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Identification, Documentation and Delineation of Coastal Migratory Bird Habitat in Alaska.

Paul D. Arneson
Alaska Department of Fish and Game
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I. Summary

Coastal marine habitat is vital to millions of waterfowl, shorebirds and seabirds in Alaska. Until recently, little had been done to quantify bird usage of coastal habitats or to quantify the habitats themselves. An objective of this study was to determine seasonal distribution and abundance, critical areas, migratory routes and breeding locales for principal bird species in littoral and estuarine habitat in the Gulf of Alaska and Bristol Bay. Concurrently, coastal bird habitat was to be delineated.

Since the project's inception, 23 bird surveys and 15 mapping flights have been completed to meet these objectives. From four surveys conducted in Lower Cook Inlet, seasonal variation in species abundance was recorded. Year-to-year differences were noted for estuaries on the north side of the Alaska Peninsula from fall surveys in 1975 and 1976. Other surveys have been done during only one season or have given only partial coverage within subunits. Results of all surveys have been used to determine concentration areas of birds during the four seasons. Literature has also been searched for past records of important areas and from recent surveys and past records, "critical" areas have been selected for all subunits of the study area. These areas were selected on the basis of their importance to breeding, migrating or wintering birds. Some critical areas remain tentative until proven or refuted by future research.

Approximately 80 percent of the study area's coastal habitat has been aerially mapped. Amounts of coastal substrate have been summarized for the mapped areas. An interrelationship is suggested between bird use of habitats, frequency of occurrence of habitat types and varying susceptibility of habitats to oil pollution.

One of the most damaging effects of oil development to coastal birds will be from oil spills that damage them physically or reduce their food supply. Development of onshore terminal facilities may destroy bird habitat, and associated aircraft and ship traffic to and from onshore facilities may disturb feeding and breeding birds. Concentrations of birds at sites designated as "critical areas" in this report may be adversely affected by any one of these means. The Copper River Delta, for example, would be damaged most if oil washed up on the sand and mud flats, while colonies at the mouth of Resurrection Bay could be seriously affected by helicopter and tanker traffic near Barwell and Rugged Islands in summer. Cape Aklek and Unishagvak colonies, although not near lease areas, could be affected by having birds from the colony fouled by oil while on feeding sites. More must be learned about each concentration area before it can be decided how it could be impacted most by oil development.

II. Introduction

There are approximately 54,700 km of tidal coastline in Alaska with an associated 1,425,000 km^2 of outer continental shelf (Sowl and Bartonek 1974). This vast coastline and associated continental shelf provide abundant habitat to millions of seabirds, waterfowl, shorebirds, passerines and other birds at some stage of their life cycle. Sanger (1972) estimated that 51 million seabirds summer in subarctic Alaskan waters

and Nisbet (1975) suggested a magnitude of 100 million birds for all Alaskan waters. Most of these breed on islands or other portions of coastline. According to Sanger (1972), who conducted pelagic boat surveys in the Gulf of Alaska, about 8 million seabirds also winter in Alaska. This estimate may increase when more information is obtained on nearshore wintering populations. Over 13 million waterfowl including 1 million geese, 12 million ducks, 70,000 swans and 150,000 cranes utilize Alaskan waters for breeding, migration staging or wintering (ADF&G 1975). An undetermined number of passerines, raptors and other birds use the littoral zone during some or all seasons of the year.

Most major waterfowl, shorebird and seabird habitats are known, but in most instances bird use or habitat diversity and size are not well quantified. Many areas of lesser importance to birds have not been identified. Because the State of Alaska's jurisdiction extends out three miles from the coast, and because this is the area most crucial to all breeding and many feeding marine birds, it is extremely important to fully assess the avifauna of the littoral and nearshore zone to determine which areas are more critical than others.

In order to evaluate coastal areas to determine which areas are most critical, it is necessary to synthesize existing literature and unpublished data on the distribution, abundance, behavior and food dependencies of birds associated with littoral and estuarine habitat within the study area. Since many areas have not been surveyed either in a particular season or in a quantitative manner, it is also necessary to conduct bird surveys to determine the seasonal density distribution, migratory routes, chronology of migrations, breeding locales and critical habitats for all bird species utilizing the littoral zone within the study area. Another objective of this project is to delineate and quantify bird habitats of the supratidal zone.

Many factors threaten Alaska's seabird populations, but developments by the petroleum industry including onshore and offshore drilling, pipelines, aircraft and ship transport and various associated activities, pose the greatest potential hazard to birds (King and Lensink 1971). Oil spills in marine waters directly affect many species of pelagic feeding and molting birds including shearwaters, fulmars, kittiwakes, phalaropes, gulls, alcids, cormorants and sea ducks (Bartonek et al. 1971). The mechanical effects of oil on bird plumage are well documented (see Vermeer and Vermeer 1974). Less obvious are the long-term effects on the ecosystem. Organisms lower on the food chain than birds may be affected less dramatically, but the long-term impact on the avifauna can be great. This may be especially true when oil is washed by tides or winds onto the productive littoral zone. Food organisms-both plant and animal-may be killed, thereby destroying extensive areas of feeding habitat for many ducks, geese and shorebirds (Vermeer and Vermeer 1975).

It is therefore essential to assess all coastline habitats for species composition and abundance of birds on a seasonal basis to determine use of the areas and then set priorities as to their importance to birds. This first assessment will be an extensive reconnaissance of the study area. Specific sites found to be more important than others will be

studied intensively to determine why birds are attracted to them. More stringent restrictions on oil development could then be set for those areas determined to be most critical.

III. Current state of knowledge

A review of past information concerning bird use of coastal areas of southern Alaska was presented in last year's annual report for Research Unit #3/4 (Arneson 1976). Included were tables of data collected on prior waterfowl surveys in various parts of the study area. It was pointed out that, in general, very little baseline seasonal information on bird use of nearshore, intertidal and supratidal areas was available for most regions.

Since the writing of last year's summary, three additional non-OCSEAP related reports have been made available that concern bird use of nearshore waters within the study area. Dwyer et al. (1976) summarized data collected in winter and summer, 1972 and 1973, from Prince William Sound. They estimated over 300,000 birds inhabiting the Sound in winter. Approximately 40 birds/km^2 utilized shoreline habitats during that season while 20 birds/km^2 were found in open water habitats. The most common taxonomic groups at that season were diving and sea ducks, gulls and alcids with estimated populations of 129,000, 87,000 and 33,000, respectively. The most abundant species were glaucous-winged gulls(37,000), black-legged kittiwakes (34,000), goldeneyes (26,000), surf scoters (25,000), white-winged scoters (23,000) and marbled murrelets (22,000).

In summer, 70 and 30 birds/km^2 were found along shoreline and open water habitats, respectively. Dwyer et al. (1976) estimated a summer population of over 500,000 birds in the Sound. Sea ducks (52,000), gulls (220,000) and alcids (137,000) were again the most abundant groups, but the species composition and relative abundance did change. Black-legged kittiwakes were the most common summer resident (141,000) followed by marbled murrelets (140,000) glaucous-winged gulls (50,000), surf scoters (28,000) and mew gulls (20,000).

A survey of bird colonies on the south side of the Kenai Peninsula from Point Adam to Cape Resurrection was conducted by the National Park Service and U.S. Fish and Wildlife Service (USFWS) (Bailey 1976a). The Chiswell Islands were the most important colony both in abundance and species diversity. Eighteen species were observed around the islands, and 42 percent of the total birds including 59 percent of the breeding pairs recorded on the survey were found there. The next most significant areas were the Pye Islands and islands at the mouth of Resurrection Bay. Tufted puffins accounted for over half the breeding pairs on the survey, followed in descending order of abundance by black-legged kittiwakes, common murres, horned puffins and glaucous-winged gulls. A third report on the distribution, abundance, migration and breeding locations of marine birds in Lower Cook Inlet by David Erikson is presently being prepared. The project was funded by Alaska Department of Fish and Game (ADF&G), Marine and Coastal Habitat Management Section and coordinated with this project so comparable data were collected. Findings will be presented in the "Results and Discussion and Conclusion" sections of this report.

IV. Study Area

During FY 76 the study area for bird studies conducted by ADF&G, Anchorage included all coastline habitat from Cape Fairweather south of Yakutat to Cape Newenham in Bristol Bay. The area was divided into eight subunits: 1 - Northeast Gulf of Alaska, 2 - Prince William Sound, 3 - South Kenai Peninsula, 4 - Lower Cook Inlet, 5 - Kodiak Archipelago, 6 - South Alaska Peninsula, 7 - North Alaska Peninsula, 8 - North Bristol Bay (Figure 1).

A ninth subunit, Aleutian Shelf from Unimak Pass to Samalga Pass, was added in FY 77, and research this fiscal year will largely be confined to subunits 7, 8 and 9.

V. Methods

Aerial bird survey techniques remained the same as outlined in previous reports. Both twin-engine amphibious and single-engine aircraft were used depending on location of the survey and therefore on safety standards desired. Airspeed varied from 95 to 225 km/hour and altitude from 30 to 45 meters. Techniques varied with the type of habitat being surveyed, and normally two bird observers were used. While surveying straight beaches, the aircraft flew 100-200 meters seaward of the waterline. The shoreside observer enumerated all birds visible to the high water level, and the oceanside observer recorded all birds within 200 meters of the aircraft. Concentrations of birds outside this zone were also noted. In estuarine and coastal floodplain habitat a total count of birds was attempted. This entailed flying back and forth over the estuarine or supratidal zone at close enough intervals to get "total" coverage.

While flying over open water between islands or while purposely flying pelagic, nearshore transects, both observers recorded all birds within 100 or 200 meters of the aircraft. Poor observation conditions or faster flying aircraft caused the zone to be reduced to 100 meters.

A third technique was the experimental, random-stratified census of Kodiak Island. Preselected count units were surveyed in their entirety on eight habitat types.

When only one bird observer was present, either a fixed distance (100 or 200 meters) technique was used or the observer counted all birds within the zone from the aircraft to high tide line.

A requirement of the station designation scheme for this project was that units be easily identifiable at low altitudes while counting birds. Therefore, recognizable geographic features were used as starting and ending points and stations were of variable size. In most instances they did not exceed 16 kilometers in length.

All observations were recorded on cassette-type tape recorders. Information recorded included the following: bird identification to lowest taxon possible (order, family, genus, species), bird numbers, habitat type in which the bird was found and any other information possible including activity, sex, color phase and counting method. Weather observations

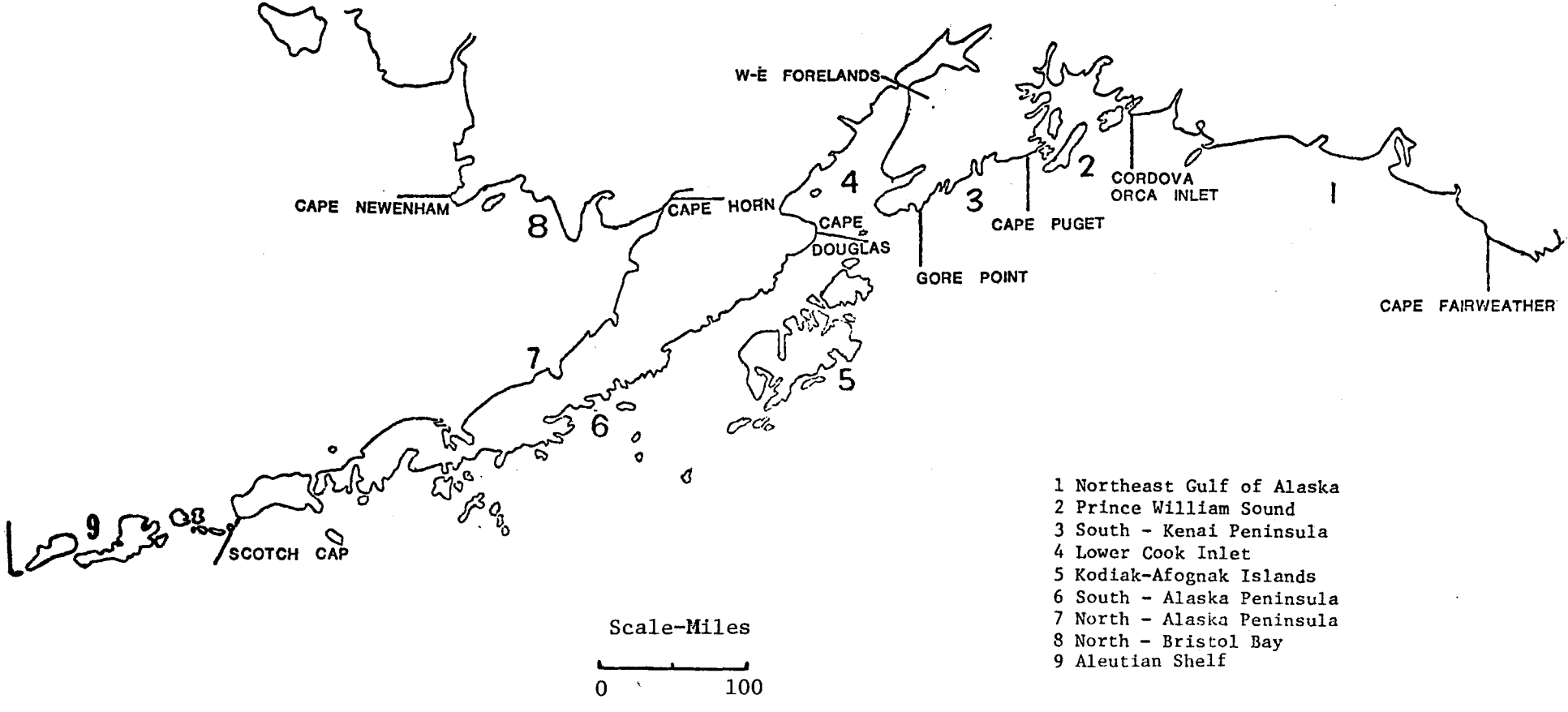

Figure 1. Study area with nine subunits for OCSEAP coastal marine bird project, Alaska Department of Fish and Game, Anchorage.

were recorded at the start of each flight and a coded survey conditions number was noted as often as conditions changed. Time was recorded at the start and end of each station.

Habitat mapping was conducted during snow-free months from both single- and twin-engine aircraft while flying at an altitude of 90-120 meters along the coastline. Information was color-coded onto USGS 1:63,360 or 1:250,000 maps using the scheme shown in Table 1.

Procurement and review of pertinent literature continued throughout the report period as historical information was located and recent literature published. Future reports will incorporate new information as it becomes available.

The order in which areas were selected for surveying was based largely upon presumed importance of the area to bird populations, vulnerability of the area to oil development and the proposed OCS planning schedule for oil lease sale areas. The amount of existing knowledge about certain areas and the extent of current research being conducted by other organizations or individuals also influenced which areas needed most research emphasis. For example, bird populations in Prince William Sound have been studied for the past several years by USFWS personnel because of the location of the terminus of the Alaska Pipeline at Valdez and future tanker traffic within the Sound. Therefore, I did not attempt to survey birds within that subunit.

VI. Results

Bird Surveys:

Since the project began in September 1975, a total of 23 bird surveys have been conducted. Of these, nine were classified "major" because they covered most of the subunit. Fourteen surveys were flown over only a small portion of the subunit, and were therefore termed partial. A summary of when and in what subunit the surveys were flown is shown in Table 2. Tracklines of where within each subunit surveys were flown are presented in Appendix A, Figures 1-15. Summaries of the number of species observed, total birds counted and number of stations surveyed for major and partial surveys are shown in Tables 3 and 4. A summary of five major surveys in four subunits by species group totals is listed in Table 5. Table 6 lists species group totals for four seasonal surveys in Lower Cook Inlet.

Data from 18 surveys are on computer tape, and information from the remaining five partial surveys is being transcribed. Unexpected delays in cleaning the tape of all errors has resulted in the lack of further computer analyses other than those presented. Information on habitat preference by birds was received too late for analysis. A compilation of the data is given in Appendices C, D and E. Analysis of bird densities along the coast will be available shortly.

Table 1. Color-coded habitat mapping system for coastal zone from Cape Fairweather to Cape Newenham.

Substrate: Color Code

Dk. Blue	Mud
Yellow	Sand
Red	Gravel
Black	Rock
Dk. Blue & Yellow	Mud and Sand
Red & Yellow	Gravel with Sand
Black & Red	Rock with Gravel (Rubble)
Green	Vegetation - Mixed grasses, sedges, forbs
Purple	Vegetation - Beach Rye
Orange	Vegetation - Eelgrass
Pink	Algae - Kelp
Brown	Stormtide line
Lt. Blue	Changed water course

Many more combinations exist

Slope of Bank

1 Flat 0-20°
2 Slight 20-40°
3 Moderate 40-60°
4 Steep 60-80°
5 Vertical 80-100°

Height of Bank

A	0-3 m	0-10 ft.
B	3-6 m	10-20 ft.
C	6-12 m	20-40 ft.
D	12-30 m	40-100 ft.
E	30+ m	100+ ft.

Table 2. Number of bird surveys by season and mapping flights completed from September, 1975 to March, 1977 by RU #3

Subunit	Number of Bird Surveys				No. of Mapping Flights	
	Winter	Spring	Summer	Fall	Major	Partial
1. Northeast Gulf of Ak.		1M	1P		1	1
2. Prince William Sound						2
3. Kenai Peninsula-South					2	
4. Lower Cook Inlet	1M,1P	1M,2P	1M,1P	1M,1P	1	1
5. Kodiak-Afognak Is.	1M*					1
6. Alaska Peninsula-South	2P			1P		2
7. Alaska Peninsula-North	2P		2P	2M	2	
8. Bristol Bay-North		1M			1	
9. Aleutian Shelf	1P					1
Total by classification	2M,6P	3M,2P	1M,4P	3M,2P	7	8
Overall Total		9M,14P			15	

M: Major P: Partial

*Random-stratified survey

Table 3. Number of species and individuals observed on aerial bird surveys (major) of five coastal regions of southern Alaska.

ID No.	Survey/Season/Date	No. of Species	No. of Additional Species Groups	Total No. of Species Identified (mimimum)	Total Birds Counted	No. of Stations Surveyed
7601	Alaska Peninsula-North Fall, Oct. 13-27, 1975	34	14	48	638,479*	201
7602	Lower Cook Inlet Winter, Feb. 9-18, 1976	20	11	31	23,138	141
7603	Kodiak, Winter Feb. 22 to Mar. 21, 1976	32	7	39	33,025	76
7604	Northeast Gulf of Alaska Spring, May 1-9, 1976	59	8	67	130,511	154
7605	Lower Cook Inlet Spring, May 3-7, 1976	41	7	48	115,292	164
7606	Bristol Bay-North Spring, May 17-20, 1976	56	7	63	45,865	110
7607	Lower Cook Inlet Summer, June 21-25, 1976	40	7	47	97,772	182
7701	Lower Cook Inlet Fall, Sept. 30-Oct. 2, 1976	38	7	45	55,682	178
7702	Alaska Peninsula-North Fall, Oct. 13-16, 1976	33	8	41	415,701	38

*Numbers of black brant included in total are likely in error. Total may be much less than 638,479.

Table 4. Number of species and individuals observed on aerial bird surveys (partial) of four coastal regions of southern Alaska.

ID No.	Survey/Season/Date	No. of Species Identified	No. of Species Group Identified	Minimum No. of Species Identified	Total Birds Counted	No. of Stations Surveyed
7601	Alaska Peninsula-South Fall, Oct. 13-27, 1975	25	7	32	36,459	14
7611	Lower Cook Inlet Winter, Mar. 5-6, 1976	7	5	12	611	5
7612	Lower Cook Inlet Winter, April 1, 1976	12	3	15	5,485	26
7613	Lower Cook Inlet Spring, May 10, 1976	13	13	26	993	8
7610	Alaska Peninsula-North Summer, June 16, 1976	2	7	9	1,282	7
7614	Lower Cook Inlet Summer, June 24, 1976	10	6	16	1,302	8
7608	Northeast Gulf of Alaska Summer, July 24, 1976	14	4	18	22,647	26
7609	Alaska Peninsula-North Summer, July 30-31, 1976	11	7	18	72,604	39
7615	Lower Cook Inlet Fall, Sept. 30, 1976	10	7	17	1,378	8

Table 5. Species composition and abundance of birds on littoral areas and nearshore water during major aerial surveys of four Alaskan regions.

	Survey Area and Dates				
Species Group	Northeast Gulf Spring May 1-9, 1976	Kodiak* Winter Feb.-Mar., 1976	Ak. Peninsula-North Fall Oct. 13-27, 1975	Ak. Peninsula-North Fall Oct.13-16, 1976	Bristol Bay-North Spring May 17-20, 1976
Loons	529	1	72	66	409
Grebes	20	5	10	27	88
Tubenoses	0	0	82	0	0
Cormorants	485	963	1,255	38	1,628
Swans	13	0	43	171	64
Geese	1,729	131	420,026**	203,702	5,495
Dabblers	5,740	3,208	23,039	31,457	876
Divers	6,362	4,465	963	607	7,320
Sea Ducks	6,938	16,975	140,364	56,125	5,914
Mergansers	1,007	207	22	87	718
Eagles, Hawks, Falcons	185	163	30	29	11
Cranes	79	0	0	0	92
Small Shorebirds	18,828	779	21,682	45,294	1,627
Medium Shorebirds	13,062	177	211	20,580	2,098
Large Shorebirds	3,283	262	94	615	50
Mixed Shorebirds	23,556	125	3,823	3,558	791
Jaegers	114	0	0	2	20
Gulls	38,978	1,814	25,372	19,706	9,005
Terns	6,420	0	1	0	1,010
Alcids	3,687	2,936	239	7	8,533
Corvids	25	590	35	28	32
Fringillids	1	0	822	146	0

* random-stratified survey, only 29% of stations were sampled.
** Numbers of black brant at Izembek Lagoon included but may be overestimated.

Table 6. Species composition and abundance of birds on littoral areas and nearshore waters during four seasonal surveys of Lower Cook Inlet.

	Season and Date of Survey			
Species Group	Winter Feb.9-11 & 18, 1976	Spring May 3,4 & 7, 1976	Summer June 21-25,1976	Fall Sept.30-Oct.2,1976
Loons	64	81	102	76
Grebes	3	48	5	76
Tubenoses	0	0	1,006	3
Cormorants	458	1,198	1,765	2,799
Swans	0	29	44	0
Geese	0	6,808	52	2,659
Dabblers	1,502	7,196	2,291	13,109
Divers	3,073	13,249	1,056	1,103
Sea Ducks	10,178	19,229	29,463	10,618
Mergansers	253	717	184	291
Eagles, Hawks, Falcons	52	38	44	40
Cranes	0	215	13	0
Small Shorebirds	464	21,380	219	166
Medium Shorebirds	3,571	1,212	264	1,453
Large Shorebirds	1	61	33	1
Mixed Shorebirds	598	0	1	0
Jaegers	0	0	1	0
Gulls	1,432	42,197	55,288	22,373
Terns	0	15	366	0
Alcids	279	525	5,321	38
Corvids	779	117	52	706
Fringillids	0	0	4	3

Habitat Mapping:

In Appendix B, Figures 1-8 show portions of the coastline mapped thus far for this project. Amounts and percent composition of the various substrates of coastline that have been mapped are listed by subunit on Tables 7 and 8. Quantities of habitat on intertidal and supratidal areas for two subunits are shown on Table 9. Atlases of USGS 1:63,360 and 1:250,000 maps containing all habitat information collected to date from aerial reconnaissance have been completed and are available for perusal at ADF&G, Anchorage office. It has not yet been decided how the information will be reproduced. As additional information is collected in areas not previously mapped, it will be added to the atlases.

Table 9. Summaries of substrate and cover types on intertidal and supratidal areas in two subunits of the study area.

Substrate and Cover Types
(Area in Kilometers^2)

Subunit	Mud Flats	Sand Flats	Mud and Sand Flats	Mixed Forbs and Grasses	Beach Rye	Eelgrass*
Lower Cook Inlet	184	80	113	197	12	2
North-Bristol Bay	217	72	73	461	14	-

* Eelgrass was difficult to detect from the air. Much more is probably present.

Critical Areas:

Past and current information on bird distribution and abundance was analyzed to establish critical areas shown in Appendix A, Figures 1-15.

VII. and VIII. Discussion and Conclusions

Bird Surveys:

Until more specific computer analyses can be completed, only general statements can be made about results of coastal bird surveys conducted so far for this project. Species diversity was greatest for Northeast Gulf of Alaska and North Bristol Bay spring surveys. This may reflect the fact that birds were in bright spring plumage and in large concentrations which made them more easily identifiable. Birds that would otherwise be lumped into species group could be listed to species. This may have accounted in part for the high diversity. Another possible explanation was that a greater variety of preferred habitats in these subunits resulted in an actual increase in species diversity. Many species were also observed on a spring flight in Lower Cook Inlet and a fall flight along the North Alaska Peninsula. As expected fewest species were identified in winter surveys. Summer diversity was relatively low because many species using coastal habitat for spring migration travelled inland for breeding.

Table 7. Quantity of various substrate types along the coastline in the eight subunits of the study area, Cape Fairweather to Cape Newenham and percentage of coastline mapped in each subunit.

	Substrate composition of mapped shoreline (kilometers)										
Subunit	Mud	Mud & Sand	Sand	Gravel	Rock	Sand & Rock	Gravel & Rock	Sand & Gravel	Sand Gravel & Rock	Total Distance Mapped	Percent of Subunit Mapped
Northeast Gulf of Alaska	13*	--*	518	148	235	10	149	41	--	1114	98
Prince William Sound	29	--	83	387	591	3	194	16	--	1303	37
South-Kenai Peninsula	--	--	31	180	731	47	41	1	--	1031	89
Lower Cook Inlet	91	41	72	396	487	23	196	110	18	1434	95
Kodiak	5	--	79	491	859	21	296	62	3	1816	55
South-Alaska Peninsula	--	--	243	248	59	8	154	67	7	786	39
North-Alaska Peninsula	444	8	706	183	26	--	79	314	16	1776	99
North-Bristol Bay	283	11	404	14	86	27	68	40	4	937	99
Aleutain Shelf	--	--	74	292	679	77	242	19	--	1383	82

* Copper River Delta/Controller Bay not completely mapped. Values will be greater.

Table 8. Summary of substrate composition along mapped shoreline in eight subunits of the study area, Cape Fairweather to Cape Newenham.

	Substrate composition of mapped shoreline (percent)									
Subunit	Mud	Mud & Sand	Sand	Gravel	Rock	Sand & Rock	Gravel & Rock	Sand & Gravel	Sand Gravel & Rock	Percent of Subunit Mapped
Northeast Gulf of Alaska	1	--	46	13	21	1	13	4	--	98
Prince William Sound	2	--	6	30	45	Tr	15	1	--	37
South-Kenai Peninsula	--	--	3	17	71	5	4	Tr	--	89
Lower Cook Inlet	6	3	5	28	34	2	14	8	1	95
Kodiak	Tr	--	4	27	47	1	16	3	Tr	55
South-Alaska Peninsula	--	--	31	32	8	1	20	9	1	39
North-Alaska Peninsula	25	Tr	40	10	1	--	4	18	1	99
North-Bristol Bay	30	1	43	1	9	3	7	4	Tr	99
Aleutian Shelf	--	--	5	21	49	6	17	1	--	82

Surveys of Alaska Peninsula North in fall 1975 and 1976 had the highest totals of birds with an average of half a million birds counted. Flight routes were repeated intentionally to get year-to-year differences in species diversity and abundance. Several differences were evident although only the large estuaries were surveyed in October 1976. Shorebirds were three times more abundant in 1976 and were found in large numbers in most of the estuaries. Conversely, sea ducks were three times more abundant in 1975. This may have been due in part to their inhabiting outer coastal waters which were surveyed in 1975 but not 1976. Also, weather conditions may not have moved them south into the survey area by October 1976.

Snow and Canada geese were less abundant in the Ugashik-Cinder River/Hook Lagoon area in 1975 than in 1976. During the second year's survey Canadas were less abundant in Izembek Lagoon than they were the year before. In 1976, emperor geese appeared to be more abundant in Nelson Lagoon and farther north than at Izembek; in 1975, however, the emperors had moved farther down the Peninsula by mid-October. Black scoters continued to be the most abundant scoter and Steller's the most abundant eider. Dabbling ducks of all species were as abundant in 1976 as in 1975.

Differences of species composition among the various estuarine complexes were also apparent from these bird surveys. These differences were probably due to habitat preference based on an interplay of substrate cover and food source. Correlations between amounts of various habitats available and bird species composition on the estuaries, can be derived from analysis of aerial surveys. However, this information has not yet been compiled and analyzed for this project. Subtle differences, such as food availability within habitat types, could only be recognized by sampling and ground truth studies. This research needs to be conducted at specific sites.

Emperor geese and sea ducks were more commonly found at Nelson Lagoon, Seal Islands and Port Heiden. More Canada geese and dabblers were found in Ugashik-Cinder River/Hook Lagoon estuaries. Shorebirds were found in all areas, but most were in Nelson Lagoon and Cinder River/Hook Lagoon. Izembek-Moffet Lagoon contained the greatest diversity and abundance of bird species. Some species or subspecies of birds migrate across Bristol Bay and the Bering Sea, using Izembek as their only staging area before migration across the Gulf of Alaska to wintering areas.

An opportunity to observe seasonal changes of bird abundance and diversity was made available in Lower Cook Inlet through cooperation with the ADF&G, Marine and Coastal Habitat Management Section. Coastal bird surveys were conducted in all four seasons and migration patterns became evident. Results of the study are presently being summarized by David Erikson. A noteworthy finding was the change in scoter population size from winter to summer. Relatively large numbers wintered in the region, but the population increased as spring migrants arrived. The population peaked in summer when large rafts were found in several locations. The most abundant scoter in nearshore waters in all seasons was the surf scoter. Concentration areas for scoters were in Kachemak Bay, Iniskin-Iliamna-Oil Bays, and Akumwarvik Bay. An offshore wintering concentration

of white-winged scoters was observed approximately five kilometers southwest of Bluff Point in Outer Kachemak Bay.

Bird-use patterns of areas in Lower Cook Inlet this year were similar to patterns reported in the past. Snow geese staged on flats of the Kenai and Kasilof Rivers in spring but bypassed the area in fall. Large numbers of scaup utilized nearshore waters in spring and goldeneyes, buffleheads and oldsquaws wintered in the region but departed for breeding grounds in summer. Shorebirds were most abundant during spring migration, but the largest concentration was observed several days after the spring survey. Warren Ballard, ADF&G Homer, estimated 1-2 million small shorebirds on Fox River Flats on May 11, 1976. Gulls were common in all seasons but most abundant in spring and summer with the arrival of breeding birds. Also, alcids were most plentiful at breeding sites in summer. Corvids frequently used coastal areas for foraging in winter but moved inland for nesting in summer.

The most abundant species groups using Lower Cook Inlet in winter were diving and sea ducks which comprised 57.3 percent of the total birds seen along the shoreline and in nearshore waters. A distant second in abundance were shorebirds (20 percent) followed by dabbling ducks and gulls with 6.5 and 6.2 percent, respectively. With the arrival of kittiwakes, gulls became the most prevalent bird in spring, comprising 36.3 percent of the total, followed by diving and sea ducks (28.2 percent) and shorebirds (19.6 percent). Gulls and diving/sea ducks remained the commonest species groups in summer with 56.5 and 31.2 percent of the total. A distant third were alcids with 5.4 percent. Most abundant in fall again were gulls (40.2 percent) followed by dabbling ducks (23.5 percent) and diving/sea ducks (21.0 percent).

Erikson (in prep.) also summarized the results of pelagic aerial surveys within Lower Cook Inlet. In winter, greatest densities of birds were found in Outer Kachemak Bay. An area centered 20 kilometers west of Point Bede contained the densest concentrations of birds in spring when alcids began migrating into the area. Summer concentrations were found both in Outer Kachemak Bay and a similar area off Point Bede but somewhat nearer shore. Shearwaters and fulmars comprised approximately 60 percent of the birds observed in the latter area. Densities in fall were again greatest in Outer Kachemak and the region off Point Bede mentioned for spring. Apparently incoming Gulf of Alaska water and outgoing Cook Inlet water causes food organisms to be concentrated in these areas where birds were most commonly seen.

Data from the other three major surveys have not been fully analyzed, but general areas of importance are explained later in this section. The spring survey of NEGOA (May 1-9, 1976) coincided with peak shorebird migration. It was after peak waterfowl movement but caught the beginning of the arctic tern migration. The total number of birds observed on the NEGOA flight was the third largest of all major surveys. As expected, the largest concentrations were observed on the Copper River Delta.

An attempt was made to catch the continuing spring migration by surveying North Bristol Bay the following week (May 17-20). Many waterfowl were still awaiting spring breakup by foraging in coastal waters of Bristol

Bay before moving farther north or inland. Many gulls were on breeding territories and alcids were at colony sites. The great species diversity for this area may be a result of the varied habitats from mud flats at the Kvichak River to rock cliffs at Cape Newenham. Surprisingly few shorebirds were observed, but it is not known at present whether this was a result of birds migrating overland or over water to breeding areas whether little habitat suitable for staging was available or whether we missed the peak of their migration.

Fewer species and lower numbers of birds were recorded during the winter survey of Kodiak because only a portion of the islands was surveyed in the stratified-random survey design. It is hoped that population totals, possibly by species, for eight designated habitat types will be compiled shortly for the entire archipelago. Wintering populations of diving and sea ducks were found throughout the islands but murres were more prevalent in Ugak and Kiliuda Bays. Mallards and other dabblers were common at stream mouths at heads of bays. Densities of most bird species appeared to be much lower on the forested Afognak-Shuyak portion of the archipelago.

Of the partial or minor surveys, the most noteworthy is the summer pelagic transects north of Unimak Island and Izembek National Wildlife Range. Large rafts of shearwaters were foraging several kilometers offshore, and 68,773 were estimated on 140 km^2 of transects. They comprised 95 percent of all birds observed on the survey. Next most abundant were murres with 2.6 percent of the total.

Pelagic surveys of Outer Kachemak and Kamishak Bays on 1 April 1976 revealed species composition differences between the two areas. Many more eiders were found in Kamishak than in Kachemak, but the reverse was true for scoters. Gulls were more common in Kamishak whereas alcids occurred more frequently in Outer Kachemak. Densities were three times greater in Outer Kachemak (60.9 vs 21.4 birds/km^2).

The value of the other partial surveys will be brought out when species abundance and diversity can be compared at specific stations or small geographic areas by season. As aircraft of opportunity become available along coastal and nearshore areas to bird observers, we will continue to take advantage of them in order to get as much bird distribution and abundance information as possible.

Several notable problems and biases arose when conducting aerial shoreline surveys that should be considered when analyzing the data. Most total figures in species lists from surveys probably represented minimum values or underestimates. There were differences between species as to how accurately birds were identified or their numbers were estimated. For example, counts of grebes should probably be higher in all cases. They appeared more frequently in ground and boat surveys, and it was assumed they dove at the approach of aircraft and remained under until the plane had passed. Also, in winter from a distance of 200 meters at 45 meters altitude, grebes resembled small alcids. Other species including cormorants, oldsquaws and common eiders dove in response to aircraft, making identification difficult.

Certain birds flush at the approach of aircraft and would be out of the transect zone when the observer arrived. Black brant were perhaps the

most difficult to count because they flushed early and were often in tight, three dimensional masses. An over estimation of up to 100,000 brant was suspected for the October 1975 survey in Izembek. Many birds moved to other parts of the lagoon and may have been recounted. Birds such as rock sandpipers and sparrows would be easier to see and estimate if they were to fly, but they often remain on the ground and are not counted.

Size difference in shorebirds from small to medium and medium to large is not always easily discernible, and misinterpretations can result from improperly identifying flocks. Identification of the three scoter species may not always be possible, and extrapolating proportions of those identified to those unidentified may not always be valid.

For safety reasons, large colonies were often avoided, and numbers were too great to enumerate from the air. Therefore, some of the largest concentrations of birds were not recorded in shoreline surveys.

By pointing out the problems, I am not attempting to discredit shoreline bird surveys. On the contrary, I feel they are very useful. My intention is to suggest that total numbers recorded most likely represent underestimates and positive identification of certain species is not always possible. Unusual sightings and new distributional records should be admitted only if they were accurately verified. In many cases, analysis should be based on species groups rather than species.

There was insufficient time to analyze and discuss apparent habitat preferences of birds as depicted by compilations of bird observations on various water types, physiographic features and substrate types. Figures 1-9, Appendices C, D and E, quantify the relative use of these various habitat types according to aerial surveys conducted for this project.

Habitat Mapping:

Approximately 80 percent of the study area has been mapped. Mapping primarily included substrate at the high tide line and quantity of habitat types from high tide to storm tide levels. Aerial reconnaissance of this nature gave only basic information as to habitat types available to coastal marine birds. As yet no systematic ground truthing has been accomplished to supplement aerial mapping.

Vegetation of the supratidal region provided nesting cover and forage plants for several species of birds. Grasses, sedges and a variety of halophytic forbs formed the predominant cover on the coastal floodplain near rivers and in estuaries. A fringe of beach rye (*Elymus* spp.) was found on most sandspits and on long straight sandy beaches. In the latter case, the narrow fringe of beach rye could be measured only in terms of distance and not area. For example, the north side of the Alaska Peninsula has a 315-km wide fringe of beach rye. Many eelgrass beds were probably overlooked when mapping at high tide. Information on distribution of eelgrass and algae (kelp) will best be described by Zimmerman and Merrell (1976) and other RU #78/79 reports.

Diversity of substrate types is a likely index to bird species diversity. Homogenous coastlines will have fewer birds per unit distance. Almost half (46 percent) of the NEGOA coastline was sand and when correlations are made between habitat type and bird species present, they will probably show a preponderance of species like gulls and terns. These birds frequent sandy beaches more than other species. Prince William Sound has only been partially mapped but ratios of substrate type will probably be similar for the rest of the subunit. In the Sound 45 percent of the coast mapped so far was rock and 30 percent gravel. Seventy-one percent of the south side of the Kenai Peninsula was rock and that percentage may rise when mapping is completed. In Subunit 4, Lower Cook Inlet, composition of the shoreline was more varied as were substrates of the north sides of the Alaska Peninsula and Bristol Bay. Kodiak and the Aleutian Shelf contained mostly rock and gravel. Much sand and gravel was mapped on the south side of the Alaska Peninsula, but only 39 percent has been delineated. Values may change when mapping is completed.

Hayes et al. (in prep.) has devised a rating scheme for the susceptibility of various coastal habitats to oil impact. His information was based upon studies of oil spills in the Straits of Magellan and Spain and a literature review. His classification of susceptibility relates to longevity of oil in the environment which may have a direct bearing on its effect to food organisms of birds and to fouling of feathers. Coastal environments listed below are in decreasing order of their susceptibility to oil as designated by Hayes et al. (in prep.):

1. Protected estuarine salt marshes
2. Protected estuarine tidal flats
3. Sheltered rocky headlands
4. Gravel beaches
5. Mixed sand and gravel beaches
6. Impermeable muddy tidal flats (exposed to winds and currents)
7. Steeper, medium to course grained sand beaches
8. Flat, fine-grained sandy beaches
9. Eroding wave-cut platforms
10. Straight, rocky headlands

In his assessment of Lower Cook Inlet, Hayes et al. (in prep.) estimated that 41.5 percent of the coastline fell into the four most susceptible habitats, 13.4 percent into the three intermediate values and 45 percent into the four environments least susceptible to oil.

This rating scheme could be applied to all coastline within the study area when combined with the habitat delineation of RU #78/79 and this project (RU #3). With bird distribution and abundance known for these habitat types, a relative index could be derived for vulnerability of coastal marine birds to oil spills. The biological significance of oil spills in these various environments must be studied to determine the long-term effects on animal populations.

Critical Areas:

As a result of past and current bird surveys and literature searches, certain coastal areas were determined to be of primary or secondary importance to marine birds. In certain instances the judgment of importance may be only tentative until more observations can be made to verify the significance. One survey, in one area during one season, is insufficient to classify an area "critical" although many birds observed at that one time. Because there are many differences in species abundance within a given area according to year, season, time of day, weather and stage of tide, the regions must be looked at several times to "prioritize" the critical areas.

Problems arose in determining relative importance of the areas because a colony, for example, may be quite important to the ecosystem within a subunit but when compared to colonies in other subunits, it looks quite insignificant. In general, primary colonies are those containing over 100,000 birds and secondary colonies those over 10,000 but less than 100,000. Classification of migration and staging areas depended on their known or suspected values to birds within a subunit. The relative significance of the critical areas should be apparent from the text.

Subunit 1 - NEGOA:

[See Appendix A, Figure 1.]
The importance of the Copper River Delta to migrating and breeding birds is well known. It is a staging area for millions of shorebirds and hundreds of thousands of waterfowl plus a nesting area for almost 50,000 waterfowl and thousands of gulls. The world's population of dusky Canada geese (*Branta canadensis occidentalis*) nests in this region. Ducks and geese use mostly the vegetated areas nearest the saltwater edge, gulls nest on the sandy, barrier islands and shorebirds feed on the extensive mud flats. The 1964 earthquake uplifted mud flats approximately two meters, and resulting successional changes in vegetation have provided waterfowl - particularly dusky Canada goose goslings - with a heavily utilized food source. The area is flooded only on the highest tides. Both floodplains and intertidal areas on each side of the Copper River are important to migrating and summering birds.

Controller Bay is similar to Copper River Delta in habitat types and therefore attracts many migrating shorebirds and waterfowl. Orca Inlet provides extensive mud flats at low tide and is used largely by foraging shorebirds.

Several other areas are suspected of having moderate usage by migrating birds. Riou Bay on the southeast side of Icy Bay contained many sea ducks and various other birds in spring 1976. A colony of Aleutian and Arctic terns was found at the end of Riou Spit. The significance of this area to birds may be comparable to that of other areas east of Kayak Island but cannot compare to the Copper River Delta in total bird usage.

Similar situations are found on other portions of the coast from Cape Suckling to Fairweather-particularly in Yakutat Bay, Blacksand Island, and Dry Bay. At these locations bird concentrations are found during at least some migration periods, but in comparison to large staging areas they may appear insignificant. Summer and winter usage of this region is undocumented. Yakutat Bay and possibly Russell Fiord may contain concentrations of summering and wintering birds as well. Blacksand Island, near the confluence of the Situk-Ahrnklin Rivers and Seal Creek, were identified by Mickleson (1975) as an important migration area. Bird usage of Dry Bay may vary from year-to-year and the earthquake's uplift may have decreased its utility.

Middleton Island contains a large colony of black-legged kittiwakes, tufted puffins, common murres, pelagic cormorants and glaucous-winged gulls. Nearshore waters of the island provide resting and foraging areas.

Subunit 2 - Prince William Sound:

[See Appendix A, Figure 2.]
Prince William Sound is unique in its value to birds. The rocky, forested islands and fiords do not support large bird rookeries or staging areas. The two largest colonies are found on Wooded Islands and Boswell Rocks where the predominant species are tufted puffins and black-legged kittiwakes, respectively. The solitary nesting, marbled murrelet, is one of the most abundant species in the Sound, and likely nesting sites are in trees and in screes above timberline. No one area can be singled out as a concentration area for the murrelets. They normally are only in small groups or pairs and are well dispersed throughout the Sound. A concentration of 10,000 Kittlitz's murrelets, which probably nest on glacial moraines and talus slopes, was observed in Unakwik Inlet in July 1972 (Isleib and Kessel 1973). It is not known if concentrations of this magnitude occur often in the Sound and whether they reoccur in the same location.

Scoters as a species group are vulnerable to oil but do not occur in large concentrations in the Sound. Nevertheless small concentrations are found in many parts of the subunit in both summer and winter. Many white-winged scoters migrate inland during summer, but many non-breeding surf scoters are present in summer. Because several species have ubiquitous distribution within Prince William Sound and occur in large numbers, the entire inner portion of the Sound is somewhat critical. Quantities of spilled oil from tankers, fires or pipeline accidents could easily coat a large portion of the Sound. Because much of the habitat could be classified "sheltered rocky headlands" - third on the oil susceptibility scale - the oil could be devastating to large numbers of birds.

Subunit 3 - South Kenai Peninsula:

[See Appendix A, Figure 3.]
Bailey (1976a) completed an intensive survey of breeding sites within much of this subunit during summer 1976. A primary colony was documented on the Chiswell Islands and secondary colonies on the Pye Islands and at the mouth of Resurrection Bay. On the Chiswells, species in greatest

abundance were tufted puffins, black-legged kittiwakes and common murres. New colony records were discovered for rhinocerous auklets and fork-tailed storm-petrels. Tufted puffins, horned puffins, black-legged kittiwakes and glaucous-winged gulls were most common on the Pye Islands. A Kittlitz's murrelet egg was found on a grass-covered ledge of Outer Island. In Resurrection Bay, black-legged kittiwakes and common murres were the most numerous species, and the areas with the most birds in descending order of magnitude were Barwell Island, Cape Resurrection, Hive Island and Rugged Island. No other "critical" areas are documented for this subunit. Winter bird use of the area has not been evaluated.

The Chiswell Island-Cape Resurrection colonies would appear to be very near aircraft and tanker corridors if an oil/gas staging area were constructed in Seward for lease areas in the Gulf. Care should be taken to protect these colonies during critical breeding periods.

Subunit 4 - Lower Cook Inlet:

[See Appendix A, Figure 4.]
Largest concentrations of birds in Lower Cook Inlet are found in summer at colonies on the seven Barren Islands. Bailey (1976b) estimated a total of 205,000 tufted puffins, 91,000 common murres, 33,800 black-legged kittiwakes, 15,700 horned puffins and 5,200 glaucous-winged gulls on the islands. Parakeet auklets were found on five islands and a rhinocerous auklet colony was found on Sud Island. The critical area around the Barrens extends well away from shore due to feeding and resting birds. Foraging distances must be studied in greater detail to determine a safe "buffer zone" for the birds.

A secondary colony is located on the south and east end of Chisik Island and on adjacent Duck Island. Black-legged kittiwakes, common murres and horned and tufted puffins from this colony apparently forage to the south in Lower Cook Inlet. Snarski (1971) estimated a total of 78,525 birds on this colony over half of which were black-legged kittiwakes.

During migration there are several areas within Lower Cook Inlet important to staging birds. Fox River Flats at the head of Kachemak Bay is a known migration staging area for waterfowl and shorebirds. Because of the sighting of an estimated 1-2 million small shorebirds in this area in spring 1976, the value of these flats may be even greater. However, this heavy usage may not be a regularly occurring phenomenon and needs to be looked into further.

Moderate usage is made of the flats at the mouths of the Kenai and Kasilof Rivers in spring. Primary species using these areas for feeding and resting during spring migration are snow and Canada geese, cranes and dabbling ducks. In fall the area across the inlet at Bachatna Flats is used for staging waterfowl. Several other migration concentration areas were pointed out by Erikson (in prep.), but future studies would be necessary to determine if this usage is an annual occurrence.

In summer, large rafts of non-breeding scoters were noted in the Iliamna-Iniskin-Oil Bay region, in Akumwarvik Bay at the head of Kamishak Bay and also on the north side of inner Kachemak Bay. Flocks of several

thousand common eiders were observed near Augustine Island in Kamishak Bay in spring, but large numbers were also observed in summer.

Concentrations of wintering birds were found in both inner and outer portions of Kachemak Bay. Perhaps the most significant were concentrations of scoters (mostly white-winged) that have been observed during at least three winters in outer Kachemak. A flock estimated at 10,000 was reported in 1968 near Dangerous Cape, we observed a flock of 10,000 white-winged scoters south of Bluff Point in 1976 and Sanger (pers. comm.) reported white-wingeds in a similar location in 1977. Murres were also common in outer Kachemak during winter. A variety of dabbling, diving and sea ducks were abundant in ice-free areas of inner Kachemak Bay in winter.

Subunit 5 - Kodiak Archipelago:

[See Appendix A, Figure 8.]
Over 200 colonies have been documented on the islands of Kodiak but only one was classified primary due to the 100,000 black-legged kittiwakes and other birds that were found there. This colony is in Boulder Bay at the mouth of Kiliuda Bay. Six colonies have been classified secondary for this report because they were estimated to contain over 10,000 birds by RU #338/343 (Lensink and Bartonek 1976). Three are located near the primary colony: one at Right Cape at the mouth of Kiliuda Bay and two in Sitkalidak Straits on Cathedral and Amee Islands. The latter is unique in that 5,000 Arctic terns and 3,000 Aleutian terns as well as 2,500 tufted puffins were found there. Three other coastal areas have concentrations of over 10,000 breeding birds. Cape Chiniak and adjacent islands, the Triplet Islands in Marmot Bay and the Noisy Islands of the outermost tip of Uganik Island. The most common species at these sites are tufted puffins, black-legged kittiwakes and the aforementioned terns.

Most habitat on Kodiak is unsuitable as staging areas for migrating geese, dabbling ducks and shorebirds. Possible sites are lagoons on the south end of the island particularly those on the Trinity Islands, but no one has looked at the area during migration. If other areas critical to migrating birds are present on the Archipelago, they are as yet unidentified.

Because bays are relatively ice-free in winter, several species utilize Kodiak as wintering grounds. Diving and sea ducks, in particular, are found well-distributed throughout the islands. Many are observed in Chiniak Bay from the road system at Kodiak and this may well be one of the densest wintering populations on Kodiak. Further research is needed to substantiate this. Many murres, crested auklets and sea ducks have been sighted in Uyak Bay in the past, and therefore, it has been designated a winter concentration area. Similarly, concentrations of murres were observed feeding in Kiliuda and Ugak Bays during last winter's survey. Whether these bays have continued year-to-year use remains to be verified.

An area on Kodiak which possibly has the densest bird populations in all seasons is Whale Passage between Kizhuyak Bay and Kupreanof Straits. Apparently, food organisms are made available by tidal currents, and many species use this 10 km^2 area. Last winter 215 birds/km^2 consisting mostly of sea ducks were found there. In other winters, thousands of

crested auklets have been observed feeding there. During summer, species composition within the Passage consists of those breeding on nearby colonies and non-breeding summer residents.

Subunit 6 - South Alaska Peninsula:

[See Appendix A, Figure 11.]
The many islands and rock cliffs of the south side of the Alaska Peninsula support more large sea bird colonies within the study area. Sixteen colonies have been documented as having over 100,000 total birds and 30 have over 10,000 birds. At the north end of the subunit there are primary colonies at Cape Aklek and Cape Unalishagvak each containing over 200,000 murres. Nearby are two secondary colonies containing 10,000 or more tufted puffins.

From Ashiiak Island near Agripina Bay to Ugaiushak Island south of Cape Kuyuyukak, seven secondary colonies are recognized. Species composition depends on the physiography at the site, but the most common species are tufted and horned puffins, black-legged kittiwakes, murres, glaucous-winged gulls and pigeon guillemots.

Within the Semidi Island group nine primary colonies are designated. Totals for the Archipelago include: 386,000 northern fulmars, 420,000 black-legged kittiwakes, 1,554,000 murres and 80,000 tufted puffins. Obviously, oil development or spills in the vicinity of these islands would have devastating effects on large numbers of birds.

One major and four secondary colonies are found in the vicinity of Mitrofania Island. Species composition for these five colonies include 11,200 glaucous-winged gulls, 26,500 black-legged kittiwakes, 210,000 murres, 4,000 pigeon guillemots, 38,000 horned puffins and 85,000 tufted puffins. The largest colony is Spitz Island with 200,000 murres and other colonies are on Mitrofania, Brother, Chiachi and Pinusuk Islands.

Another critical area is the Shumagin Archipelago because of its three primary and ten secondary colonies. The three largest colonies are on Karpa Island, Big Koniuji Island and Castle Rocks with total numbers of 263,000, 203,000 and 119,000 birds, respectively. Species composition of birds in this area resembles that of previously mentioned colonies except that moderate numbers of parakeet and crested auklets are also found there.

The last concentration of bird colonies on South Alaska Peninsula is south of Deer Island on small islands of the Sandman Reefs where six secondary colonies are located and at Amagat Island at the mouth of Morzhovoi Bay where a major colony is found. The most abundant species at these colonies are horned and tufted puffins - birds highly susceptible to oil contamination because they spend a large portion of their time on water.

During migration two areas can be classified critical due to large numbers of birds utilizing them. Morzhovoi and Cold Bays and in particular Big, Middle and Kinzarof Lagoons had large numbers of staging black brant, Canada geese, emperor geese and other waterfowl during the past

two fall surveys. Also, in October 1976 tens of thousands of shearwaters were feeding throughout Morzhovoi Bay. Shearwater use may be irregular, but there is traditional waterfowl use of the areas.

In winter, both of the previously mentioned bays are suspected of having substantial sea duck concentrations particularly in mild winters. During the only other quantitative waterfowl survey of South Alaska Peninsula in winter, concentrations were found in Kujulik Bay and the Sanak Islands. The report of that survey (Havens 1970) suggested both these areas plus Morzhovoi Bay as key waterfowl winter habitat.

Another secondary colony is located at Bird Island south of Otter Cove on Unimak Island. Murres are the predominant species.

More quantitative surveys need to be done in order to fully assess the value of this subunit to marine birds. Due to the vastness of coastline and inclement weather in this region, it is difficult to evaluate the area by aircraft.

Subunit 7 - North Alaska Peninsula:

[See Appendix A, Figure 11.]
The only substantial colony within this subunit is on the north end of Amak Island and on two small islands north of Amak. Six seabird species were reported as present, but no quantitative estimate was given (Lensink and Bartonek 1976). The value of estuaries on North Alaska Peninsula is so well-known that further explanation is unnecessary. Those worthy of critical area status are : Ugashik, Cinder River/Hook Lagoon, Port Heiden, Seal Islands, Nelson Lagoon/Mud Bay, and Izembek/Moffet Lagoons. These areas are essential for staging to a variety of birds in both spring and fall migrations.

Another area of great importance to migrating birds is Bechevin Bay at the end of the Peninsula. Both St. Catherine Cove and Hook Bay were supporting large numbers of black brant, Canada and emperor geese, other waterfowl and larids when they were surveyed in fall 1975 and 1976. Urilia Bay on Unimak Island is suspected of supporting large numbers of migrating birds, but this area has not been surveyed during this study.

During moderate to severe winters much of this area is frozen and would not support large numbers of birds. However, tidal currents through False Pass maintain open water and therefore the Bechevin area is suspected of having considerable bird usage. In mild winters such as 1976-1977 waterfowl, sea ducks and emperor geese utilized bays and estuaries as far north as Egegik (possibly farther but no other areas were searched).

Subunit 8 - North Bristol Bay:

[See Appendix A, Figure 12.]
Seabird colonies on cliffs of Cape Newenham constitute one of the largest concentrations in the North Pacific (King and Lensink 1971). Species composition totals of the one major and five secondary colonies included: 309,110 murres; 71,460 black-legged kittiwakes; 5,000 tufted puffins;

790 cormorants, 500 glaucous-winged gulls and 252 horned puffins. Nearby Cape Pierce and Shaiak Island colonies add 139,498 birds to the total, most of which are murres and kittiwakes.

Walrus Islands are another area of prime importance to birds, supporting three primary and two secondary seabird colonies. The largest is on North Twin where an estimated 521,000 murres reside in summer. South Twin has an additional 500,000 murres. Other common species are black-legged kittiwakes, tufted puffins and cormorants. Because the combined total in a relatively small area is over 1.5 million birds, this critical breeding area should be safeguarded as much as possible from oil and gas development.

From a survey done last spring two areas were judged important migration staging areas and several others are possibly important. Large numbers of sea and diving ducks, particularly scaup, were rafting in salt water of Nushagak Bay while they waited for breeding areas to thaw. Over 2,000 scaup were seen on Flounder Flats. Additional waterfowl and larids were at the mouths of Nushagak, Wood, Snake and Igushik Rivers. Several thousand black brant and other waterfowl were found staging in Nanvak Bay also. Many birds were found in Kulukak Bay especially at the floodplain of the Kanik River and at Osviak Bay. These areas would have to be looked at more frequently to determine the degree of bird usage. Past fall surveys indicated both Nanvak Bay and Kanik River as staging areas, but no fall surveys have been conducted by this principal investigator.

During severe winters this area is frozen so there would be minimal bird usage. It is not known what birds would be present in mild winters but I suspect that some sea duck concentrations may inhabit the area. However, no areas could be classified critical winter habitat.

Subunit 9 - Aleutian Shelf:

[See Appendix A, Figure 13.]
Emphasis of OCSEAP projects has just recently been shifted into this subunit, and therefore current information is sketchy. An estimated 375,000 tufted puffins breed on Kaligagan Island, 100,000 on Rootok Island, 100,000 on the Baby Islands and 50,000 on Avatanak Island. Bogoslof Island is another important colony with 15 nesting species including red-legged kittiwakes and fork-tailed storm-petrels (Byrd and Divoky 1975). The most easterly colonies of whiskered auklets are found in this subunit. Other significant colonies may be found when future searches are made.

During migration, passes between islands may contain substantial concentrations of birds. Unimak Pass is a known migration corridor, but the same may be said for Akutan, Umnak and Samalga Passes. These areas may also be important summer and winter feeding areas. During this winter's survey, rafts of crested auklets and murres were observed in both Akutan and Unimak Passes.

Samalga Island is an area deserving special mention. During two recent flights to the island (in October 1976 and March 1977) by the principal investigator, large numbers of birds were present. In winter large

numbers of geese, dabbling ducks, sea ducks and shorebirds were recorded. A fox was sighted on the island, likely precluding breeding concentrations, but the area should be given "critical" status if the observed concentrations are recurring.

IX. Needs for Further Study

It was proposed that all coastal marine bird habitat from Cape Fairweather to Cape Newenham during the period from September, 1975 to the present be delineated. Concurrently, bird usage of coastal environments was to be documented, preferably for all four seasons. Because lack of time and money and inclement weather precluded the realization of all the objectives, it is suggested that coastal bird surveys be continued. Much good information on "critical" areas for coastal marine birds can be derived from baseline aerial reconnaissance, but surveys must be conducted in all seasons and if possible during the same season on successive years. Bird use of a region in many cases would vary from year-to-year, but this may not alter its status as "critical."

With delays in OCS lease sales, perhaps more coastal bird surveys could be conducted in the Gulf of Alaska (currently the project is restricted to Bristol Bay and Aleutian Shelf lease areas) to get additional information prior to the sales. Areas classified as "tentatively critical" now could either be taken off the list or reclassified as "positively critical." Simultaneously, coastal habitat delineation not previously done could then be completed.

Coastal bird surveys completed to date have not been standardized for time of day; tide level or weather conditions. Because birds' behavioral responses to these factors vary, bird distribution and use of habitats as depicted by aerial surveys may be biased. Therefore, it is suggested that a small study area be selected that has a wide variety of bird habitats, a large species diversity and different bird uses (i.e. feeding, nesting, roosting). Preferably the area should have no logistics problems to hinder research. Boats and aircraft should be readily available.

Kachemak Bay is an area that fulfills most of these requirements. Besides convenient aircraft and boats, several vantage points for ground observation are accessible; two moderately sized colonies are present in the bay; it is used by migrating shorebirds and waterfowl; and it has substantial winter and summer use by non-breeding birds. The area has a sandspit, mud flats, coastal floodplain, lagoons, bays, fiords and rocky coast.

Together with the bird distribution study, food habits work could be done to determine what prey species are available and utilized by birds. An attempt could be made to determine foraging distances from colonies. It may also be an area to determine effects of human disturbance to colonies.

Another possible study site would be the Port Moller estuarine complex. A wide variety of habitats and birds are present, but logistics support would be less convenient.

Aerial reconnaissance and mapping of the supratidal zone (from high tide to storm tide levels) have not been sufficient to characterize vegetation and bird use of the region. Ground truth studies could be initiated to determine how the different subunits differ in plant species composition and bird use of this zone.

Gaps in knowledge of species composition and abundance are apparent for colonies on the Walrus Islands in Bristol Bay and the Fox and Krenitzin Islands in the Aleutian Shelf lease area. Both areas could be used to monitor effects of oil and gas development if population dynamics studies were initiated soon. Other colony complexes worthy of population dynamics work are those near Cape Aklek-Unalishagvak and Mitrofania Island. Because of its proximity to potential lease areas and large numbers of birds found there, Middleton Island is a logical choice for intensive colony work.

The NEGOA synthesis meeting pointed out two things that possibly warrant further bird work. One, the gyre northwest of Kayak Island, should be looked at more closely for feeding habits of birds and general bird use in the area. Oceanographers' drogues also went into Prince William Sound, and more intensive work should therefore be conducted in that subunit. Murrelets, both marbled and Kittlitz's, are one of the most abundant birds in the Sound, and ornithologists know very little about them. Studies to determine abundance, distribution and breeding biology (if possible) seem warranted. A starting point would be Unakwik Bay where 10,000 Kittlitz's murrelets were observed in 1972.

X. Summary of 2nd Quarter Operations

A. Aircraft activities

1. Field trip schedule: From February 28 to March 4, 1977 shoreline surveys were conducted using a Peninsula Airways Grumman Widgeon.
In conjunction with a marine mammals survey, nearshore bird surveys were conducted from a Peninsula Airways Grumman Widgeon on March 16-18, 1977.

2. Scientific party: For the first survey Paul Arneson and David McDonald, ADF&G, Anchorage did the bird censusing. On the second survey only one bird observer, Paul Arneson, ADF&G, Anchorage was present.

3. Methods: Standard shoreline survey methods as reported in previous quarterly and annual reports were utilized on the first survey. Bird observers looked out both sides of the aircraft. Only one observer was present on the second survey, and he either looked out a fixed distance of 200 meters while doing open water transects or counted birds in nearshore waters and on the beach while flying the coastline.

4. Localities: See Appendix A, Figures 14 and 15 for tracklines of surveys.

5. Data collected: During the February 28-March 4 survey approximately 2635 kilometers of shoreline were surveyed for birds. Data for the survey are presently being transcribed from cassette tapes and have not been analyzed. About 2375 kilometers of shoreline and open water were surveyed on March 16-18, and none of the data for that survey have been transcribed.

6. Milestone chart: See Table 10 for update of data submission.

B. Problems

The most frustrating problem has been delays in getting data analyzed because of computer programming problems. This has been the major cause of slippages in the data submission schedule. Much time has been spent correcting and recorrecting errors on printouts and we have been unable to devote necessary time for important analyses. Various other factors including preparations for and attendance at synthesis meetings, untimely illness of the programmer, and additional, unscheduled field trips have caused further delays.

As mentioned in the previous quarterly report, cutbacks in operational funds together with increased costs curtailed some planned surveys. Fortunately, logistics will be provided by OCSEAP for a survey of Bristol Bay in the spring. Perhaps other unforseen aircraft of opportunity will be available at other times of year whereby bird observers could use the aircraft for portions of the time or sit in an unoccupied seat to get at least partial but important bird information. This may include aircraft off NOAA vessels in the vicinity in summer or from work being done by other PI's in the same area (e.g. NMFS marine mammal flights in the Krenitzin and Fox Islands.)

Scientific data collection in Alaska has the unavoidable setback that time, money and patience run out when inclement weather delays successful completion of a scheduled survey. Important information is often lost in such situations.

C. Funds expended:

Salaries	$ 9,234
Per Diem/Travel	1,030
Contractual Services (Air Charter)	4,600
Commodities	268
Equipment	0
Total	$15,132

TABLE 10. Milestone Chart

Project Research Unit #3 P.I. Paul D. Arneson Date FY '77

MAJOR MILESTONES	QUARTERS 1 O	N	D	2 J	F	M	3 A	M	J	4 J	A	S
Bristol Bay-North Aerial Bird Surveys △								△			?	
Alaska Peninsula-North Aerial Bird Surveys △	▲					▲		△			?	
Aleutian Shelf Aerial Bird Surveys △					▲	▲				△	△	
Bristol Bay-North Habitat Mapping ○								○				
Alaska Peninsula-North Habitat Mapping ○	●											
Aleutian Shelf Habitat Mapping ○	●										?	
Quarterly Reports □			■			■			□			
Annual Report □						■						
Final Reports □												□
Supplemental Bird Surveys ⬡						⬢			⬡	⬡		

Milestones △ Planned

▲ Completed

XI. Literature Cited

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APPENDIX A

Tracklines of aerial bird surveys conducted by Alaska Department of Fish and Game, Anchorage. Study area includes coastline from Cape Fairweather to Cape Newenham. Known or suspected critical areas for migrating, breeding or wintering birds are designated.

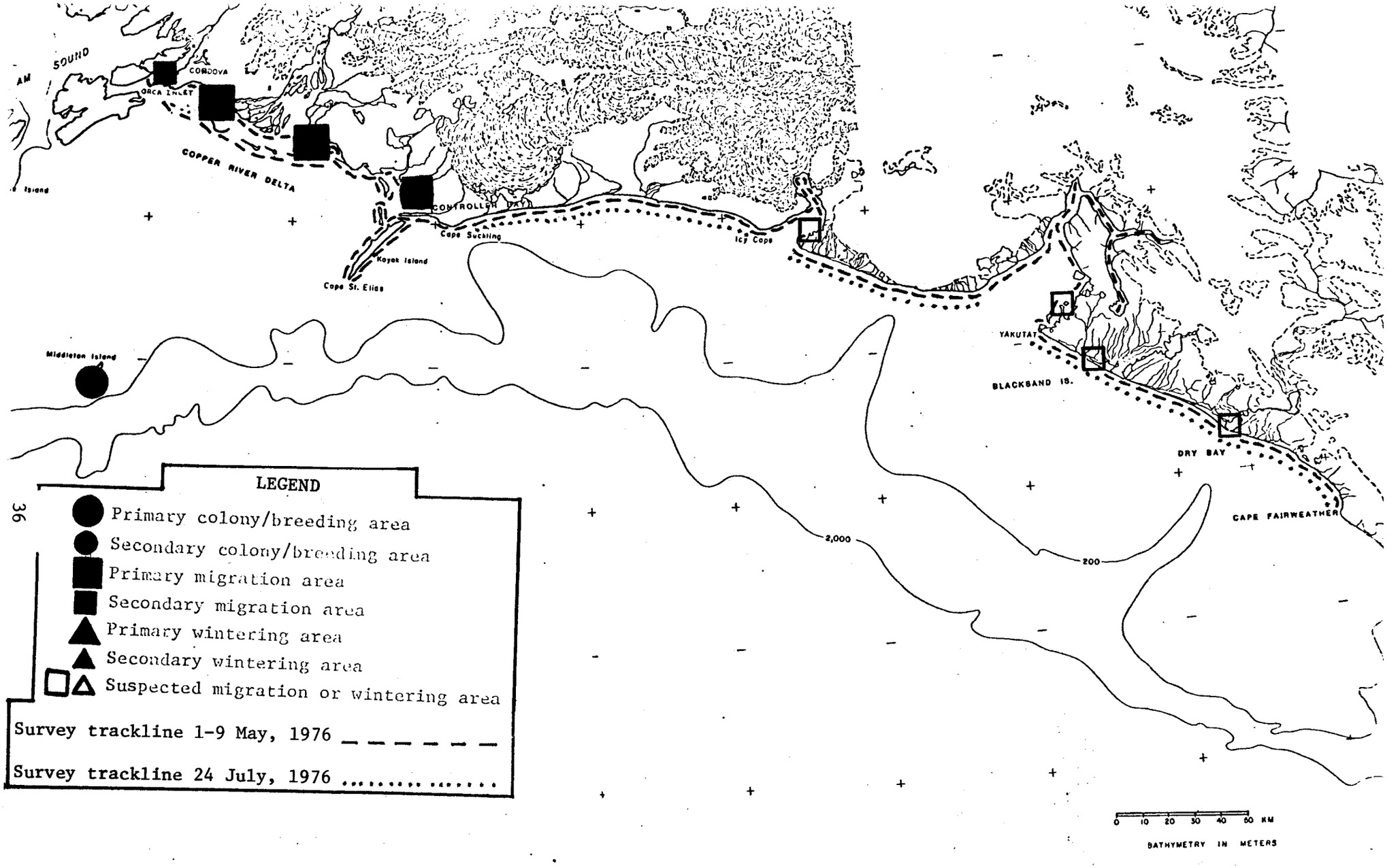


Figure 1. Tracklines of aerial bird surveys in Northeast Gulf of Alaska. Symbols denote known or suspected critical areas for birds.

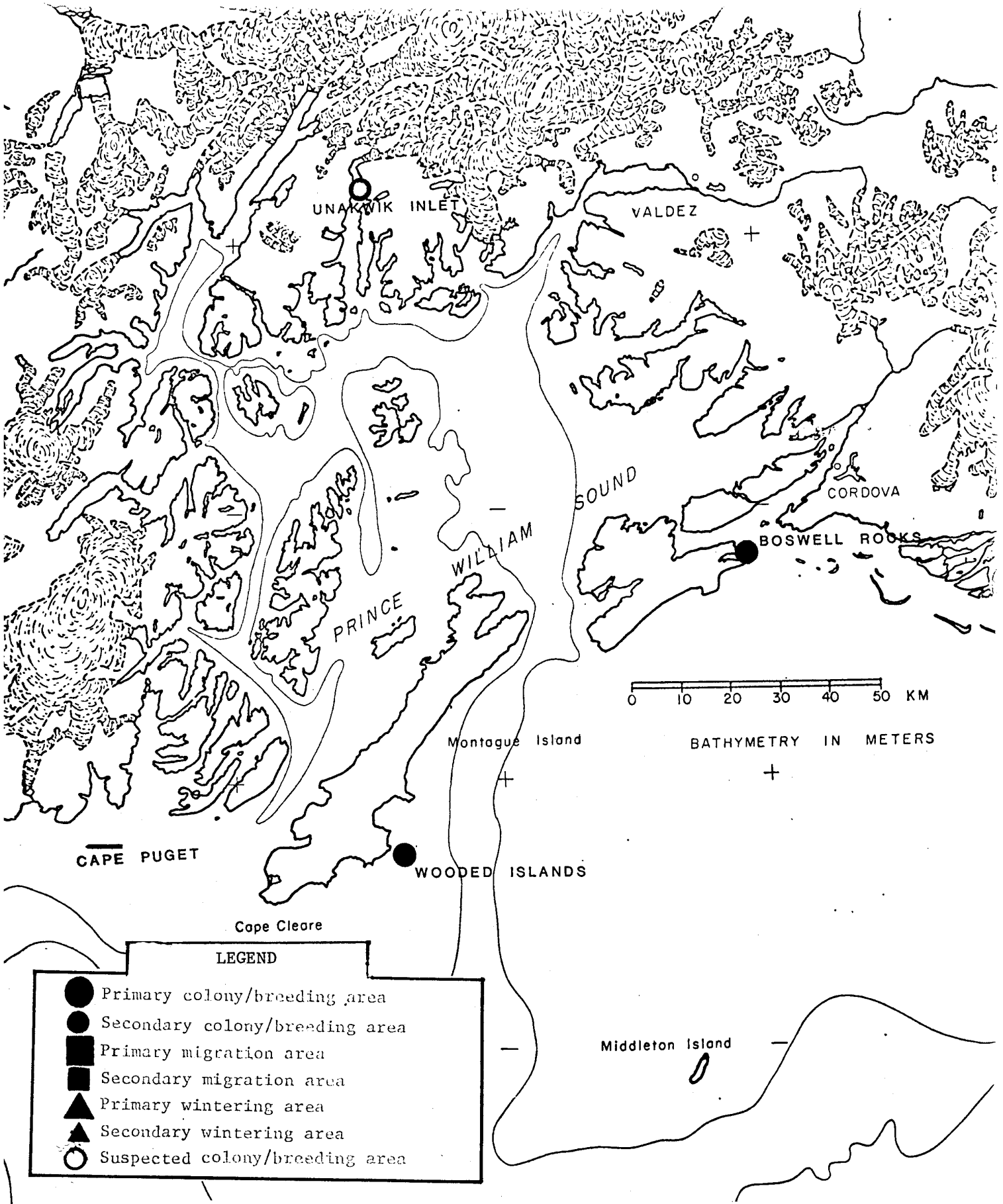


Figure 2. Known or suspected critical areas for birds of Prince William Sound. No aerial surveys conducted in this subunit.

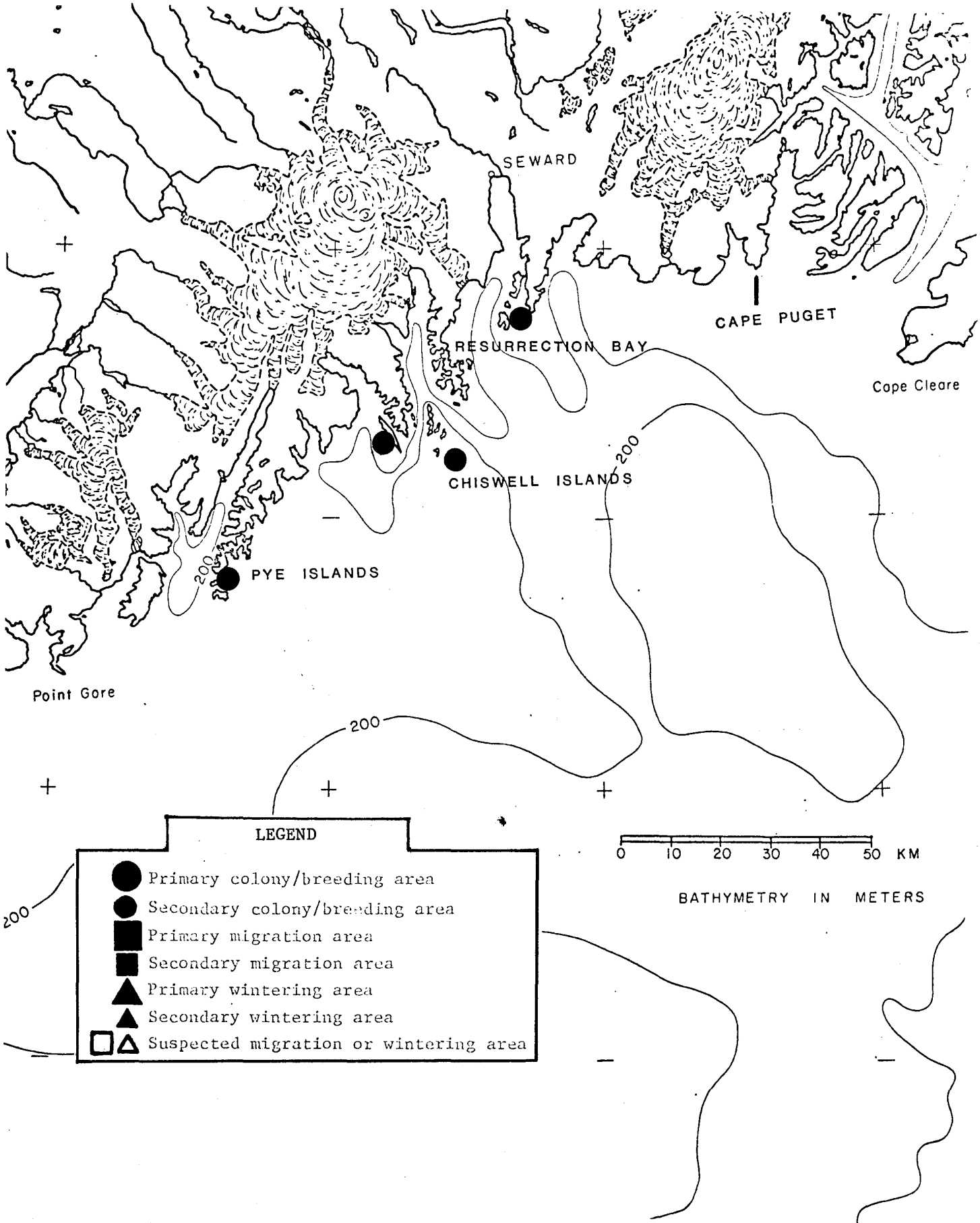


Figure 3. Known critical areas for birds of Kenai Peninsula - South. No aerial surveys conducted in this subunit.

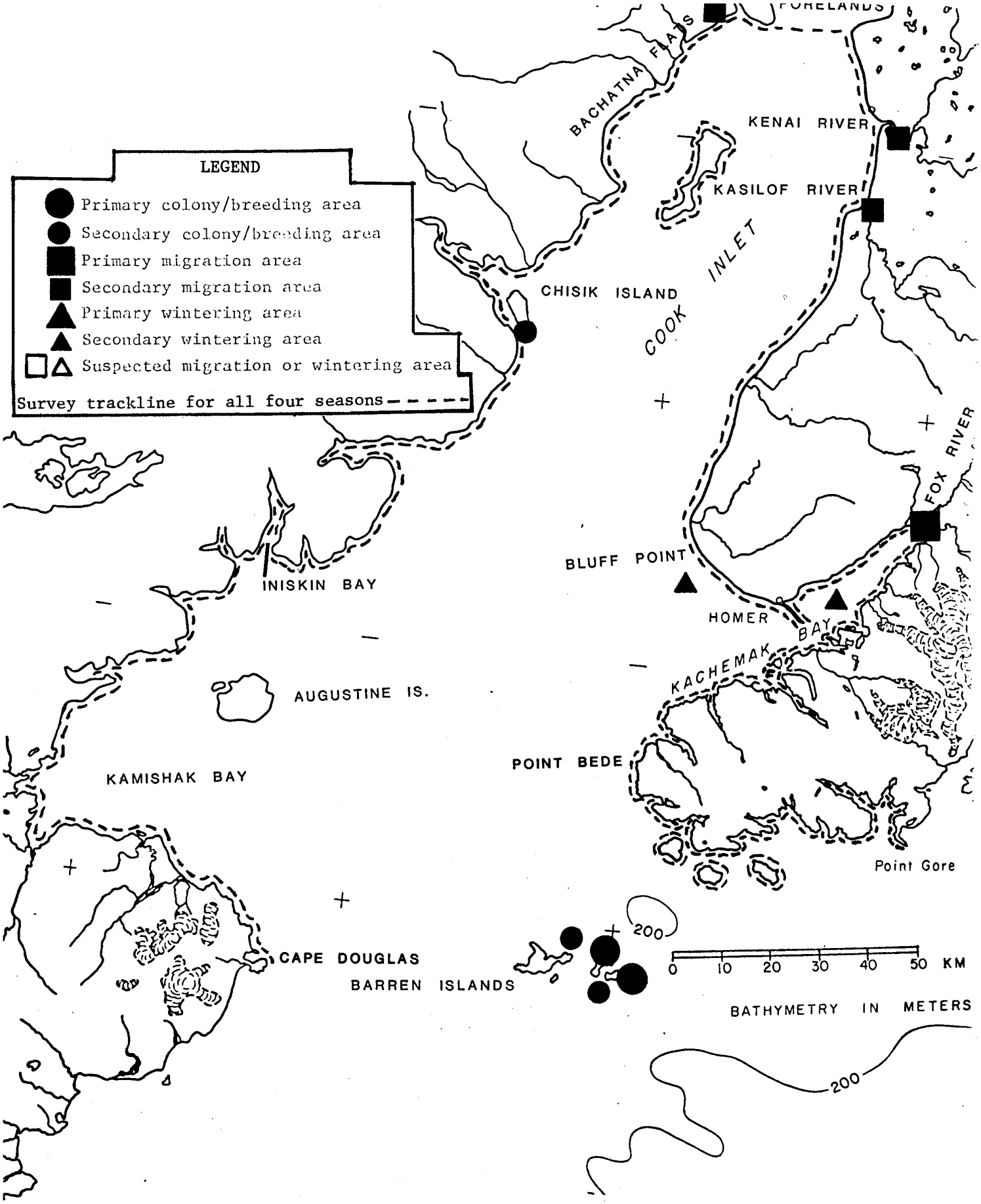


Figure 4. Trackline of aerial bird surveys flown in all four seasons in Lower Cook Inlet. Symbols denote known critical areas for birds.

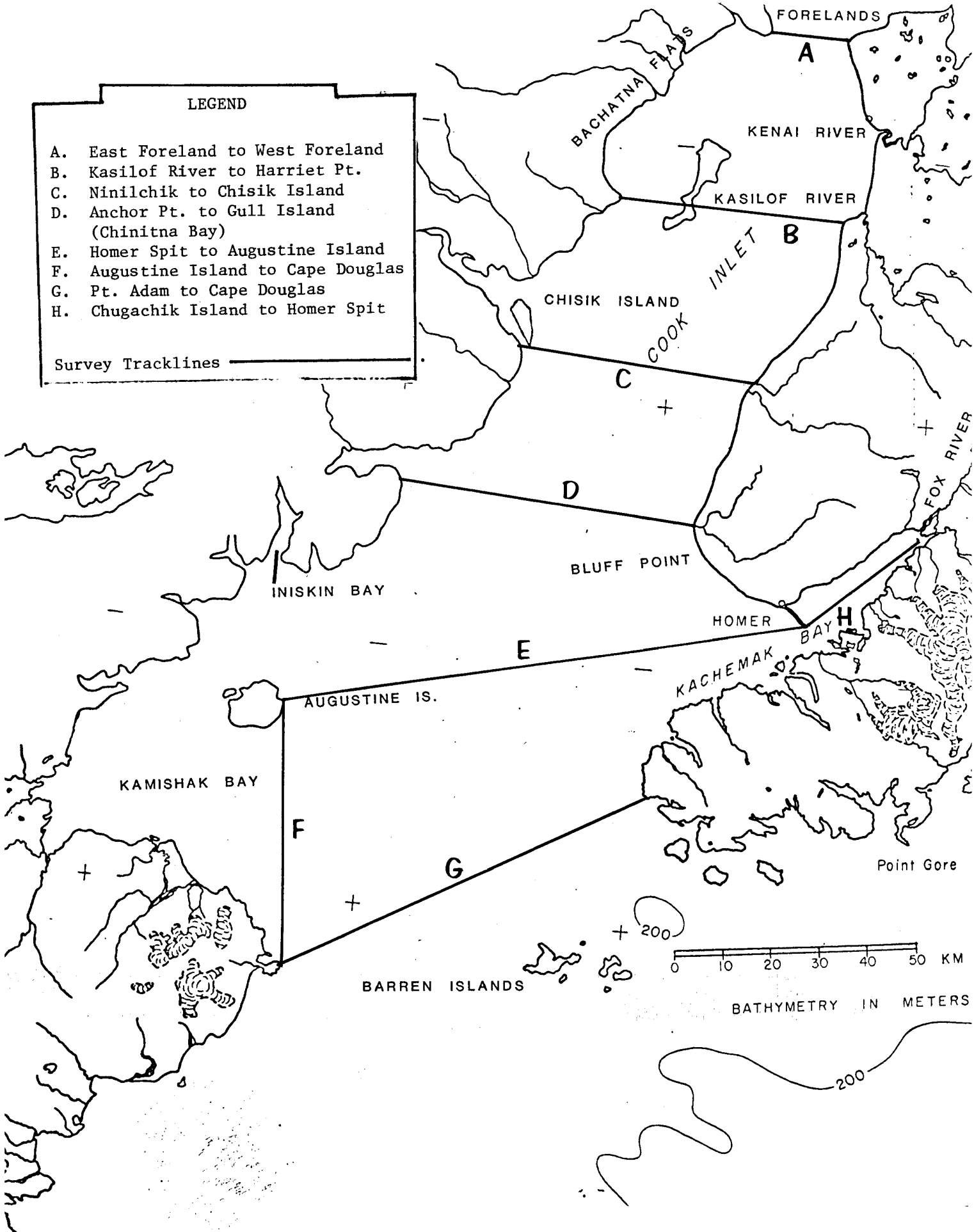


Figure 5. Trackline of pelagic aerial bird surveys flown in all four seasons in Lower Cook Inlet.

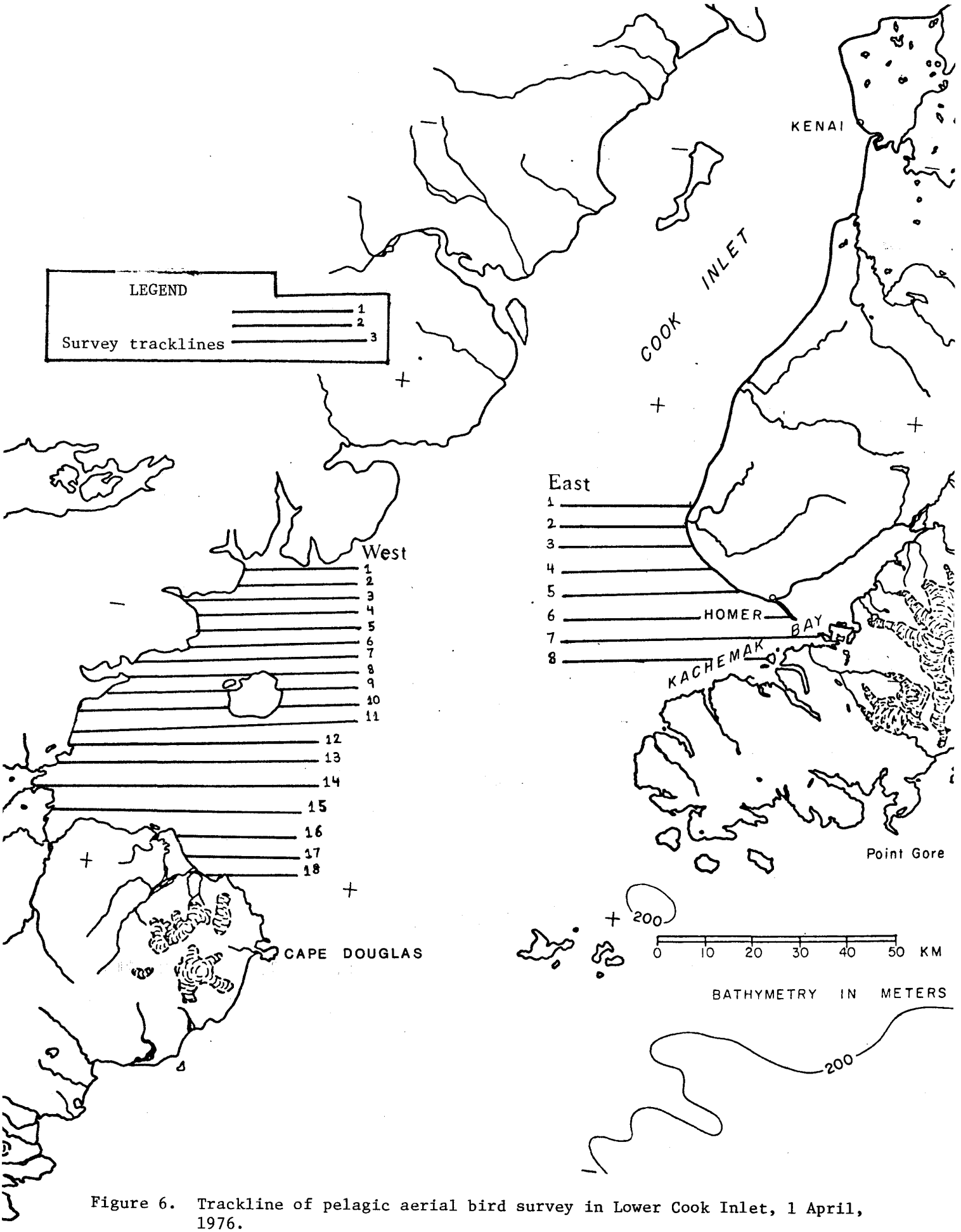


Figure 6. Trackline of pelagic aerial bird survey in Lower Cook Inlet, 1 April, 1976.

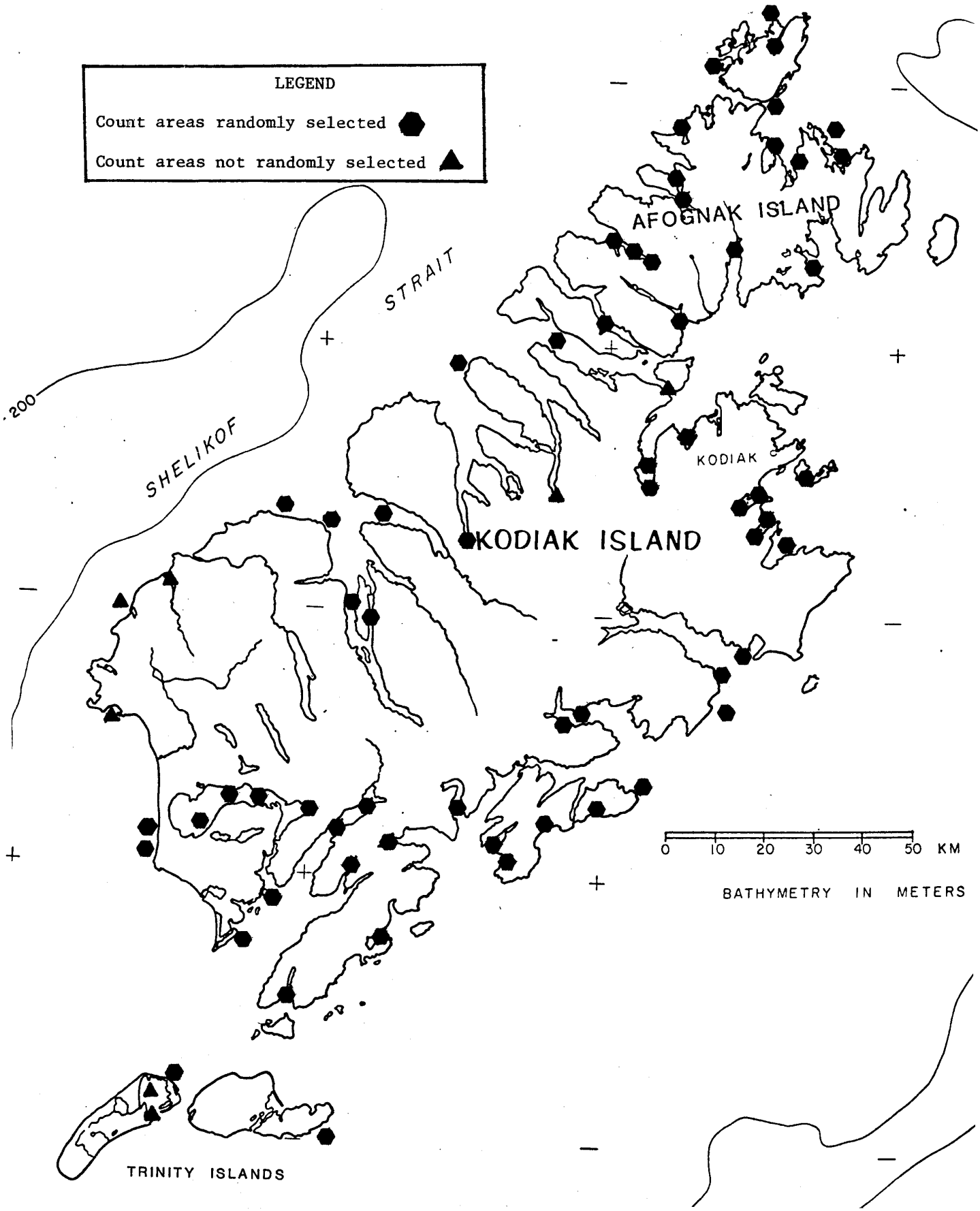


Figure 7. Count areas sampled during aerial bird surveys in Kodiak Archipelago February and March 1976. A stratified-random scheme was used.

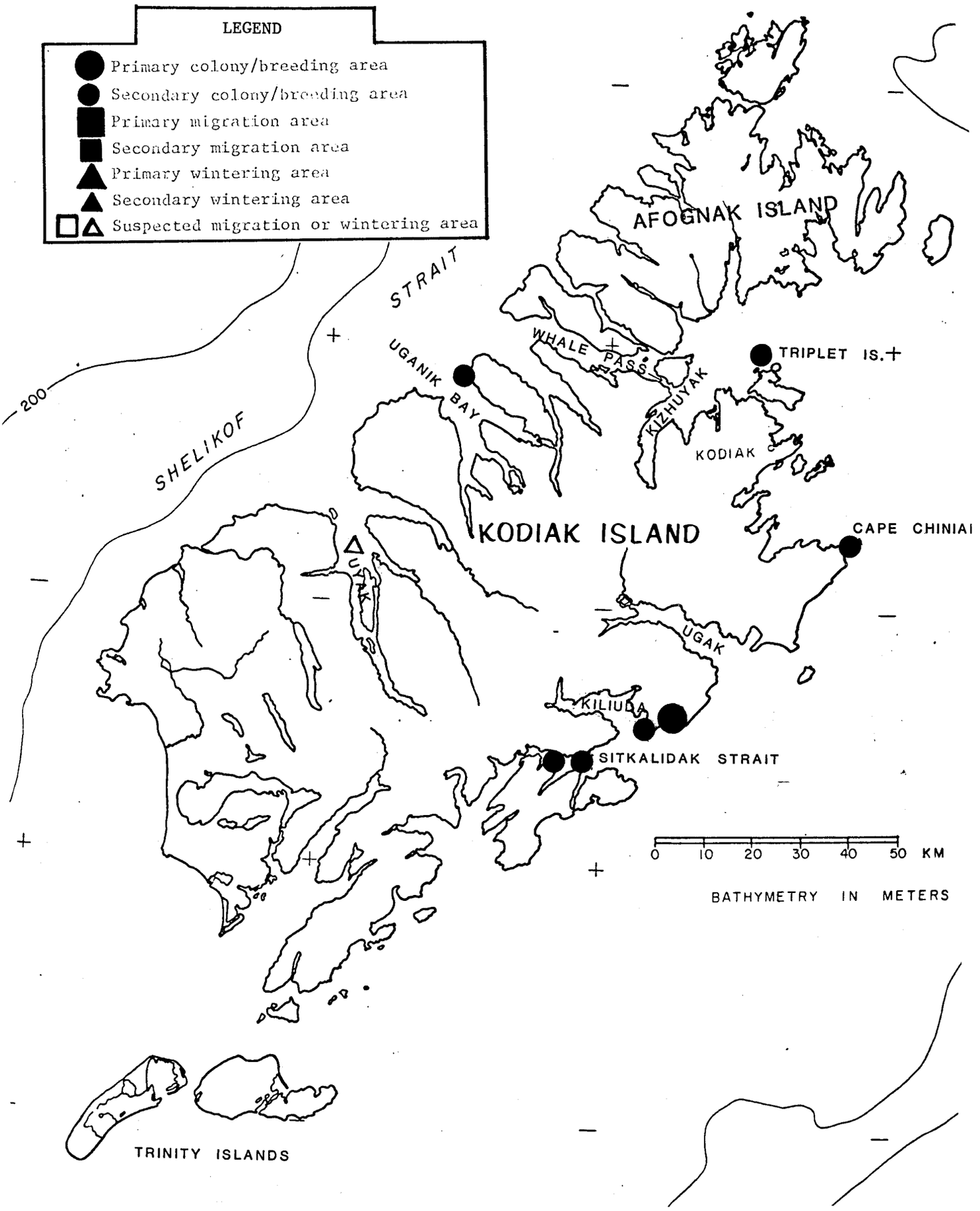


Figure 8. Known or suspected critical areas for birds of Kodiak Archipelago.

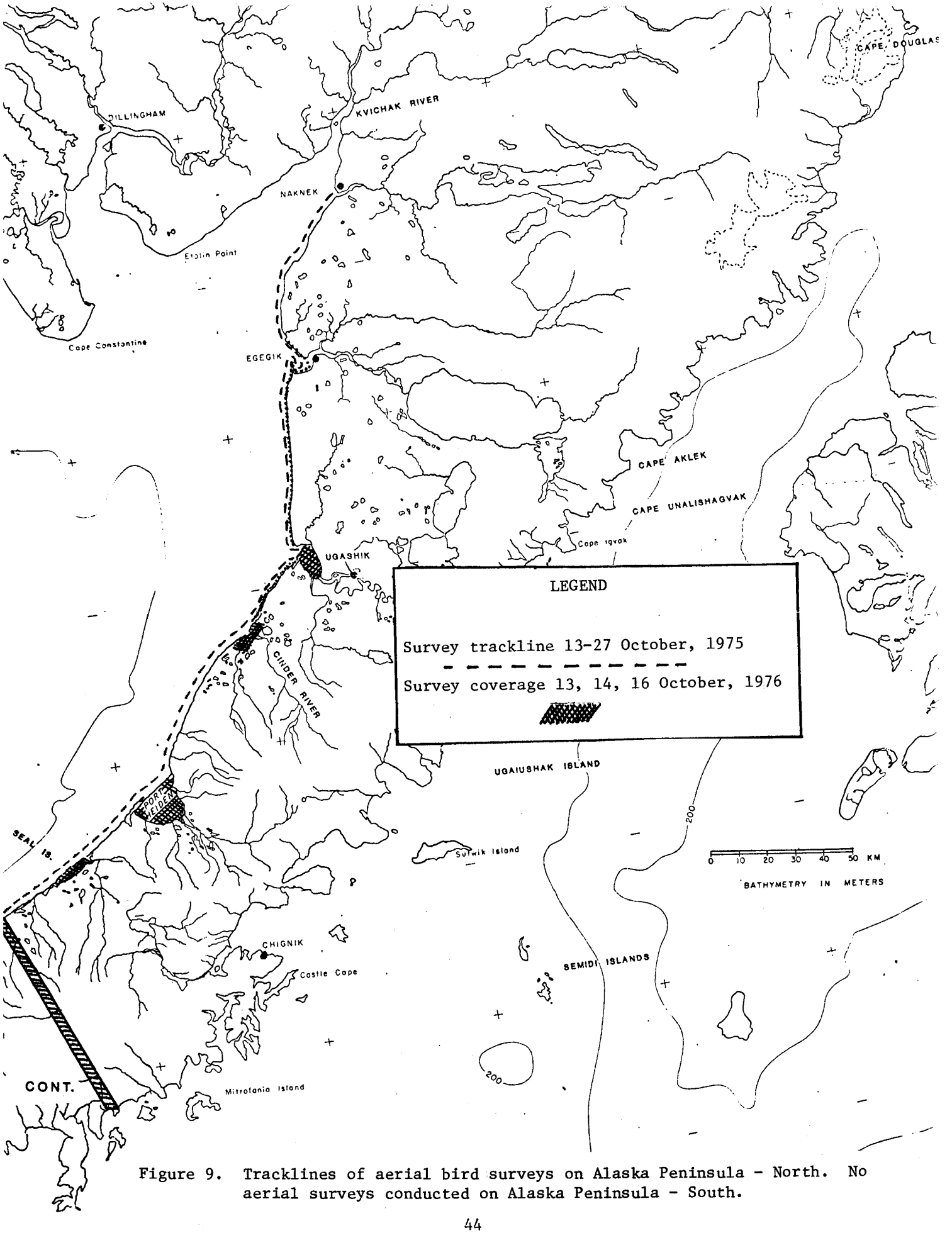


Figure 9. Tracklines of aerial bird surveys on Alaska Peninsula - North. No aerial surveys conducted on Alaska Peninsula - South.

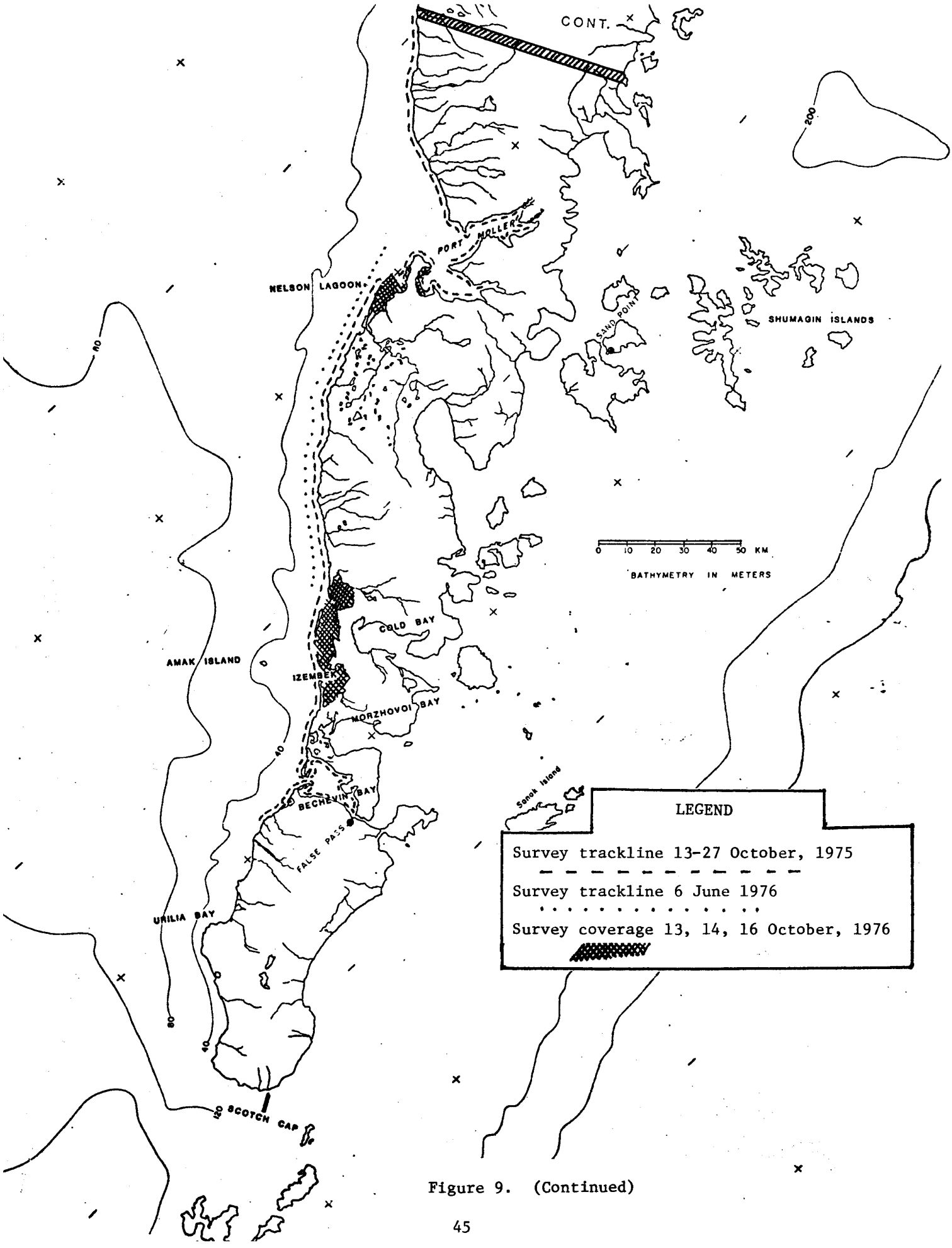


Figure 9. (Continued)

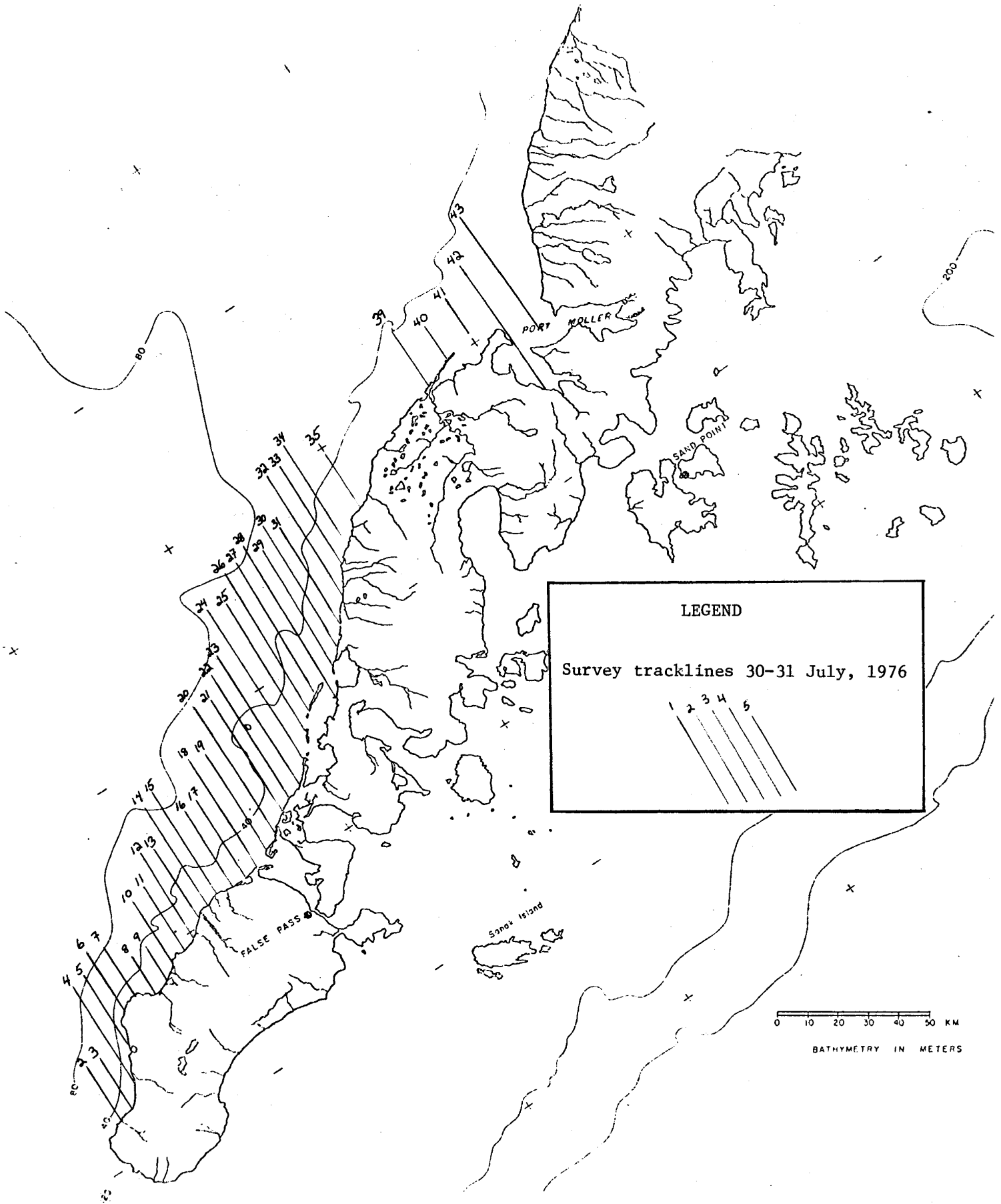


Figure 10. Tracklines of pelagic aerial bird surveys on Alaska Peninsula - North 30-31 July, 1976.

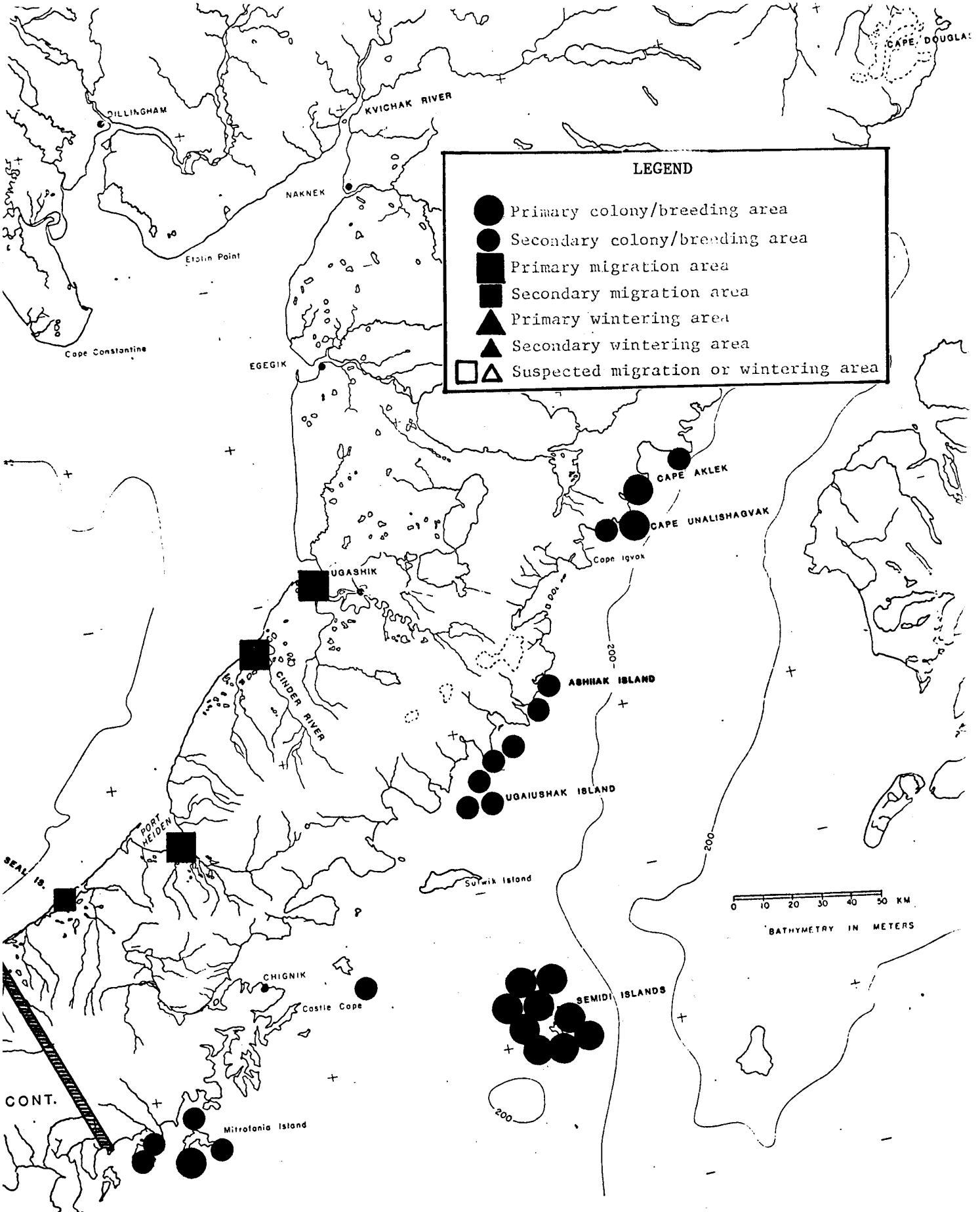


Figure 11. Known or suspected critical areas for birds of Alaska Peninsula - North and South.

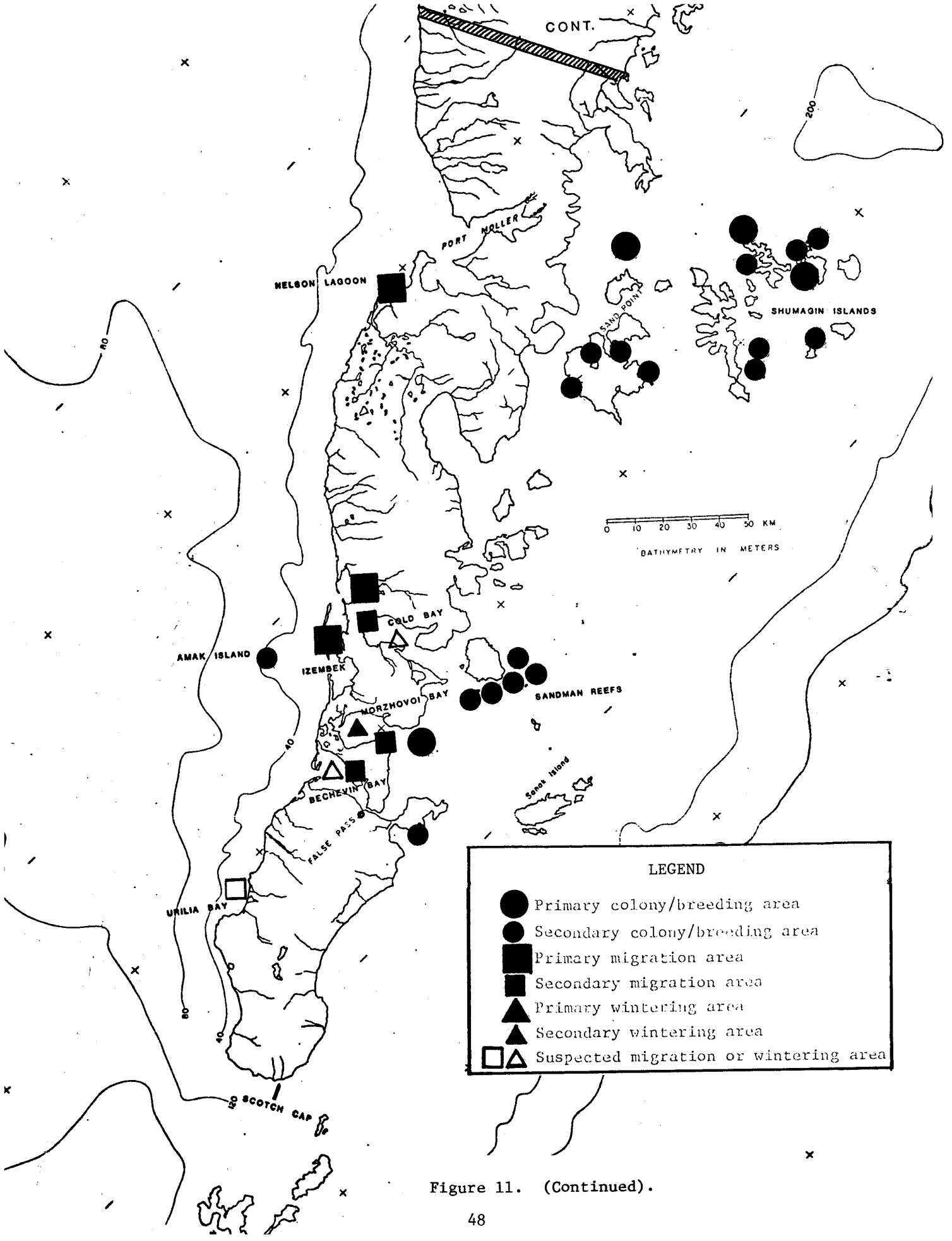


Figure 11. (Continued).

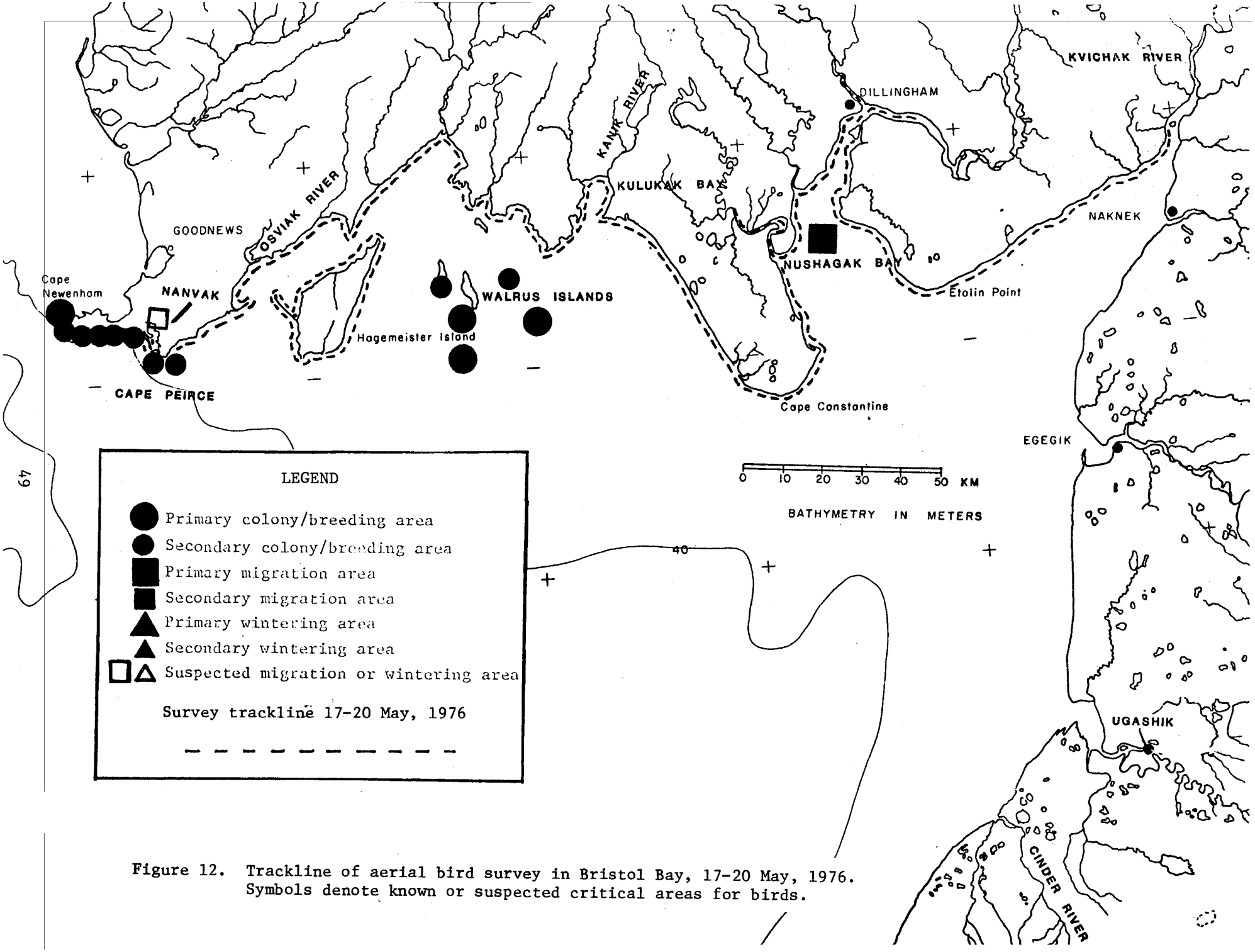


Figure 12. Trackline of aerial bird survey in Bristol Bay, 17-20 May, 1976. Symbols denote known or suspected critical areas for birds.

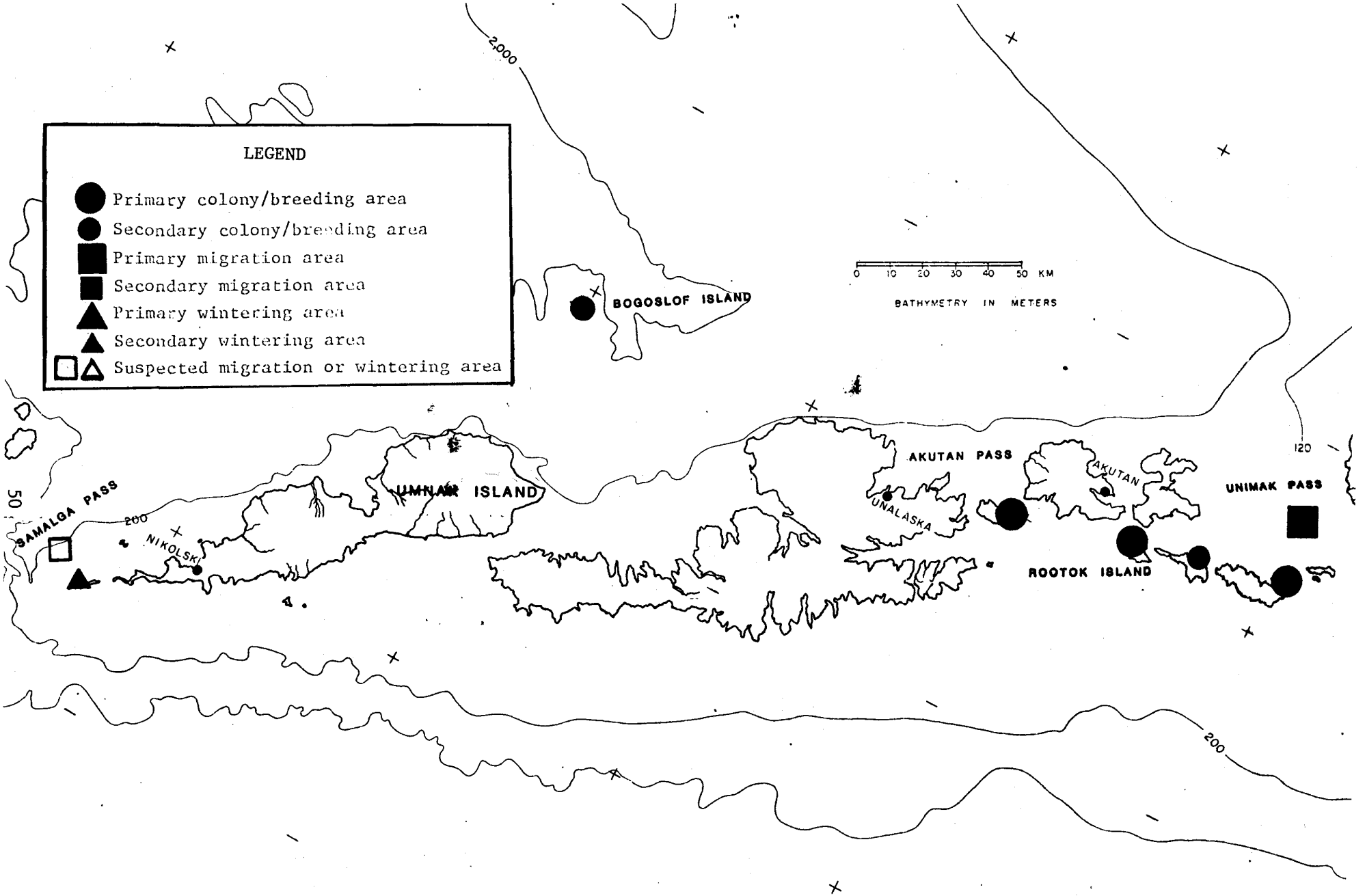


Figure 13. Known or suspected critical areas for birds of Aleutian Shelf. No aerial surveys conducted in this subunit.

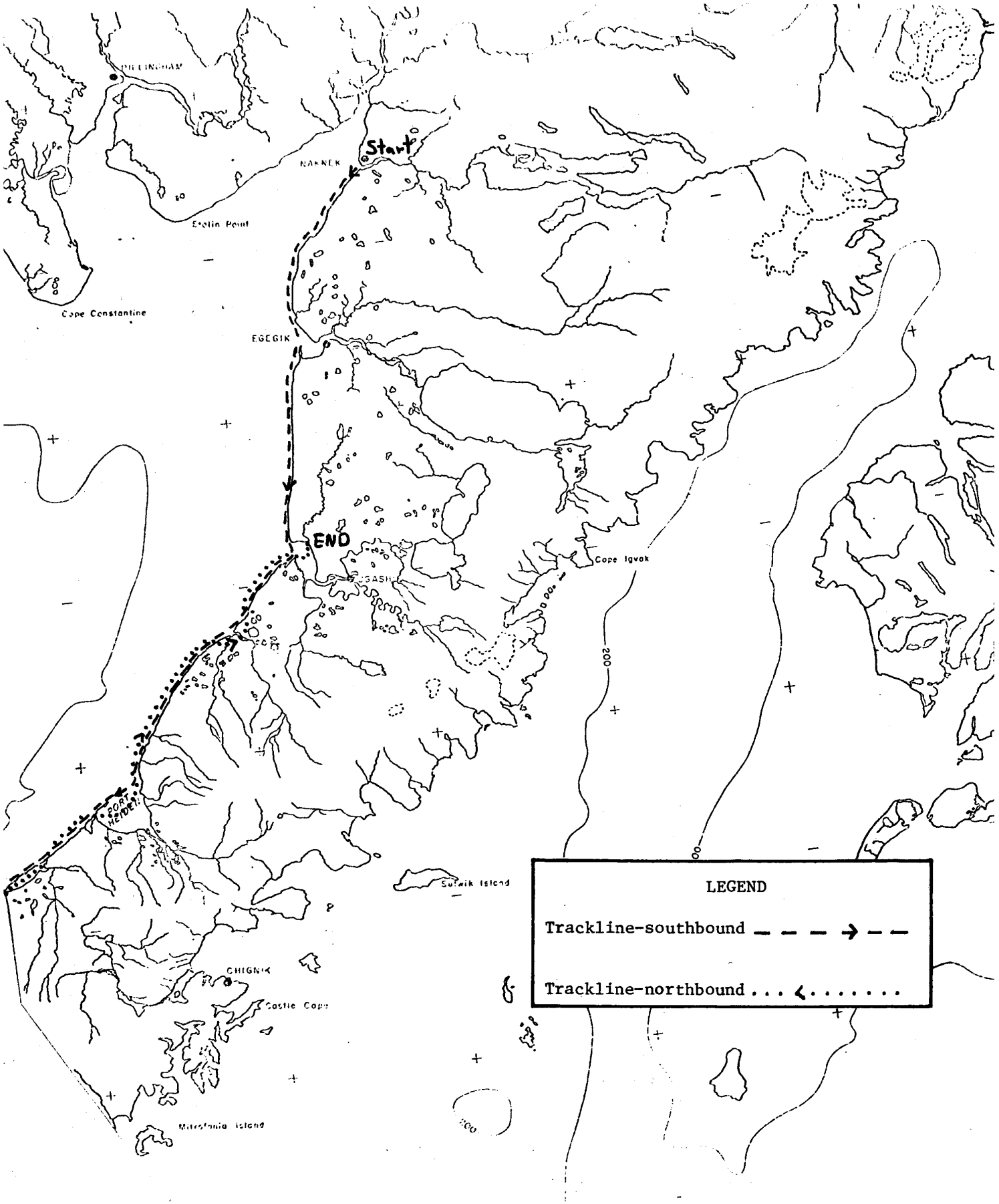


Figure 14. Tracklines of aerial bird survey on Alaska Peninsula-North, 28 February-4 March, 1977

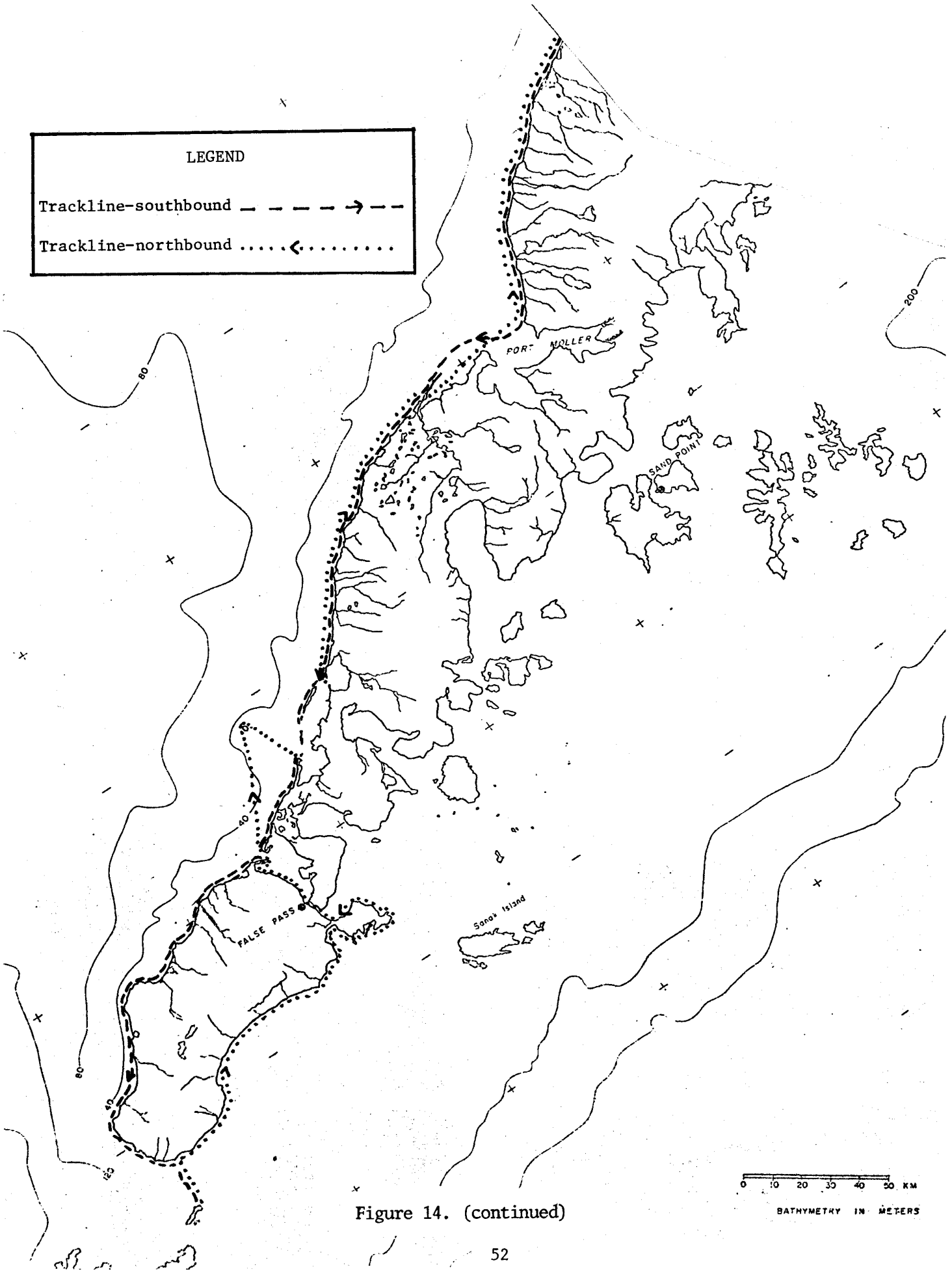
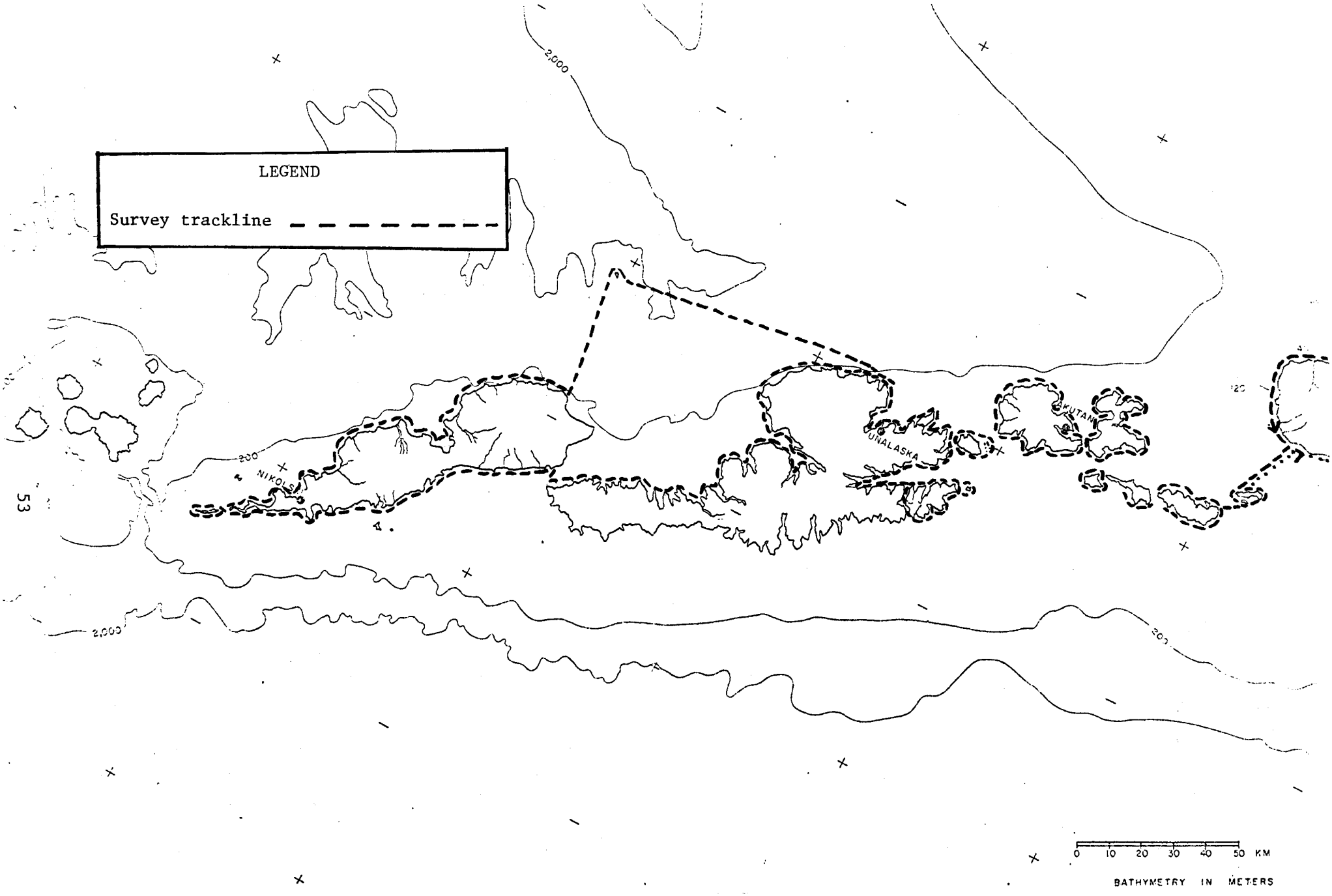


Figure 14. (continued)



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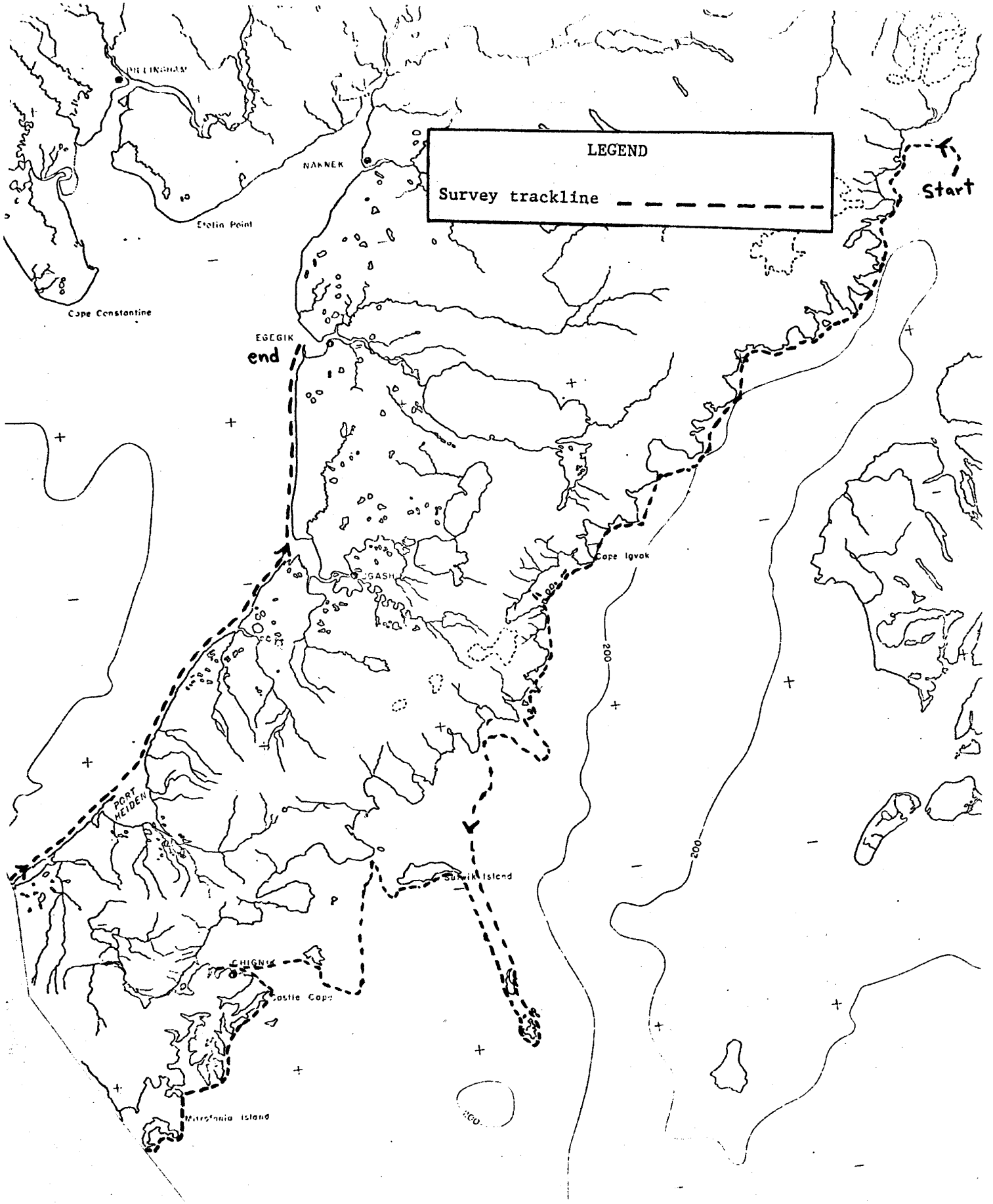

Figure 15. Trackline of aerial bird survey on Alaska Peninsula-South, 16-18 March, 1977

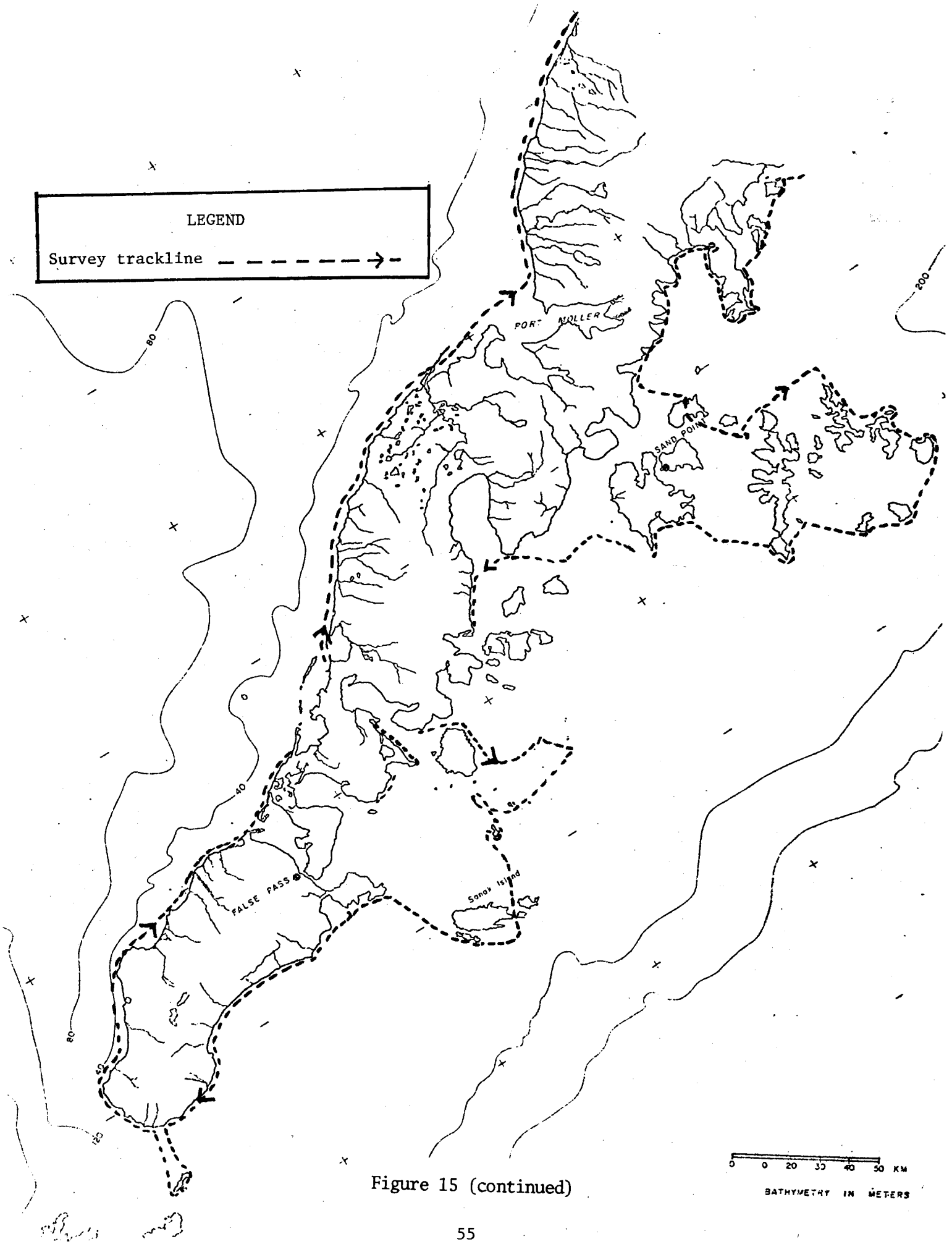

Figure 15 (continued)

APPENDIX B

Habitat mapping coverage for nine subunits within the study area. Information from mapped areas is available at Alaska Department of Fish and Game, Anchorage.

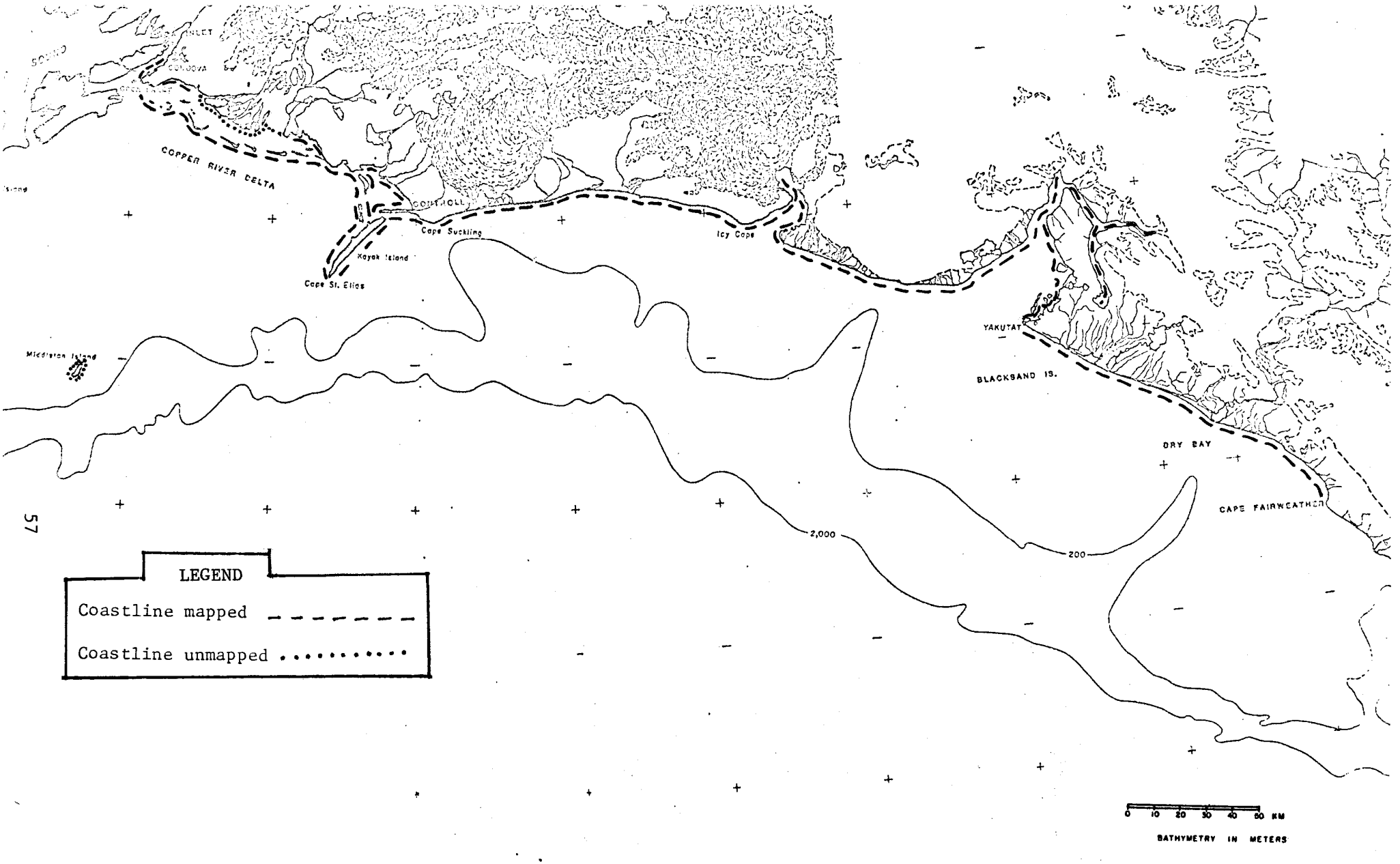

Figure 1. Habitat mapping coverage of Northeast Gulf of Alaska.

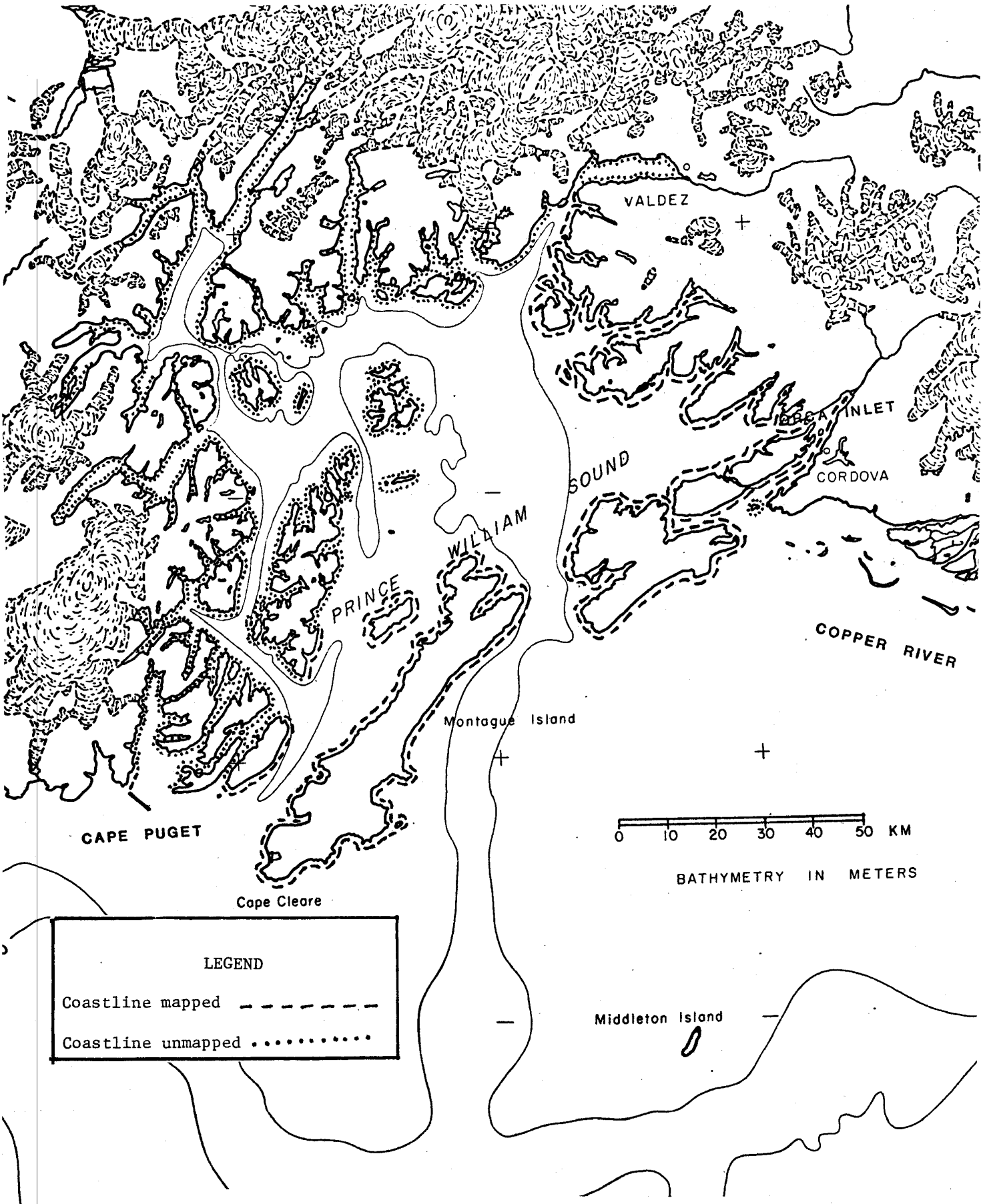

Figure 2. Habitat mapping coverage of Prince William Sound.

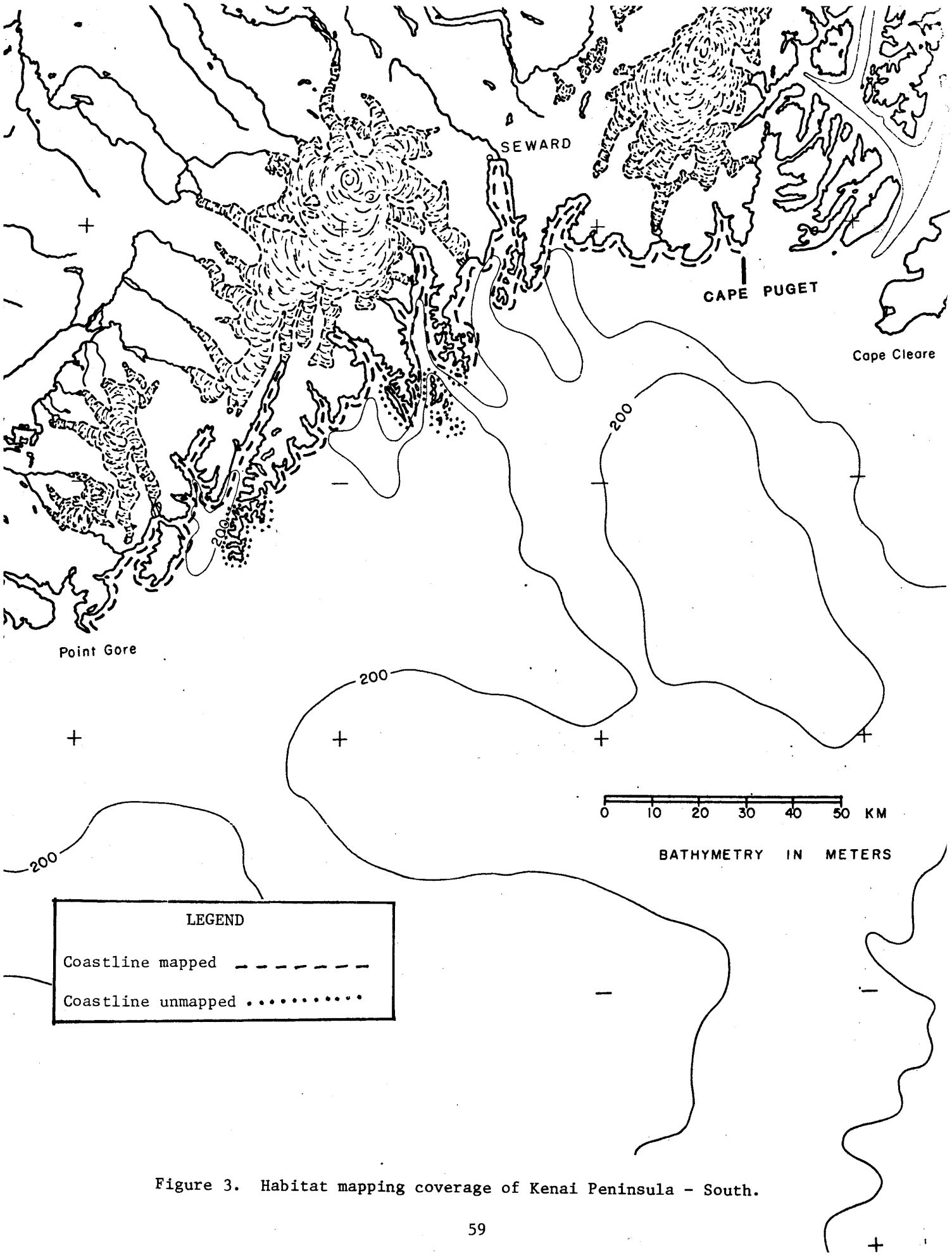

Figure 3. Habitat mapping coverage of Kenai Peninsula - South.

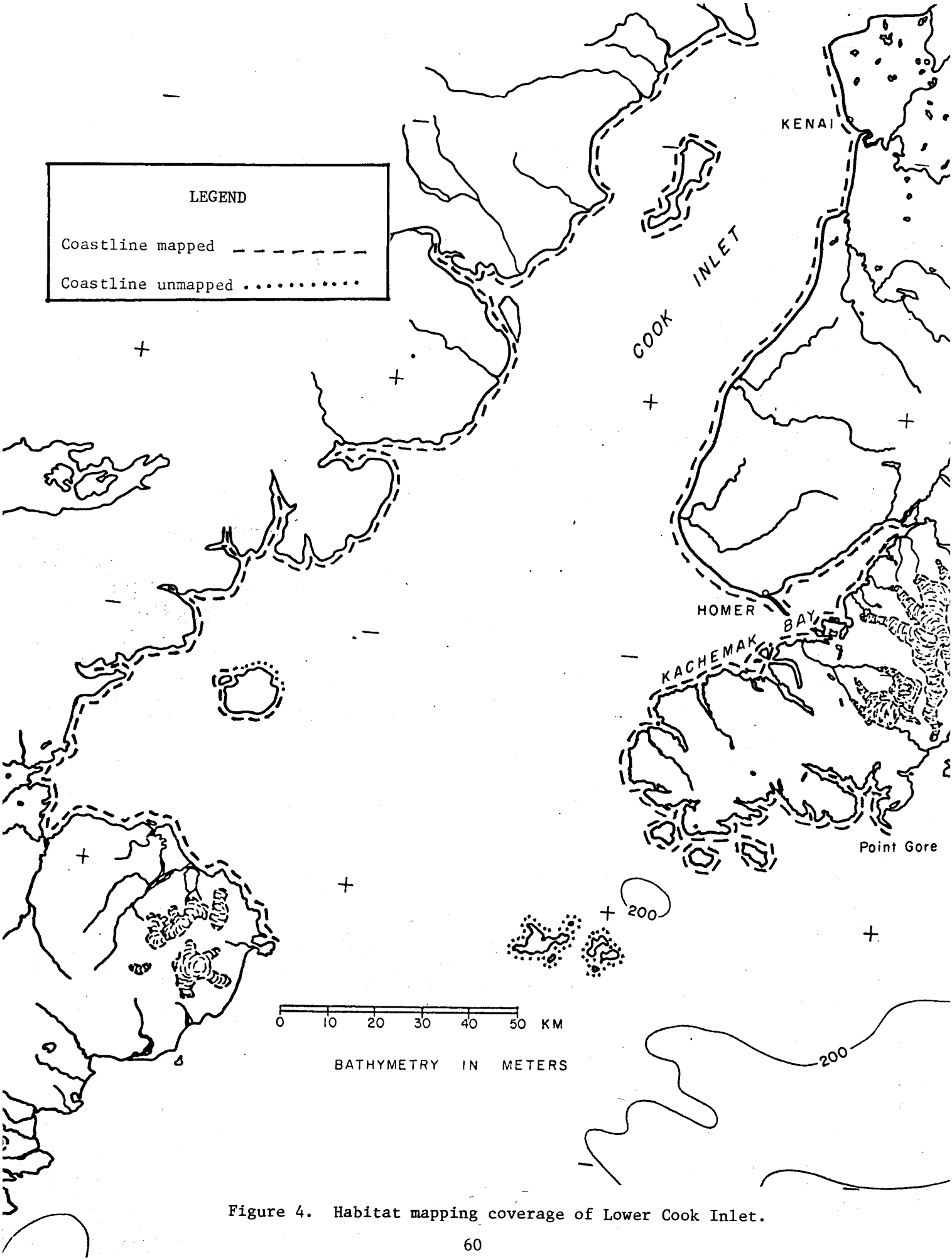

Figure 4. Habitat mapping coverage of Lower Cook Inlet.

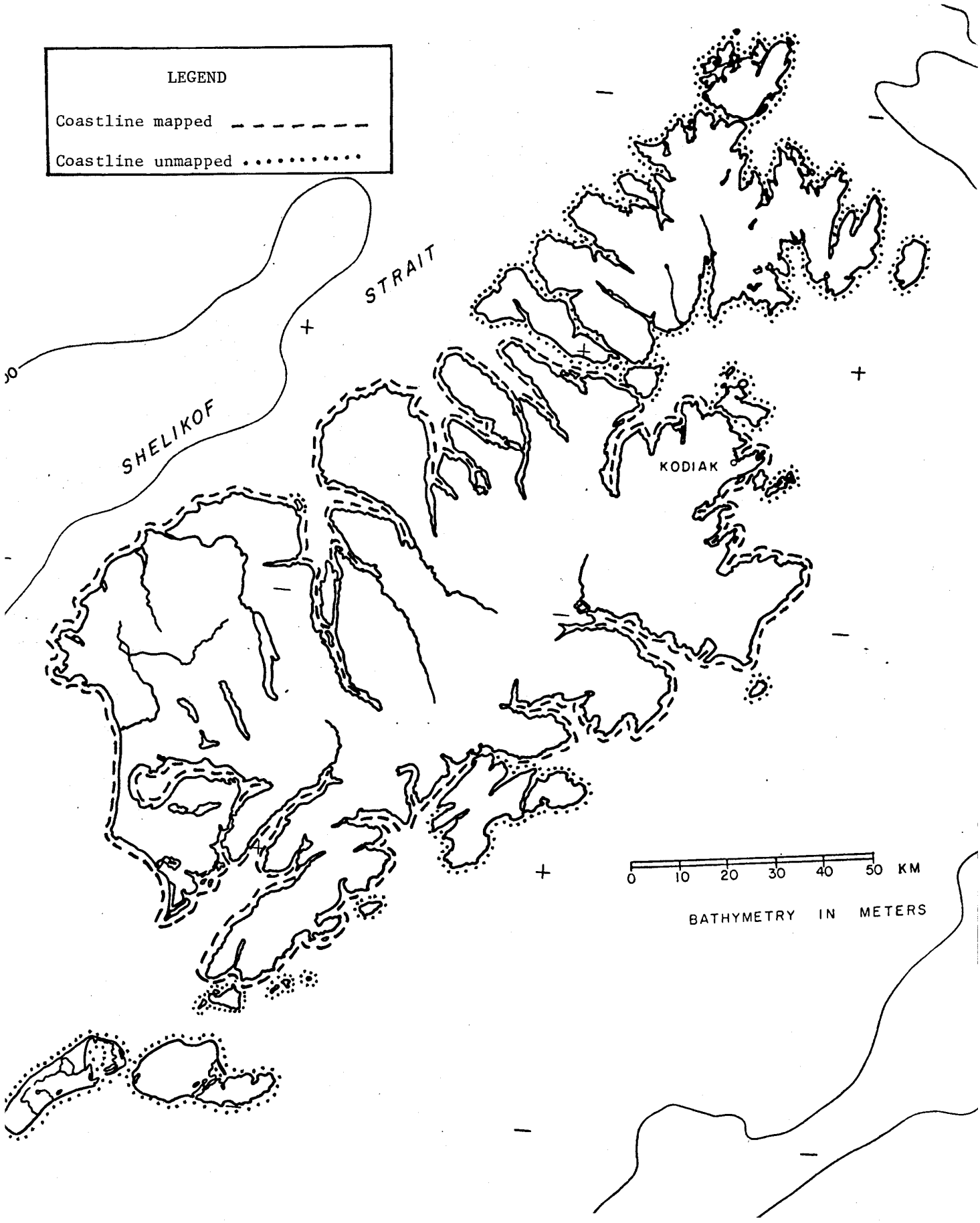

Figure 5. Habitat mapping coverage of Kodiak Archipelago.

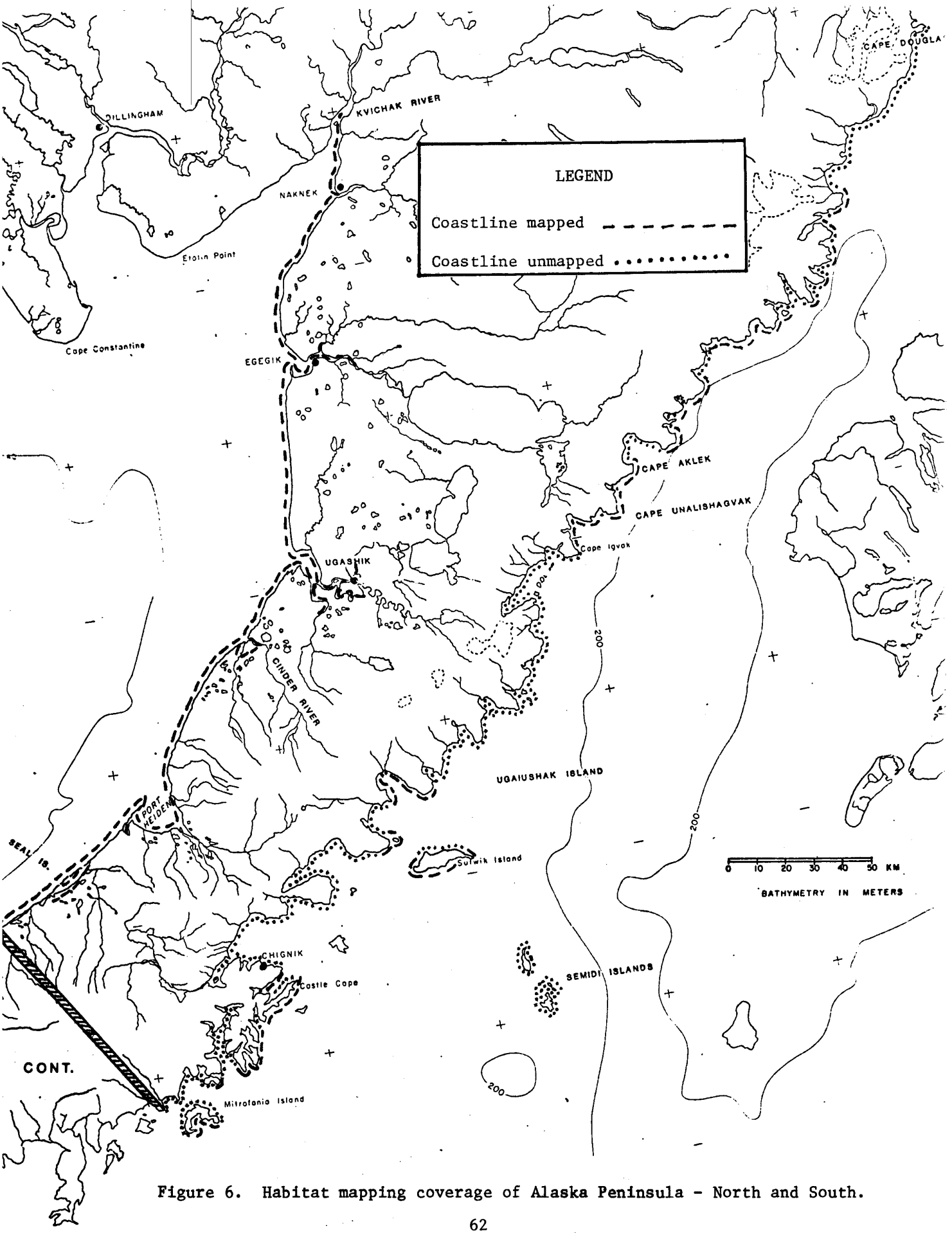

Figure 6. Habitat mapping coverage of Alaska Peninsula - North and South.

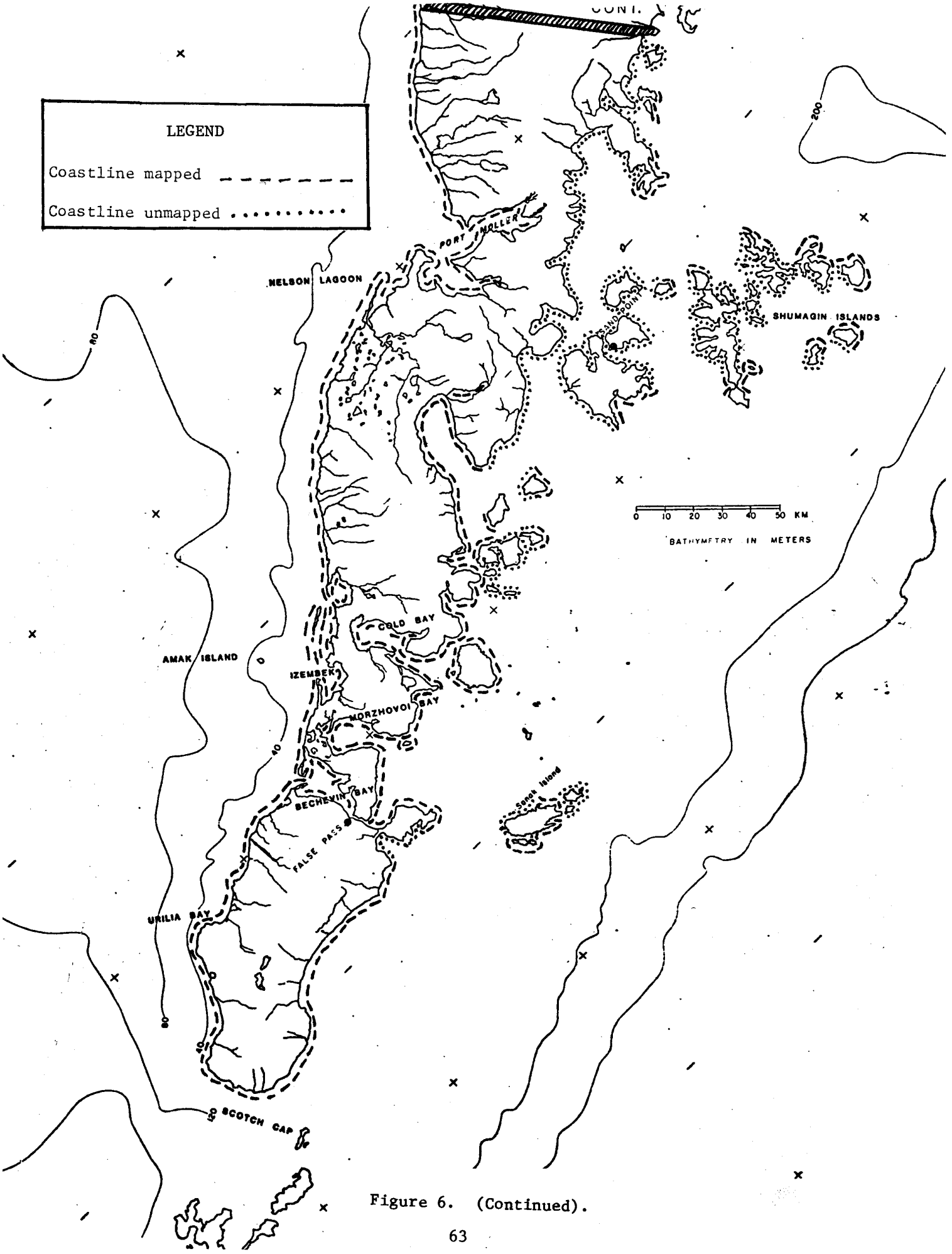

Figure 6. (Continued).

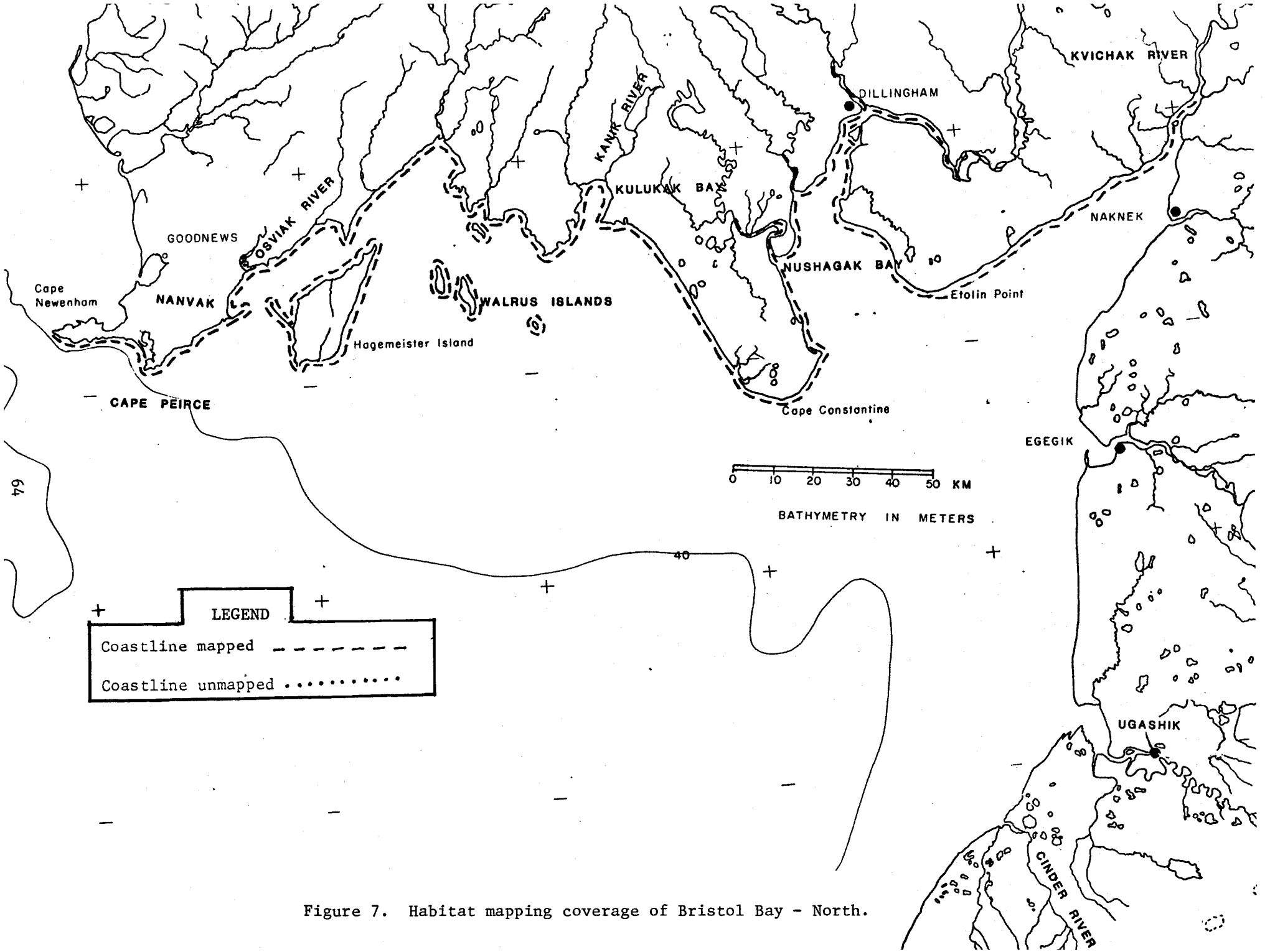

Figure 7. Habitat mapping coverage of Bristol Bay - North.

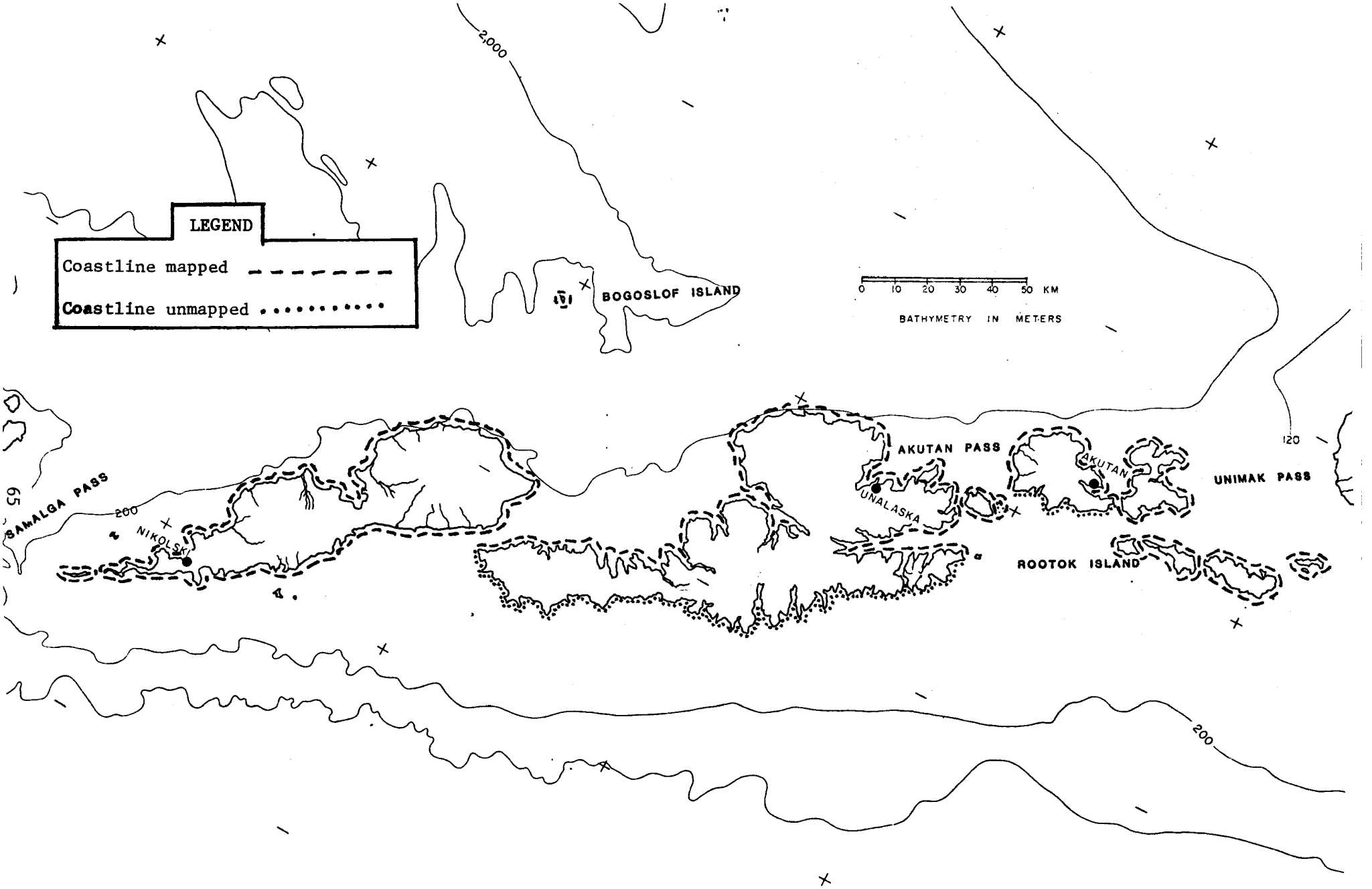

Figure 8. Habitat mapping coverage of Aleutian Shelf.

APPENDIX C

Aerial survey bird observations by water type. Compilation of nine major surveys in five subunits of the study area.

Table 1. Aerial survey bird observations by water type for Northeast Gulf of Alaska, 1-9 May 1976 (ID No. FG7604).

Species Group	WATER TYPES								
	Bay	Lagoon	Embayment	Fjord	Unprotected Shoreline	Brackish Pond or Lake	Fresh Water Pond or Lake	Lotic Environment	TOTAL
Loons	211		144	12	156				523
Grebes	12		1	5	2				20
Tubenoses									
Cormorants	270		40	8	167				485
Swans	4		6	3					13
Geese	157		1006	4	559				1726
Dabblers	1825		2866	470	447	12			5620
Divers	2279		1501	2006	236	12			6034
Sea Ducks	3787		498	1615	1315				7215
Mergansers	112		562	43	98				815
Eagles, etc.	26		48	6	105				185
Cranes					79				79
Sm. Shorebi.	3007		14,530	49	795				18,381
Med. Shore.	4329		7566	24	1052				12,971
Lg. Shorebi.	2567		625	6	59				3257
Mx. Shorebi.	10,780		11,978	155	643				23,556
Jaegers	31		55	20	8				114
Gulls	5987		5378	1593	25,982		25		38,965
Terns	1718		2085	131	2477				6411
Alcids	8			17	3662				3687
Corvids	10		7	1	7				25
Fringillids			1						1
OtherPasser.	6		52		6				64
TOTAL	37,126		48,949	6168	37,855	24	25		

Table 2. Aerial survey bird observations by water type for Lower Cook Inlet, 9-18 February 1976 (ID. No. FG7602).

Species Group	WATER TYPES: Bay	Lagoon	Embayment	Fjord	Unprotected Shoreline	Brackish Pond or Lake	Fresh Water Pond or Lake	Lotic Environment	TOTAL
Loons	29	3		12	20				64
Grebes	2				1				3
Tubenoses									
Cormorants	138	4		8	308				458
Swans									
Geese									
Dabblers	1325	159		18					1502
Divers	2369	267	227	116	73	12			3064
Sea Ducks	5691	45	119	272	3268			125	9520
Mergansers	156	65	19	2	11				253
Eagles,etc.	37	3		2	10				52
Cranes									
Sm.Shorebi.	305	2			157				464
Med.Shore.	3527				49				3576
Lg.Shorebi.	1								1
Mx.Shorebi.	495				103				598
Jaegers									
Gulls	100	36		1	1295				1432
Terns									
Alcids	107	21		87	64				279
Corvids	562				217				779
Fringillids									
OtherPasser.	1				25				26
TOTAL	14,845	605	365	518	5601	12		125	

Table 3. Aerial survey bird observations by water type for Lower Cook Inlet, 3-7 May 1976 (ID No. FG7605).

Species Group	WATER TYPES								
	Bay	Lagoon	Embayment	Fjord	Unprotected Shoreline	Brackish Pond or Lake	Fresh Water Pond or Lake	Lotic Environment	TOTAL
Loons	37	1	2	1	33	2		5	81
Grebes	16	10	5	1	16				48
Tubenoses									
Cormorants	505	20	3	4	666				1198
Swans	2							27	29
Geese	1161	1			630	4747		270	6809
Dabblers	1314	281	563		429	3639	2	968	7196
Divers	10,593	619	19	94	995	1		929	13,250
Sea Ducks	10,440	373	10	94	8047			265	19,229
Mergansers	305	257	3	10	91			50	716
Eagles, etc.	16	4			14	1		3	38
Cranes					2	65		148	215
Sm. Shorebi.	13,698	220			7326	71		65	21,380
Med. Shore.	879	38			287	8			1212
Lg. Shorebi.	18				38			5	61
Mx. Shorebi.									
Jaegers									
Gulls	8385	996	65	5	31,737	421		588	42197
Terns					7	8			15
Alcids	96	28		1	398			2	525
Corvids	34	65		9	9				117
Fringillids									
OtherPasser.	1								1
TOTAL	47,500	2913	670	219	50,725	8963	2	3325	

Table 4. Aerial survey bird observations by water type for Lower Cook Inlet, 21-25 June 1976 (ID No. FB7607).

Species Group	WATER TYPES: Bay	Lagoon	Embayment	Fjord	Unprotected Shoreline	Brackish Pond or Lake	Fresh Water Pond or Lake	Lotic Environment	TOTAL
Loons	14	1		3	77	3		7	105
Grebes	2				3				5
Tubenoses	1				1005				1006
Cormorants	156				1602			3	1761
Swans	2				40			2	45
Geese	9				38			5	52
Dabblers	705		49		478	266	65	728	2291
Divers	818	2			182	1		53	1056
Sea Ducks	18,716	517	59	21	10,061			87	29,461
Mergansers	33	2	9		60			5	109
Eagles,etc.	18	4			20			2	44
Cranes			5		1	1		6	13
Sm.Shorebi.	97		3		93	20		6	219
Med.Shore.	38		26		164	17		19	264
Lg.Shorebi.	20				11			2	33
Mx.Shorebi.								1	1
Jaegers					1				1
Gulls	14,835	138	231		34,861	4		4755	54,824
Terns	110		46		177	3		29	365
Alcids	57	31		10	5223				
Corvids	26	2	7	8	5			3	5321
Fringillids	2		2						4
OtherPasser.	7	1	2		7			23	40
TOTAL	35,666	698	439	42	54,109	315	65	5736	

Table 5. Aerial survey bird observations by water type for Lower Cook Inlet, 30 September-2 October 1976 (ID No. FG7701).

Species Group	WATER TYPES: Bay	Lagoon	Embayment	Fjord	Unprotected Shoreline	Brackish Pond or Lake	Fresh Water Pond or Lake	Lotic Environment	TOTAL
Loons	9	1		1	65			1	77
Grebes	44				31				75
Tubenoses	1			1	1				3
Cormorants	803	129		75	1792				2799
Swans									
Geese	369				132			2158	2659
Dabblers	7150	1806		208	2859	157	9	924	13,113
Divers	789	63			210	6		35	1103
Sea Ducks	5361	801		273	4150			33	10,618
Mergansers	49	43		44	30			125	291
Eagles,etc.	20	3		2	14			1	40
Cranes									
Sm.Shorebi.	16				150				166
Med.Shore.	1289	11		22	52	45		35	1454
Lg.Shorebi.									
Mx.Shorebi.									
Jaegers									
Gulls	8331	3346		373	9416			907	22,373
Terns									
Alcids	11			7	20				38
Corvids	351	139		43	172			1	706
Fringillids	2				1				3
OtherPasser.									
TOTAL	24,595	6342		1049	19,095	208	9	4220	

Table 6. Aerial survey bird observations by water type for Kodiak Archipelago, 22 February-24 March 1976 (ID No. FG7603).

Species Group	WATER TYPES								
	Bay	Lagoon	Embayment	Fjord	Unprotected Shoreline	Brackish Pond or Lake	Fresh Water Pond or Lake	Lotic Environment	TOTAL
Loons	88				8				96
Grebes	5								5
Tubenoses									
Cormorants	834	12			117				963
Swans									
Geese	79	30			22				131
Dabblers	2156	366	686						3208
Divers	4053	308	97		7				4465
Sea Ducks	14,765	765	198		1247				16,975
Mergansers	191	9			7				207
Eagles, etc.	109	11	1		42				163
Cranes									
Sm. Shorebi.	419	25			335				779
Med. Shore	176				1				177
Lg. Shorebi.	222				40				262
Ax. Shorebi.	125								125
Jaegers									
Gulls	1088	393	17		316				1814
Terns									
Alcids	2931				6				2937
Corvids	526	37	1		26				590
Fringillids									
OtherPasser.	12	12							24
TOTAL	27,779	1968	1000		2174				

Table 7. Aerial survey bird observations by water type for Alaska Peninsula-North, 13-27 October 1975 (ID No. FG7601).*

Species Group	WATER TYPES: Bay	Lagoon	Embayment	Fjord	Unprotected Shoreline	Brackish Pond or Lake	Fresh Water Pond or Lake	Lotic Environment	TOTAL
Loons	55	1	3		71				130
Grebes	9	3				1			13
Tubenoses	81				1				82
Cormorants	1128	2			542			1	1673
Swans	2		23		8			8	41
Geese	375,855	34,495	34,672		3936			767	449,725
Dabblers	11,750	2104	7972		556	321	1300	893	24,896
Divers	655	547	108		52	30	89	46	1527
Sea Ducks	84,427	11,468	19,495		24,932	6		40	140,368
Mergansers	16	3	8		13			8	48
Eagles, etc.	16	12	6		19			2	55
Cranes									
Sm. Shorebi.	1304	2528	16,818		893			271	21,814
Med. Shore.			68		143			1	212
Lg. Shorebi.	15		27		70			1	113
Mx. Shorebi.	1100	33	2053		658			4	3848
Jaegers									
Gulls	12,798	1489	4089		9156	20		56	27,608
Terns			1						1
Alcids	201	6	2		37				246
Corvids	11	7	4		18			3	43
Fringillids	361		83		378				822
OtherPasser.	24	30	64		170			4	292
TOTAL	489,808	52,728	85,496		41,653	378	1389	2105	

*Needs corrections. Water types misinterpreted by transcriber.

Table 8. Aerial survey bird observation by water type for Alaska Peninsula-North, 13-16 October 1976 (ID No. FG7702).

Species Group	WATER TYPES								
	Bay	Lagoon	Embayment	Fjord	Unprotected Shoreline	Brackish Pond or Lake	Fresh Water Pond or Lake	Lotic Environment	TOTAL
Loons		8	41		16			1	66
Grebes		6	18		3	1			28
Tubenoses									
Cormorants		26	12						38
Swans			73			94	4		171
Geese	232	136,825	64,210		616	959		860	203,702
Dabblers		4736	20,493			5114	387	727	31,457
Divers		9	224			110	440	158	941
Sea Ducks	3039	19,138	64,347		261	1		158	86,944
Mergansers		1						86	87
Eagles, etc.		8	18					3	24
Cranes									
Sm. Shorebi.		1367	40,462		3,303			162	45,294
Med. Shore.		10,517	10,004		12	17		37	20,587
Lg. Shorebi.			561			2		45	608
Mx. Shorebi.			3247		8			303	3558
Jaegers			2						2
Gulls	18	3942	14,279		751	63	21	638	19,712
Terns									
Alcids		1	6						7
Corvids		13	11		3	1			28
Fringillids		39	81		25			1	146
OtherPasser.		81	123			1			205
TOTAL	3289	176,717	218,212		4998	6363	852	3179	

Table 9. Aerial survey bird observation by water type for Bristol Bay-North, 17-20 May 1976 (ID No. FG7606).

Species Group	WATER TYPE: Bay	Lagoon	Embayment	Fjord	Unprotected Shoreline	Brackish Pond or Lake	Fresh Water Pond or Lake	Lotic Environment	TOTAL
Loons	77	1	4		238	65		21	406
Grebes	15				57			16	88
Tubenoses									
Cormorants	114		26		1480			8	1628
Swans	12		3		1	30		18	64
Geese	4404	4	715		118	21		191	5453
Dabblers	338	2	6			254		206	806
Divers	768	29	16		3820	554	2	1498	6687
Sea Ducks	658	143	5		4919	67		81	5873
Mergansers	67	6	18		316	110		180	697
Eagles,etc.					5			6	11
Cranes	11		12		4	9		46	82
Sm.Shorebi.	490	6	29		649	152		254	1580
Med.Shore.	901	52	86		755	45		176	2060
Lg.Shorebi.	26	2	1		7	1		5	42
Mx.Shorebi.	392		5		347	3		44	791
Jaegers	1				3	2		11	17
Gulls	1901	109	414		4503	229	25	1268	8449
Terns	99	126	78		573	18		97	991
Alcids	78				8455				8533
Corvids	2	1			19			2	24
Fringillids									
OtherPasser.	9		2		8	6		12	37
TOTAL	9705	481	1420		26277	1556	27	4140	

APPENDIX D

Aerial survey bird observations by physiographic feature. Compilation of nine major surveys in five subunits of the study area.

Table 1. Aerial survey bird observations by physiographic feature for Northeast Gulf of Alaska, 1-9 May 1976 (ID No. FG7604).

Species Group	PHYSIOGRAPHIC FEATURE											
	Beach	Coastal Floodplain	Intertidal Area	Tide Upwelling	Sandspit	Barrier Island	Other Island	River Delta	Stream Delta	Cliff	Manmade Structure	River Bank
Loons	294		21		16	28	9	146	9			
Grebes	8		4				1	5	2			
Tubenoses												
Cormorants	126		45		10		263	41				
Swans	7							6				
Geese	289		48		35	127	82	1113	30			
Dabblers	762		398		68	7	261	3049	1075			
Divers	2781		683		32	2	808	1991	45			
Sea Ducks	4655		734		60	8	1260	520	51			
Mergansers	108		13		29		36	617	12			
Eagles, etc.	110		4		4	7	8	47	4		1	
Cranes						79						
Sm. Shorebi.	1371		637		59		1281	14,603	366			
Med. Shore.	2309		1029		8		1565	7823	22			
Lg. Shorebi.	769		1				1830	654	2			
Mx. Shorebi.	738		10,225		150		50	12,118	275			
Jaegers	35				2			62	13			
Gulls	15,133		1879		407	3866	12,608	3920	1127			
Terns	2447		51		278	1	276	2384	974			
Alcids	421		3				3263					
Corvids	10				3		2	8	2			
Fringillids						1						
OtherPasser.	6		4				8	46				
TOTAL	32,379		15,779		1161	4126	27,743	49,153	4009		1	

Table 2. Aerial survey bird observations by physiographic feature for Lower Cook Inlet, 9-18 February 1976 (ID No. FG7602).

PHYSIOGRAPHIC FEATURE

Species Group	Beach	Coastal Floodplain	Intertidal Area	Tide Upwelling	Sandspit	Barrier Island	Other Island	River Delta	Stream Delta	Cliff	Manmade Structure	River Bank
Loons	59							5				
Grebes	3											
Tubenoses												
Cormorants	293				3		162					
Swans												
Geese												
Dabblers	277				1111			114				
Divers	1759		219		288		124	655	28			
Sea Ducks	6827		98		1606		741	443		463		
Mergansers	190		1				2	24	36			
Eagles, etc.	30		8		5		5	2		2		
Cranes												
Sm. Shorebi.	71		247		145		1					
Med. Shore.	3530				6		40					
Lg. Shorebi.	1											
Mx. Shorebi.	95		380		35		3	85				
Jaegers												
Gulls	793		8		602		5	20		4		
Terns												
Alcids	243						3	141		29		
Corvids	306		162		69		170	71		1		
Fringillids												
OtherPasser.	1						25		1			
TOTAL	14,478		1123		3870		1281	1423	65	499		

Table 3. Aerial survey bird observations by physiographic feature for Lower Cook Inlet, 3-7 May 1976 (ID No. FG7605).

Species Group	PHYSIOGRAPHIC FEATURE											
	Beach	Coastal Floodplain	Intertidal Area	Saltchuck	Sandspit	Barrier Island	Other Island	River Delta	Stream Delta	Cliff	Manmade Structure	River Bank
Loons	64		12		2		1	2				
Grebes	36		1				7			4		
Tubenoses												
Cormorants	248	1	87		31		207	1		622		
Swans	2							27				
Geese	152	4600	66		2		1046	943				
Dabblers	846	2517	1619	76			1148	771	139			80
Divers	2329	137	9671		507		263	170	133	39		
Sea Ducks	7951	144	7314		949		2332	167	7	333		32
Mergansers	269	49	313				14	54	3	12		
Eagles, etc.	15	3	12				5		1	1		1
Cranes	2	45					20	148				
Sm. Shorebi.	575	4058	14733		200		1534	105	110			65
Med. Shore.	63		155		800		192			2		
Lg. Shorebi.	17		36				2			1		5
Mx. Shorebi.												
Jaegers												
Gulls	4827	569	3816	18	1001		25958	1251	335	4002	369	3
Terns		8	7									
Alcids	185		4		1		265			70		
Corvids	78		36				2			1		
Fringillids												
OtherPasser.												
TOTAL	17,569	12,131	37,882	94	3493		32,996	3639	728	5087	369	186

Table 4. Aerial survey bird observations by physiographic feature for Lower Cook Inlet, 21-25 June 1976 (ID No. FG7607).

Species Group	PHYSIOGRAPHIC FEATURE											
	Beach	Coastal Floodplain	Intertidal Area	Tide Upwelling	Sandspit	Barrier Island	Other Island	River Delta	Stream Delta	Cliff	Manmade Structure	River Bank
Loons	34	3	6				2	50				7
Grebes	2						3					
Tubenoses	2						1004					
Cormorants	536		91		8		1091	30		8		1
Swans		2	42									
Geese		15	27				5	5				
Dabblers	138	958	870				164	85				76
Divers	455	54	468				79					
Sea Ducks	19,611		6857		193		2762					40
Mergansers	18	1	83					12	2			4
Eagles, etc.		3	8				10	5				
Cranes		6					5	1				1
Sm. Shorebi.	95	29	5				3	87				
Med. Shore.	1	41	133		16		3	70				
Lg. Shorebi.	18	1					8	6				
Mx. Shorebi.		1										
Jaegers	1											
Gulls	19,711	835	9467		1619		17,182	6182	35	179	3	63
Terns	144	66	9		6		113	28				
Alcids	170				1		515					
Corvids	31				1		2	4				
Fringillids	2						2	1				
OtherPasser.	3	6					3	1				
TOTAL	40,972	2021	18,066		1844		27,556	6567	37	187	3	192

Table 5. Aerial survey bird observations by physiographic feature for Lower Cook Inlet, 30 September-2 October 1976 (ID No. FG7701).

PHYSIOGRAPHIC FEATURE

Species Group	Beach	Coastal Floodplain	Intertidal Area	Tide Upwelling	Sandspit	Barrier Island	Other Island	River Delta	Stream Delta	Cliff	Manmade Structure	River Bank
Loons	63						8	1	4			
Grebes	60		7		2		7					
Tubenoses	3											
Cormorants	699		129		5		1921		27	18		
Swans												
Geese	4		2142				132	365				16
Dabblers	4391	60	4957		45		12	3136	245			263
Divers	754		215		24		15	67	28			
Sea Ducks	8614		1185		127		671		16			5
Mergansers	83		65					113				10
Eagles, etc.	21		5		1		10	3				
Cranes												
Sm. Shorebi.	92						74					
Med. Shore.	1314	3	13		15		29	80				
Lg. Shorebi.												
Mx. Shorebi.												
Jaegers												
Gulls	10,300		6780		921		2047	1847	333		99	46
Terns												
Alcids	25						13					
Corvids	391	1	139				162		12			1
Fringillids	2						1					
OtherPasser.												
TOTAL	26,786	64	15637		1140		5102	5612	665	18	99	341

Table 6. Aerial survey bird observations by physiographic feature for Kodiak Archipelago, 22 February-24 March 1976 (ID No. FG7603).

PHYSIOGRAPHIC FEATURE

Species Group	Beach	Coastal Floodplain	Intertidal Area	Tide Upwelling	Sandspit	Barrier Island	Other Island	River Delta	Stream Delta	Cliff	Manmade Structure	River Bank
Loons	95						1					
Grebes	5											
Tubenoses												
Cormorants	719		12	134			92				6	
Swans												
Geese	101		30									
Dabblers	2078		247		43			671	169			
Divers	3971		283	7	17		55	97	35			
Sea Ducks	10,921		594	1903			452	198				
Mergansers	194		4	8					1			
Eagles, etc.	100		7		1		23	1		31		
Cranes												
Sm. Shorebi.	754		25									
Med. Shore.	121			6			50					
Lg. Shorebi.	62						200					
Mx. Shorebi.	125											
Jaegers												
Gulls	1479		106	73	22		113	17	4			
Terns												
Alcids	2896			37			3					
Corvids	506		7	5			19	1	50	1	1	
Fringillids												
OtherPasser.	23						1					
TOTAL	24,150		1315	2173	83		1009	985	259	32	7	

Table 7. Aerial survey bird observations by physiographic feature for Alaska Peninsula-North, 13-27 October 1975 (ID No. FG7601).*

Species Group	PHYSIOGRAPHIC FEATURE											
	Beach	Coastal Floodplain	Intertidal Area	Tide Upwelling	Sandspit	Barrier Island	Other Island	River Delta	Stream Delta	Cliff	Manmade Structure	River Bank
Loons	122		2			1		3				
Grebes	6	1					4					
Tubenoses	75		3				4					
Cormorants	1663		7			2		1				
Swans	16	8						31				
Geese	402,061	12	7083		792	2796	595	34,911				
Dabblers	13,790	1765	142					9199				
Divers	1042	101	225					154				
Sea Ducks	96,930	18	8434		81	11,256	3513	19,165				
Mergansers	27	8						13				
Eagles, etc.	42		5					8				
Cranes												
Sm. Shorebi.	1919	277	303		2	2448	118	16,747				
Med. Shore.	21	1						190				
Lg. Shorebi.	35	50						28				
Mx. Shorebi.	1179	612						2057				
Jaegers												
Gulls	16,406	331	3455		1047	837	399	4065				
Terns								1				
Alcids	182		35			4	6	2				
Corvids	34						2	7				
Fringillids	358	41	320				20	83				
OtherPasser.	161	22				30	20	59				
TOTAL	536,069	3247	20,014		1922	17,374	4681	86,724				

*Needs corrections. Physiographic features misinterpreted by transcriber.

Table 8. Aerial survey bird observations by physiographic feature for Alaska Peninsula-North, 13-16 October 1976 (ID No. FG7702).

PHYSIOGRAPHIC FEATURE

Species Group	Beach	Coastal Floodplain	Intertidal Area	Tide Upwelling	Sandspit	Barrier Island	Other Island	River Delta	Stream Delta	Cliff	Manmade Structure	River Bank
Loons	12		36					14				
Grebes	3	1	17			2		5				
Tubenoses												
Cormorants			26	4				12				
Swans		24						143				
Geese	1355	12,790	40,510		1858	9366	11,339	26,049				260
Dabblers		3761	6416				6985	14,163	130			115
Divers	2	20	201					343				
Sea Ducks	3202	3	48,142		429	5551	42	29,575				
Mergansers			1					86				
Eagles, etc.	3	2	6		5		2	9		1		1
Cranes												
Sm. Shorebi.		570	15,422		3678	3495	8010	14,034				85
Med. Shore.		1853	8,069		13	2366	2629	5623				34
Lg. Shorebi.					20			588				
Mx. Shorebi.			8			1200	1500	550				300
Jaegers								2				
Gulls	652	289	5272		3272	1891	4669	3069	478			61
Terns												
Alcids			6					1				
Corvids	3	1	11		2	1		10				
Fringillids	25	37				54	25	5				
OtherPasser.		140	8				50	7				
TOTAL	5257	19,491	24,151	4	9277	23,926	34,751	94,288	608	1		856

Table 9. Aerial survey bird observations by physiographic feature for Bristol Bay-North, 17-20 May 1976 (ID No. FG7606).

Species Group	Beach	Coastal Floodplain	Intertidal Area	Tide Upwelling	Sandspit	Barrier Island	Other Island	River Delta	Stream Delta	Cliff	Manmade Structure	River Bank
Loons	293	79	16		1			4				10
Grebes	68	2	1		1					2		14
Tubenoses												
Cormorants	1384	4	11		10		137	26		51		5
Swans		45	6					2				11
Geese	3512	252	985		5		8	677				23
Dabblers	40	649	46				43	3				60
Divers	2071	1656	2286				17	32	12			1150
Sea Ducks	4490	99	764		112		90	39		244		62
Mergansers	369	141	31					18				158
Eagles, etc.	3	3	1					2				2
Cranes	2	61	9				3	15				2
Sm. Shorebi.	411	522	500		35		74	5				26
Med. Shore.	1289	573	136		4		39	7				5
Lg. Shorebi.	19	12	5				9	1				1
Mx. Shorebi.	631	10	2				100	5				43
Jaegers	2	12					1					5
Gulls	4120	1707	1196		141		465	82	169	314	17	729
Terns	447	158	274		43			36	9			41
Alcids	434		18		236		5879			1966		
Corvids	20	9	2									1
Fringillids												
OtherPasser.	6	30	5									
TOTAL	19,611	5994	6294		588		6865	954	190	2577	17	2348

APPENDIX E

Aerial survey bird observations by substrate type. Compilation of nine major surveys in five subunits of the study area.

Table 1. Aerial survey bird observations by substrate type for Northeast Gulf of Alaska, 1-9 May 1976 (ID No. FG7604).

Species Group	SUBSTRATE TYPE									
	Mud	Sand	Gravel	Rock	Mud & Sand	Sand & Gravel	Sand, Gravel & Rock	Water	Land Ice	Sea Ice
Loons								523		
Grebes								20		
Tubenoses										
Cormorants				150				335		
Swans	2							11		
Geese	647	49		18			190	625		
Dabblers	391	33		10		24		4106	5	3
Divers	27			7				6308		
Sea Ducks		20						7268		
Mergansers				1				814		
Eagles, etc.	21	106	4	7		6		12	7	
Cranes								79		
Sm. Shorebi.	14,890	1599		35	145	300	23	857	65	
Med. Shore.	10,041	615		1581	25	6		272	26	
Lg. Shorebi.	2099	98		700	2			43		
Mx. Shorebi.	21,148	283					600	1280		
Jaegers	27	10	2			9		25	2	2
Gulls	4218	12,147	298	7267	1	723	241	10,377	49	42
Terns	852	2589	4	3	30	357		1485	40	
Alcids								3687		
Corvids	2	7		6				3		
Fringillids		1								
OtherPasser.	30	5		1		5		18		2
TOTAL	54,395	17,562	308	9786	203	1430	1054	38,148	194	49

Table 2. Aerial survey bird observations by substrate type for Lower Cook Inlet, 9-18 February 1976 (ID No. FG7602).

Species Group	SUBSTRATE TYPE									
	Mud	Sand	Gravel	Rock	Mud & Sand	Sand & Gravel	Sand, Gravel & Rock	Water	Land Ice	Sea Ice
Loons								64		
Grebes								3		
Tubenoses										
Cormorants				65				393		
Swans										
Geese										
Dabblers	60							1442		
Divers	138			3				2871		57
Sea Ducks			5	20				9946		207
Mergansers		1						226		24
Eagles,etc.	2		8	6				1	1	
Cranes										
Sm.Shorebi.	127		20	1						
Med.Shore.	3281		4	17						
Lg.Shorebi.										
Mx.Shorebi.	180		35	30				87	200	
Jaegers										
Gulls				3	5	15		963	7	8
Terns										
Alcids								274		
Corvids	2		3	6				2	7	
Fringillids										
OtherPasser.				25				1		
TOTAL	3790	1	75	176	5	15		16,273	215	296

Table 3. Aerial survey bird observations by substrate type for Lower Cook Inlet 3-7 May 1976 (ID No. FG7605).

Species Group	SUBSTRATE TYPE									
	Mud	Sand	Gravel	Rock	Mud & Sand	Sand & Gravel	Sand, Gravel & Rock	Water	Land Ice	Sea Ice
Loons								75		
Grebes								48		
Tubenoses										
Cormorants				474				473		
Swans					27			2		
Geese	3193			530	1682	675		153		
Dabblers	615			10	662	5		4574		
Divers				100				13,129		
Sea Ducks			15	43		1232		17,834		
Mergansers				4		53		654		
Eagles, etc.	5		2	3	1	3	1	4		
Cranes					193			2		
Sm. Shorebi.	17,314		40	50	425	1438		40		
Med. Shore.	138			184	810	16		18		
Lg. Shorebi.	41			14				1		
Mx. Shorebi.										
Jaegers										
Gulls	1497	923	1575	658	820	888	40	2585	8	
Terns	10							5		
Alcids				41				484		
Corvids			26	1		8	14	7		
Fringillids										
OtherPasser.										
TOTAL	22,813	923	1658	2112	4620	4318	55	40,088	8	

Table 4. Aerial survey bird observations by substrate type for Lower Cook Inlet, 21-25 June 1976 (ID No. FG7607).

Species Group	SUBSTRATE TYPE									
	Mud	Sand	Gravel	Rock	Mud & Sand	Sand & Gravel	Sand, Gravel & Rock	Water	Land Ice	Sea Ice
Loons								102		
Grebes								5		
Tubenoses								1006		
Cormorants	13			848				904		
Swans	2							42		
Geese								47		
Dabblers	437							1841		
Divers	53							1003		
Sea Ducks		32	40	28			64	28,409		
Mergansers	2							169		
Eagles, etc.	3		4	6		1	1			
Cranes	6							1		
Sm. Shorebi.	38							20		
Med. Shore.	68				4			127		
Lg. Shorebi.	4		10	13						
Mx. Shorebi.	1									
Jaegers										
Gulls	8091	8119	3790	10,303	35	61	409	1953		
Terns	94							46		
Alcids				264				5042		
Corvids	3			1						
Fringillids	3									
OtherPasser.										
TOTAL	8818	8151	3844	11,463	39	62	474	40,717		

Table 5. Aerial survey bird observations by substrate type for Lower Cook Inlet, 30 September-2 October 1976 (ID No. FG7701).

Species Group	SUBSTRATE TYPE									
	Mud	Sand	Gravel	Rock	Mud & Sand	Sand & Gravel	Sand, Gravel & Rock	Water	Land Ice	Sea Ice
Loons								76		
Grebes				1				75		
Tubenoses								3		
Cormorants		2	1	1734				1062		
Swans										
Geese	2523			132				4		
Dabblers	2480		40	83				10,218		
Divers		15	28					1058		
Sea Ducks		44		11				9565		
Mergansers	2							289		
Eagles, etc.	8	4	2	10				3		
Cranes										
Sm. Shorebi.	91	55		8				12		
Med. Shore.	99	3	1200	112				23		
Lg. Shorebi.										
Mx. Shorebi.										
Jaegers										
Gulls	9889	920	2840	1798		262		4572		53
Terns										
Alcids				1				38		
Corvids				295				131		
Fringillids				2				1		
OtherPasser.										
TOTAL	15,092	1043	4141	4187		262		27,130		53

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