gull migration data, Pt. Barrow, Sept-Ott 1987.

Rec.					Adults			Juveniles			Unidentified		
#	Date	Start	stop	Location	#	Bhv	Dir	#	Bhv	Dir	#	Bhv	Dir
511	Ott 8	940	950	Base of spit	9	fly	12	6	fly	12			
512	oct 8	940	950	Base of spit	2	fly	6						
513	Ott 8	950	1000	Base of spit							10	fly	12
514	Oct 8	1000	1010	Base of spit	14	fly	12	1	fly	12			
515	Ott 8	1010	1020	Base of spit	1	fly	6	1	fly	6			
516	Oct 8	1010	1020	Base of spit	2	fly	12	5	fly	12			
517	Ott 8	1020	1030	Base of spit	5	fly	12	5	fly	12	2	fly	12
518	Ott 8	1030	1040	Base of spit									
519	Ott 8	1040	1050	Base of spit									
520	Ott 8	1050	1100	Base of spit									
521	Oct 8	1100	1110	Base of spit									
522	Ott 8	1425	1435	Base of spit									
523	Ott 8	1435	1445	Base of spit									
524	Ott 8	1445	1455	Base of spit									
525	Ott 8	1455	1505	Base of spit									
526	Ott 8	1505	1515	Base of spit									
527	Ott 8	1515	1525	Base of spit									
528	Ott 8	1525	1535	Base of spit									
529	Ott 8	1535	1545	Base of spit									
530	Oct 8	1545	1555	Base of spit									
531	Ott 8	1555	1605	Base of spit									
532	Ott 8	1605	1615	Base of spit									
533	Ott 8	1615	1625	Base of spit									
534	Ott 9	1025	1035	Base of spit									
535	Ott 9	1035	1045	Base of spit									
536	Ott 9	1045	1055	Base of spit									
537	Ott 9	1055	1105	Base of spit									
538	Ott 9	1105	1115	Base of spit									
539	Ott 9	1115	1125	Base of spit									
540	Ott 9	1125	1135	Base of spit									
541	Ott 9	1435	1445	Base of spit									
542	Ott 9	1445	1455	Base of spit									
543	Ott 9	1455	1505	Base of spit									
544	Ott 9	1505	1515	Base of spit									
545	Ott 9	1515	1525	Base of spit				1	fly	6			
546	Ott 9	1525	1535	Base of spit									
547	Ott 9	1630	1640	Base of spit									
548	Ott 9	1640	1650	Base of spit									
549	Ott 9	1650	1700	Base of spit									
550	Ott 9	1700	1710	Base of spit	2	fly	6	3	fly	6			
551	Ott 9	1710	1720	Base of spit									
552	Ott 9	1720	1730	Base of spit				2	fly	12			
553	Ott 11	1400	1401	NARL-->camp							50	feed	
554	Ott 11	1455	1505	Base of spit									
555	Ott 11	1505	1515	Base of spit									
556	Ott 11	1515	1525	Base of spit	1	fly	6						
557	Ott 11	1515	1525	Base of spit	1	fly	12						
558	Ott 11	1525	1535	Base of spit	7	fly	6	7	fly	6			
559	Ott 11	1535	1545	Base of spit	23	fly	6	12	fly	6	7	fly	6
560	Ott 11	1545	1555	Base of spit	27	fly	6	11	fly	6			
561	Ott 11	1555	1605	Base of spit	5	fly	6	4	fly	6			

Appendix 1. Ross' gull migration data, Pt. Barrow, Sept-Ott 1987.

Rec.					Adults			Juveniles			Unidentified		
#	Date	Start	Stop	Location	#	Bhv	Dir	#	Bhv	Dir	#	Bhv	Dir
562	Ott 11	1605	1615	Base of spit	52	fly	6	21	fly	6			
563	Ott 11	1615	1625	Base of spit	60	fly	6	39	fly	6			
564	Ott 11	1615	1625	Base of sPit	2	fly	12						
565	Ott 11	1625	1635	Base of spit	55	fly	6	26	fly	6			
566	Ott 11	1635	1645	Base of sPit	40	fly	6	18	fly	6			
567	Ott 11	1645	1655	Base of spit	25	fly	6	23	fly	6			
568	Ott 11	1655	1705	Base of spit	59	f ly	6	22	fly	6			
569	Ott 11	1705	1715	Base of sPit	40	fly	6	19	fly	6			
570	Ott 11	1715	1725	Base of sPit	10	fly	6	7	fly	6			
571	Ott 12	945	955	Base of sPit	4	fly	12						
572	Ott 12	945	955	Base of spit	6	fly	6						
573	Ott 12	955	1005	Base of spit	6	fly	6	4	fly	6			
574	Ott 12	955	1005	Base of spit	2	fly	5	1	fly	5			
575	Ott 12	1005	1015	Base of spit	2	fly	4	1	fly	6	3	fly	4
576	Ott 12	1015	1025	Base of spit	3	fly	6	11	fly	6			
577	Ott 12	1025	1035	Base of spit									
578	Ott 12	1035	1045	Base of sPit									
579	Ott 12	1045	1055	Base of sPit	13	fly	6	6	fly	6			
580	Ott 12	1055	1105	Base of spit									
581	Ott 12	1105	1115	Base of sPit	4	fly	6	1	fly	6			
582	Ott 12	1115	1125	Base of spit									
583	Ott 12	1125	1135	Base of sPit	3	fly	12	6	fly	12			
584	Ott 12	1500	1510	Base of spit	7	fly	5		fly				
585	Ott 12	1510	1520	Base of spit	4	fly	6	2	fly	6			
586	Ott 12	1520	1530	Base of sPit	4	fly	5	6	fly	5	2	fly	5
587	Ott 12	1520	1530	Base of spit	2	fly	12	1	fly	12			
588	Ott 12	1530	1540	Base of spit									
589	Ott 12	1540	1550	Base of spit									
590	Ott 12	1550	1600	Base of spit							35	fly	6
591	Ott 12	1600	1610	Base of spit	2	fly	6	2	fly	6			
592	Ott 12	1610	1620	Base of spit									
593	Ott 12	1620	1630	Base of spit	1	fly	6	1	fly	6			
594	Ott 12	1630	1640	Base of spit	1	fly	12	1	fly	6			
595	Ott 12	1640	1650	Base of spit									
596	Ott 12	1620	1621	Pt Barrow							32	feed	
597	Ott 13	915	925	Base of spit									
598	Ott 13	925	935	Base of spit									
599	Ott 13	935	945	Base of spit	1	fly	6	7	fly	6			
600	Ott 13	945	955	Base of spit	7	fly	6	4	fly	6			
'601	Ott 13	955	1005	Base of spit									
602	Ott 13	1005	1015	Base of spit									
603	Ott 13	1015	1025	Base of sPit									
604	Ott 13	1025	1035	Base of spit									
605	Ott 13	1035	1045	Base of spit									
606	oct 13	1045	1055	Base of spit	2	fly	6	1	fly	6			
607	Ott 13	1055	1105	Base of spit	3	fly	6	2	fly	6			
608	Oct 13	1105	1115	Base of spit	2	fly	6	1	fly	6			
609	Ott 13	1105	1115	Base of spit	1	fly	12						
610	Ott 13	1115	1125	Base of spit	2	fly	12	2	fly	12			
611	Ott 14	955	1005	Base of spit	2	fly	6						
612	Ott 14	1005	1015	Base of spit									

Appendix 1. Ross' gull migration data, Pt. Barrow, Sept-Ott 1987.

Rec.					Adults			Juveniles			Unidentified		
#	Date	Start	Stop	Location	#	Bhv	Dir	#	Bhv	Dir	#	Bhv	Dir
613	Ott 14	1015	1025	Base of sPit	2	fly	12						
614	Ott 14	1025	1035	Base of spit									
615	Ott 14	1035	1045	Base of spit	5	fly	6	2	fly	6			
616	Ott 14	1035	1045	Base of spit	1	fly	12						
617	Ott 14	1045	1055	Base of spit									
618	Ott 14	1055	1105	Base of spit									
619	Ott 14	1105	1115	Base of spit	2	fly	12	1	fly	6			
620	Ott 14	1115	1125	Base of spit				1	fly	12			
621	Ott 14	1125	1135	Base of spit				3	fly	6			
622	Ott 14	1125	1135	Base of spit				1	fly	12			
623	Ott 14	1450	1500	Base of spit									
624	Ott 14	1500	1510	Base of spit	1	fly	6	1	fly	6			
625	Ott 14	1510	1520	Base of spit	5	fly	12	5	fly	12			
626	Ott 14	1520	1530	Base of spit	4	fly	6	1	fly	6	1	fly	12
627	Ott 14	1530	1540	Base of sPit	7	fly	6	5	fly	6			
628	Ott 14	1530	1540	Base of spit	1	fly	12						
629	Ott 14	1540	1550	Base of spit	11	fly	6	5	fly	6			
630	Ott 14	1550	1600	Base of sPit	1	fly	6						
631	Ott 14	1600	1610	Base of spit				1	fly	6			
632	Ott 14	1610	1620	Base of sPit	1	fly	12						
633	Ott 14	1610	1620	Base of sPit	2	fly	6						
634	Ott 14	1620	1630	Base of sPit	2	fly	12						
635	Ott 14	1620	1630	Base of sPit	1	fly	6						
636	Ott 14	1630	1640	Base of sPit	6	fly	12	1	fly	12			
637	Ott 14	1630	1640	Base of spit	2	fly	6						
638	Ott 14	1640	1650	Base of spit	4	fly	6	2	fly	6			
639	Ott 15	955	1005	Base of spit				2	fly	12			
640	Ott 15	955	1005	Base of sPit				1	fly	6			
641	Ott 15	1005	1015	Base of spit									
642	Ott 15	1015	1025	Base of spit									