92 ~~DAVID NYSEWANDER COPY~~

Sowls

RESULTS OF A MARINE BIRD AND MAMMAL SURVEY OF THE WESTERN ALEUTIAN ISLANDS SUMMER 1978

Robert H. Day
Brian E. Lawhead
Tom J. Early
Elaine B. Rhode

ALEUTIAN ISLANDS NATIONAL WILDLIFE REFUGE

January 1979

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (con't)

LIST OF FIGURES (con't)

LIST OF FIGURES (con't)

LIST OF FIGURES (con't)

LIST OF TABLES

LIST OF TABLES (con't)

LIST OF TABLES (con't)

LIST OF TABLES (con't)

I. INTRODUCTION

The 1978 field season of the Aleutian Islands National Wildlife Refuge continued a wildlife inventory program begun in 1977. The main objectives of the program are to survey and census all islands within the refuge with special emphasis on describing marine bird and mammal colonies.

The Aleutian Islands and their wealth of wildlife play an important role in the marine ecosystem of the subarctic North Pacific Ocean and the Bering Sea. Nevertheless, the overall biology of the Aleutian Islands Refuge and the magnitude of its populations are poorly known as a result of remoteness and inaccessibility. Highlights of the biological knowledge gained during the few previous studies are discussed in Day et al. (1978).

The results of the 1978 field season are presented in this report. In addition to census work on marine birds and mammals, the field crew accomplished numerous other projects to expand wherever possible information on Aleutian Islands and their fauna and flora:

1) Pelagic bird transects and locations of cetacean sightings were recorded as part of long-term projects for determining the distribution and abundance of these animals within the Aleutians.

2) Murre activity patterns were studied at Agattu Island to aid in planning future census techniques for the two species.

3) Permanent monitoring plots were set up and worked on various islands to document long-term population changes of marine birds.

4) Intensive initial studies were conducted at the auklet colony on Kiska Island to catalog the colony and to better understand these birds, the most abundant marine bird species in the Aleutians.

5) Terrestrial transects and plots were worked on islands recently eliminated of foxes, in order to observe the effects of foxes on terrestrial bird communities in the Aleutians.

6) Raptor aerie locations and populations were recorded to develop a catalog of Aleutian raptor aeries for future monitoring.

7) Beached animal surveys were run to determine natural mortality of marine birds and mammals in the Aleutians.

Despite the accomplishments, the work completed in the 1978 season was only a fraction of what was scheduled. Poor weather, mechanical difficulties, scheduling conflicts, and numerous other problems combined to drastically reduce the field crew's efficiency. The remaining available work time was used to advantage: Table 1 presents the timetable of activities in the 1978 field season.

The authors of this report would like to acknowledge and thank the following people for their aid in the summer's project:

Kent Hall assisted in collection of the field data and in editing this report.

Personnel of the Refuge Office in Adak aided in numerous ways throughout the field season.

Dennis Woolington and Dan Yparraguirre allowed us to share their Aga Cove camp during storm and sun.

Personnel of the Amchitka Field Station provided hot showers, good food, and fine companionship.

The crew of the R/V Aleutian Tern was the lifeline during the project and provided mighty fine food and companionship and excellent boatsmanship.

G. V. Byrd, D. D. Gibson, and R. D. Jones offered background information on the Aleutians from previous work in the islands.

This report is dedicated to the handfull of explorers and biologists who have given us a finer appreciation for this last stretch of true frontier in Alaska.

Table 1. Schedule of events for the 1978 field season.

DATE	PERSONNEL AND PLACES	ACTIVITY
17 May	Day, Lawhead, Rhode aboard *R/V Aleutian Tern* at Kodiak	
27 May-4 Jun	Day, Lawhead, Rhode aboard *Tern* from Kodiak to Adak	pelagic transects
28 May	Day, Lawhead, Rhode ashore Baby Islands	census colonies
5-15 Jun	At Adak	
19-23 Jun	Day, Early, Hall, Lawhead, Rhode ashore Agattu	aid with Goose Release
23 Jun-6 Jul	same ashore Agattu	census cliff-nesters, permanent plots, beached animal surveys
7-10 Jul	Day, Early, Lawhead, Rhode ashore Nizki and Alaid	census sea lions, beached animal surveys terrestrial transects
13-25 Jul	Day, Hall, Lawhead, Rhode ashore Buldir	permanent plots, beached animal survey, census sea lions,
26 Jul	Day, Early, Hall, Lawhead, Rhode at Kiska	coastline surveys
27-28 Jul	same ashore Sirius Point (old flow)	map auklet colonies, auklet plots
29,31 Jul	same ashore Sirius Point (new flow)	auklet plots
1-8 Aug	same ashore Sirius Point (old flow)	auklet plots
9-11 Aug	same at Kiska	coastline surveys, beached animal survey, census sea lions
12 Aug	same at Little Kiska and Tanadak	coastline surveys, beached animal survey, census sea licus
13 Aug	Same at Amchitka	end of season

II. CENSUS TECHNIQUES

Following the system set in 1977, our methods for censusing marine birds and mammals were catagorized by two basic techniques: coastline surveys and onshore counts. Coastline surveys involved recording the number of individuals of each species encountered while circumnavigating each island in a Zodiac boat. In order to record the location of these sightings, the perimeter of an island was divided into segments (transects), the length of each transect depending upon species densities espected and the presence of distinguishing topographic features to aid in replication of boundaries. The distance between observers and shoreline varied from 25 to 500 m, reflecting the width of the kelp band surrounding an island.

Onshore counts, used mostly for birds, were made in areas where systematic sampling of the species present lent itself to a better estimate of the population. Methods varied from burrow-sampling to a census technique based upon a bird's diurnal rhythm activities.

In all cases, the goal was to use a uniform set of techniques that minimized observer error and allowed repetition. In addition, methods needed to be sufficiently precise to enable detection of real changes in populations and to allow monitoring of population trends. Only data from permanent census plots are sufficiently precise to be used in the latter context. The major problem is that any censusing program is a compromise (albeit sometimes poor) between the need for accuracy and the need for speed.

The following discussion lists the techniques used in censusing and in estimating bird and mammal populations in the Aleutian Islands. This will form the basis both for a set of uniform methods to be used within the Aleutians and for a starting point in further discussions on census techniques.

Northern Fulmar

All colonies located were recorded on large-scale maps. Counts were made of all birds in flight above the colony. Although detailed counts of the number of nests present are preferable to flight counts, colonies in the Aleutians are generally inaccessible due to topography; Nettleship (1976) discusses methods for censusing from nest counts.

In extrapolating our estimates from flight counts, we assumed the following: (1) all the birds had been flushed from the nests; (2) one-half of the population (i.e., one member of each pair) was off feeding at sea; and (3) approximately 35% of the birds present in a colony were non-breeders (Hatch 1977, 1978).

# of breeding pairs = (# of birds counted) X (0.65)

However, the estimation of the actual number of pairs is much more complex. Populations of birds on colony vary widely during the course of a season, depending on the stage of breeding and reproductive success. Data from Hatch (1977, 1978) show that population estimates may vary as much as 1,000% from the actual breeding population. In addition, Dott (1975) discusses the importance of weather and time of day to colony attendance. This, censusing Northern Fulmars is an extremely complex project that needs further exploration. Indeed, it becomes questionable whether the estimates for Fulmar colonies which were derived in the 1977 field season are actually worth quoting.

Leach's Storm Petrel and Fork-Tailed Storm Petrel

All colonies located were recorded on maps. Although a systematic burrow count is the preferred method (Nettleship 1976; Byrd 1976), this method is not feasible in most of the Aleutians because of difficulties associated with locating nest-sites. Presumably, foxes have forced most petrels to nest in crevices rather than their preferred burrow nests.

Double-Crested Cormorant, Pelagic Cormorant, and Red-Faced Cormorant

The first species nests only as far west as the Islands of the Four Mountains in the Eastern Aleutians. The technique for censusing this species was the same as for the latter two more common species.

All colonies observed were recorded on maps. Colony location is especially important since cormorants frequently change nesting cliffs from year to year. The numbers of occupied (active) nests were tallied for each species; use of unoccupied nests is discussed under "cormorant species". Numbers of birds not on colony were identified by species when possible to gain an idea of species ratios;

however, this was possible in very few cases.

# of breeding pairs = # nests occupied (for any given species)

Cormorant Species

The calculation process for the numbers of cormorants relied on the results of the estimation of breeding pairs of individual species, discussed in the preceeding listing.

For all colonies or nests that were mapped, unoccupied nests were listed in this "species" category. Also, all flying or feeding cormorants seen during the course of the coastline survey were recorded. Then, using the assumption that one member of each breeding pair of an individual species was away from the nest, we subtracted the number of breeding pairs (not birds) of identified species from the total number of cormorants counted to determine the number of non-breeders.

# of non-breeders = (# birds counted) - (# breeding pairs of individual species)

# of nests = # of nests counted

Note that the number of non-breeders would include both immatures and non-breeding adults.

An attempt to determine specific identification and age of as many birds as possible was made, but this was generally too time-consuming for the data it yielded.

Glaucous-winged Gull

All colonies located were recorded on maps. Counts of individual adults, immatures, and fledglings were recorded. The sum of the number of adults seen was divided by two to calculate the number of breeding pairs. This technique probably over-estimates the number of breeding pairs because no correction factor is used to account for non-breeding adults. Totals were calculated for the numbers of immatures and fledglings seen.

# of breeding pairs = (# of adults) ÷ 2

# of immatures = # of immatures

A more preferred method of censusing (especially on large colonies) is a sampling scheme of actually counting nests, as discussed in Nettleship (1976). However, on islands with foxes present, gulls select nest sites on inaccessible areas.

<u>Black-legged Kittiwake</u> and <u>Red-legged Kittiwake</u>

All colonies located were recorded on maps. All nests were counted since each represented a breeding pair. A nest was defined as a structure which appeared large enough to contain an egg. All colonies were photographed for later detailed counts.

# of breeding pairs = # of nests counted

When counting nests, it is preferable to subdivide the cliff-face into smaller sections, especially in large colonies. While this reduces the possibility of great error in counting, it does not completely eliminate it. Brun (1971) demonstrated that repetitive counts on the same cliff are best for more accurate estimates of numbers of nests, and showed that single counts may have a counting error of up to 2.5% of the estimated number of nests (the mean value of the number of nests counted in all repetitive counts). This method is certainly something to strive for, but would be far too time-consuming in extremely large colonies.

<u>Arctic Tern</u> and <u>Aleutian Tern</u>

All colonies located were recorded on maps. All birds that flew over the nesting area were counted when flushed. The number of adult birds counted was then divided by two to obtain the number of breeding pairs.

$$\# \text{ of breeding pairs} = (\# \text{ of adults counted}) \div 2$$

White et al. (1977) used this technique to census the large, low-density tern colonies on Amchitka Island. It appears to be the most reasonable technique and may be critically important for low-density colonies in that the added disturbance from a large-scale sampling scheme (see Nettleship 1976) would probably cause great desertion in these easily-disturbed species. However, if these counts are done during the chick-rearing stage, the number of breeding pairs would be underestimated by this technique.

On small offshore islands where these species sometimes nest, the entire island would be censused for nests (if it was early in the breeding season). Otherwise, the number of birds over the colony would be counted, as discussed above.

Common Murre and Thick-billed Murre

All colony sites located were recorded on maps and photographed. A visual count of individual birds was made and recorded in terms of numbers of birds present at a certain time of day. Data were then analyzed following the procedure outlined in "Section IX - Murre Study Plots".

Pigeon Guillemot

The number of birds observed during each coastline survey was recorded: any large concentrations (fairly rare) were noted on a map. We subjectively estimated that only 50% to 60% of those birds present were counted due to the advanced state of the breeding season. This corrected estimate of the number of breeding birds was then divided by two, in order to determine the number of breeding pairs.

$$\# \text{ of breeding pairs} = [(\# \text{ of birds counted})\ (1.8)] \div 2$$

Kittlitz's Murrelet

This species is sufficiently rare in the Aleutians to be noted simply as absent or present and to record location and number of birds when present.

Ancient Murrelet

As discussed in the storm-petrel section, the most accurate way of estimating a burrow-nesting species is to make a burrow count, either by direct census or in random plots. This is usually impossible in the Aleutians, so most of the estimates are subjective. For a more thorough discussion of the main techniques, see the previous account for storm-petrels.

Parakeet Auklet

This species generally nests in low density along most coastlines in the Aleutians. Hence, the estimator used is primarily the same as for the other low-density species. The main assumption is that 50% of the breeding birds were seen on each coastline census; the corrected number was then divided by two to calculate the number of breeding pairs. (However, since 0.5 and 2 are reciprocals, they divide out in the formula, leaving the number of pairs essentially the same as the number of birds counted.)

$$\#\text{ of breeding pairs} = \#\text{ of birds counted}$$

Parakeet Auklets occasionally nest in colonies along with the *Aethia* auklets; when this happens, the census technique follows that used for those species (see next discussion).

Crested Auklet, Whiskered Auklet, and Least Auklet

These birds are probably the most difficult of all the Aleutian seabird species to census. Censusing them is a time-consuming project since many plots are needed for accuracy and each plot takes one evening for a person to complete.

The census technique is based upon auklet work done by Byrd and Knudtson (in prep.) on Buldir Island in 1976, with a slight modification in 1977 (Day et al. 1978). These species show very specific patterns of arrival and departure on the colony throughout the day (see Fig. 1 for a schematic chart of colony attendance). Since the patterns diverge most during the evening hours, this is the best time to census auklets. The essential premise of the census technique is that the number of birds entering the talus minus the number of birds leaving (plus a correction factor for the number which just stand around on the rocks) yields a reasonably good estimate of the total number of breeding birds in the colony.

The assumptions underlying this technique are that: (1) daily changes in colony attendance are not great; (2) both members of a pair enter their nest site daily after 1800 hours during the post-hatching period; and (3) non-breeders comprise an insignificant part of the colony population during the chick-rearing stage.

The following is a detailed description of the sampling and estimation schemes.

A. Sampling Scheme

1) Examine the colony on foot and delineate the area covered by the colony on a map.

2) Divide the total area covered by the colony into 100 m^2 (10 X 10 m) plots.

3) Sample these plots either randomly or as a replicative sample with plots laid on a compass bearing. It is better to use the latter method on large colonies for ease in relocating plots. Select as many plots as time will allow for examination.

4) Locate these plots in the field and mark the corners with permanent markers.

5) Conduct counts during alternate 15-minute periods starting when there first appears to be a net number of birds into the plot. This varies from colony to colony, but generally begins between 1630 and 1900 hours. End the counts as late as possible (preferably either when lack of visibility prohibits further observations or when birds stop moving). Make all counts from the same observation post, located at least five meters from the edge of the plot (to avoid disturbance to the birds).

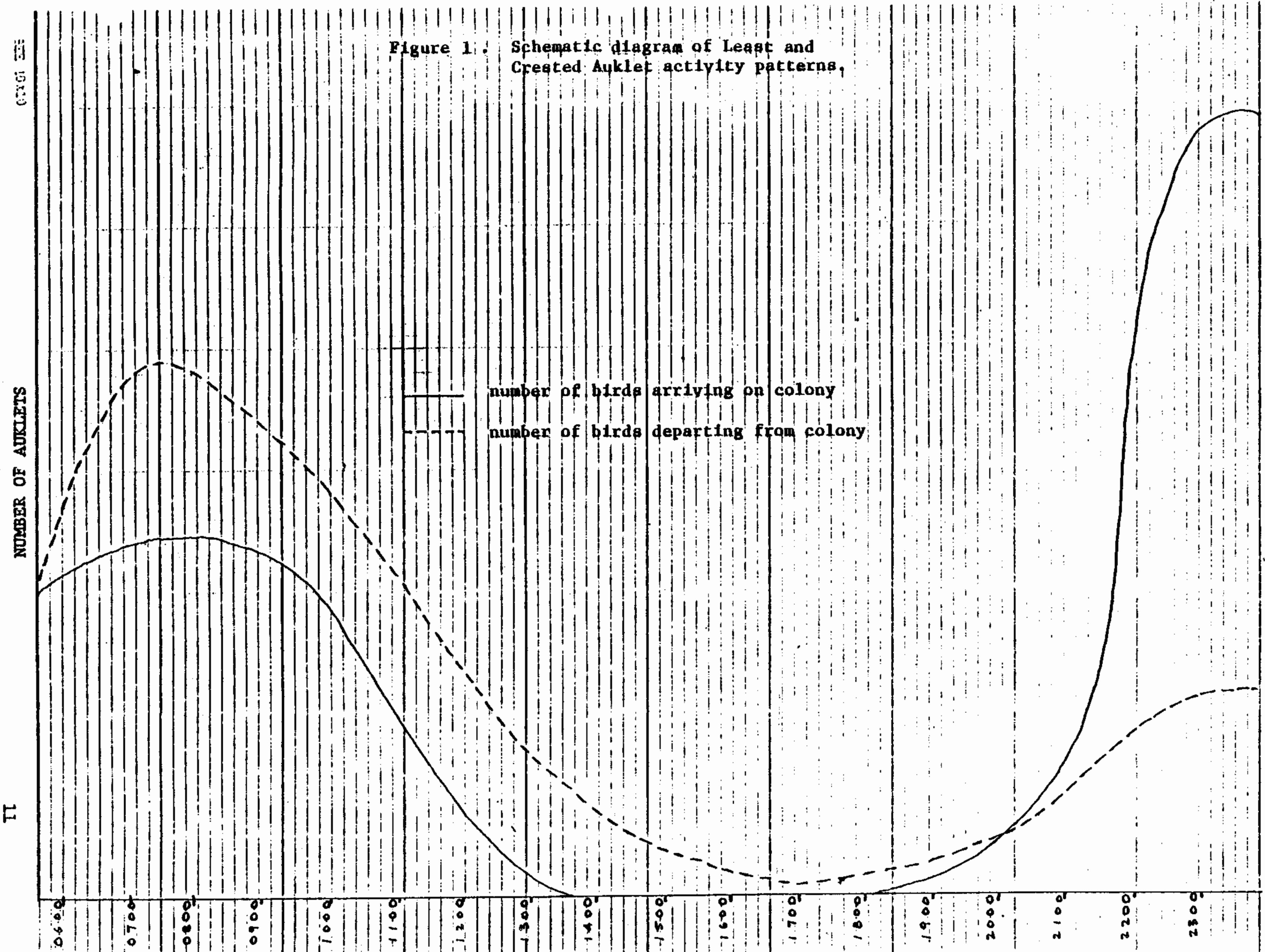


Figure 1. Schematic diagram of Least and Crested Auklet activity patterns.

6) Record the following plot characteristics before counting each plot:

    (a) the stage of the breeding cycle (i.e., egg-laying, incubation, or size of the chick),

    (b) weather conditions (wind speed, direction, temperature, barometric pressure, and precipitation),

    (c) the location of the plot (in the colony),

    (d) altitude, aspect (°True), elevation and distance from water,

    (e) percentage of vegetation cover and vegetation type,

    (f) approximate talus size and depth,

    (g) observer,

    (h) date.

7) Record the following for <u>each</u> species during <u>each</u> 15-minute count:

    (a) the number of birds standing on the surface of the plot at the moment the count begins,

    (b) the number of birds landing on the surface of the plot during the entire observation period,

    (c) the number of birds leaving the surface of the plot during the entire observation period,

    (d) the number of birds standing on the surface of the plot at the moment the count ends,

    (e) all disturbances which cause 50% or more of the birds on the plot to depart,

    (f) the time of the count, and

    (g) any other pertinent information affecting the numbers of birds in the count.

B. Estimation Scheme

1) Record the data in the following manner:

Time		Symbol (for any species)
t_1	# of birds at the beginning of each 15-minute count	a
	# arrivals	b
	# departures	c
t_2	# of birds at the end of each 15-minute count	d

2) The net number of birds arriving at each plot during each 15-minute period equals the number of birds arriving (b) minus the number of birds departing (c), plus the number of birds standing on the rocks at the beginning of the count (a) minus the number of birds standing at the end of the count (d).

$$\text{net number of birds arriving} = (b-c) + (a-d)$$

3) Sum the net totals of each 15-minute period for each species and double it since observations were made for only one-half the evening (15 minutes out of each half-hour period). This equals the total estimate (X) for the net number of birds that entered the plot that evening.

4) Sum total net values (X) of all plots worked and then calculate a mean and standard deviation for the plots (again for each species). In most cases the inter-plot variation is great enough and plots are few enough in number that the standard deviation generally is close to the mean in size.

5) Variance (s^2) is calculated as follows:

$$s^2 = \frac{(\sum_{i=1}^{n} X_i - \bar{X})^2}{n-1}$$

where X_i = net number of birds in any particular plot

$\bar{X}$ = average net number of birds per plot

n = the total number of plots in the sample

6) The total number of birds of a particular species in the colony equals the mean number of birds per plot multiplied by the total number of plots in the colony (N).

$$\# \text{ of birds} = \bar{X} \cdot N$$

This estimator scheme should be calculated for each species.

7) The standard deviation of this estimate is the sample standard deviation (square root of the variance) multiplied by the total number of plots in the colony.

Horned Puffin and Tufted Puffin

The preferred method of censusing these species is to census burrows in random plots. However, inaccessibility of puffin burrows in most cases makes this technique unusable in the Aleutians. This is critical since these birds nest in low densities along all of the coastline. Thus, a technique of only censusing large concentrations would lead to an underestimation of the numbers of puffins actually present.

All colonies located were recorded on maps. The number of birds observed during coastline surveys was also recorded. The assumption was made that only 10% of the birds present in the area surveyed were seen. The corrected estimate for the number of birds was then divided by two, in order to calculate the number of breeding pairs.

$$\# \text{ of breeding pairs} = [(\# \text{ of birds counted})(10)] \div 2$$

This was the estimator for low-density populations. However, the method of estimation for small offshore rocks with more concrete numbers of birds in a small area was slightly different. It consisted of a subjective field estimate of the number of pairs present, determined directly by the number of birds seen around the island and the amount of available habitat.

Bald Eagles and Peregrine Falcons

Aeries and adults encountered during the coastline surveys were recorded; the aeries or approximate nest sites were plotted on the maps. Falcon nest site locations often were judged only by the presence of defensive birds. The number of aeries was used to estimate breeding pairs.

$$\# \text{ of breeding pairs} = \# \text{ of aeries/suspected aeries counted}$$

The young in or nearby each aerie were recorded and also noted on the map with the nest location. For estimating production of fledged young per successful nest and for further discussion of raptors, see the section "Avian Predators".

Sea Otters, Steller Sea Lions, and Harbor Seals

Marine mammals were counted as part of each coastline survey. Several locations permitted onshore counts (see section "Marine Mammals" regarding sea lions), otherwise all censusing was conducted from the Zodiac or the R/V Aleutian Tern when rip tides were too dangerous.

Although all sea otters seen within the shallow coastal waters were counted, undoubtedly some were missed (25%) so a correction factor was applied to the population estimate (for discussion see "Marine Mammals").

$$\text{area population of otters} = \#\ \text{counted} \times 1.33$$

Direct estimates of Steller sea lions and harbor seals were made from individual counts. Whenever possible, adults and pups were tallied separately.

III. ISLAND DESCRIPTIONS

Islands in the Fox, Rat, and Near Island groups were visited with varying intensity during the 1978 field season. Table 2 lists the approximate acreages and length of shorelines for islands visited in the 1978 survey.

FOX ISLANDS

The Fox Islands comprise the easternmost group, extending approximately 290 miles westward from the Alaska Peninsula to Samalga Pass. Brief stops were made within this group at the Baby Islands and Bogoslof Island (see Fig. 2).

BABY ISLANDS

Five tiny, low, wave-cut benches (Fig. 3) form the Baby Islands near Unalaska Island in the center of the Fox group. Akutan Pass, with its strong rip tides, separates them from Akutan Island to the north-northeast; Baby Pass lies between them and their closest neighbor, Unalga Island, about one mile to the soutwest. Rank growths of vegetation cover the gently rolling tops and extend to the cliff edges. Barren rock cliffs, fissures, and sea stacks form the perimeters while small, rocky beaches lie between tongues of sheer headlands. The five islands total about 285 acres and have an estimated 3.8 miles of shoreline (Table 2). Extensive intertidal areas fringed by kelp beds and broken by many rocks and reefs surround the islands and form harbor seal, Common Eider, and Black Oystercatcher habitat. No fresh water is available. At present, these islands are not under refuge jurisdiction.

BOGOSLOF ISLAND

Bogoslof and Fire Islands form the summit of a large submarine volcano that rises over 1,000 fathoms from the floor of the Bering Sea (Fig. 4). Lying 30 miles northwest of Unalaska Island in the Fox group, Bogoslof and its companion are designated a National Wildlife Refuge and Wilderness Area. The main island, about one mile long, comprises two parts: Old Bogoslof, formed in 1796 by a series of eruptions that enlarged the "Ship Rock" of Russian navi-

Table 2. Approximate areas and shoreline distances for islands visited in 1978*

ISLAND	AREA	SHORELINE
Baby Islands	285 acres	3.8 miles
Bogoslof	160 (in 1947)	-
Agattu	55,535	70.5
Alaid	1,468	9.4
Nizki	1,707	11.8
Buldir	4,915	12.0
Kiska	69,598	89.5
Little Kiska	1,843	9.7
Tanadak	-	-

* from Sekora (1973)

- information not available

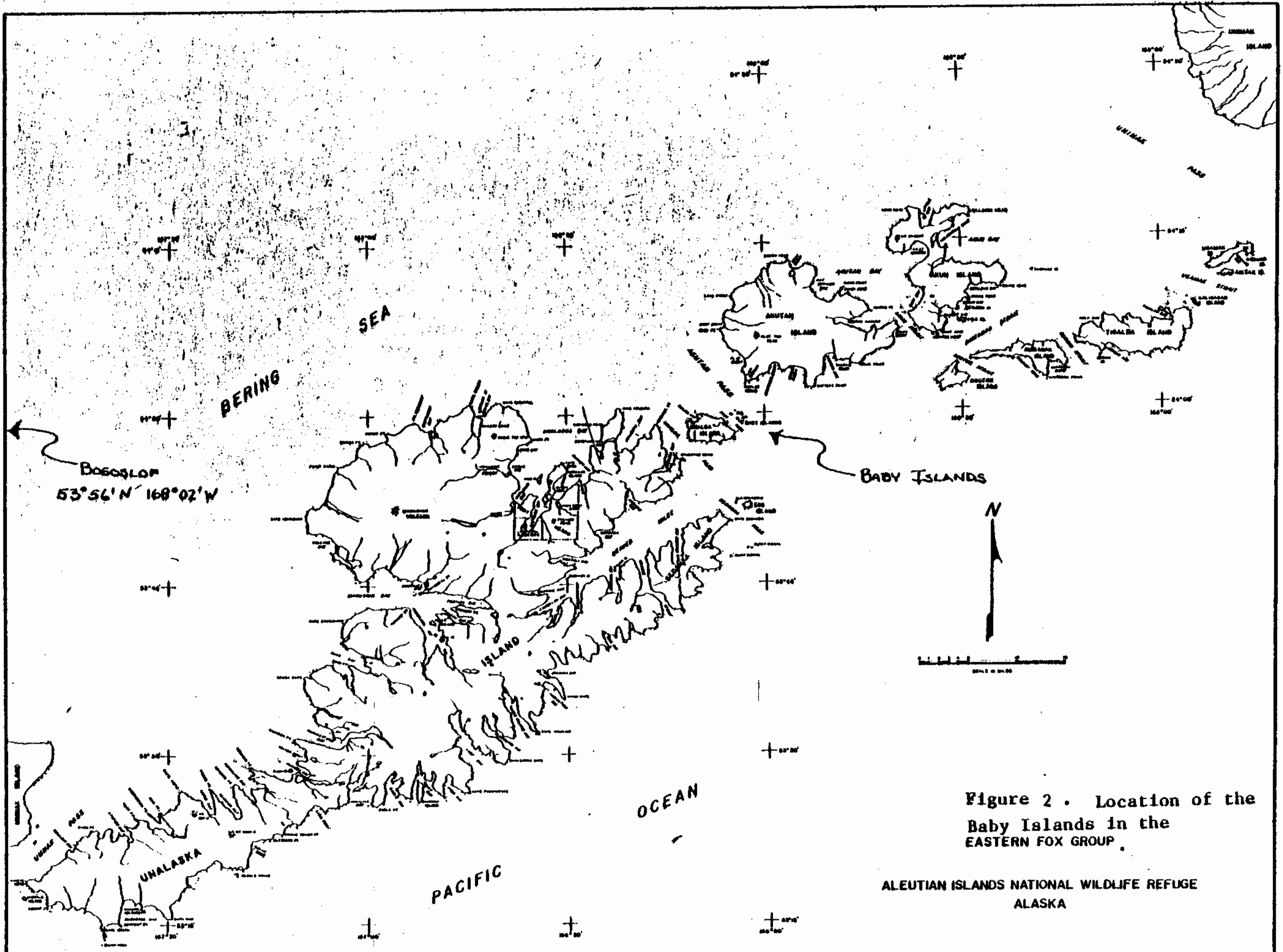


Figure 2. Location of the Baby Islands in the EASTERN FOX GROUP.

ALEUTIAN ISLANDS NATIONAL WILDLIFE REFUGE
ALASKA

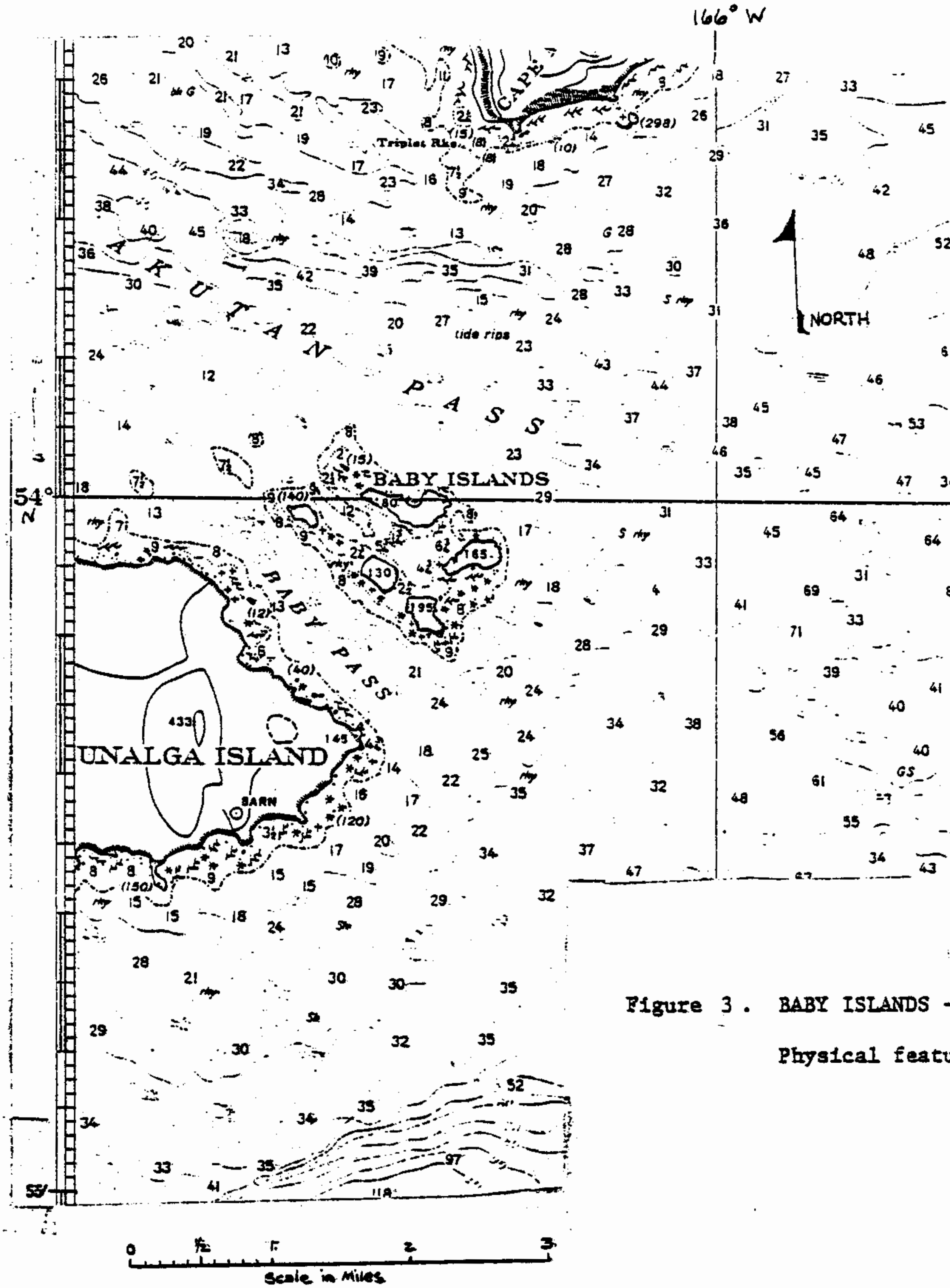


Figure 3. BABY ISLANDS - Physical features.

gation; and a dome-shaped lava plug from the vent of the volcano, formed in 1927. These two landforms are joined by several hundred yards of flat beach covered with drift and sea lion skeletal remains. Old Bogoslof is a gently sloping tableland with 50- to 100-foot cliffs providing habitat for murres. The south end rises to a sharp peak and joins the 330-foot spire of Castle Rock by a knife-edge ridge. Wide pebble beaches beneath the eastern and western cliffs offer hauling grounds for Steller sea lions. The lava plug provides more murre, kittiwake and cormorant habitat on its vertical sea walls and may offer crevice nest sites in its loosely piled jumble of rocks facing Old Bogoslof. Fire Island, about one-quarter mile northwest of Bogoslof, is a straight-sided dome 225 feet high that was formed in an 1883 eruption. It too provides murre and kittiwake habitat. No fresh water is available on either island.

NEAR ISLANDS

Westernmost of the Aleutians is the Near Island group (Fig. 5), 300 miles from Russia's Commander Islands. Within this group, at the eastern end, is a subgroup called the Semichi Islands: Shemya, Alaid and Nizki. The latter two and Agattu Island to the south were visited this season.

AGATTU ISLAND

Second largest of the Near Islands, Agattu is roughly triangular in shape, narrow at the western end and widening to the east (Fig. 6). Its northern shore is about 19 miles in length; the southern, about 16; and the eastern, about 11. Mountain peaks rise to more than 2,000 feet along the northern shore. South of these mountains are gently rolling hills and plateaus and hundreds of shallow lakes and ponds thought to be of glacial origin. Inland vegetation is low and sparse, but along the shore and on bluff tops it becomes lush. The shoreline is varied and supports most of Agattu's wildlife. High bluffs and cliffs alternate with U-shaped valleys emptying onto beaches of boulders or sand. Offshore rocks, reefs and stacks are common, and some sea caves have been formed; thus, cormorant, kittiwake, and murre habitat is abundant. Introduced foxes have been eliminated or nearly so.

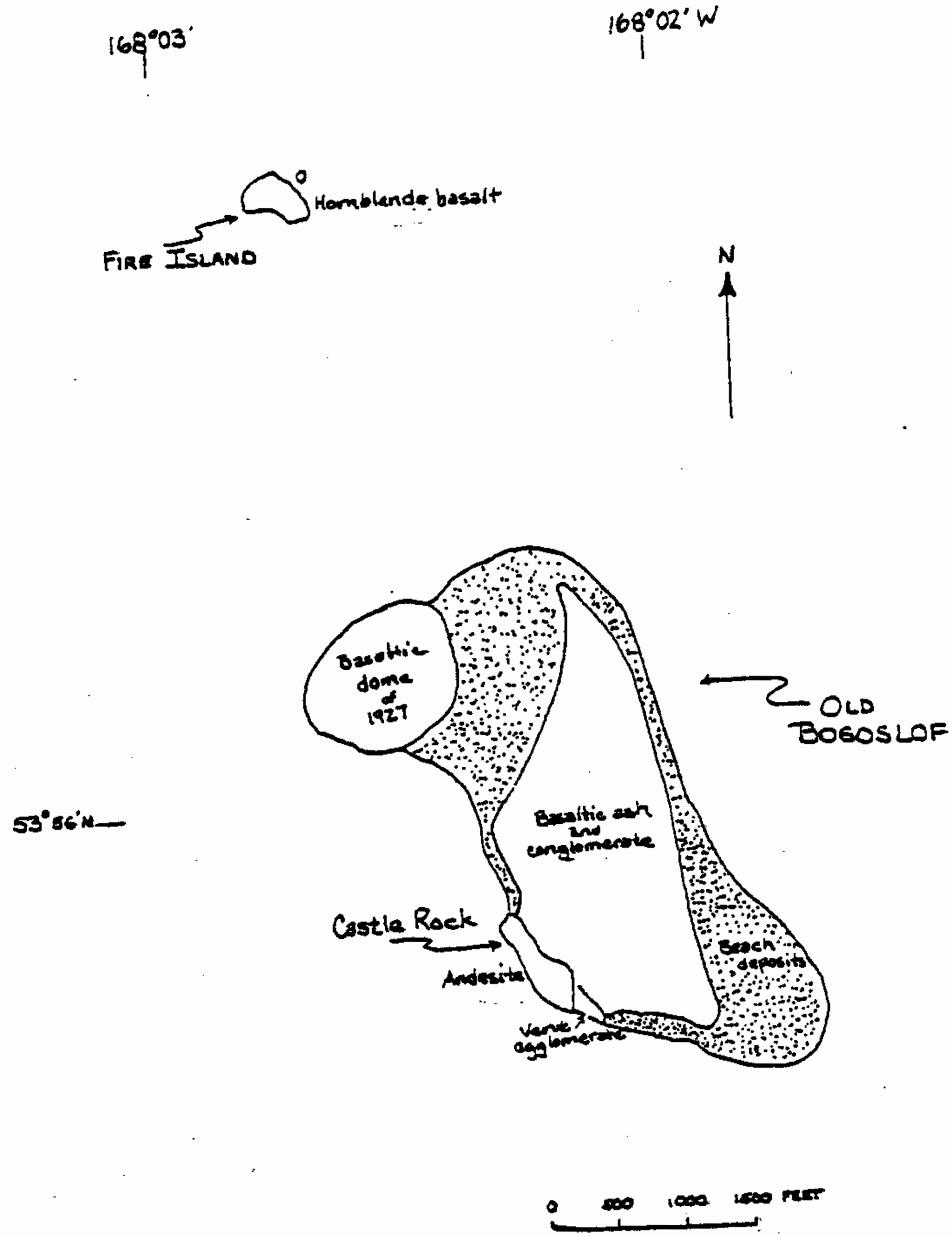


Figure 4. BOGOSLOF ISLAND – Physical features in 1978.

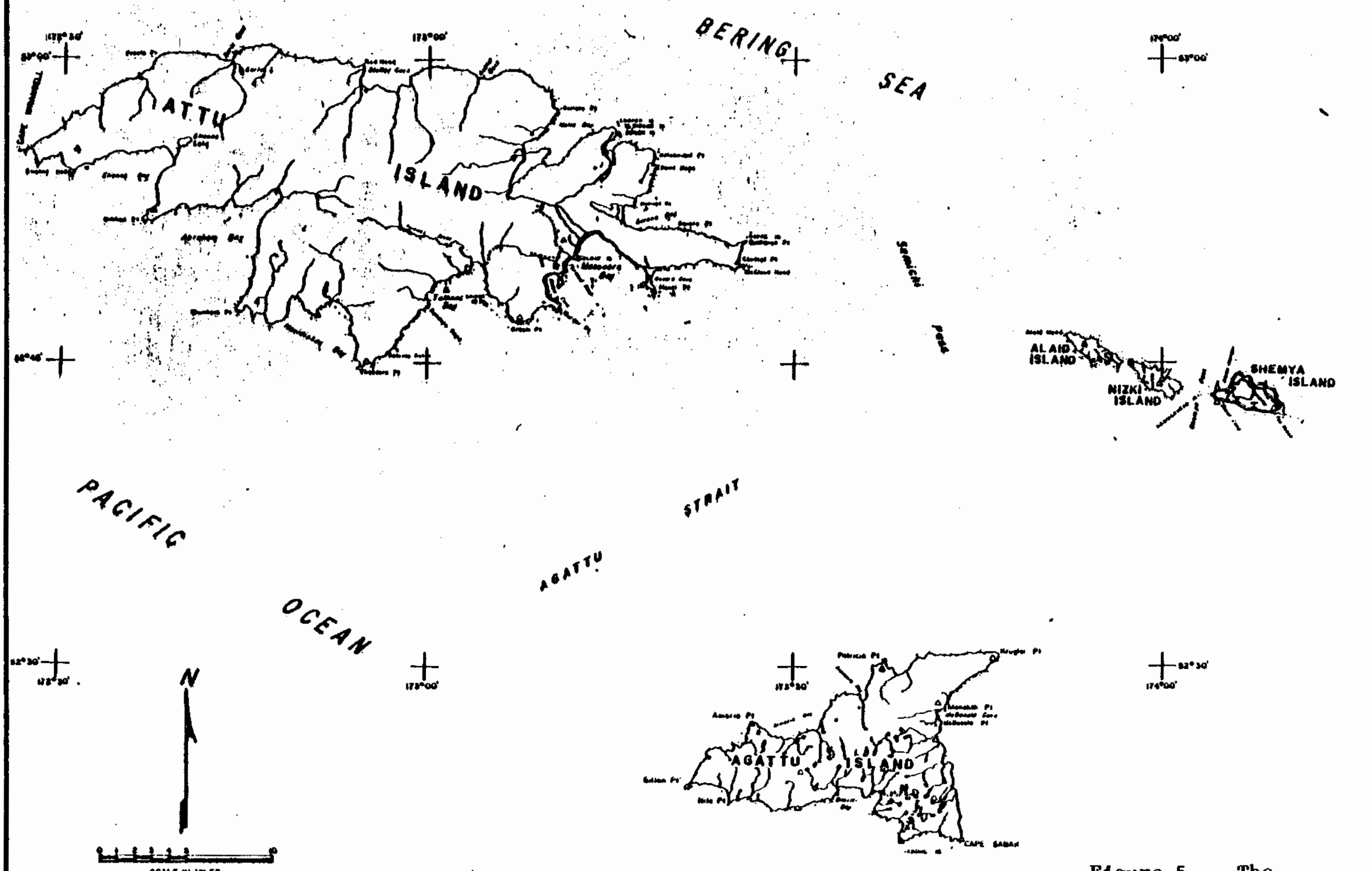


Figure 5 . The

NEAR ISLAND GROUP.

ALEUTIAN ISLANDS NATIONAL WILDLIFE REFUGE
ALASKA

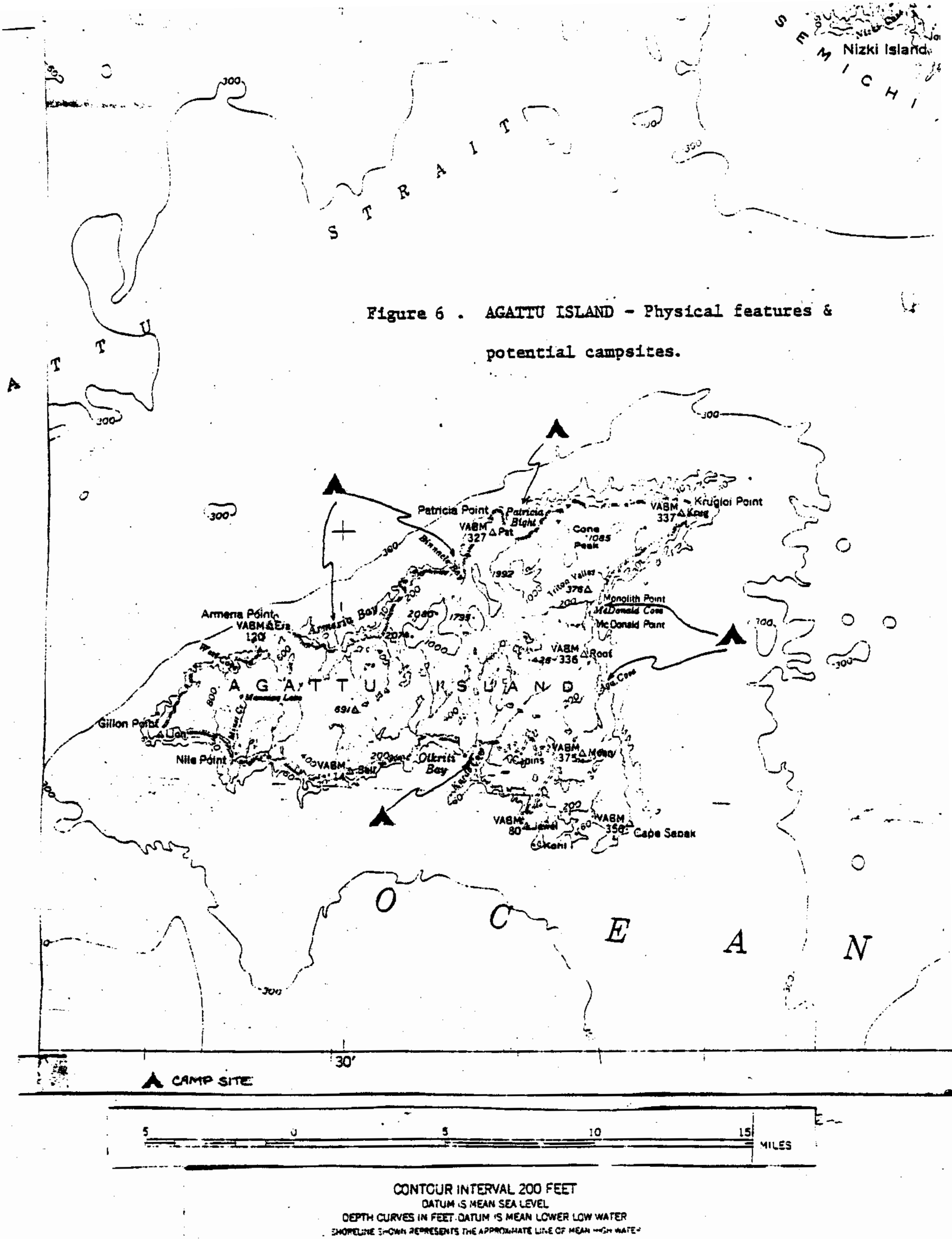


Figure 6 . AGATTU ISLAND - Physical features & potential campsites.

ALAID ISLAND

The westernmost Semichi Island, Alaid (Fig. 7) currently is connected to neighboring Nizki Island by a quarter-mile sand spit that periodically is removed by tidal action and storms. Attu Island lies 16 miles west-northwest of Alaid across Semichi Pass. Except for two 650-foot peaks on its western end, Alaid is low and rolling with about 10 ponds and lakes. The rocky cliffs and headlands below the peaks provide cormorant habitat on this three-mile long island. The shoreline is fringed with reefs and on the south side the beach is mainly sand as the island tilts gently into the sea. Sea lion and harbor seal habitat is plentiful along the 9.4 miles of shoreline. Puffin burrow sites are available at sea slope crests and on vegetated offshore stacks. Inland from the wide Elymus beach edge, lichen tundra predominates. Fox trails crisscross the island, but these introduced animals recently were removed. Fresh water and campsites are available.

NIZKI ISLAND

Central of the Semichis, Nizki Island is joined to Alaid on the west by a sand spit. Shemya Island lies to the east, one and one-third miles across Shemya Pass. This low-lying island is a wave-cut platform about three miles long by one mile wide (Fig. 8), with the highest elevation 165 feet. Much of the shoreline is steep sea slope or rocky cliff with good cormorant habitat, especially on the western headlands and nearby stacks. Most beaches are cobble or boulder and are frequently interrupted by sheer headlands. Numerous reefs and rocks surround the island. Introduced foxes were eliminated recently but trails are still evident in the low vegetation of the gently rolling interior. Nizki has about 10 freshwater lakes. Numerous campsites are available.

RAT ISLANDS

The Rat Islands in the western Aleutians lie between the Andreanof Island group to the east and the Near Island group to the west. The group extends nearly 180 miles from Amchitka Pass westward to Buldir Island and encompasses 11 main islands (Fig. 9).

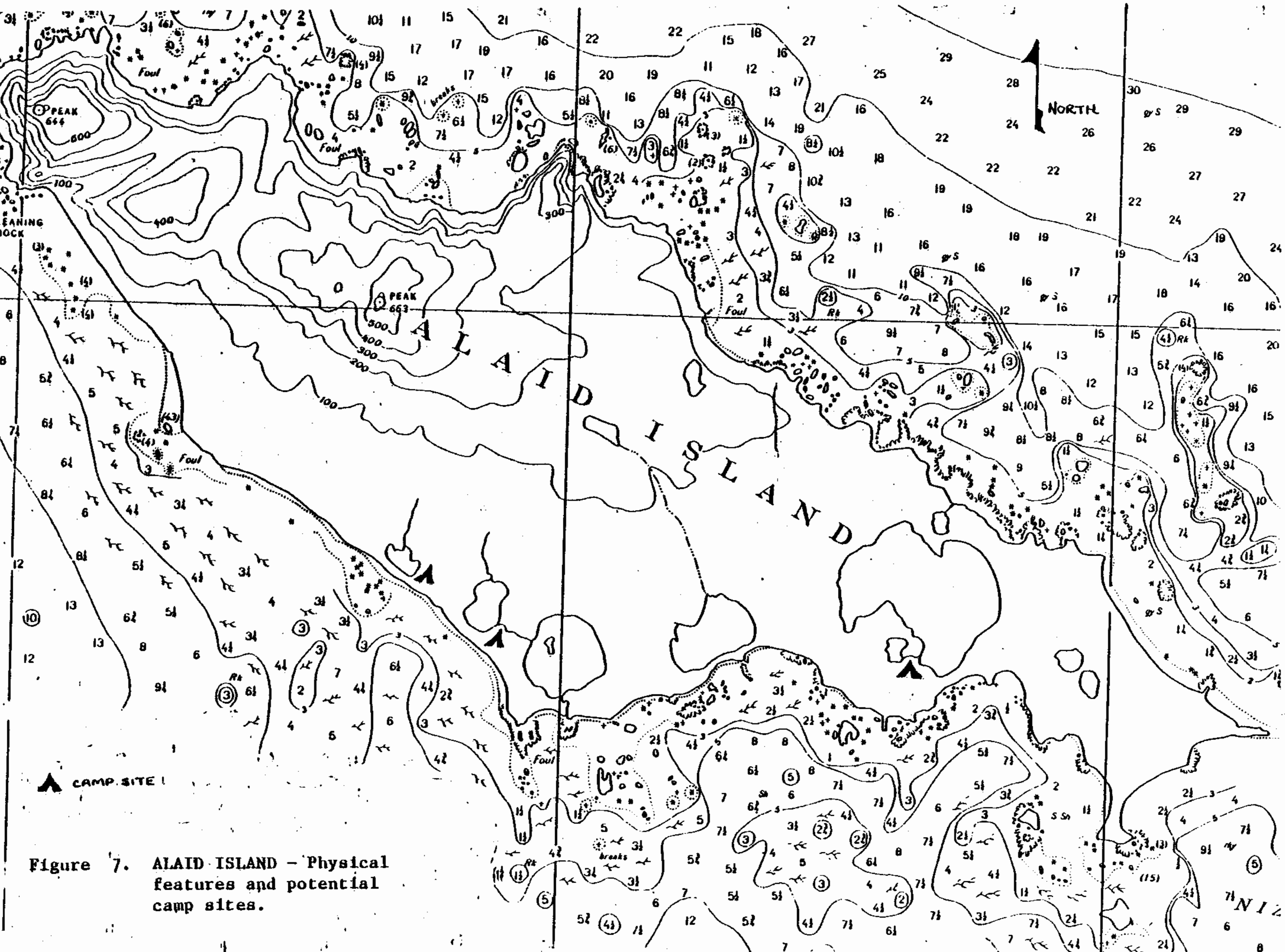


Figure 7. ALAID ISLAND - Physical features and potential camp sites.

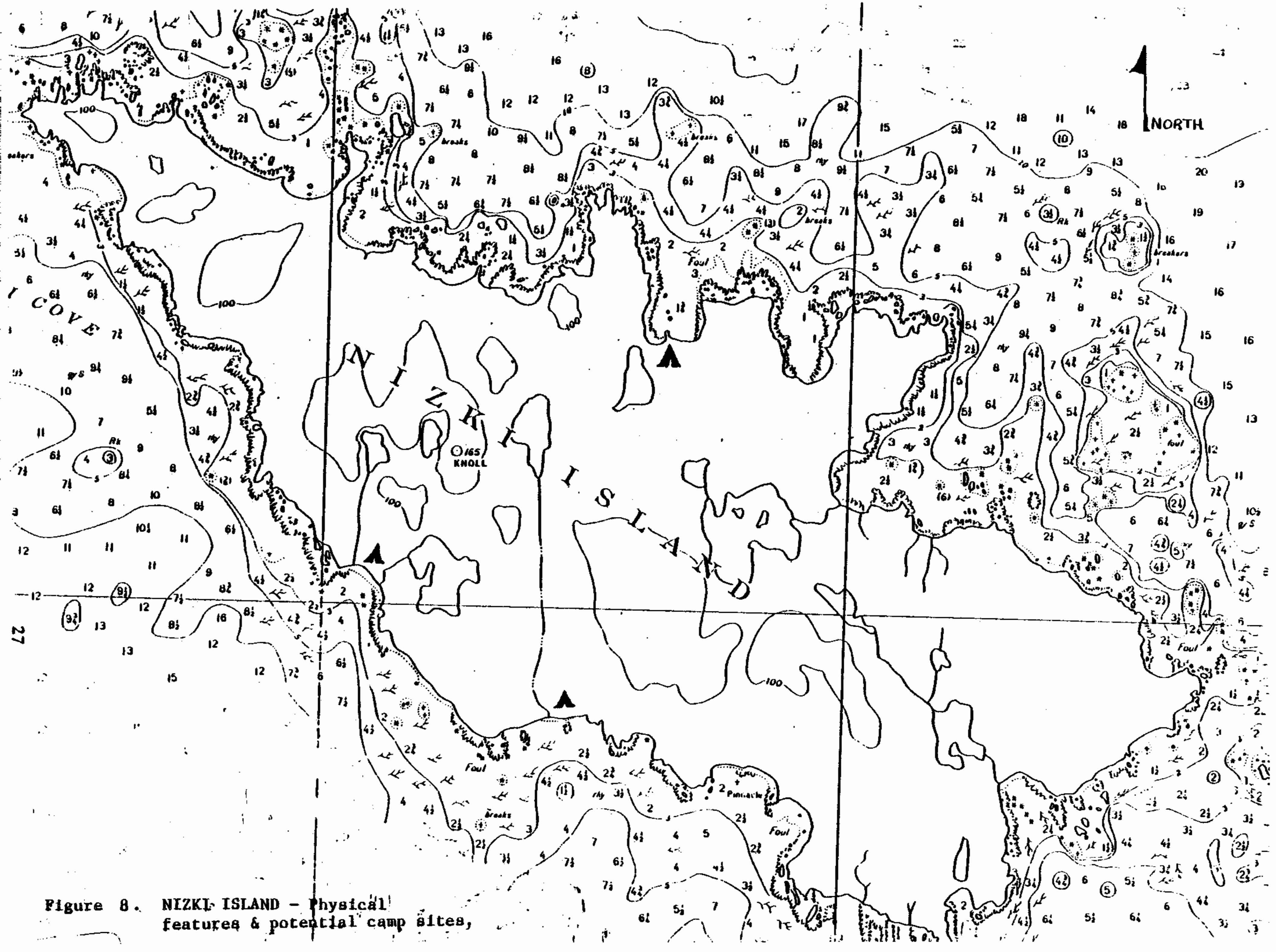


Figure 8. NIZKI ISLAND - Physical features & potential camp sites,

BULDIR ISLAND

Buldir is the westernmost of the Rat Islands and the most isolated of the Aleutians (Fig. 10). Kiska to the east and Shemya to the west are each about 70 miles from Buldir. This three-by-five mile island is volcanic in origin and has four prominent peaks, the tallest being 2,152 feet in elevation. Only two relatively large areas are flat, one being suitable for camping. Most of the shoreline is precipitous, with slide areas and vertical cliffs offering ample crevice and cliff nester habitat. Narrow boulder and cobble beaches provide breeding and hauling grounds for sea lions. The lush vegetation typical of the shore fringe on other islands extends inland more than one-half mile and up to 1,000 feet in elevation. The interior and sea slopes offer prime burrow-nester habitat. There are only two small lakes but many freshwater streams. Foxes were never introduced here and the island supports the last wild breeding population of Aleutian Canada geese. The island has been studied intensively by refuge biologists since 1974.

KISKA ISLAND

An active volcano rising to 4,004 feet dominates the northeastern end of this 22-mile long island (Fig. 11). The southwestern portion, a glaciated submarine ridge, is crowded with rugged mountains and deep, U-shaped valleys. The western shoreline is quite precipitous. Several extensive lava flows have emerged from Kiska volcano: an older, down-slope flow one to several centuries old; and a 1965 basal flow, both providing outstanding auklet habitat. A low, broad valley lies southwest of the volcano and holds several large brackish lakes and many freshwater ponds. Another pass, much narrower, cuts across the island from Kiska Harbor on the eastern shore to a small bight on the western side. Kiska Harbor is one of the few well-sheltered anchorages in the western Aleutians; it has black sand beaches, as do many of the island's valley outlets. Rocky shorelines and offshore rocks predominate along the southwestern end of Kiska and provide the island's major sea lion habitat. Kelp grows thickly around most of the island except below Kiska Volcano where water depth plunges to 600 fathoms. The nearest islands are Little Kiska and Tanadak, off the mouth of Kiska Harbor, and Segula about 20 miles east.

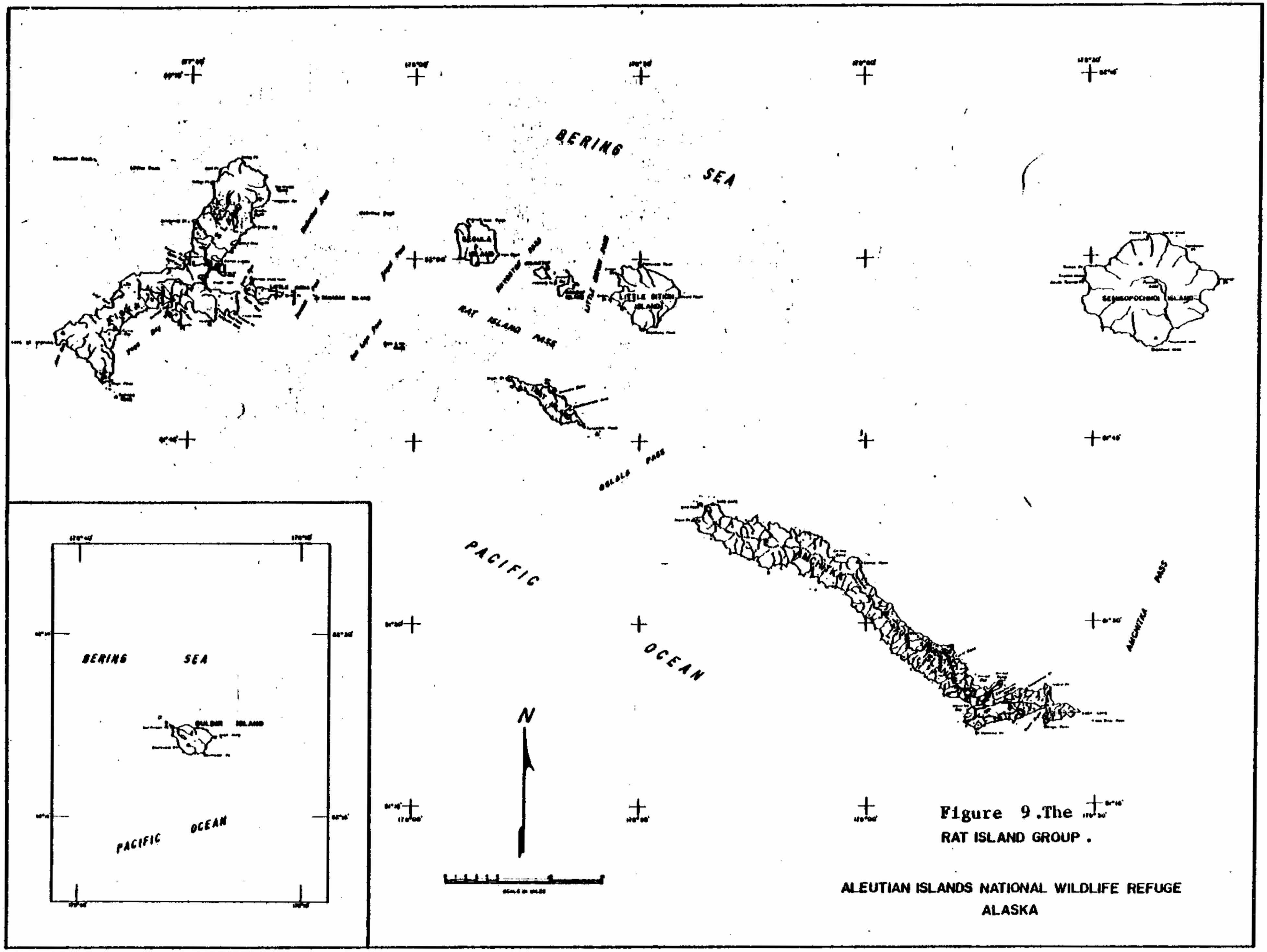
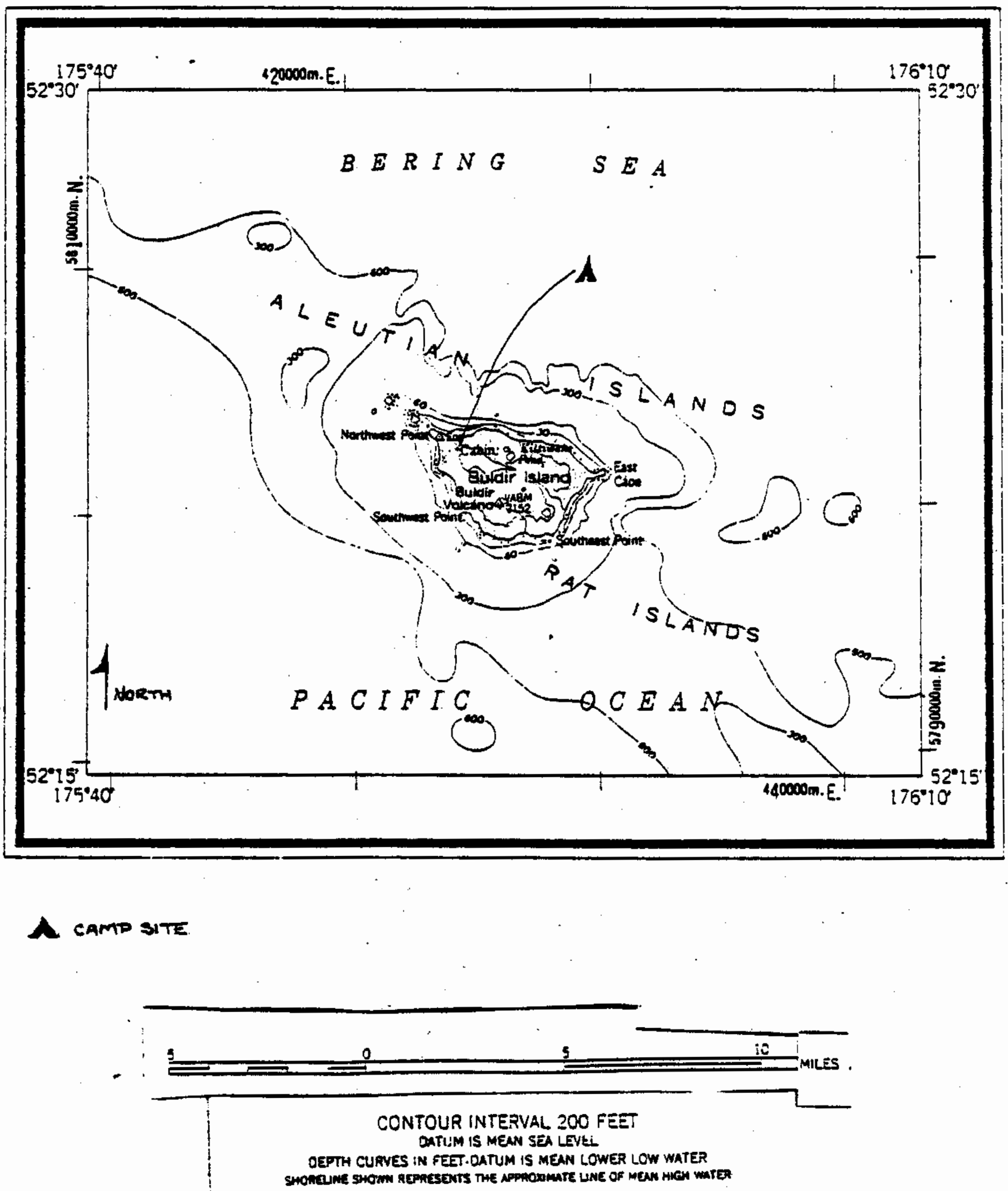
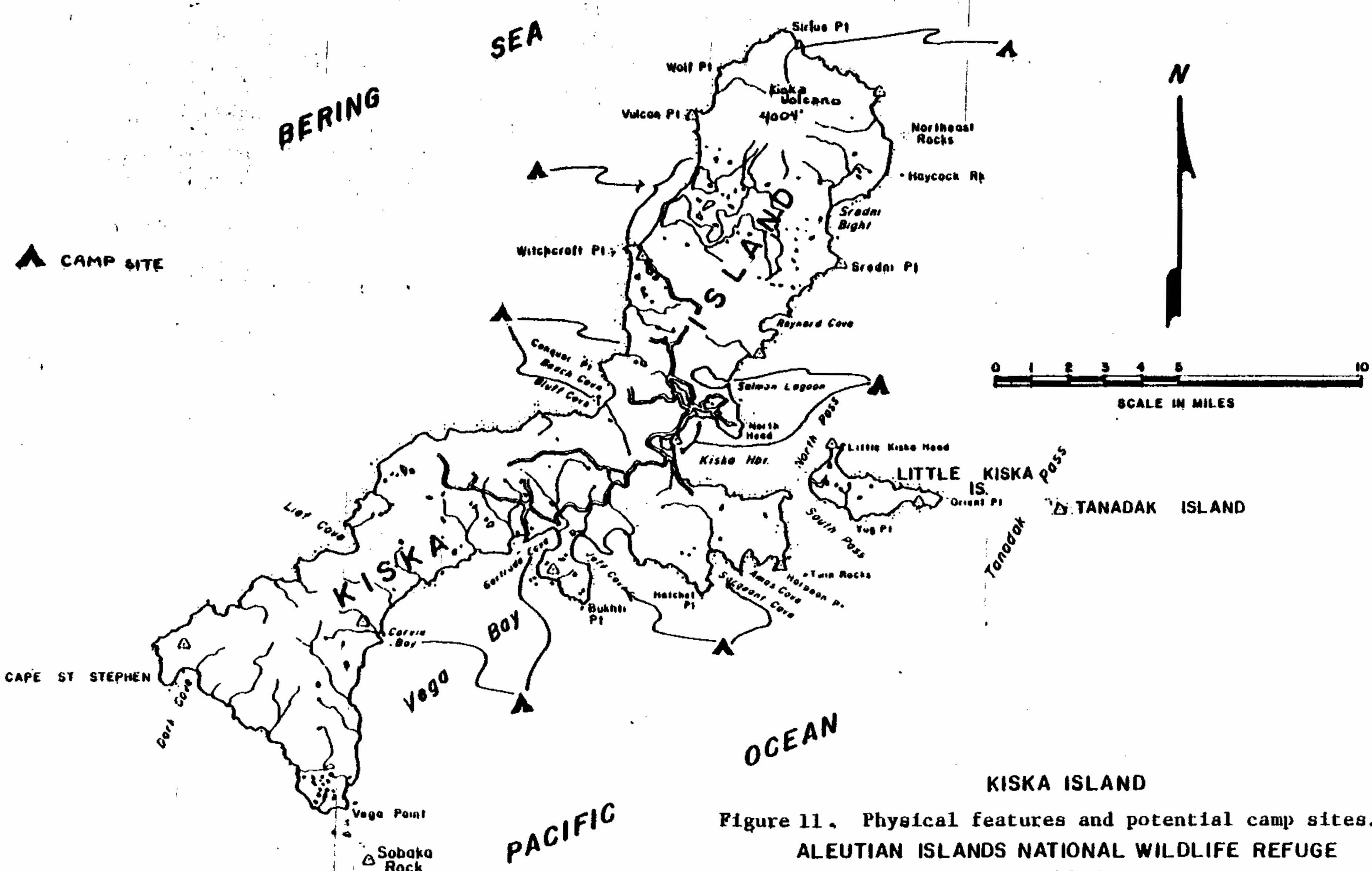


Figure 9. The RAT ISLAND GROUP.

ALEUTIAN ISLANDS NATIONAL WILDLIFE REFUGE
ALASKA

Figure 10. BULDIR ISLAND - Physical features and potential camp sites.





KISKA ISLAND

Figure 11. Physical features and potential camp sites.
ALEUTIAN ISLANDS NATIONAL WILDLIFE REFUGE
ALASKA

LITTLE KISKA

Little Kiska lies at the mouth of Kiska Harbor, less than a mile across South Pass from the bigger island (Figs. 11 & 12). On an east-west axis, this island is slightly L-shaped and measures about three miles by one to two miles. Columnar basalt and pillow lava form many of the sheer cliffs, and cormorants utilize clefts in the rock faces for nesting and loafing. The only beaches of any extent are on the north and west sides of the island. Intertidal shelves, rocks and reefs provide habitat for harbor seals. Dense beds of floating kelp surround the island, coinciding with a large sea otter population. Vegetated sea slopes, cliff edges, and stacks offer habitat for several burrow-nesting species. The interior has several small ponds and is hilly, with a maximum elevation of 304 feet. Best landing beaches face Kiska Harbor with a secondary landing site across the neck of Little Kiska Head at Navy Cove. The island has no foxes.

TANADAK

Tanadak ("very small island" in Aleut) is an irregularly shaped wave-cut bench about 3.5 miles east of Little Kiska across Tanadak Pass (Fig. 11). Wide beds of floating kelp surround the island in summer. There are strips of boulder beaches between bare to partially vegetated headlands and cliffs of volcanic rocks. The beaches, rocky platforms at the base of cliffs, and numerous offshore rocks offer prime hauling out habitat for Steller sea lions and harbor seals. Vegetated cliff edges offer some puffin habitat but the interior is relatively flat with a maximum elevation of 90 feet. The cliffs and several sea caves provide cormorant habitat. No fresh water or campsites are available.

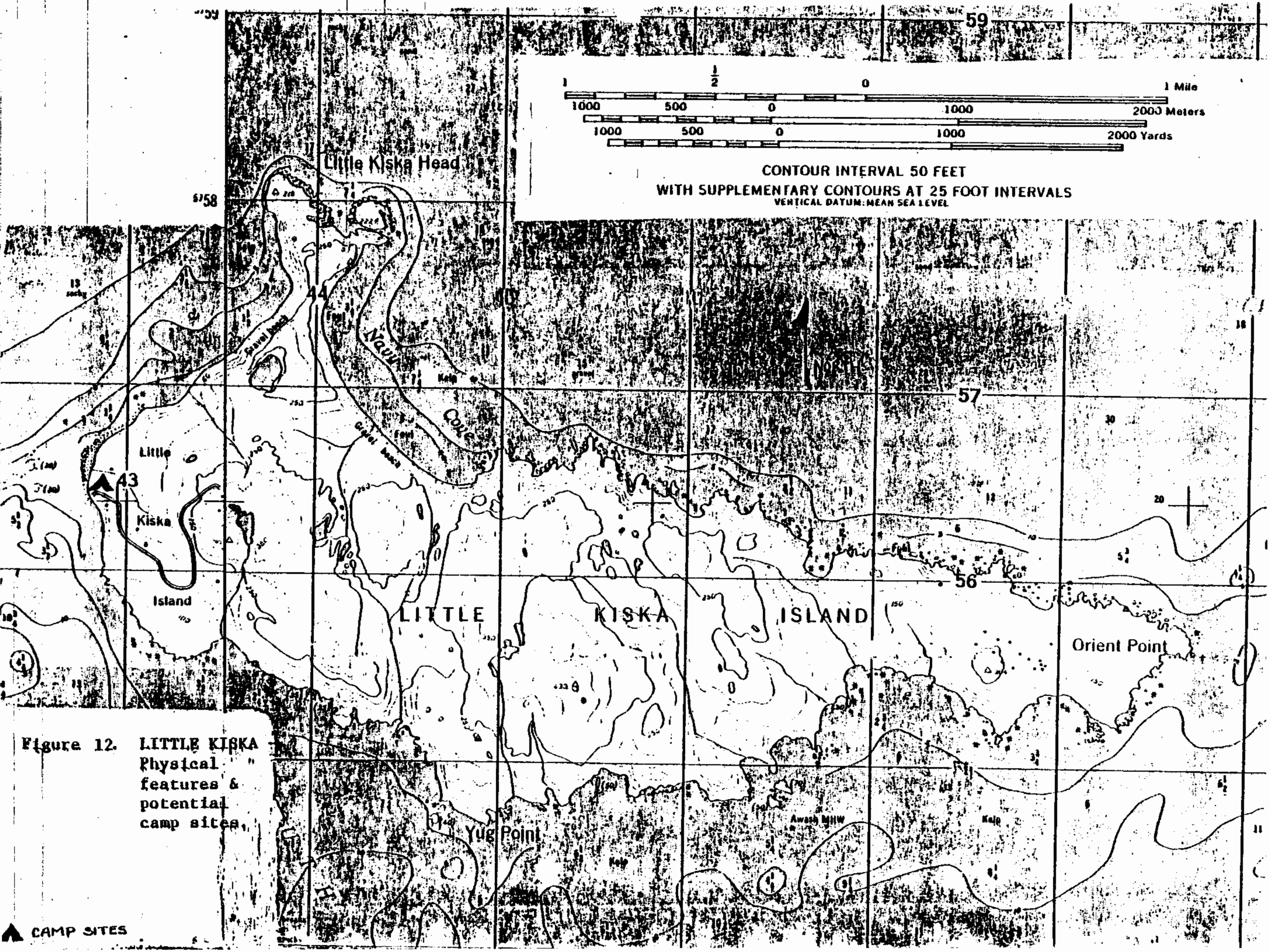


Figure 12. LITTLE KISKA Physical features & potential camp sites.

IV. ISLAND SPECIES ACCOUNTS

This section discusses the results of intensive census work in the Western Aleutians and a cursory survey of the Baby Islands. Accompanying the narrative for each western island is a table summarizing population estimates for marine birds and raptors on each island. Appendix I lists exact counts of individual species observed on the coastline surveys. A map(s) also accompanies each island discussion showing the locations of major bird concentrations.

Baby Islands (Fig. 13)

These are a group of five small and fairly flat islands lying between Unalga and Akutan Islands. All are fox-free, although they did have minor introductions in the past. The species of greatest numbers is the Tufted Puffin which is abundant.

Five random plots were censused along the edge of Baby #2 to determine burrow density: the data are presented below. Although the sampling scheme of using a standardized width of coastline for sampling is questionable, it was employed due to the brevity of our visit. Plots were extended inland until no more burrows were found (see below). In some cases this included flat ground due to high burrow densities in the area.

Plot #	Width (ft)	Depth Inland (ft)	Area Sampled (Width X Depth)	# Burrows Found	# Burrows Per Square ft
1	10	25	250	33	0.13
2	10	21	210	27	0.13
3	20	57	1140	92	0.08
4	18	60	1080	123	0.11
5	18	50	900	55	0.06
		$\bar{X}$ = 42.6			$\bar{X}$ = 0.102
				Standard Deviation =	0.031

Note that the mean number of burrows per square foot is general, without regard to the distance inland that birds are nesting in any one segment. It also does not reflect the total number of birds that are nesting in cliff crevices and talus slopes which were inaccessible.

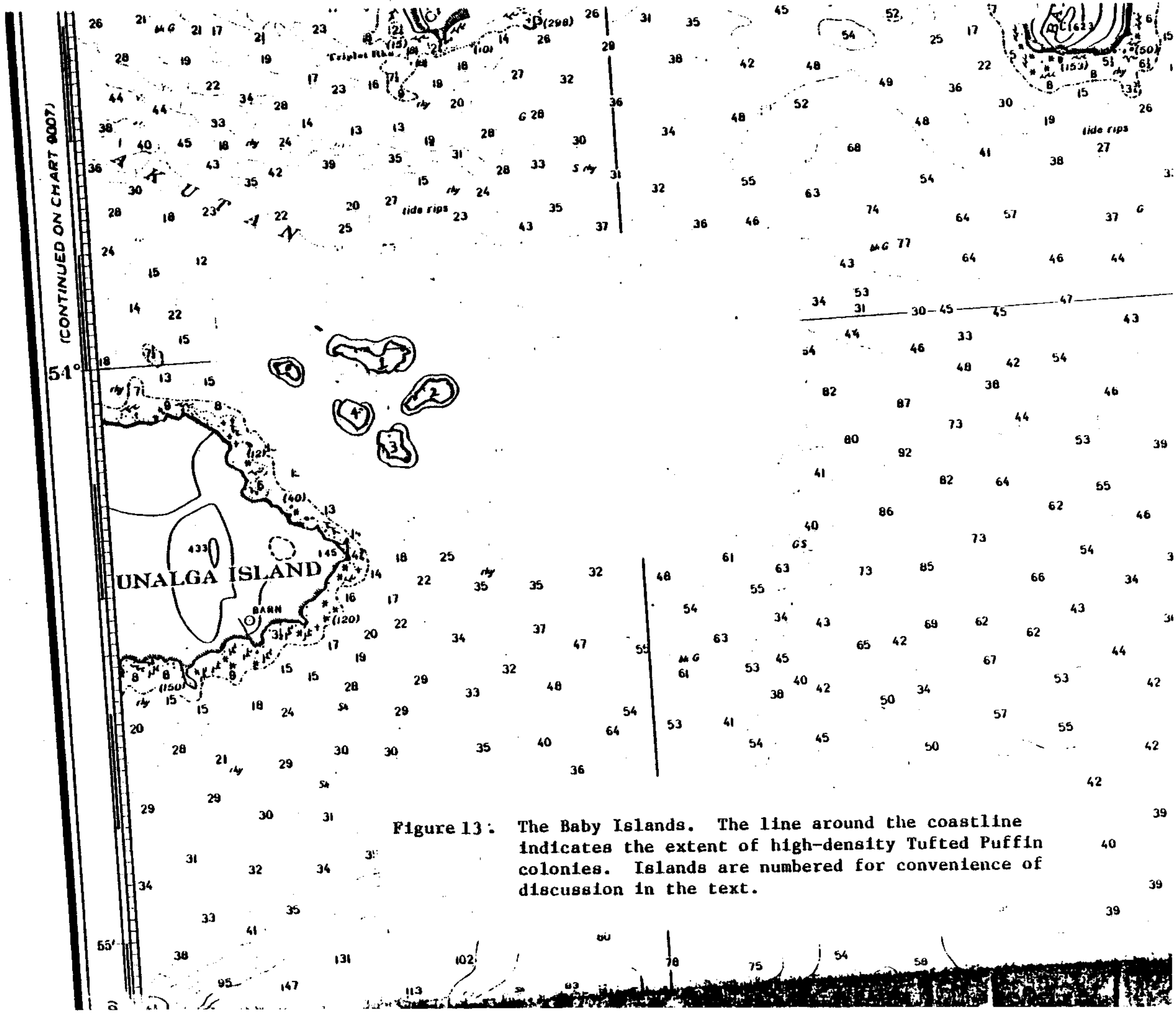


Figure 13: The Baby Islands. The line around the coastline indicates the extent of high-density Tufted Puffin colonies. Islands are numbered for convenience of discussion in the text.

All areas of coastline that appeared to have approximately the same high density of puffin burrows as the study plots were then mapped. This coastline was then multiplied by the estimated depth of used habitat based on the sample data to determine total area of used puffin habitat. Although we did not completely circumnavigate "Baby #5" due to strong tide rips, it appeared that densities were uniformly high around the island. Data are presented below.

Island	Circumference (ft)	Est Sq Ft of Used Puffin Habitat (Circumference X 42.6')	Est No. Burrows (0.102 sq ft X Area)		
1	4,770	203,202	20,727	s*	6,299
2	5,720	243,672	24,855	s	7,554
3	3,820	162,732	16,599	s	5,045
4	3,340	142,284	14,513	s	4,411
5	3,180	135,468	13,818	s	4,200
Totals	20,830	887,358	90,512	s	27,509

s* = Standard Deviation

The assumptions of our estimation scheme follow:

1) burrow densities on the other islands are comparable to those on Baby #2 where the five plots were worked,

2) the distance puffins nest inland is roughly proportional to burrow densities,

3) all burrows are occupied by one pair of birds, (They certainly appear to be so, in contrast to other areas observed.)

4) there are approximately 5,000 pairs of puffins nesting in crevices and low density areas.

Thus, the total estimate of Tufted Puffins on the Baby Islands is approximately 90,000 ± 27,500 pairs. This represents about 317.6 burrows per acre of the total 285 acres in the Baby Islands Sekora (1973). Note, however, that this is not necessarily the number of puffins actually nesting. Recent work by Wehle at Ugaiushak Island indicates that as low as 50% of the actively-used burrows have eggs laid in them. Therefore, the number of reproducing Tufted Puffins in the Baby Islands may be lower than the estimate of pairs present.

In addition to the large numbers of Tufted Puffins, the Babies are home to a variety of other species. Since Baby #2, 3, and 4 were completely circumnavigated but Baby #1 and 5 were only partially censused, we are assuming that the numbers presented here are indicative of the populations.

The rocks and reefs and extensive low beach areas around the islands provide excellent habitat for shore-dwelling species. One pair of Black Oystercatchers was observed on each island. A total of 101 adult male, three immature male, and 31 female Common Eiders were observed along the shorelines of these islands; more were probably present in the areas missed. A total of 52 harbor seals and 10 adult and four pup sea otters were observed within the survey area.

On 25 June 1973 Byrd (unpub. notes) counted 350 to 400 Glaucous-winged Gull nests on the islands. Our visit occurred in May, before the birds began nesting. It is probable that not all adults had arrived yet, for we only counted 279 adults in the area.

Both Bald Eagles and Peregrine Falcons apparently nest here. We found one eagle aerie on Baby #2 with two newly-hatched young and also pairs of adults on islands #1 and 3 (Baby #5 was not surveyed closely). Although we saw no Peregrine Falcons in the islands, George Putney (pers. comm.) stated that a pair was present around the steep cliffs of Baby #5 on 25 June 1973.

Three species of cormorant are present, but the Double-crested did not appear to be nesting. Of the islands surveyed, only Baby #2 had any nests: 196 Red-faced and 29 Pelagic Cormorant nests in small colonies were counted at the northeast and southeast corners of the island.

Byrd (unpub. notes) also noted about 100 Common Murres on Baby #2 and stated that they were sitting in the grass with the puffins. We saw about 50 murres off Baby #2 which appeared to be all commons, but they primarily came off the cliff faces. Unfortunately, all the birds probably had not arrived on colony yet.

Although Byrd (unpub. notes) saw only 60 Pigeon Guillemots, we counted almost 200 birds in our survey.

We did not find any burrows of nocturnal seabirds during our onshore survey of Baby #2. However, we did see remains of two Ancient Murrelets. Byrd (unpub. notes) saw several hundred Ancients in the vicinity of the islands in the early evening, so there is a strong probability of nesting by this species (and probably by petrels also) somewhere in the group.

Horned Puffins were not common in this area: Byrd observed "a few" and we counted only 80 birds. They are definitely overshadowed by the tremendous numbers of Tufted Puffins.

Passerines were fairly common here. We saw three Common Ravens and an abundance of Song Sparrows on Baby #2. No Lapland Longspurs or Gray-crowned Rosy Finches were noted on Baby #2 and their status in the rest of the group must be questioned.

In summary, the Baby Islands contain excellent, but small, mixed colony of seabirds that is densely populated by Tufted Puffins. In addition to puffins, a number of other species of marine birds nest here. Cormorants and murres prefer this area as well as eiders and seals; in general, the islands have a good mix of species. They would be ideal for a study of Tufted Puffins in the eastern Aleutians although the lack of freshwater and the presence of strong tide rips could pose problems. This group would be an excellent acquisition to the existing refuge as the islands represent one of the finest seabird colonies in the eastern Chain. It was with disbelief that we read the signs posted on the beach: "No Hunting, No Fishing, No Trespassing - Property of Akutan Native Corporation."

Kiska Island (Table 3, Figs. 14 and 15)

We spent a total of 17 days on and around Kiska, a majority near the auklet colony. Kiska is a large island with many foxes; consequently, nesting birds are generally inaccessible. The exception to this is the auklet colony at Sirius Point.

Auklets are by far the most abundant species of marine birds nesting on Kiska Island. As discussed in "Section VIII - Auklet Census," the colony itself is easily divided into three sub-colonies: 1) a large new lava flow which rose from the ocean in 1965, 2) a large old flow several centuries old (Coats et al. 1961), and 3) a smaller old flow or talus east of the main colony (Fig. 14).

The tremendous number of auklets is almost impossible to describe. Estimates indicate the number of birds on Kiska may be approximately three times the size of the large Gareloi colonies! However, due to the greater acreage, the densities are much lower on Kiska. With a total estimate of 1.4 million Least and Crested Auklets on Kiska (Leasts outnumbering Cresteds five to one), there is little doubt that this is the largest auklet colony known. (The next-largest colony known is 1.1 million auklets on Little Diomede Island, W. Drury, pers. comm.) It also must be noted that this is a minimum figure, for many birds had fledged by the time we were finishing our work. For a more thorough discussion of this colony, see the sections "Auklet Census" and "Permanent Plots."

Parakeet Auklets also were primarily concentrated in the area along the north side of the island. Since none were seen in the Sirius Point plots, we assume they were nesting in cliff-crevices; however, farther east along the coast they were nesting in talus areas at the water's edge.

Although no Whiskered Auklets were seen on colony, a number of birds were present around the island. We observed approximately 600 birds in tide rips off Cape St. Stephen on 10 August, and a few birds came aboard the boat at night while anchored north of Vega Point. Unfortunately, we were unable to determine the origin of these birds.

The Sirius Point auklet colony was also home to many arctic fox living a life of plenty by denning in the lava crevices. No attempt was made to estimate the number of dens in the colony, but the density appeared quite high. A majority of bird carcasses found in fox food caches were those of hatching-year birds, especially Least Auklets. One cache contained at least 5 crested and 15 least auklets outside the den with the heads bitten off. These birds emerge frequently from their nest crevices a day or two before fledging and stand on the surrounding rocks, totally vulnerable to prowling foxes.

A small Black-legged Kittiwake colony occupied the cliffs midway between the west side of the auklet colony and Wolf Point. Approximately 100 nests were on a small offshore rock and the rest (290)

Table 3. Population estimates for Kiska Island.

SPECIES		ESTIMATE
Leach's Storm - Petrel		+
Fork-tailed Storm-Petrel		+
Pelagic Cormorant		26p
Red-faced Cormorant		77p
Cormorant sp.		6+n
Cormorant sp.	nonbreeders	890i
Glaucous-winged Gull		480p
Glaucous-winged Gull	nonbreeders	280i
Black-legged Kittiwake		390p
Murre sp.	nonbreeders	30i
Common Murre	nonbreeders	15i
Pigeon Guillemot		280p
Ancient Murrelet		+
Kittlitz's Murrelet		+
Parakeet Auklet		2,000p
Crested Auklet		116,000p
Whiskered Auklet		+
Least Auklet		580,000p
Horned Puffin		2,750p
Tufted Puffin		5,000p
Bald Eagle		19a
Bald Eagle	nonbreeders	26i

NOTE: a = aeries
i = individuals
n = nests
p = pairs
+ = present, no estimate made

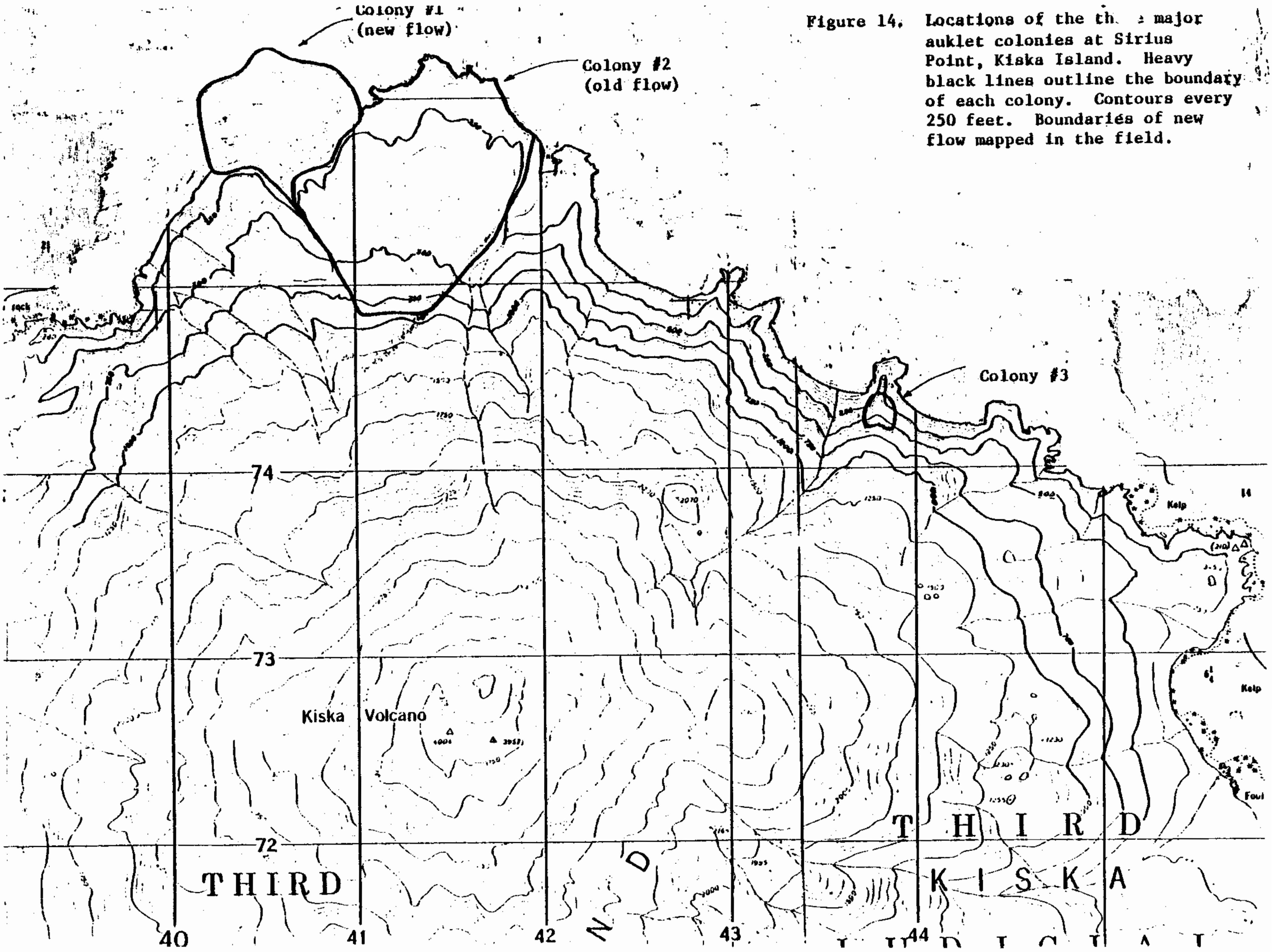


Figure 14. Locations of the th. e major auklet colonies at Sirius Point, Kiska Island. Heavy black lines outline the boundary of each colony. Contours every 250 feet. Boundaries of new flow mapped in the field.

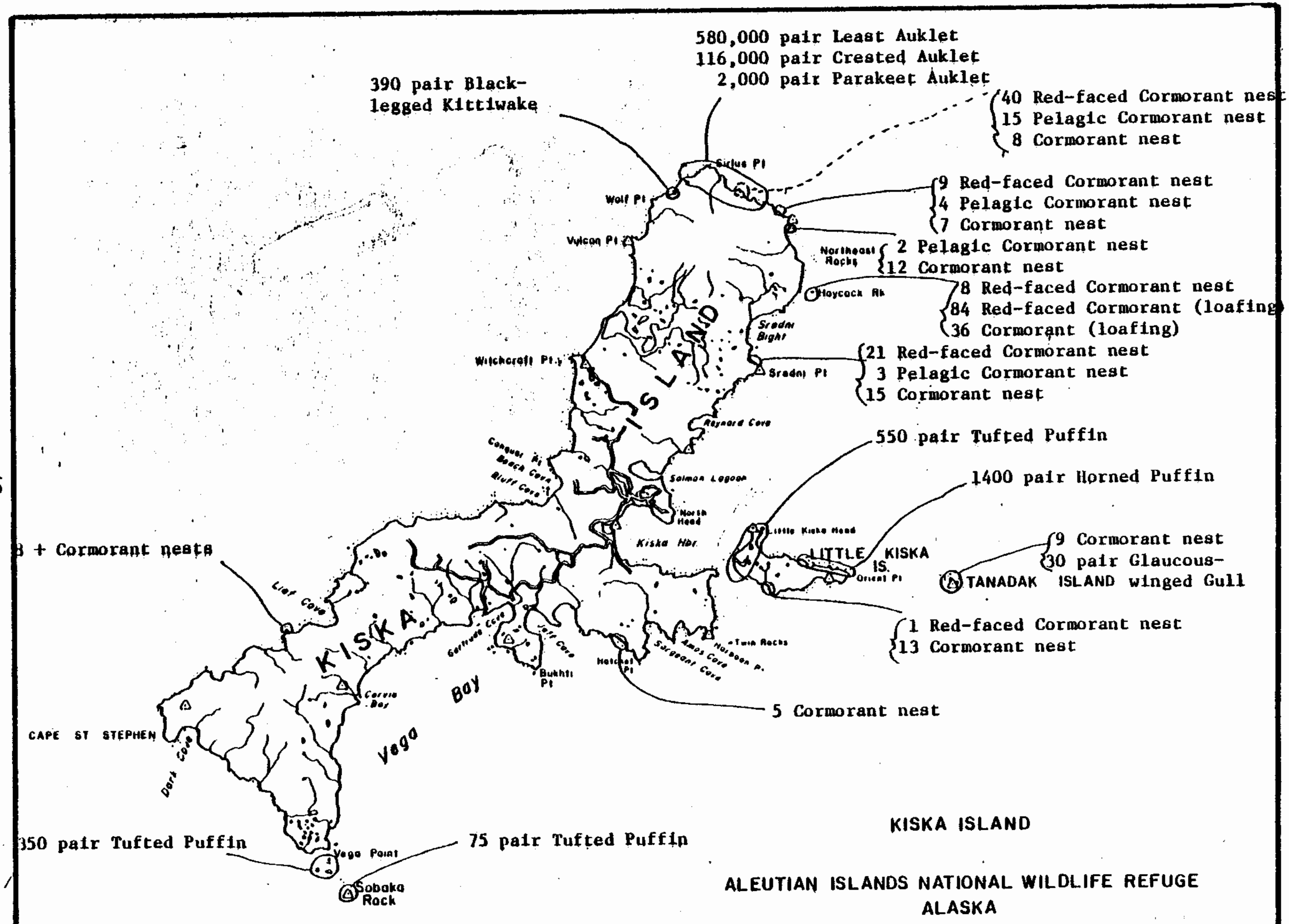


Figure 15. Location of seabird concentrations in the Kiska Island area.

were either clinging to the cliffs about 200 feet above the water or on cliffs just above wave height on the southwest side of the small bight. A total of 839 individual kittiwakes were counted from photos taken from the Zodiac at time of census.

Small cormorant colonies were scattered along the coastline on cliff faces. The largest colony was in a small cove just east of Sirius Point (Fig. 15); two small colonies were present just east of this large colony. Other cormorant colonies were observed at Haycock Rock, the north side of Sredni Point, just west of Hatchet Point, and just south of Lief Cove.

Puffins appeared to be nesting along the entire shoreline in low densities, while the offshore rocks appeared to be heavily utilized; this was especially true in the Sobaka Rock area. The same phenomenon was noted last year, in that birds apparently move onto the offshore rocks to nest if the main island has introduced foxes.

One of the more interesting observations this year was that of three Kittlitz's Murrelets sitting at the mouth of Gertrude Cove. This is in an area of fairly deep bays with high peaks and ridges nearby, so it is feasible that they were nesting in this area.

Once again we had great difficulty in determining the numbers of nesting nocturnal birds. The size of Kiska Island defies quick surveys and even good guessing. Although Leach's and Fork-tailed Storm-Petrels were observed frequently at Kiska Harbor and off the northeast side of the island, their nest locations are unknown. Storm-petrels were also sighted near the south end of the island where the Sobaka Rock group probably provides nesting habitat. Numerous Ancient Murrelets were observed sitting in Kiska Harbor, but we could not determine where they nested.

Low numbers of Common Eiders and Harlequin Ducks were present around Kiska's coast, and a few broods of eiders were observed. Parasitic Jaegers were also present here, apparently nesting in low numbers.

In summary, Kiska Island is a rather limited marine bird colony for variety. It hosts only a few cormorant colonies and a kittiwake colony, all small in size. However, the incredible populations of auklets nesting in the lava on Sirius Point make this island one of the most important marine bird colonies in the Aleutians, and certainly the largest auklet colony known to science.

Little Kiska Island (Table 4, Fig. 15)

Little Kiska, a small island just east of Kiska, was spared the introduction of foxes. Consequently, even though it could not be described as a spectacular colony, the island has an abundance of birds.

Glaucous-winged Gulls were found in profusion, taking advantage of the lack of terrestrial predators. We observed them nesting on hummocks in the tundra and in old bomb craters. Trapp (1976) considered them abundant and noted two small colonies near the west end.

Cormorants were quite common, and a small colony was located on the south side near Yug Point. All nests were deserted except for one of a Red-faced Cormorant. In contrast, Trapp (Ibid.) found a colony of 70 to 75 Red-faced Cormorants nesting on the cliffs just east of Little Kiska Head on 2 July 1976, so this colony has obviously been deserted in the past two years.

Tufted Puffins were abundant, occupying the bluffy areas around Little Kiska Head and along the south shoreline where they were especially common. Horned Puffins, in contrast, were uncommon around most of the island except for the rocky talus and cliff areas on the northeast coast.

Lawhead, Early, and Hall were able to confirm nesting by Ancient Murrelets and both storm-petrels on the island. Active burrows of these nocturnals were found on an overgrown boulder area near the peak of Little Kiska Head. No attempt was made to sample the extent of nesting over the entire island, so a reliable estimate of numbers is unavailable. No sample plot was established due to multiple nesting in single burrows and the large talus creating spacious nesting areas in inaccessible locations. Trapp (Ibid.) observed a flock of 150-200 Ancient Murrelets just north of Navy Cove on 2 July 1976, indicating at least that many nest there. The area appears to have the best burrow habitat on the island, so most of the nocturnal birds probably nest there.

Rock Ptarmigan, Rock Sandpipers, and Northern Phalaropes all breed on Little Kiska, as indicated by Trapp (Ibid.). He considered the ptarmigan to be abundant but noted only small numbers of the latter two species. Not surprisingly, numerous Parasitic Jaegers nest here.

Table 4. Population estimates for Little Kiska Island.

SPECIES		ESTIMATE
Leach's Storm-Petrel		+
Fork-tailed Storm-Petrel		+
Pelagic Cormorant	nonbreeders	4i
Red-faced Cormorant		1p
Red-faced Cormorant	nonbreeders	9i
Cormorant sp.		13n
Cormorant sp.	nonbreeders	165i
Glaucous-winged Gull		200p
Glaucous-winged Gull	nonbreeders	330i
Pigeon Guillemot		175p
Ancient Murrelet		+
Horned Puffin		1,500p
Tufted Puffin		3,300p
Bald Eagle		2a
Peregrine Falcon		2a

NOTE:
a = aeries
i = individuals
n = nests
p = pairs
+ = present, no estimate made

Up to six birds were seen at one time and others were observed over most of the island. As was noted in 1977, high densities of jaegers seem to be related to an absence of foxes.

In summary, Little Kiska is a relatively well-mixed colony with generally low numbers of most species nesting there. However, Tufted Puffins are fairly abundant overall and Horned Puffins nest locally in abundance, though only on the northeast part of the island. A cormorant colony reproducing in 1976 was not active in 1978.

Tanadak Island (Table 5, Fig. 15)

Tanadak is a small flat-topped island surrounded by steep cliffs. The island serves as a fairly large sea lion breeding colony, but does not support an abundance of birds.

Only eight species of birds were recorded and numbers of all were low. Roosting Glaucous-winged Gulls, primarily immatures, and more than 100 roosting cormorants were present. The latter were concentrated mainly on a cliff-face on the east side of the island, probably used occasionally as a colony site. Although not confirmed, there appears to be enough proper habitat for any (or all) of the three nocturnal species to breed here. We made no inland surveys because of the inaccessibility of the uplands.

In summary, Tanadak is a small, poorly-populated island occupied primarily by sea lions.

Table 5. Population estimates for Tanadak Island

SPECIES		ESTIMATE
Leach's Storm-Petrel		+ (probably)
Fork-tailed Storm-Petrel		+ (probably)
Pelagic Cormorant	nonbreeders	16i
Red-faced Cormorant		2p
Cormorant sp.		9n
Cormorant sp.	nonbreeders	103i
Glaucous-winged Gull		30p
Glaucous-winged Gull	nonbreeders	215i
Pigeon Guillemot		12p
Ancient Murrelet		+ (probably)
Horned Puffin		25p
Tufted Puffin		15p
Bald Eagle		1a
Peregrine Falcon		1a

NOTE: a = aeries
i = individuals
n = nests
p = pairs
+ = present, no estimate made

V. AVIAN PREDATORS

As in 1977, avian predators were counted during the course of each coastline survey. This year, in addition to tallies of raptors, the location of known or suspected aeries were noted on a map (Fig. 16). These locations should be checked in future years to see how many aeries are used again. Variability in nest site use occurs on Amchitka (White et al. 1977); however, the Amchitka population may represent a special case due to the artificially high numbers of breeding pairs (Ibid., page 251) occurring there at the time White et al. (1977) did their work. Thus Amchitka's variability may not have been characteristic of an entirely natural population.

The Bald Eagle is the most abundant avian predator in the Aleutians (Day et al., 1978). In 1977 the field crew counted 55 aeries and estimated another three or four aeries in the census area. In 1978, censusing only 25% of the amount of territory covered in 1977, we located between 30-35% of the same number of aeries. Data on numbers of aeries and the inter-aerie distances for islands surveyed in 1977 and 1978, and for Amchitka for 1969 to 1974, are presented in Table 6. Note that these figures indicate the number of pairs which set up territories and raised young, rather than the number which just set up territories. Unfortunately, this method has limitations, for Sherrod et al. (1976) noted that some bias occurs when estimating the percent of successful nests from single trips to aeries. However, as most of the aeries were located when the young were fairly large, it is doubtful that few, if any, of these aeries would have been abandoned later in the season due to eaglet mortality.

Shown in Table 6, the average distance between aeries in 1977 was fairly uniform, with a few exceptions. Gareloi probably had two more aeries than were located, bringing the total to four aeries and placing the subsequent mean distance between aeries surprisingly close to the computed average for all the islands (see Table 7). Hundreds of thousands of seabirds nest on Gareloi, making it likely that more than two breeding pairs of eagles are able to take advantage of the tremendous food supply. However, the possibility remains that two or more aeries failed early in the season. It is also feasible that a number of aeries on Amatignak and Semisopochnoi were missed during the survey, as evidenced by the great distances between sites on these islands. Note that the "small" Delarofs (with coastline mileages much less than 10 miles each) only had one or two aeries apiece. These were

Figure 16. Location of Bald Eagle and Peregrine Falcon aeries on Kiska, Little Kiska, and Tanadak Islands and neighboring rocks. Numbers in parentheses refer to the number of young in the nest or fledged. Aeries with question marks in parentheses probably exist, but are not known for certain. The larger the area of the circle, the more uncertain we are about exact location of the aerie.

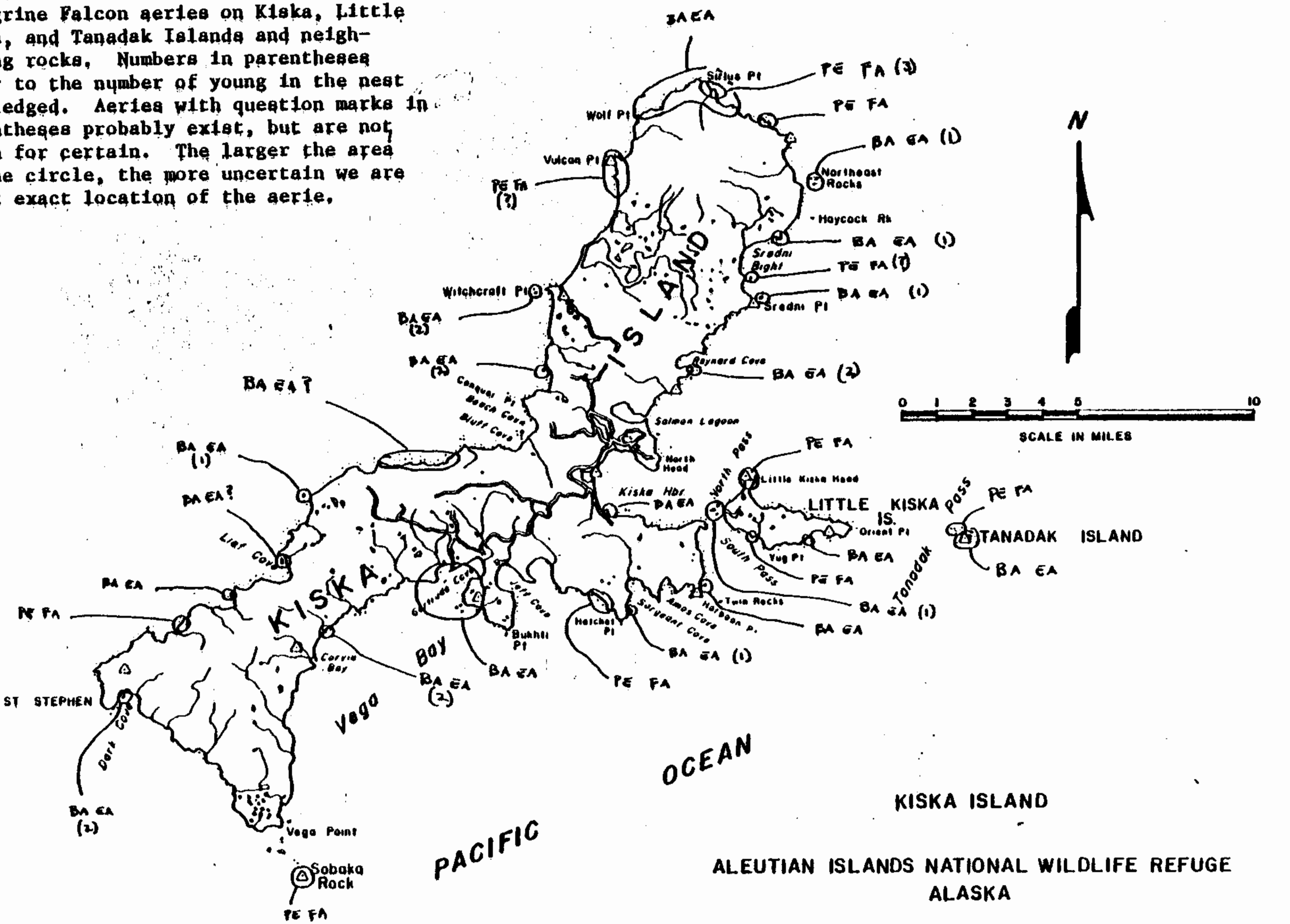


Table 6. Number of successful aeries and inter-aerie distances of Bald Eagles and Peregrine Falcons on selected islands in the western Aleutians. Numbers in parentheses indicate maximum possible numbers of successful aeries and their respective inter-aerie distances.

		BALD EAGLE		PEREGRINE FALCON	
ISLAND	MILES OF COASTLINE*	# OF AERIES	# OF MILES BETWEEN AERIES	# OF AERIES	# OF MILES BETWEEN AERIES
1977					
KANAGA	114.6	25	4.6	6	19.1
BOBROF	8.2	1	8.2+	1	8.2+
GARELOI	19.4	2 (4)	9.7 (4.8)	2 (3)	9.7 (6.5)
ULAK	18.4	4	4.6	1	18.4+
AMATIGNAK	16.2	1	16.2+	1	16.2+
KAVALGA	13.8	3	4.6	1	13.8+
"SMALL" DELAROFS* (TOTAL)	21.5	7	3.1	3	7.2
SEMISOPOCHNOI	40.0	2 (4)	20.0 (10.0)	1 (2)	40.0 (20.0)
* ILAK, SKAGUL, OGLIUGA, UNALGA					
1978					
KISKA	89.5	15 (17)	6.0 (5.3)	5 (7)	17.9 (12.8)
LITTLE KISKA	9.7	2	4.8	2	4.8
TANADAK	0.9	1	0.9+	1	0.9+
1969-1974					
AMCHITKA	106.5	39.3[x]	2.7	12.7[°]	8.4

* from Sekora (1973)

x average for 1969, 1970, 1974 from White *et al.* (1977)

° average for 1970-1972 from White *et al.* (1977)

usually at opposite ends of the islands. Small islands (less than three miles of coastline) from the 1977 survey not discussed in the table (e.g., Gramp Rock, Tag Islands) seem to be too small to allow more than one pair of eagles to nest there. Tanadak (east of Little Kiska) seems to follow this trend, for it also has only one aerie. However, the data at this point are too incomplete to predict the maximum size an island may be and yet have only one active pair of eagles. Undoubtedly, there are other factors involved that have not been taken into account.

Table 7 gives the weighted averages of distances between aeries on most islands surveyed in 1977 and 1978, as well as from Amchitka between 1969 and 1974. Data for 1971 and 1972 from Amchitka are not used since there is some indication that the AEC garbage dump allowed an abundance of eagles to breed (see White et al. 1977). As in Table 6, these figures are for aeries actually producing young. The difference between 1977 and 1978 averages is probably due to differences in habitat, although undetected breeding failure may have been a cause. Using our method, the average inter-aerie distance at Amchitka is small, averaging about one-half that of the islands we surveyed. It is assumed that this is a result of both abundant nesting habitat and an abundant food supply.

A minimal field estimate for production of fledged young in 1977 was 1.2 young produced per successful nest. Sherrod et al. (1976) recorded an average of 1.42 young produced per successful nest at Amchitka, close to our 1977 figure. In 1978 information was gathered on 11 aeries in the Kiska Island area: six contained one young and five contained two young for a mean of 1.45 young produced per active aerie. Although some mortality may have taken place before fledging as discussed by White et al. (1977), this was probably negligible on the current survey for most young were very large (and thus quite close to fledging) or had already fledged. Thus, it is likely the calculation of 1.45 young produced per active aerie is close to the average number actually produced. Therefore, we estimate that between 25 and 28 Bald Eagles were fledged on Kiska, Little Kiska, and Tanadak Islands in 1978.

Although much less common that the Bald Eagle, the Peregrine Falcon is the second most abundant avian predator in the Aleutians. In the 1977 survey area there were approximately 30% as many active Peregrine Falcon aeries as active Bald Eagle aeries (Day et al. 1978); in the

Table 7. Weighted averages of Bald Eagle inter-aerie distances (in miles of coastline) from selected islands in the western Aleutians.

YEAR	$\bar{X}$*	S.D.	n (AERIES)	COMMENTS
1977	4.5	0.8	44	Excludes Amatignak and Semisopochnoi and uses lower average for Gareloi
1978	5.2	0.2	19	Kiska and Little Kiska; uses lower average for Kiska
1969,1970,1974 (AMCHITKA)	2.7	0.2	118	Data approximated from White *et al.* (1978)

*$\bar{X}$ = mean inter-aerie distance

Shumagin Islands in 1976 there were approximately 25% as many (Day 1977; Moe 1977). A rough approximation from the data presented in White et al. (1977) indicates that the figure for Amchitka was about 32%, a ratio remarkably consistent with the other areas. In contrast, the data from the Kiska area for 1978 (Table 7) indicate Peregrine aeries were about 45% as abundant as eagle aeries. The reason for this is not known, although it is probable that the large population of auklets in the Sirius Point colony contributes to this increased relative number of aeries. There should be no shortage of food with the great number of auklets present (see section "Auklet Census"). Aeries were relatively evenly spaced around the perimeter of the island except for extra aeries in the vicinity of the Sirius Point auklet colony.

As was discussed in the 1977 report, the difficulty of determining the exact location of most Peregrine aeries made it impossible to estimate the production of active aeries. Our meager data indicate between two and three young are fledged from each successful nest every year. White et al. (1977) demonstrated a fledging success of 2.66 young per successful falcon nest at Amchitka, a high fledging rate when compared with other areas.

Judging from the decreases in population size and fledging rate at Langara Island, British Columbia, Nelson and Myres (1976) concluded that both were primarily the result of a decrease in the Peregrine's primary prey, the Ancient Murrelet and the Cassin's Auklet. At this point there is no way to determine whether Crested Auklet populations in the Aleutians are decreasing and thus project potential changes in falcon populations since this species was found to be the major food of Peregrines at Amchitka (Williamson and Emison 1969). However, at Buldir Island, Ancient Murrelets appear to be as important as Crested Auklets (pers. obs.), so there is the possibility that any decline in populations of either of these prey species could cause a decrease in falcon populations in the Aleutians.

As was noted earlier, our census method is not precise enough to determine decreased production of falcons (due to difficulty in locating nests), so it is doubtful that gradual long-term population changes due to decreased production will be detected. However, our technique hopefully is good enough that repeated censuses of the coastline will reveal any large-scale population changes.

VI. MARINE MAMMALS

Three species of non-cetacean marine mammals were encountered at the various islands surveyed: the sea otter (*Enhydra lutris*), Steller sea lion (*Eumetopias jubatus*), and harbor seal (*Phoca vitulina*). Our census techniques are described earlier in this report, so the following species accounts are primarily discussions of results and censusing problems.

Sea otter

Intensive fur hunting by Russians, Europeans, and Americans, over the period from the mid-18th century to the end of the 19th century, brought this species to the brink of extinction. Protected under the provisions of an international treaty signed by the U.S., Great Britain, Japan, and Russia in 1911, the Aleutian population grew from local remnant groups and gradually repopulated a number of islands from which otters had been extirpated. This process continues today, with the Near Islands having been repopulated between 1959 and 1964 (Kenyon 1969).

The Islands of Four Mountains are apparently in the very early stages of repopulation, with the first modern sighting in 1969 (Sekora 1973), although none were seen there in 1972 by refuge personnel or in 1978 by our party in traveling through the group (our coverage was by no means complete). Kenyon (1969), listing the Andreanof, Rat, and Fox Island groups in descending order of population magnitude, noted that "the greatest population of sea otters in the world today is in the central to outer Aleutian Islands.

Both the Delarof group of the Andreanofs, surveyed by refuge personnel in 1977 (Day *et al*. 1978), and the Rat Islands, portions of which were surveyed in 1977 and 1978, apparently harbored remnant populations in 1911, since Amchitka Pass (which separates the two island groups) serves as an effective barrier to dispersal (Kenyon 1969). Indications are that the populations on some islands in both these groups approached maximum size in the 1930-40 period. In the Rat Islands, population reduction then apparently occurred through dispersal and mortality from malnutrition due to depleted food sources. In the Delarofs the population reduction is thought to have occurred through emigration to Tanaga, with a second population peak occurring in the late 1950's, following immigration back from Tanaga after the population reached high levels there (Kenyon 1969). By the mid-1960's, the Delarof population had experienced another decline, as had Amchitka's and Semisopochnoi's. Semisopochnoi Island was repopulated with otters after 1943 from Amchitka dispersals. The remainder of the Rat Islands showed population growth (Kenyon 1969).

The results of our 1978 survey of Kiska, Little Kiska, and Tanadak Islands are presented in Table 8, along with the results of Kenyon's 1959 and 1965 surveys. The results of Day et al. (1978) are also included, both to re-examine their data using a different correction factor and to summarize the findings to date of the refuge island survey. Aerial surveys of the western Chain were conducted in 1959 (Kenyon and Spencer 1960) and 1965 (Kenyon and King 1965). In order to compensate for animals not seen, a correction factor was applied to the counts obtained, thereby generating a population estimate. Similarly, we corrected our surface survey counts to arrive at the population estimates presented in Table 8.

Dates of the surveys discussed above were: 1959, 19-27 May; 1965, 29 April-3 May; 1977, 5 July-1 August; and 1978, 26 July-12 August. The 1977 survey covered Kanaga, Bobrof, the Delarofs, and Semisopochnoi (Day et al. 1978); our 1978 survey covered only Kiska, Little Kiska, and Tanadak.

As pointed out by Kenyon and Spencer (1960), "it is axiomatic that not all otters could have been seen on any count." Thus, any population estimate is only as good as the correction factor upon which it is based. Kenyon and Spencer (1960) compared aerial, dory, and shore counts and discussed the advantages and disadvantages of each. Kenyon (1969) also discussed some of the 1959 data as it pertained to correction factors. In general, they found that single aerial counts yielded numbers similar to, or somewhat less (76%) than the mean of replicate dory counts in the sample areas. Aerial counts revealed 65-85% of the otters recorded on the highest dory counts. In making such comparisons, it is important to know what proportion of the population is detected by the dory surveys; Kenyon (1969) tentatively offered the premise "that the maximum number of otters seen on surface surveys failed by 15% to include all those present." Elsewhere in

Island	Counts of Adult Otters 1959[1]	1965[2]	1977-78[3]	Estimates of Total Population 1959[4]	1965[4]	1977-78	Square Miles of Habitat[4]	Otters Estimated Per Square Mile of Habitat 1959[4]	1965[4]	1977-78
Andreanof Islands										
Kanaga	1822	1054	1527	2429	1405	2036	95	26	15	21
Bobrof	57	32	60	76	53	80	2	38	26	40
Delarof Group										
Gareloi	41	83	100	68	111	133	9	8	12	15
Unalga	51	16	108	85	27	144	8	10	3	18
Kavalga	275	155	234	367	207	312				
Ogliuga	112	144	122	149	192	163				
Skagul-Tag-Ugidak	281	46	64	375	77	85	52	22	10	13
Gramp Rock	134	32	33	179	53	44				
Ilak	49		73	82		97				
Ulak	352	107	153	469	143	204	20	30	13	17
Amatignak	102	70	105	136	117	140				
Rat Islands										
Semisopochnoi	393	203	238	524	271	317	32	16	8	10
Kiska-Little Kiska-Tanadak & Tanadak Pass	1127	1137	1374	1503	1516	1832	78	19	19	23
TOTAL	4796	3079	4191	6442	4172	5587		$\bar{x}$ = 21	13	20

[1] Source: Kenyon & Spencer 1960
[2] " : Kenyon & King 1965
[3] " : Day *et al.* 1978 and present study
[4] " : Kenyon 1969

Table 8. Counts, population estimates, and densities of sea otters for selected islands (after Kenyon 1969).

his discussion, however, he cited comparisons of aerial and surface surveys, done by Lensink in the Shuyak and Barren Islands, that indicated that "at least 59% of the otters in an area may be missed on a surface survey." As a result of Lensink's work, and because he thought that single surface counts could entirely miss small, local populations, Kenyon (1969) stated that surface surveys were "generally less useful" than aerial surveys.

In spite of Lensink's findings, we are confident that our survey detected most of the otters present, and that the magnitude of our correction factor should be close to that used by Kenyon (1969) for his aerial surveys. Kenyon used a sliding scale in making his population estimates: for counts of one to 15 otters, he estimated 50% of the total were seen; for 16 to 100 otters, 60% were seen; and for more than 100 otters, 75% were seen. He did this because he realized that, for aerial surveys, the probability of detecting animals was greater where populations were dense than where they were sparse.

We had no basis for assuming that the same holds true for surface surveys, so we applied a single correction factor uniformly to all our counts. Because Kenyon and Spencer (1960) found that aerial counts were similar to the mean of replicate dory counts at Amchitka, we estimated that we detected about 75% of the otters present, and thus multiplied our counts by a correction factor of 1.33. This correction factor yields a much more conservative estimate than would result from the correction factor suggested by Lensink's work. On the other hand, our estimates would be high if 1) there was duplication due to movement of otters into or out of survey areas between survey days (since we were unable to cover some islands in one day), or 2) we actually counted more than 75% of the population.

We have also presented the results for those islands surveyed in 1977 by Day _et al_. (1978), using our correction factor to generate population estimates. This was done because no estimates were given in that report; surface counts only were presented (the correction factor used in their Table 25 was not intended as an estimator of population size).

Density figures are presented in Table 8 and compared to those calculated by Kenyon (1969) for his 1959 and 1965 surveys. The "square miles of habitat" in the table are taken directly from Kenyon (1969), and represent the areas around each island covered by water up to 30 fathoms in depth. There is some dispute over whether or not this represents all of the available feeding habitat, as otters have been found feeding in deeper water. Schneider (1976) considered feeding habitat to include depths to 40 fathoms, while Lensink (1958) and Calkins (oral presentation at OCSEAP Vertebrate Consumers Workshop, Oct 1978) extended it to 50 fathoms. Although the outer limits of feeding habitat are thus open to question, by far the greatest amount of otter activity in the western Aleutians occurs within the 30-fathom curve. At any rate, use of Kenyon's figures allows direct comparison to our data. It is interesting to note that the estimated population at Bobrof in 1977, at 40 per square mile, was at a density that Kenyon (1969) considered to be a maximum, making population reduction through emigration or mortality a likely prospect if food supplies are depleted.

The 1977-78 counts and population estimates represent increases from Kenyon and King's 1965 survey, although the populations generally are below the levels reported by Kenyon and Spencer for 1959. Thus it appears that the populations are still recovering from the reductions that occurred between the 1959 and 1965 surveys, with the exception of Kiska, Little Kiska, and Tanadak, where the population is at the highest level yet reported.

One of the advantages of surface surveys is that females with pups are easily seen and counted. We recorded all pups seen during each survey (Appendix I) and calculated the percentage of adults with dependent pups (Table 9) for the various populations. These figures are only point-in-time approximations of production, since pups may be born at any time of the year (Kenyon 1969). Juveniles recently separated from their mothers were counted as adults. The observed range of values, from 21.4% to 29.2% shown in Table 9 is surprisingly small, suggesting similar rates of natality and mortality among the islands surveyed.

Problems encountered in sea otter surveys have been discussed by Kenyon (1969), Kenyon and Spencer (1960), Lensink (1958), and Schneider (1976). Schneider (1976) pointed out factors affecting visibility that any survey design must deal with: sea state; lighting conditions; presence of confusing objects such as birds, other marine

Table 9. Percentage of sea otter adults with dependent pups in the Aleutian Islands, 1977-78.

Island or complex	Percentage adults with dependent pups[a]
Kanaga	21.5
Bobrof	28.3
Gareloi	26.0
Kavalga-Ogliuga-Skagul-Tag-Ugidak	24.8
Ilak-Gramp Rock	29.2
Unalga-Dinkum Rocks	25.0
Ulak-Tanadak-Amatignak	27.5
Semisopochnoi	21.4
Kiska-Little Kiska-Tanadak	25.3

[a] Juveniles not with parents counted as adults.

mammals, and kelp (Nereocystis) stems; and behavioral traits of the otters themselves, since "a percentage of the animals are under water at all times." He stressed the need for a precise classification code for viewing conditions to aid in evaluating survey results.

Kenyon and Spencer (1960) presented a concise comparison of the advantages and disadvantages of aerial, boat, and shore surveys. A major drawback of boat surveys is the amount of time required to adequately cover otter habitat in a given area; consequently, several years are required to survey island groups that can be covered in the span of a few days by air. Thus, data can be outdated by the time such a survey is completed, if populations are experiencing rapid rates of change.

The attendent expenses for boat surveys are greater than for an aerial survey, but the fact that our surveys gather colony location and population data for birds and other mammals justifies the expense. The other major problem is that "changing weather conditions may interrupt surveys, causing inaccuracies in censusing because of movements of otters from one area to another" (Kenyon and Spencer 1960). In periods of poor weather, otters move from exposed to sheltered areas and may thus be duplicated in counts if the survey is interrupted by such weather. For that matter, any interruption of the survey can cause inaccuracies, because otter's home ranges may include up to 10 miles of coastline (Kenyon 1969); on large islands like Kiska and Agattu, movements of otters between survey days could introduce an appreciable error that would be difficult to evaluate.

In view of the above discussion, certain recommendations for future surveys are warranted:

1) comparative, simultaneous aerial and Zodiac surveys should be considered at Amchitka, in order to provide more information on the proportion of the population that is seen on such surveys; the fact that Amchitka is scheduled for survey in 1979, and that an OAS aircraft may be available at Adak, make such work feasible;

2) a classification code for viewing conditions should be adopted to aid in evaluation of survey results; examples can be found in Kenyon (1969) and Schneider (1976);

3) because there is geographical segregation by sex and age in many sea otter populations in the Aleutians (Kenyon 1969, Schneider 1976), efforts should be made to delineate "female" and "male areas"; such baseline information will be very useful in assessing impacts of disturbances on otter populations; and

4) when feeding otters are observed from refuge vessels, water depth should be noted in an effort to provide more information on the extent of their feeding habitat.

Steller sea lion

In North America, the Steller sea lion breeds from the Channel Islands of southern California to the Pribilof Islands, with the center of abundance for the species being the Aleutian Islands (Kenyon and Rice 1961). In 1961, the population of the Aleutians was approximately 100,000, or 33-50% of the total estimated species population (Kenyon and Rice 1961).

Seasonal variation occurs in use of breeding rookeries and hauling grounds. To quote Kenyon and Rice (1961):

> "Within its latitudinal range of year-round abundance .... local seasonal or longitudinal movements of variable degree occur. In general, it appears that breeding grounds are also used as hauling grounds at all seasons but some hauling grounds are used only at certain seasons. During the breeding season, non-breeders may occupy areas not used during winter months."

Besides variation in use of these areas, there is seasonal variation in number of animals present. Mathisen and Lopp (1963) found that numbers "were low in the early spring, reached a maximum in the late summer months, and declined again toward the end of the year;" summer populations were "commonly" two to three times larger than winter populations. The authors offered two possible explanations: 1) many animals may migrate from the vicinity, or 2) animals may spend increasing amounts of time away from rookeries and hauling grounds while foraging. They considered the second explanation more likely. Kenyon and Rice (1961), on the other hand, documented a northward movement of some adult and subadult males in the Bering Sea in late summer and early fall.

Populations increase at breeding rookeries by mid- to late May, as mature bulls establish territories (Braham et al. 1977). Pupping begins toward the end of May and continues through June; on Chernabura Island in the Shumagins, the pupping period lasted from 24 May to 27 June in 1958 (Mathisen et al. 1962). On Bogoslof Island in 1978, pupping had started at the time of our visit on 31 May. Sandegren (1970) reported that cows go to sea for the first time 5 to 13 days following parturition, after which "periods on land or sea rarely exceed 24 hours." Breeding occurs 10 to 14 days after parturition (Sandegren 1970), signalling a decline in territorial behavior by breeding bulls; Mathisen et al. (1962) found that no mating occurred after 10 July and bulls allowed intrusions by other bulls on their territories by early July. Sandegren (1970) recorded periods of continuous territory maintenance by bulls ranging from a few days to over 60 days. He found that females induced pups to go to sea about four to five weeks after birth. Thus, by mid- to late July colonies could be expected to be declining in size. Sandegren (1970) obtained his highest counts "at the very onset of the breeding season" in late May.

Results of our 1978 survey are presented in Table 10 with comparative data from several past surveys. Due to the rather complex array of survey dates and types, each island and the details of surveys pertaining to it are discussed individually. The general details of the Agattu surveys apply to the other islands as well.

AGATTU ISLAND: The 1957-58 figures presented(in Table 10) for Agattu Island are from Mathisen and Lopp (1963) and are rough visual estimates made from Fisheries Research Institute (F.R.I.) tagging vessels between May and September (dates not specified). The Karab Cove (listed under Otkriti Bay) estimate was made in 1957, and the Gillon Point estimate in 1958. No mention was made of percentage of pups. Kenyon and Rice (1961) performed an aerial survey between rookeries and hauling grounds because of the early date. They estimated an error of six to ten percent in their numbers.

Kenyon and King (1965) conducted another aerial survey on 2 May 1965, in late afternoon. The 1959 and 1965 surveys counted adults only, and the 1965 figures are no doubt low due to the earliness of the date; Kenyon and King (1965) realized that their figures were depressed,

Location of Hauling Ground or Rookery		1957-58[1]	1959-60[2]	1965[3]	1969-72[4]	1978[5]
		Estimated Number of Sea Lions				
AGATTU:	Gillon Point	1000	3000		750	1500*
	Otkriti Bay	30	100	1300	--	0
	Cape Sabak	--	3300		8635	8100*
ALAID		--	1500	2500	2500	4800
BULDIR:	North shore	550	--		--	--
	Northwest Point	--	--	3500	--	1850*
	South shore	--	2500		4350	--
KISKA:	Sirius Point	--	--		65	22
	Wolf Point	--	--		--	14
	N of Lief Cove	--	--	1485	--	3750*
	Cape St. Stephen	--	1000		--	1350*
	Vega Point-Sobaka Rocks	150	400		--	930*
TANADAK		--	50		--	670*
BOGOSLOF:	Old Bogoslof	6813*	1000	--	--	800-1000
	Fire Island		100	--	--	0

[1]Source: Mathisen & Lopp 1963
[2] " : Kenyon & Rice 1961
[3] " : Kenyon & King 1965
[4] " : Sekora 1973
[5] " : Present study
*Including pups

Table 10. Estimated numbers of Steller sea lions on selected islands; see text for details of surveys. Dashed spaces indicate areas not surveyed or for which no information is available.

mentioning as an example their sighting of a large concentration, consisting of two herds and totaling about 3,000 animals, five miles off the east coast of Atka in late April. Sekora (1973) gave no specific dates of surveys and did not mention whether his figures included pups; the most specific information is that shipboard and dory surveys were conducted during late spring and summer from 1969 to 1972.

Other rough estimates for Agattu were provided by K. Whitten (pers. comm.) who estimated approximately 2,000 animals at Gillon Point in early July of 1975, and by J. Trapp (fide Whitten) who estimated up to 10,000 at Cape Sabak, although Whitten thought this latter figure was high. Whitten also noted 30 to 40 cows with pups on an offshore rock in West Cove.

Our 1978 Agattu estimates were obtained by K. Hall from both the R/V Aleutian Tern and Zodiac inflatable boats. He estimated 3,800 animals on several beaches on the east side of Cape Sabak (from the Tern) and 4,300 on the west side (from Zodiac) on 8 July (see Fig. 17). On the same day, he estimated 1,500 animals were hauled out on Gillon Point (from Zodiac and the Tern) (see Fig. 18). Due to the difficulty in differentiating pups from adults while aboard boats, no pup estimates were obtained; they were included in the total. The island will be surveyed completely in 1979.

ALAID-NIZKI ISLANDS: We found no estimates for Alaid Island prior to Kenyon and Rice's (1961) aerial survey conducted between 19 and 27 May 1959. Kenyon and King's (1965) aerial estimates were made on 2 May 1965. Sekora (1973) presented an estimate but no details. In late June of 1975, Trapp (1975) estimated 4,500 to 5,400 animals on the island, noting that the colonies were "composed almost entirely of bachelor bulls or yearlings, ... no harems or pups" were observed. Whitten (pers. comm.) saw 20 to 30 cows with pups later in the summer along a portion of Northwest Cove beach.

On 8 July 1978 Day, Lawhead, and Rhode estimated a total of 4,800 animals hauled out on the island's beaches; no pups were seen, even though the animals were observed at close range from cliff-tops above the beaches. The distribution of subcolonies is presented in Fig. 19. Weather conditions were less than optimal, hence our

Figure 17. Location of Steller sea lion colonies at Cape Sabak, Agattu Island, 1978. Numbers stated include pups.

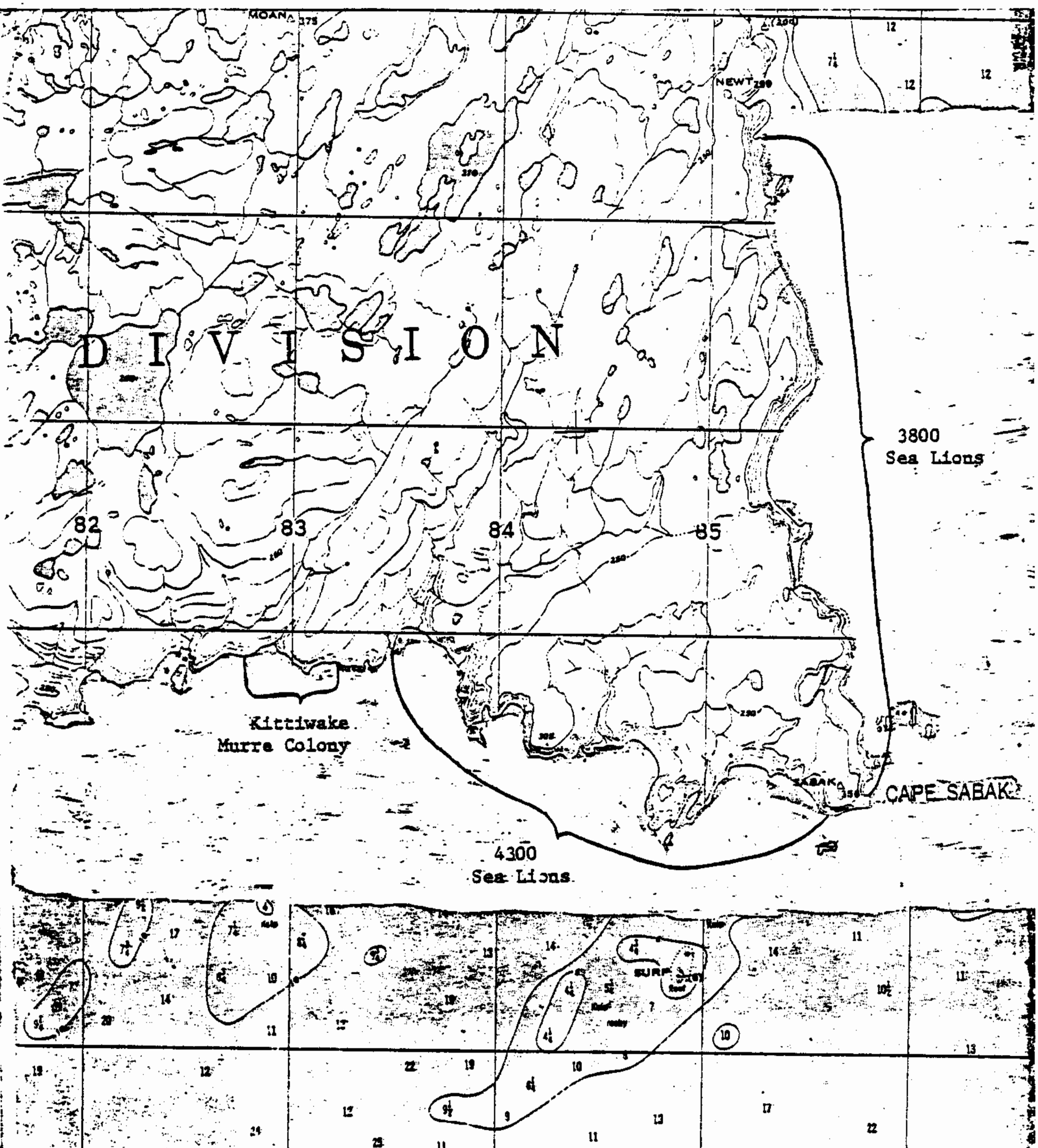


Figure 18. Location of Steller sea lion colonies at Gillon Point, Agattu Island, 1978. Numbers stated include pups.

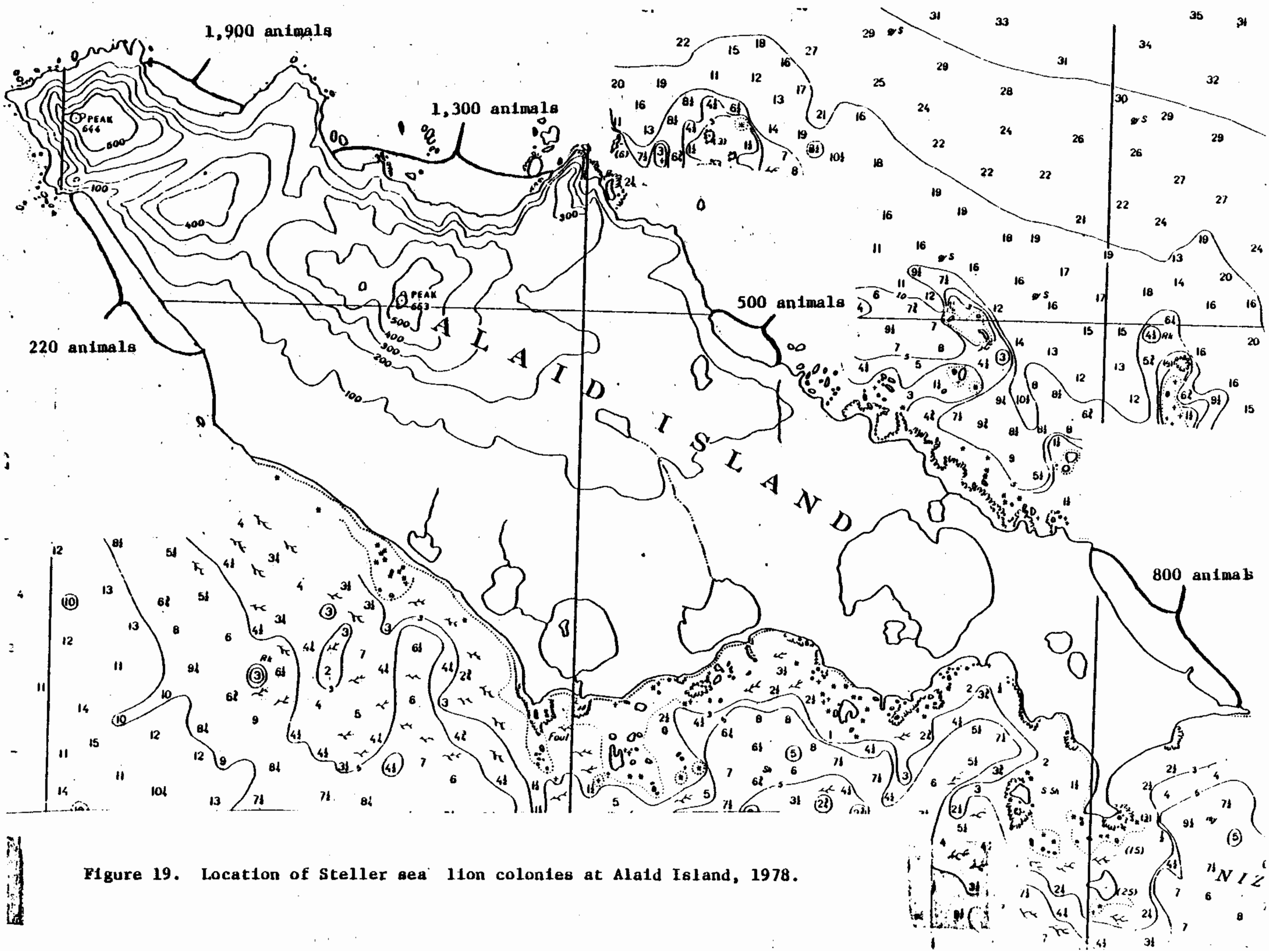


Figure 19. Location of Steller sea lion colonies at Alaid Island, 1978.

figures are only approximate; anyone who has attempted to count densely packed sea lions in high winds and wind driven mist can appreciate the problems. Despite the poor weather, however, we are confident that no pups were present. All other age and sex classes were represented, with a preponderance of subadult males. Several cows were observed "flirting" with large bulls, but no harems were apparent. Thus, when Trapp's observations are considered with ours, it appears that Alaid is primarily a hauling ground for subadult and nonbreeding animals, although breeding may occur to a very limited extent in some years.

Like Trapp (1975), we found no hauling areas on Nizki Island. The only sea lions observed were the carcasses of several bulls.

BULDIR ISLAND: Visual estimates from F.R.I. tagging vessels in the summer of 1957 provided the figure for the north shore. Kenyon led an aerial survey between 19 and 27 May 1959 and another on 2 May 1965. No details are available for Sekora's (1973) estimate.

We did not attempt a census of the island; instead, K. Hall counted the animals present between the tip of Northwest Point and North Bight Beach on 21 July, as part of an ongoing monitoring effort. Sixteen percent of the total were pups. These numbers are certainly minimal, since pups were quite large and an unknown (but probably small) percentage had already left the area. A census made by Byrd and other refuge personnel in 1974 revealed that between 5,000 and 6,000 sea lions used the island (Day, pers. comm.). A complete census should be done in 1979.

KISKA ISLAND: The only information prior to Kenyon's aerial surveys was an estimate of 150 sea lions on Sobaka Rock in the summer of 1957 by F.R.I. personnel. The dates of Kenyon's aerial surveys were the same as for Buldir. Sekora never completely surveyed the island (D.D. Gibson, pers. comm.) and presented only an estimate for Sirius Point.

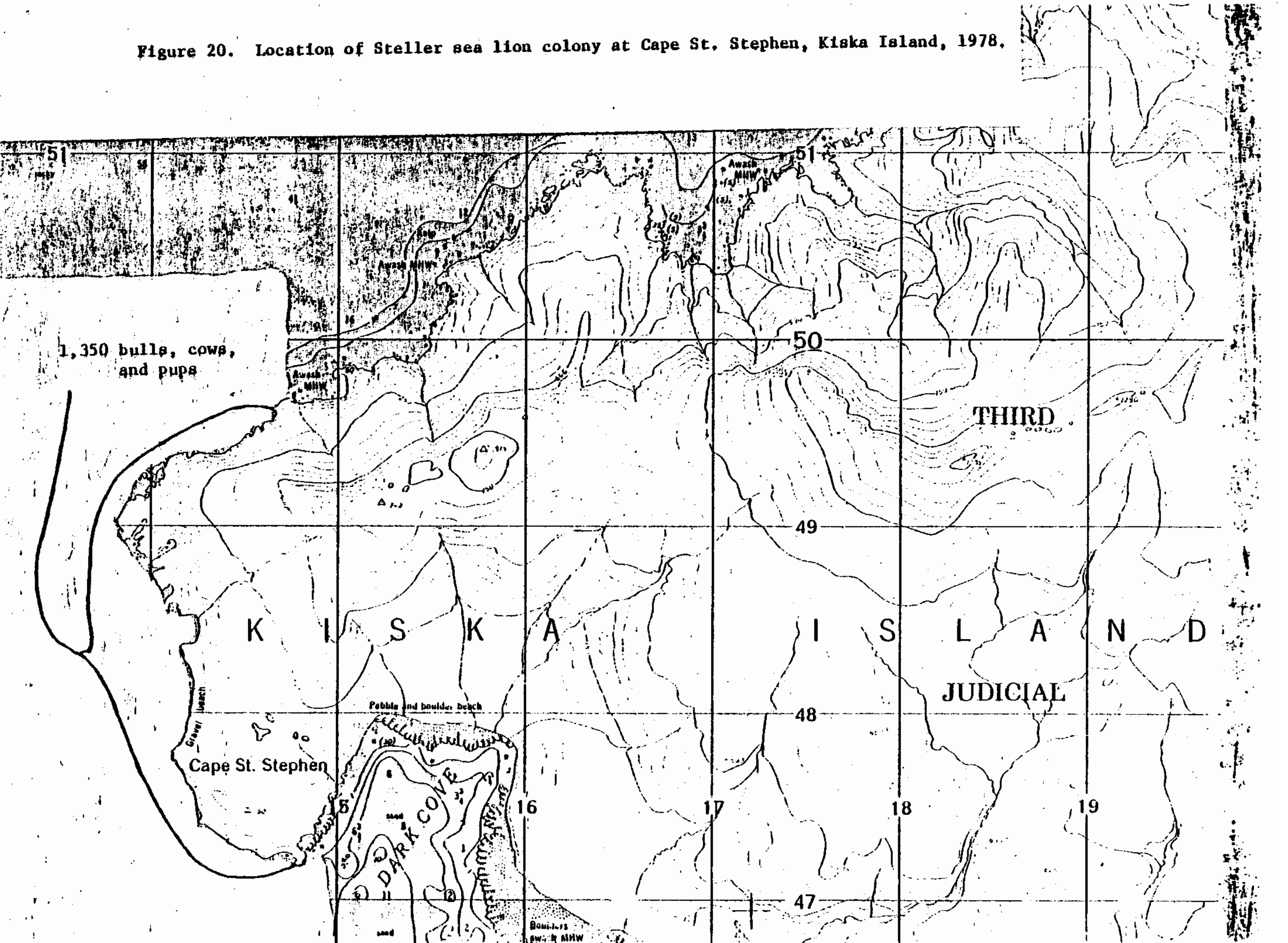
Our surveys were conducted on 26 July (Sirius and Wolf Points) and 9 to 11 August (remainder of colonies). The counts of the Cape St. Stephen (Fig. 20) and Lief Cove (Fig. 21) colonies were made from the R/V Aleutian Tern, while the rest were from a Zodiac. We encountered difficulties in differentiating pups and adults because of our low viewing angle and the relatively large size of the pups; also, because of the late date of our survey, an unknown percentage of cows and pups had vacated the rookeries. The only information on the proportion of pups to adults was obtained for Sobaka Rock (Fig. 22) where 21% of 327 animals were pups. The Sobaka Rock, Cape St. Stephen, and Lief Cove colonies were rookeries, whereas Sirius and Wolf Points were hauling grounds for non-breeders.

The most significant result of our Kiska survey was the discovery of the large rookery north of Lief Cove; Kenyon and Rice (1961) made no mention of this colony and Kenyon and King's (1965) figures for Kiska are low enough to lead one to believe that the colony was non-existent at that time (colony locations were not specified in their report). Thus it appears that a major breeding colony has become established on Kiska at least since 1959, and perhaps since 1965. Our estimate for this colony represents the mean of several counts and should only be considered an approximation. Fig. 23 shows the locations of all sea lion populations on Kiska Island.

TANADAK: The only previous estimate for this colony was from Kenyon's 1959 aerial survey in late May. Kenyon and King (1965) lumped this colony with Kiska. The 1978 survey was by Zodiac on 12 August, and Day and Rhode combined pups with adults (for the same reasons given in the Kiska discussion). Fig. 23 shows the location of all sea lion populations on Tanadak Island.

BOGOSLOF ISLAND: Murie (1959) reported that Scheffer estimated 800 animals at this colony in 1938; no specific date was provided. Mathisen and Lopp (1963) counted 6,813 animals on aerial photographs taken on 13 and 14 August 1957; 46% were pups. Kenyon and Rice's (1961) figures were obtained on an aerial survey on 3 March 1960, well before the breeding season. Kenyon and King (1965) did not survey the island in 1965, and Sekora (1973) provided no figures for the island. Braham et al. (1977) regarded Bogoslof as one of the major breeding colonies in the eastern Aleutians; based on aerial photographs, they presented the following numbers: 1,872 in August 1975; 3,599 in June 1976; 2,127 in August 1976; and 490 in October 1976.

Figure 20. Location of Steller sea lion colony at Cape St. Stephen, Kiska Island, 1978.



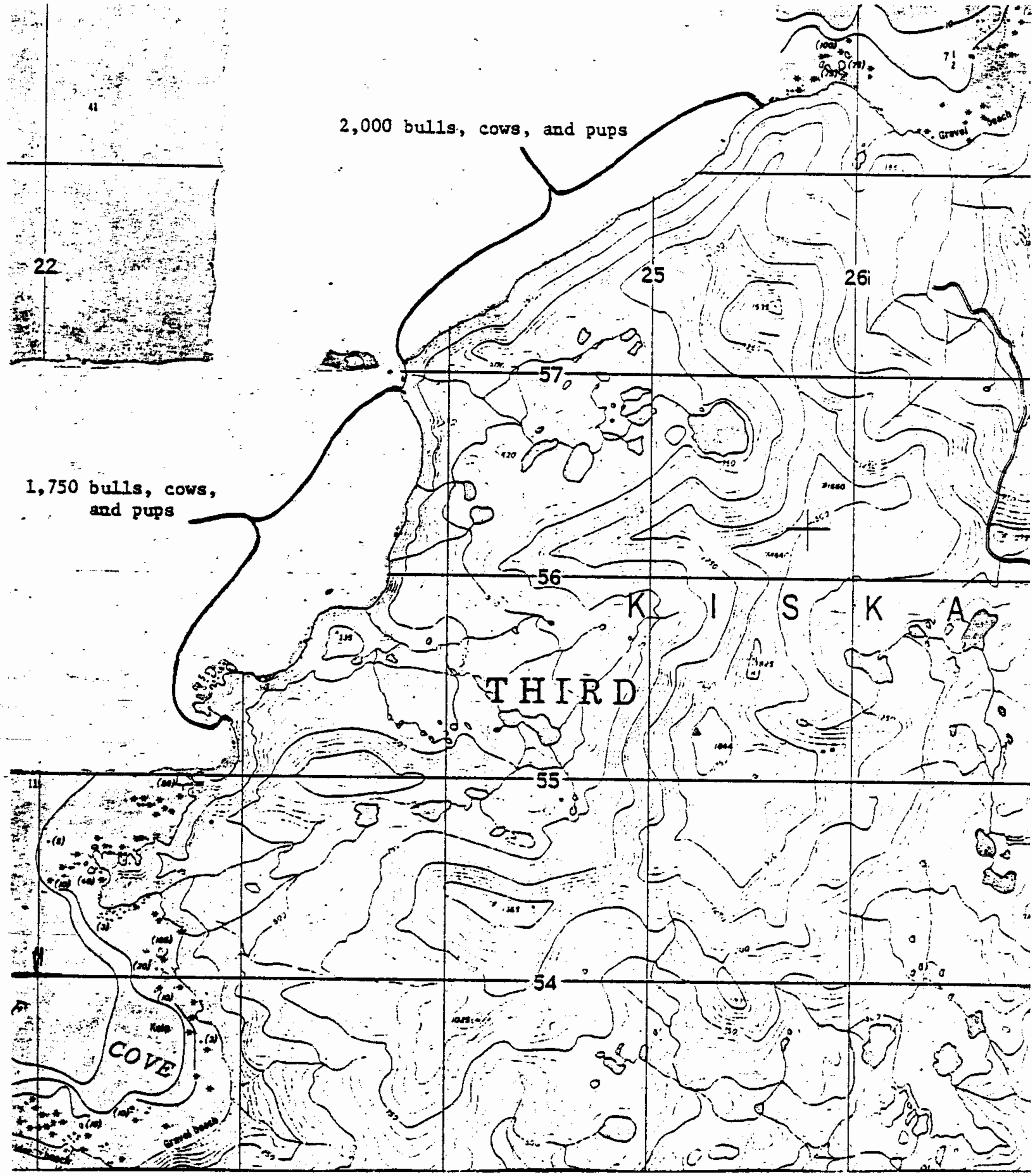


Figure 21. Location of Steller sea lion colony near Lief Cove, Kiska Island, 1978.

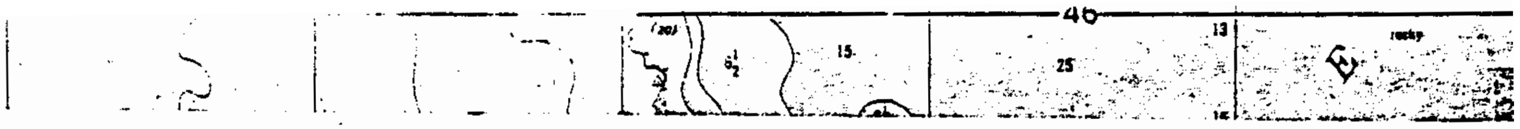


Figure 22. Location of Steller sea lion colony at Vegu Point, Kiska Island, 1978.

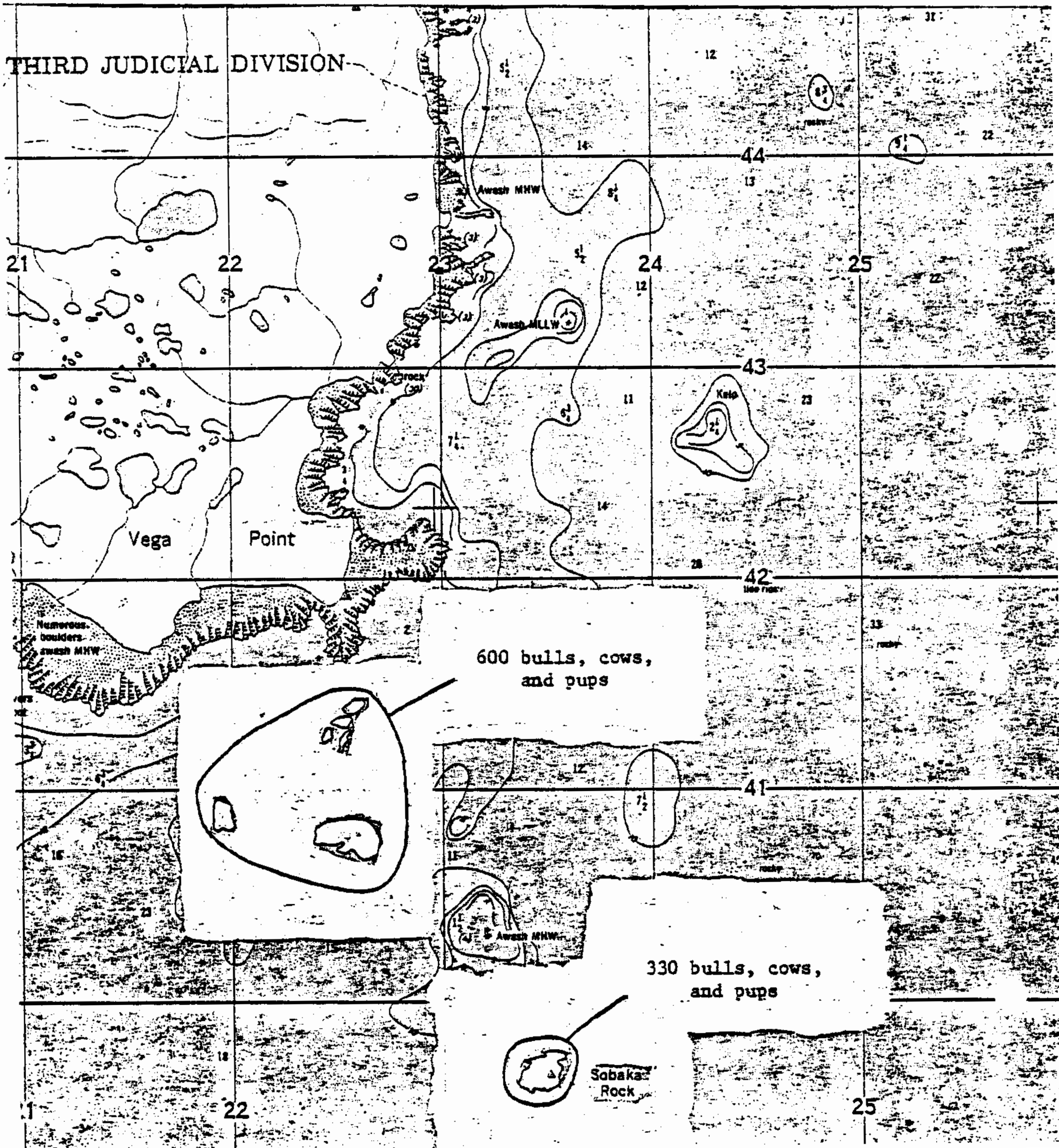
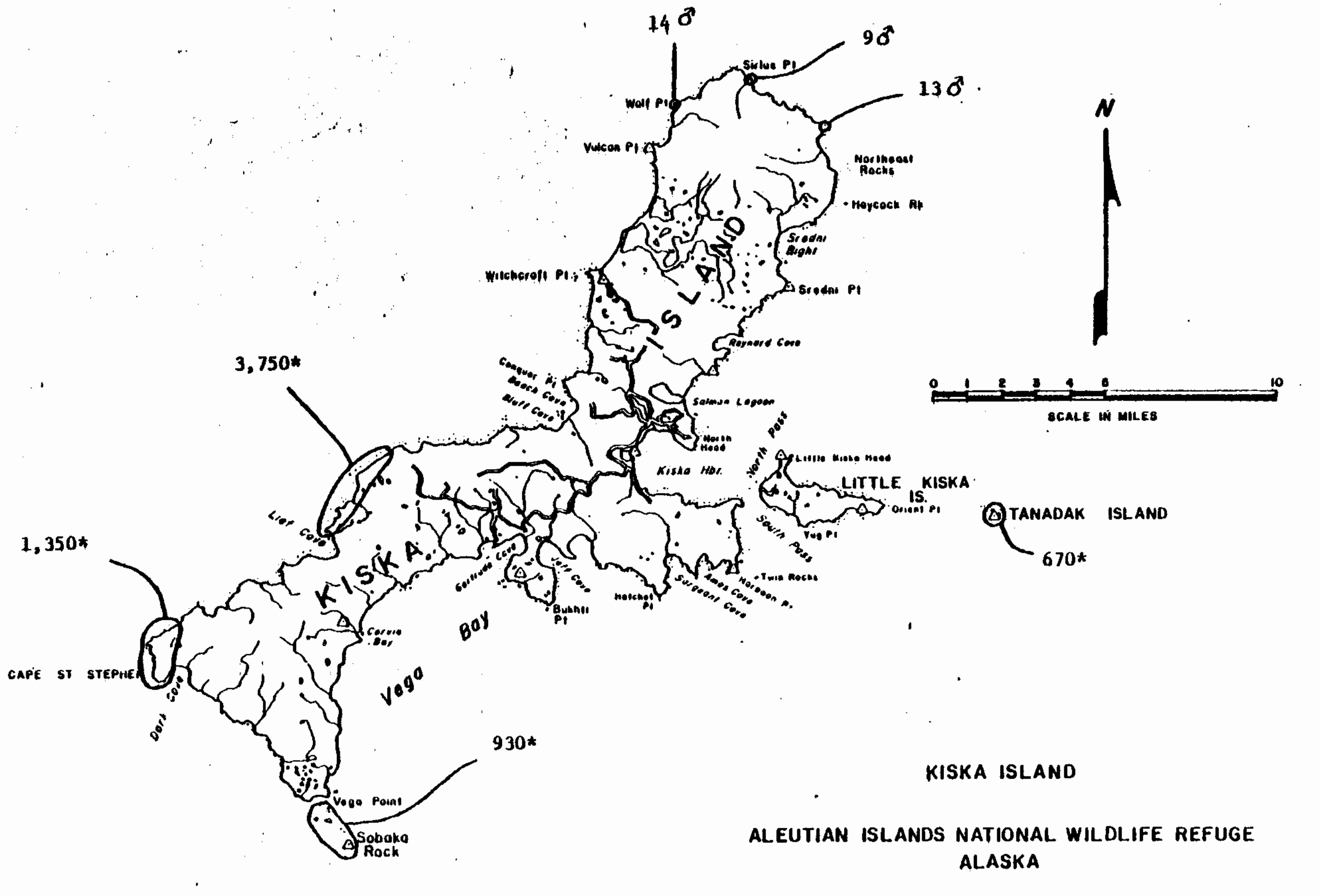


Figure 23. Locations of all Steller sea lion populations near Kiska Island, 1978. Numbers marked with an asterisk (*) include bulls, cows, and pups.



Based on our brief reconnaissance of Bogoslof on 31 May 1978, we estimated that 800 to 1,000 animals were present. The cows had just begun pupping, so the majority of animals probably had not arrived yet. However, it is possible that this colony is subject to large fluctuations in size in different years.

Agattu, Alaid, Kiska, and Tanadak all have experienced substantial increases in sea lion populations since the work by Kenyon and Rice (1961). This fact, when considered with our discovery of a new rookery on Kiska, places the findings of Braham et al. (1977) in an interesting light. They reported an apparently substantial decline of sea lion populations in the eastern Aleutians to "less than half of the estimated numbers in the late 1950's." Once all of the sea lion colonies in the western Aleutians have been adequately censused, it will be possible to compare the eastern and western populations and gauge the magnitude of the changes that have occurred.

Whether natality and/or mortality rates differ between the two regions, or whether a large-scale population shift from east to west has occurred, are questions that need to be addressed. At this juncture, without data from other unsurveyed western islands, we can only speculate on the nature and causes of the observed increase in the western Aleutians.

Several considerations are important when planning and executing future sea lion censuses:

1) Timing of surveys on a seasonal basis is crucial. Surveys should commence no earlier than the latter half of May and no later than the first half of July. Ideally they should be done as soon after pupping as possible and should be completed before post-breeding dispersal begins.

2) Diurnal rhythms of the animals must be considered. Kenyon and Rice (1961), Mathisen and Lopp (1963), and Sandegren (1970) all found that the number of animals hauled out on colonies was greatest in the afternoon, between about 1200 and 1600 hours. Animals leave in the evening to feed, returning by early morning. Sandegren (1970) recorded the highest levels of activity in territorial bulls at high tide and in the evening and night, and the lowest at low tide.

3) Weather conditions affect the number of animals hauled out. During periods of stormy weather, numbers are lower than during mild, calm weather (Kenyon and Rice 1961, Mathisen Lopp 1963, Sandegren 1970), although Sandegren (1970) noted that numbers were also low when solar radiation was "intensive" (a rare condition in the Aleutians). Kenyon and Rice (1961) cited J. Brooks' findings that when adequate space is available above the beach, animals simply move up further during stormy weather. This was apparently the case on Alaid during our survey, judging by the large number of animals remaining ashore.

4) Observer error can be substantial when attempting to count densely packed colonies of sea lions. The low viewing angle inherent in boat surveys adds to this error. Therefore, whenever possible, simultaneous counts by several observers should be made, and shore-based counts from cliff-tops should be attempted. The latter approach yields much more accurate counts and is usually topographically feasible.

Harbor seal

Harbor seals are distributed along the length of the Aleutian Chain, primarily in shallow nearshore waters. Offshore rocks, intertidal ledges and bars, and beaches are preferred hauling-out sites. The only feasible way to count seals is when they are hauled out at such sites; hence, some knowledge of the factors affecting hauling-out behavior is required in planning and evaluating surveys. Bishop (1967) found that "under normal conditions, tides are most important in determining duration and timing of haul-out." Although animals will haul out "anytime," more do so during low tides. He also stated that numbers of hauled-out seals decrease during periods of high winds and associated heavy surf, although Day (unpub. notes) found the exact opposite in the Shumagin Islands.

No reliable population estimates exist for the islands covered by our survey. Harbor seals have generally not been censused during sea otter and sea lion surveys in the past because of the difficulties inherent in such surveys. Aside from being difficult to see (especially during aerial surveys), the seals have patterns of hauling-out behavior that introduce practical difficulties into survey design, in that it is seldom possible to schedule surveys strictly during low tides. As a result, counts are difficult to evaluate and compare.

Despite such difficulties, Kenyon and King (1965) counted seals incidental to their sea otter survey. Intensity of coverage and effort was low since this species was of secondary importance. They counted 145 seals in the Kiska-Little Kiska-Tanadak complex in late May. We surveyed Kiska on 26 July and 9 to 11 August and Little Kiska and Tanadak on 12 August 1978. The island totals were 439 adults and 30 pups around Kiska; 287 adults and 16 pups around Little Kiska; and 105 seals (including pups) at Tanadak, for an area total of 877 seals (including pups). Our pup figures are low due to the relatively large size of the pups at the time of our survey and the low viewing angle from our survey boats; thus, they are inadequate measures of pup production. Our surveys were conducted without regard to tidal stage, and we failed to note this information at the time. Also, as with sea otters, the intervals between survey days at Kiska introduce the possibility of inflated numbers resulting from duplication during counts on successive days.

For counting seals, surface surveys are preferable to aerial surveys. Seals that are not hauled-out become curious at the passage of a Zodiac or other small boat, and observe its progress (at least in these unhunted populations), thus allowing a more complete count in a given area.

In areas of high seal population densities, replicate land-based counts at hauling areas would provide the best information. Such counts could be conducted on a year-round basis at Adak or Amchitka to provide better information on the range of variation in numbers of hauled-out animals.

Future surveys should ideally be conducted during low tides in fair weather. Practical constraints will obviously cause deviations from this ideal, but tidal stage and trend should at least be noted during coastline surveys so that results can be better evaluated.

VII. BULDIR ISLAND BAND RETURNS

Refuge biologists, lead by G.V. Byrd, initiated long-term banding projects on Buldir Island in 1974 when intensive study of that fox-free island and its endangered geese began. Species banded in plots, mist nets, and drives included both storm-petrels, Ancient Murrelets, Glaucous-winged Gulls, the Aethia auklets, and Aleutian Canada Goose. Although 1978 recapture efforts focused only on the first three species, one banded gull was recovered (see "Beached Animal Surveys" for details). Buldir's banded bird population is a treasure trove of growing information that will go to waste if not maintained. Banding efforts declined in 1977 and were non-existent in 1978.

Although no additional birds were banded or worn bands replaced, a fifth year of data was retrieved and added to the breeding biology study of Leach's and Fork-tailed Storm-Petrels on Buldir Island during the 1978 season. Four existing plots were monitored twice (two plots each on 14/17 July and 15/18 July) and permanent plot boundaries were established (described in "Permanent Plots"). A three-day interval was set between burrow checks to increase changes of observing both members of each pair.

Despite the attempt to allow pairs to trade incubation shifts between burrow checks, some birds (as indicated by 10 banded petrels) had shorter or longer shifts. Byrd and Trapp (in prep.) show that shifts from one to five days can occur, with Leach's averaging about three days and Fork-tails about two days. Indeed, of the 10 banded individuals recorded both visits, 7 (70%) were Leach's. Byrd and Trapp also recorded periods of nonattendance of one, three, and six days on successful nests. Four nests (two from each species) with eggs were unattended during one visit. Nevertheless, a total of 46 banded petrels (19 Fork-tailed and 27 Leach's) were recaptured this year (Table 11). Data on 29 (63%) go back to 1974 and 1975, with 14 (30%) banded in 1974. Table 12 contains the summary of recapture history since 1975.

At least 20 (43%) banded birds in plots #1-3 used the same burrow as in a previous year (Table 13). Fifty percent of these birds have used the same burrow for at least three years. Lowest return use of burrows (33%) was recorded in the Stint Creek plot (Plot #3), which has the steepest slope (45°) and major slumping problems.

Eight banded pairs were recaptured in three of the plots. Of these, 4 (50%) pairs had changed mates since last recorded. One pair (Fork-tailed) had been together at least three seasons. Data for mate retention and site tenacity demonstrated by 1978 recoveries are presented in Table 13.

Only one banded Ancient Murrelet was found in the petrel plots, probably due to the late date and most birds had departed for the sea. The few occupied burrows located between 14-19 July had pipped eggs or downy Ancients. In 1977 at least five banded murrelets were recaptured when the plots were visited prior to the onset hatching (28 June and 1 July). Table 14 lists the band recoveries for both 1977 and 1978. One burrow used by a pair of banded Ancients with two eggs in 1977 was occupied in 1978 by Leach's petrels with an egg.

For details on all birds found within the four petrel plots, see "Permanent Plots" and Appendix II.

Table 11. Banded Storm-Petrels recaptured in 1978 at Buldir.

	BAND #	SPECIES		DATE BANDED	1978 BURROW #[bc]		HISTORY OF BIRD BY BURROW # IN PAST YEARS[bd]
Plot #1	1171-06813	Leach's		6/11/74	14		2 -'74
NW Point	1171-06815	Leach's		6/11/74	C13		*13-'74,75,76
(Old #2)	1171-06843	Leach's	pair	7/15/74	78-01	X loose	*X -'74,75,76
	1171-06631	Leach's	pair	8/ 6/75	78-01	nearby	*X —— '75, ?
	1171-06635	Leach's	pair	8/16/75	C21		27 —— '75
	1211-85026	Leach's	pair	6/28/77	C21		*C21 —————— '77(W/bird #06816)
	1211-85029	Leach's		6/28/77	78-15B		C32 —————— '77
	1211-85030	Leach's		6/28/77	C12		*C12 —————— '77
	831-88008	Fork-tailed		6/28/77	C10		new, unmarked '77
Plot #2	53-193828	Fork-tailed		7/29/74	47/50		*47/50-'74,75, ?,77
Outhouse	53-193845	Fork-tailed	pair	7/29/74	37, 36/41		*37/42-'74,75,76, ?
(Old #3)	53-193528	Fork-tailed	pair	7/10/75	37, 36/41		*37/42 —— '75,76, ?
	53-193507	Fork-tailed	pair	5/30/75	21/UNM2	connected	27/36 —— '75;*20/28 in 77
	53-193531	Fork-tailed	pair	7/21/75	21/UNM2	to 20/28	*20/28 —— '75,-, 77
	rebanded 1211-85020			6/28/77			
	53-193530	Fork-tailed		7/21/75	7		*7/2 —— '75,76,77
	rebanded 1211-85021			6/28/77			
	53-193509	Fork-tailed		6/ 5/75	18/26/29/UNM7		27/36 —— '75
	53-193529	Fork-tailed	pair	7/11/75	10/B		11/21 —— '75; 34 in '76
	53-193533	Fork-tailed	pair	7/24/75	10/B		6Y —— '75; 2/15m in '76
	1171-06821	Leach's		6/23/74	78-06		29,UNM7,38-'74,75,76
	1171-06826	Leach's		6/27/74	33/47		*33/47-'74,75,76
	1171-06848	Leach's		7/29/74	28/37		18/26-'74,25/34 in 75;43/46 in '76
	1171-06852	Leach's		7/29/74	48/51		54 -'74
	1171-06608	Leach's		5/30/75	4/16B		*4,16A —— '75, ,?
	1171-06617	Leach's		6/29/75	A		*A —— '75,76,77
	1171-06618	Leach's		7/10/75	40/43		23 —— '75
	1171-38264	Leach's		6/ 8/76	Ya		*Ya —— '76
	831-88002	Leach's		6/28/77	22/29		22/29 —————— '77
	831-88004	Leach's	pair	6/28/77	41		*41,44 —————— '77
	831-88005	Leach's	pair	6/28/77	41		*41,44 —————— '77

Table 11. Banded Storm-Petrels recaptured in 1978 at Buldir (cont'd).

	BAND #	SPECIES		DATE BANDED	1978 BURROW #[bc]	HISTORY OF BIRD BY BURROW #[bd] IN PAST YEARS
Plot #3	1171-06817	Leach's	pair	6/18/74	78-05	35 -'74 ,76
Stint Creek	1171-06835	Leach's		7/ 5/74	78-05	40 -'74,75,76
(Old #1)	1171-06840	Leach's	pair	7/15/74	10/26	*10/26-'74
	1171-06611	Leach's		6/ 5/75	10/26	A ——'75
	53-193815	Fork-tailed		6/11/74	78-08	18 -'74;UNM3 in '75
	53-193822	Fork-tailed		6/18/74	20/24	25 -'74,75
	1171-06602	Fork-tailed		5/28/75	3/6	*6 ——'75,76
	1171-06605	Fork-tailed		5/28/75	25/38	*38 ——'75
	53-(193)671[a]	Fork-tailed		7/ 2/76	7/11	?
Plot #4	53-193547	Fork-tailed		5/23/76	24	Past history for South Marsh plot not available at time of report.
South Marsh	53-193550	Fork-tailed		5/25/76	78-01	
	831-87909	Fork-tailed		7/29/76	16	
	1171-38209	Leach's		5/25/76	43	
	1171-38211	Leach's		5/26/76	10	
	1171-38227	Leach's	pair	5/28/76	38	
	1171-38229	Leach's		5/28/76	38	
	53-193577	Fork-tailed		6/ 6/76	20	

a Three digits enclosed in parentheses were barely legible and correctness is uncertain.

b Any burrow # indicated by two numbers separated by a slash or comma is the result of renumbering of burrows. In all cases, the first number is that given by G.V. Byrd in 1976; the second (and third) number(s) given would be burrow number(s) assigned by Byrd in 1974 or 1975, and are only included for cross-referencing purposes.

c Any burrow # beginning with the prefix 78- indicates the burrow was marked in 1978.

d Any burrow # marked with an asterisk (*) indicates use of the same burrow in different years by the same bird.

Table 12. Summary of recapture history for Storm-Petrels at Buldir.

	YEAR BANDED	TOTAL NUMBERS FORK-TAILED	TOTAL NUMBERS LEACH'S	1978 RECAPTURE[b] FT	1978 RECAPTURE[b] L	1977 RECAPTURE[b] FT	1977 RECAPTURE[b] L	1976 RECAPTURE[b] FT	1976 RECAPTURE[b] L	1975 RECAPTURE[b] FT	1975 RECAPTURE[b] L
Plot #1	'74	5	6	0	3(50)	1(20)	1(17)	0	0	0	4(67)
NW Point	'75	0	5	-	2(40)	-	0	-	2(23)		
	'76	0	2	-	0	-	1(50)				
	'77	4	8	1(25)	3(38)						
	TOTAL	9	21	1(11)	8(38)	1(20)	2(15)	0	2(18)	0	4(67)
Plot #2	'74	13	22	2(15)	4(18)	3(23)	0(0)	4(27)	11(52)	5(38)	13(59)
Outhouse	'75	15	21	7(47)	3(14)	5(33)	2(10)	3(23)	9(41)		
	'76	3	1	0	1(100)	1(33)	2a				
	'77	1	5	0	3(60)						
	TOTAL	32	49	9(28)	11(22)	9(29)	4	7(25)	20(46)	5(38)	13(59)
Plot #3	'74	20	17	2(10)	3(18)	**		1(5)	5(29)	11(55)	6(35)
Stint Creek	'75	15	3	2(13)	1(33)			5(33)	1(33)		
	'76	3	1	1(33)	0						
	'77	**	**	0	0						
	TOTAL			5(13)	4(19)			6	6	11(55)	6(35)
Plot #4	'76	**	**	4	4	**					
South Marsh	'77	**	**	**							
	TOTAL			4	4						

** Information not available at time of writing.

a Additional 1976 banded Leach's recaptured in Plot #2 in 1977 may have come from adjoining check plot or from nightly mist netting efforts - not determinable at time of writing.

b Numbers in parentheses are the percentage of recaptured birds from the total possible for that banding year.

Table 13. Nest-site tenacity and mate retention summary (by plot) of Storm-Petrels, Buldir 1978.

	# BIRDS RECAPTURED 1978	TOTAL # IN SAME BURROW	# IN SAME BURROW FOR AT LEAST 2 YR	3 YR	4 YR	TOTAL # PAIRS	# PAIRS WITH SAME MATE FOR AT LEAST 2 YRS	3 YRS	# PAIRS WHICH CHANGED MATES
Plot #1	9	5	3	0	2	2	1	0	1
Plot #2	20	12	5	2	5	4	2	1	1
Plot #3	9	3	2	1	0	2	0	0	2

Table 14. Banded Ancient Murrelets recaptured in 1977 & 1978 at Buldir.

1977

	BAND #		DATE FOUND	YEAR BANDED	BURROW	STATUS
Plot #2	533-32815		6/28	1975	3/15A	2 eggs
	533-32817		6/28	1975	53/27/36	2 eggs
	1123-44604		6/28	1976	42/45	2 eggs
	1123-44607	pair	6/28	1976	39/U3	2 eggs
	1123-44605		7/ 1	1976	39/U3	

1978

Plot #2	1163-99883	7/14	banding report form not found	53/27/36	6/28 2 eggs pipped 7/1 1 pipped, 1 hatching

VIII. AUKLET CENSUS

Sekora et al. (in press) found that Crested, Least, Whiskered, and Parakeet Auklets comprise 41.5% of the total breeding birds within the Aleutian Islands National Wildlife Refuge. They further state that these species have their center of abundance in the Delarof and Rat Island groups. Providing verifying evidence in 1977, Day et al. (1978) found that well over 80% of the birds in the islands surveyed within these groups were of the above four species. Further work in the Rat Island group this field season shows that the auklets (primarily Leasts and Cresteds) comprise well over 95% of the birds in the Kiska Island area.

In preparation for censusing, the Sirius Point auklet colony on the lava flows of Kiska Volcano was divided into three strata (colonies) based on a field appraisal of density and geographic differences (Fig. 24). The census technique employed originated from auklet studies on Buldir Island in 1976 (Byrd and Knudtson in prep.) and was discussed in detail by Day et al. (1978). The technique was essentially used intact except for one major change: instead of making plot locations entirely random as was done in 1977, plots were laid out on a compass bearing (see Fig. 47 in "Section XI - Permanent Plots"). This was in answer to the immense size of the Kiska auklet colony, where the old lava flow covers an area of 9.3 x 10^5 m^2 and the new lava flow is 4.2 x 10^5 m^2 in area; obviously, that is far too large an area to relocate random plots with only one corner of each plot marked. In addition, the large, gently-sloping lava flow there lent itself easily to this technique.

A patch of flow 75m wide on the east side of the flow was not counted in the total area estimate of the old flow, for it was heavily overgrown with Elymus and contained few birds. We assumed that densities in Colony #2 were the same on the two side areas of lava as in the much larger center section which we sampled.

The plots were laid out in groups of five along a compass bearing of 012°T; this bearing line ran along the longest length of the largest part of the colony (see Fig. 47 in "Permanent Plots"). A replicative sampling scheme was used to locate the plot lines, which in this case were 10 plots (100m) apart. Location of plots on the transect lines was also determined by replicative sample, with intervals of 240 or 280m between seaward plot edges. All plot poles were placed in the lower (seaward) east corner of each plot.

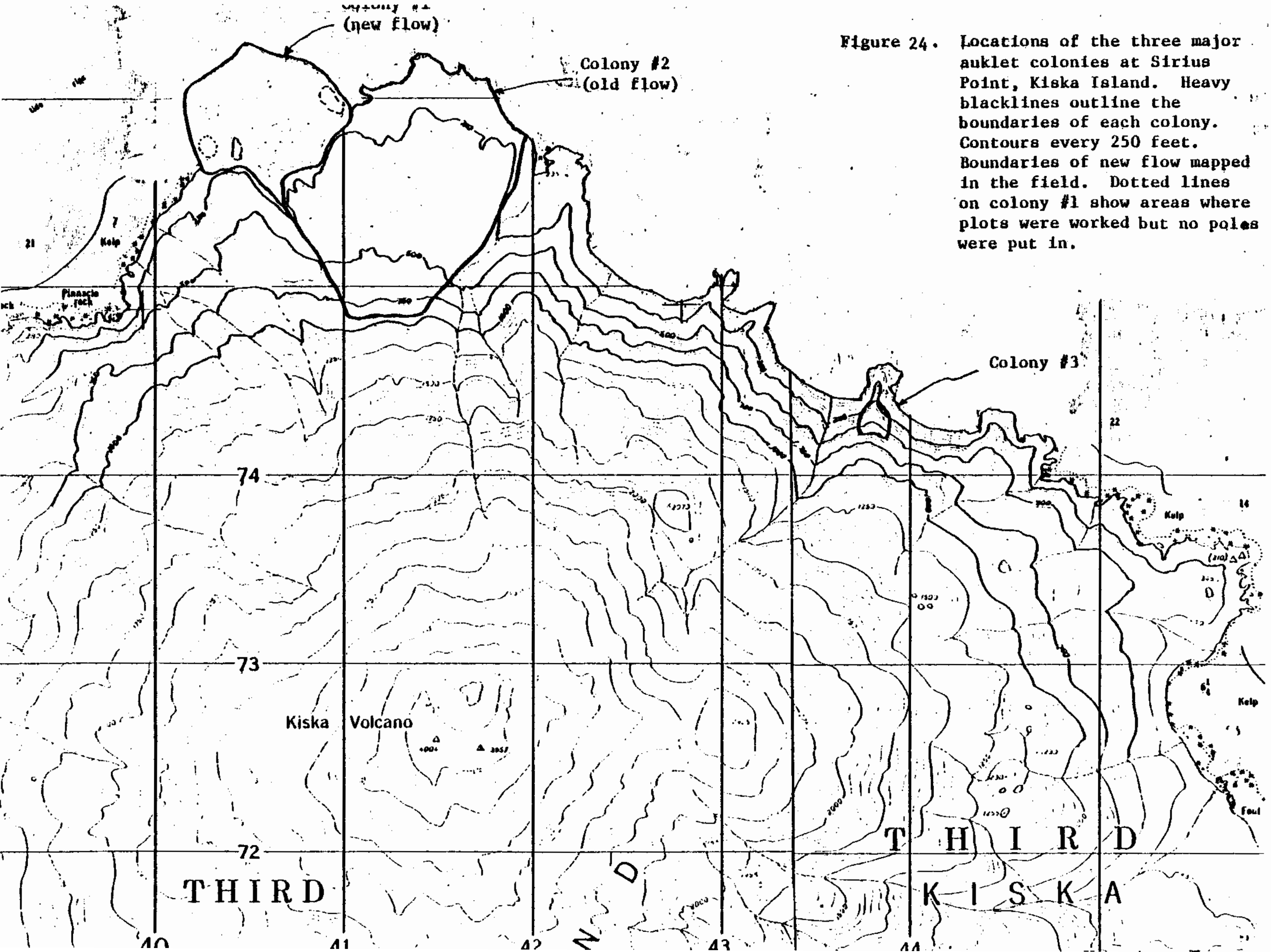


Figure 24. Locations of the three major auklet colonies at Sirius Point, Kiska Island. Heavy blacklines outline the boundaries of each colony. Contours every 250 feet. Boundaries of new flow mapped in the field. Dotted lines on colony #1 show areas where plots were worked but no poles were put in.

Data on the 15 marked plots on the old lava flow are presented in Table 29 ("Permanent Plots"). Note that only ten of those plots were worked this year. We arrived on colony too late to catch all the birds: many had fledged or were fledging, and we were able to observe the decline each evening. By the time we were able to count the last plots, too few birds remained to make it worthwhile to continue. All of the plots should be worked next season; this should be done earlier in the breeding cycle to avoid the problem encountered this year.

In addition to the plots on the old lava flow, a total of ten plots were worked on the new lava flow (colony #1). We attempted to lay plots on a compass line, as in the old flow, but the extremely unstable new rocks made this impossible. Also, climbing over the rugged surface proved too dangerous to permit using this technique; thus, no permanent plots were located there. Plots were not entirely random, for they were placed only in areas easily accessible from the water. Location of these plots is shown in Figure 24.

The number of 10 x 10m plots in each stratum (colony) is given in Table 15. The average number of birds in each stratum and total estimates of auklet populations for each colony are also presented in Table 15. Note that although we were unable to work on colony #3, we used the mean densities from colony #2 for the estimate of total auklets there. Colony #3 appeared at least that densely-populated, looking at it from the sea.

As practiced last year, we omitted the confidence intervals from our estimates. The variability between plots is so great that the confidence interval essentially "swallows up" the estimate. This is a result of the limited number of plots worked on each colony— a poor compromise between the need for accuracy and the need to cover a large geographic area during the summer.

As is shown in Table 15, there are approximately 1.4 million Crested and Least Auklets on Sirius Point, with Leasts outnumbering Cresteds by a ratio of 5 to 1. At this point, it is the largest known auklet colony in the world. However, we feel the estimate is an absolute <u>minimum</u> and believe that the actual population is closer to two million birds. By carrying out the plan to resurvey these plots earlier in the season and to work more plots, the estimate in future years should become more accurate.

Table 15. Estimate of total populations of Crested and Least Auklets on the Sirius Point Auklet Colony.

COLONY NUMBER	# OF PLOTS SAMPLED (n)	# OF PLOTS IN COLONY (n)	AVERAGE # LEAST AUKLETS/PLOT	AVERAGE # CRESTED AUKLETS/PLOT	EST. # LEAST AUKLETS	EST. # CRESTED AUKLETS	TOTAL AUKLETS
1	10	4,300	180.2	14.8	774,860	63,640	838,500
2	10	9,300	37.4	17.8	347,820	165,540	513,360
3	0	300	37.4*	17.8*	11,220	5,340	16,560
TOTAL					1,133,900	234,520	1,368,420

* Average densities from colony #2 used for colony #3.

The Kiska's new flow (colony #1) has the greatest number of birds, approximately 800,000 auklets. Although it is less than one-half the size of the old flow (colony #2), it contains approximately 1.6 times as many auklets. There are many more Least Auklets in the new flow than in the old; but the density of Crested Auklets is actually greater in the old flow. Although this may be a result of earlier fledging by Leasts (plots on the old flow were worked late in fledging), most of this difference is attributable to poorer nesting habitat for Least Auklets in the old flow. Since the flow is several hundred years old, many of the smaller crevices have filled in with debris, leaving primarily larger crevices that are the preferred habitat of Cresteds. Aggression by Cresteds could play the major role in the reduction of Least Auklets where potential nest-site competition becomes important. For a thorough discussion of this aspect of habitat use, see Bedard (1969).

In summary, the auklet colonies at Kiska Island are the largest known in the world, with an estimated minimum of 1.4 million birds nesting there. The Least Auklet is the most abundant species, comprising approximately 80% of the total colony. The relatively unweathered new lava flow (colony #1) has both the greatest number of birds and the greatest number of Least Auklets, the latter is probably due to the greater abundance of nesting crevices available for these birds.

IX. MURRE STUDY PLOTS

AGA COVE - General

Two permanent study plots for murres and Kittiwakes were established this summer at Aga Cove (see "Permanent Plots"). Plot #1 was established primarily as a Black-legged Kittiwake plot (although it included murres), while plot #2 was intended primarily for Common and Thick-billed Murres.

During our stay at Aga Cove, we attempted to refine our census technique for murres by studying attendance patterns on the nesting cliffs in plot #2. We conducted three all-day counts (24-26 June) of birds on the ledges at half-hour intervals from 0630 to 2230 hours (local time); times for beginning and ending were determined by the amount of light available for identifying the birds by species. Additional counts were conducted on 2 and 4-6 July, but only for portions of these days. In addition to the above counts, we recorded numbers of birds arriving and departing two high-density Common Murre nesting ledges during the second 15-minute segment of each half-hour count on 25 and 26 June. Ledges were counted with the aid of a 20X spotting scope, and birds were tallied on hand-held counters. The study plot was photographed and divided into three high-density ledges (A,B,C) and one low-density ledge (D); the remainder of the study plot contained scattered pairs of birds, and was lumped as one low-density "ledge" (subplot E).

The analyses that follow are brief, owing to a lack of the computer facilities and time needed to adequately treat the data. Nevertheless, the most pertinent aspects of the data for censusing are highlighted. The data collected are far from complete and can only provide a framework for future work.

Stage of breeding

Since murre attendance at the nesting cliffs varies considerably on a seasonal basis (Hickey and Craighead 1977, Lloyd 1975, Tuck 1960), it is imperative that the phenological stage of the birds be determined before any serious census effort is undertaken. We endeavored to determine this by observing the nesting ledges with a spotting scope since the inaccessibility of the study plot precluded direct visits to the ledges. In order to confirm the presence of eggs or chicks on a given ledge, this method required lengthy observation; because the amount of time available for such observation was limited, it is impossible to consider our assessment more than a rough approximation.

On 24 June, all subplots in plot #2 had at least a few birds on eggs, with several high-density ledges potentially having a large percentage of birds incubating; eggs were noted for both species. On 26 June, several more birds were confirmed as incubating in each subplot. More effort was expended in the collection of this information beginning with the 4 July counts, and continuing on 5 and 6 July (estimates of the percentage breeding will follow in this section). By 6 July it was clear that more birds than originally suspected were well into incubation, but the appearance of a recently-hatched Common Murre chick on one ledge came as a surprise.

Tuck (1960) lists the incubation period of Common Murres as varying from 30 to 35 days, so the egg from which this chick (and any others that went unseen) emerged was laid during the first week of June. Since it seems likely that the onset of egg-laying would occur relatively synchronously, we presume that our counts for 2-6 July are representative of the last third of the incubation period. This would place the 24-26 June counts in the middle third of incubation. Again, these are approximations at best and could be early, as we left the island on 7 July and were not able to monitor hatching. A brief visit to the study plot on 8 August by D. Woolington and D. Yparraguirre, refuge biologists monitoring the Agattu release of Aleutian Canada Geese, revealed many chicks approximately "half the size" of adults on the cliffs. Chicks this size should be very close to fledging, indicating hatching about mid-July. This supports our general conclusions regarding the stage of breeding.

Not all eggs seen were close to hatching in early July. We recorded several instances of eggs that were laid between 26 June and 4 July (Common), as well as one that was laid on 5 July (Common) and one on 6 July (Thick-billed). These eggs were laid in low-density areas of the plot near the colony margins, leading us to speculate that the birds nesting there were probably inexperienced, young birds, or failed breeders relaying. Day observed an attempted act of predation by a Glaucous-winged Gull at a nest site from which the egg was missing the following day. Several copulations were observed as well during this period.

The foregoing information provides a rough time-frame within which to consider the diurnal attendance analyses that follow.

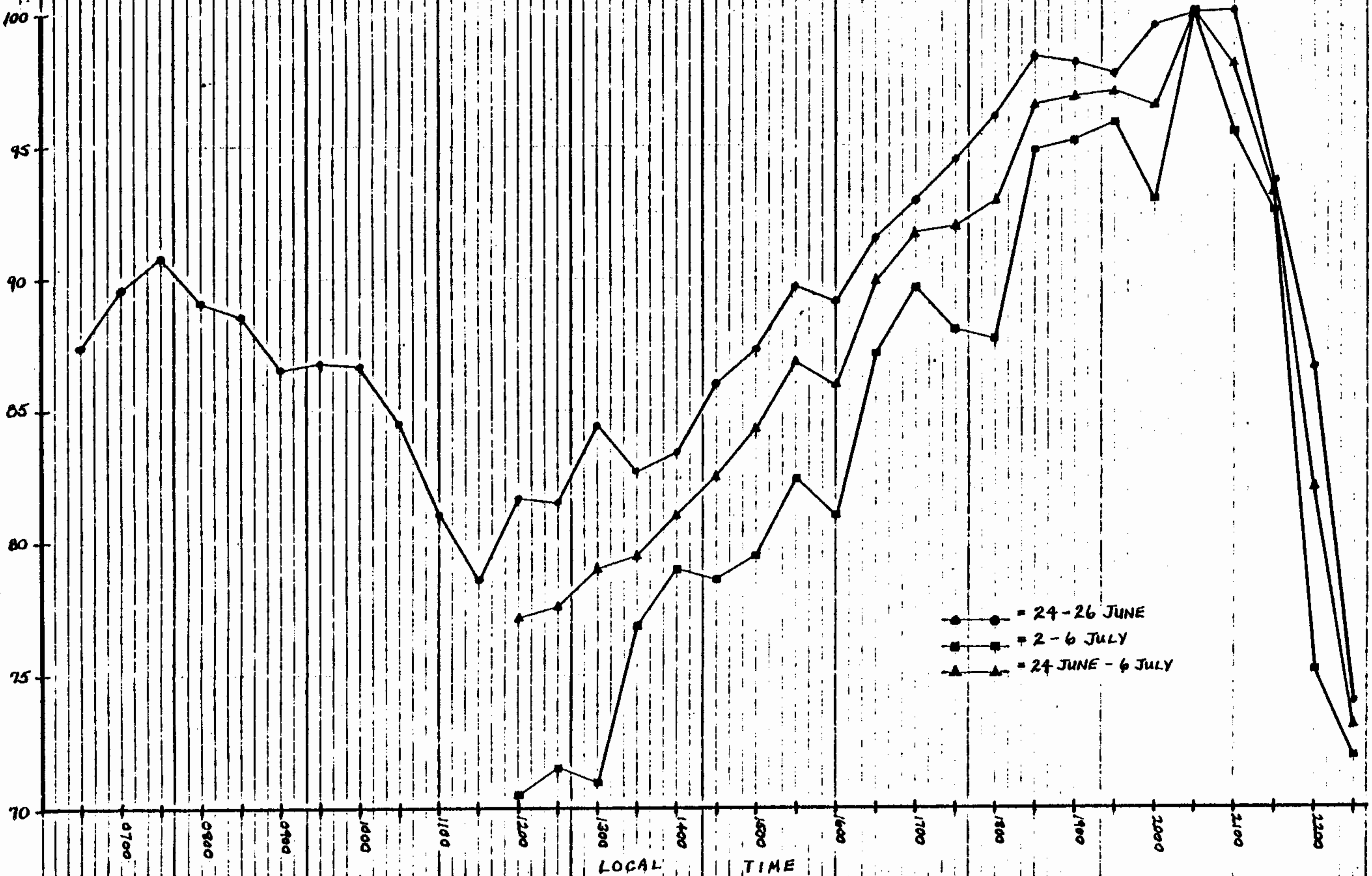
Diurnal attendance patterns

In analyzing our data for patterns of diurnal attendance, we first tabulated all of the counts for each of the four easily defined ledges (A,B,C,D) in the plot; the remainder of the plot, consisting of a number of small, low-density ledges, was lumped as subplot E. Each count was then converted to a percentage of the maximum count for that particular day. For each half-hour period, counts were summed to arrive at a total count for all birds, for Common Murres, for Thick-billed Murres, for high-density Common ledges (A,B,C), and low-density Common ledges (D,E), and "percent of daily maximum" was computed for each count in each category. An example of these data is presented in Fig. 29. Two approaches were then taken with these categorized data.

The first approach was to calculate mean numbers of birds during a given count time for each 30-minute interval during the "mid-incubation" period (24-26 June), the "late incubation" period (2-6 July). Standard deviation of the mean was calculated and was used to compute the coefficient of variation for each count (after Lloyd 1975), which is simply the standard deviation expressed as a percentage of the mean, allowing quick comparison of the extent of variation for counts of different magnitudes. After these values were obtained, each mean count was expressed as a percentage of the maximum mean count for that particular period.

This approach was used for the five categories: total birds, total Commons, total Thick-billed, high-density Commons, and low-density Commons. The "percent of maximum mean count" value was chosen as the ordinate variable in Figs. 25, 26, and 27, in order to allow direct comparison of the different categories presented, since the magnitude of their means is quite different in several cases. To avoid confusion when comparing two categories in the same graph, we generally presented only the curve for 24-26 June since the data cover the entire daylight period for these dates; the only exception is Fig. 25, which presents data for all three periods. The tabulated data upon which this approach is based appear in Appendix III, Tables 1 through 5.

Figure 25. Total birds present on Agattu Study Plot #2, 24 June - 6 July 1978.



The second approach in analyzing the attendance data was to calculate "mean percent of daily maximum count" (not mean number) for each count in the 24-26 June, 2-6 July, and 24 June - 6 July periods in each of the five categories. This was done by finding the mean value for the "percent of daily maximum" figures, mentioned earlier, for each period. Standard deviation was calculated for each mean, as well as coefficient of variation for all but the high and low density categories. Figs. 30 and 31 employ "mean percent of daily maximum count"as the ordinate variable, and here again we have presented only the curves which represent the all-day counts on 24-26 June. Data from which Figs. 30 and 31 are drawn are presented in Appendix III, Tables 6 through 8.

Graphical analyses of the diurnal attendance data are presented in Figs. 25 through 31, and are briefly discussed below.

Fig. 25 - The data from which this graph was drawn appear in Table 1, Appendix III. The figure shows the attendance curves for all of the birds in plot #2, expressed as percent of maximum mean count, and shows the general pattern of diurnal attendance encountered: a minor peak early in the morning preceded a decline to a low just before midday, followed by a fairly steady increase to the evening peak, followed by a precipitous decrease that apparently continued after dark. The mid-incubation curve not only showed consistently higher numbers for a given time than the late incubation curve, but was consistently less variable as well (at least for those times for which we have data from both periods).

Fig. 26 - Comparison of Common and Thick-billed attendance totals is presented in an attempt to examine interspecific differences that would be masked by examining Fig. 25 alone. In a very broad sense, both species show the same general pattern described by Fig. 25, although Thick-billed counts were subject to relatively greater fluctuations and higher variation. This may be partially explained by the small numbers of this species in our plot since each individual assumes a disproportionate importance when compared with large samples, such as that for total Common Murres. Most of the birds in the plot were Commons, so it is not surprising that this curve corresponds closely with that for total birds in Fig. 25. [The data for this figure are in Appendix III, Tables 2 and 5.]

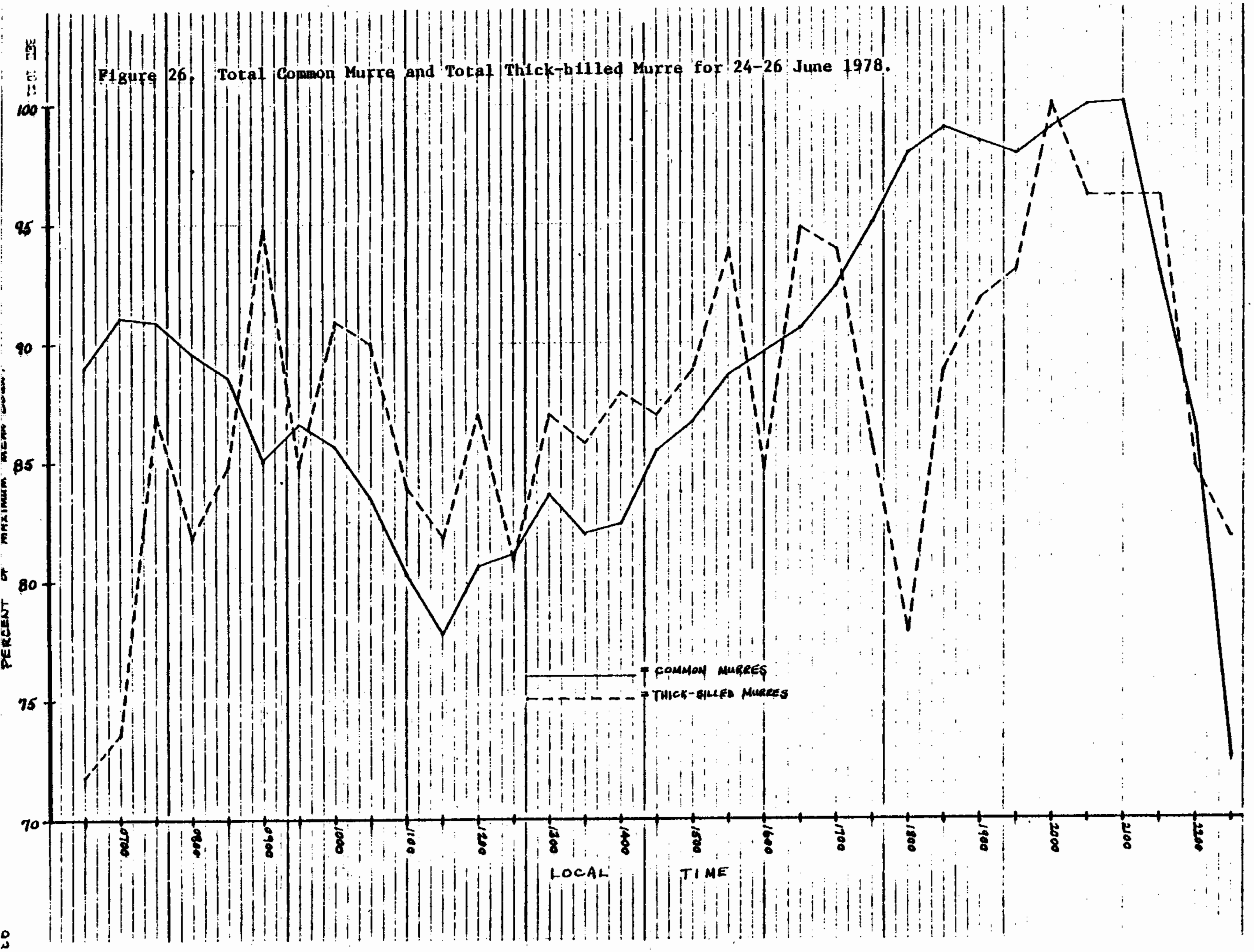


Figure 26. Total Common Murre and Total Thick-billed Murre for 24-26 June 1978.

Fig. 27 - Because Common Murre nesting densities range from very low (on small, isolated ledges) to extremely high (on broad, flat ledges), we attempted to examine the effect of density on attendance patterns. The low density figures were compiled from ledges D and E, small ledges with several pairs on each, while the high density figures are sums of ledges A,B, and C, all of which had several rows of birds for portions of their length. "High" density as used here is a relative term, as there were no ledges in the plot that approached maximum nesting density for the species. Again, because the majority of birds in the plot were Common Murres on high density ledges, this curve closely follows that in Fig. 25. The low density curve follows the same general trend but, like the Thick-billed curve in Fig. 26, fluctuates erratically and exhibits higher variation in its counts. [The data for this figure are in Appendix III, Tables 3 and 4.]

Fig. 28 - As a result of the preference of Thick-billed Murres for narrower ledges (Tuck 1960), the species' highest densities are comparable with the low densities of the Commons. Thus, low density Commons and Thick-billeds were compared in an effort to determine if attendance patterns might be influenced more by density than by species identity. The ordinate variable chosen in this case was "mean number of birds" for each count, instead of a percentage, as the numbers involved were close enough to conveniently allow graphic comparison. The curves are similar; both fluctuate quite a bit despite a general increase toward evening. Coefficients of variation are roughly similar, with that of low density Commons being slightly higher overall. Thus, at least a portion of the variation in the attendance counts appears to be a function of density, although the extent of such variation remains unqualified for our data. [Data for this figure are presented in Appendix III, Tables 4 and 5.]

Fig. 29 - Counts of total murres are presented for 24, 25, and 26 June as "percent of daily maximum", primarily to illustrate that, although magnitude of counts may vary considerably from day to day, the proportion of the birds present on the cliffs throughout the day remains relatively constant from one day to the next (the largest standard deviation for the 24-26 June period comprised 8% of the mean). [Data for this figure were drawn from Appendix III, Table 9.]

Figure 27. High Density Common Murre and Low Density Common Murre for 24-26 June 1978

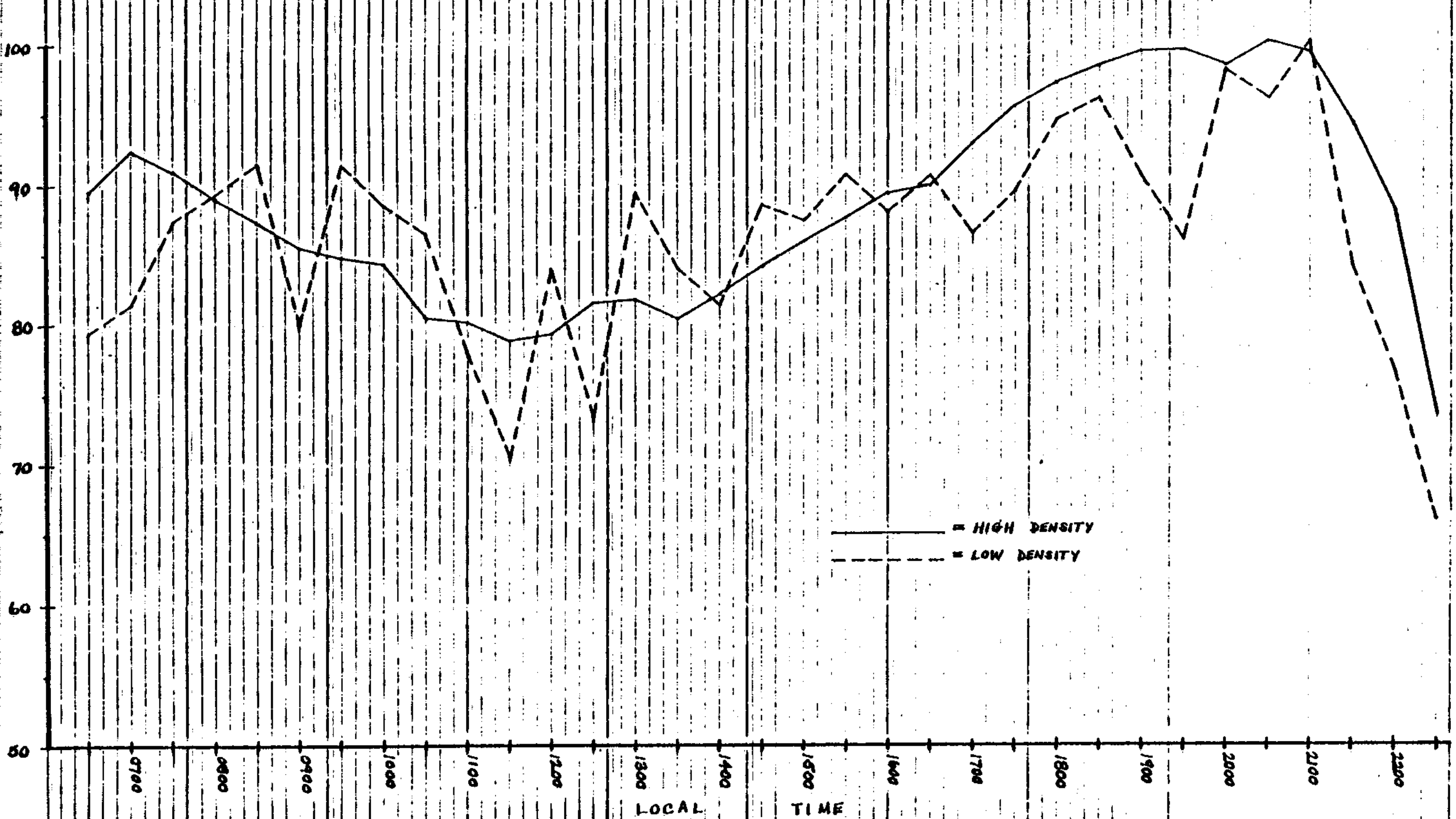
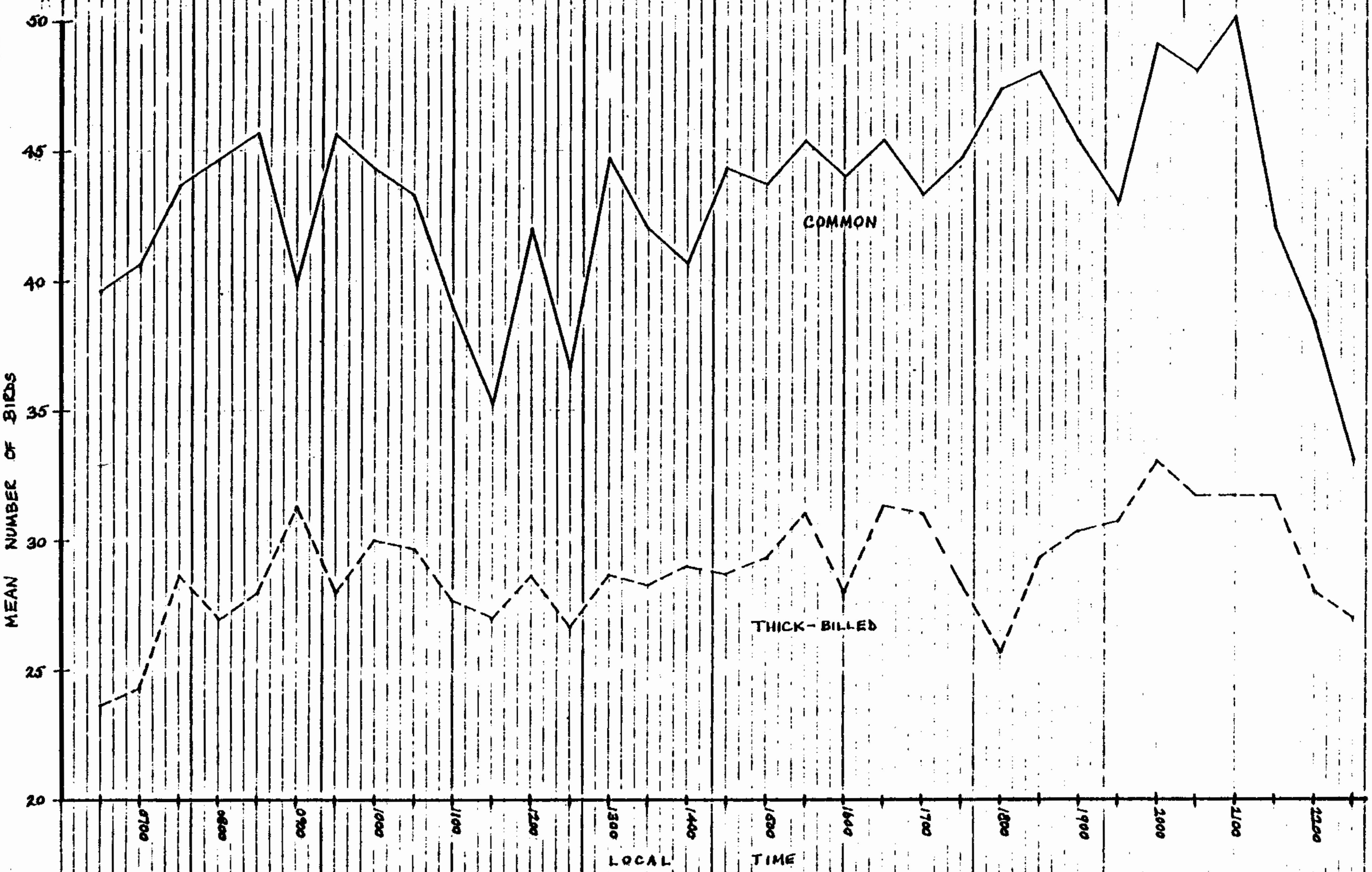


Figure 28. Thick-billed Murre and Low Density Common Murre for 24-26 June 1978.



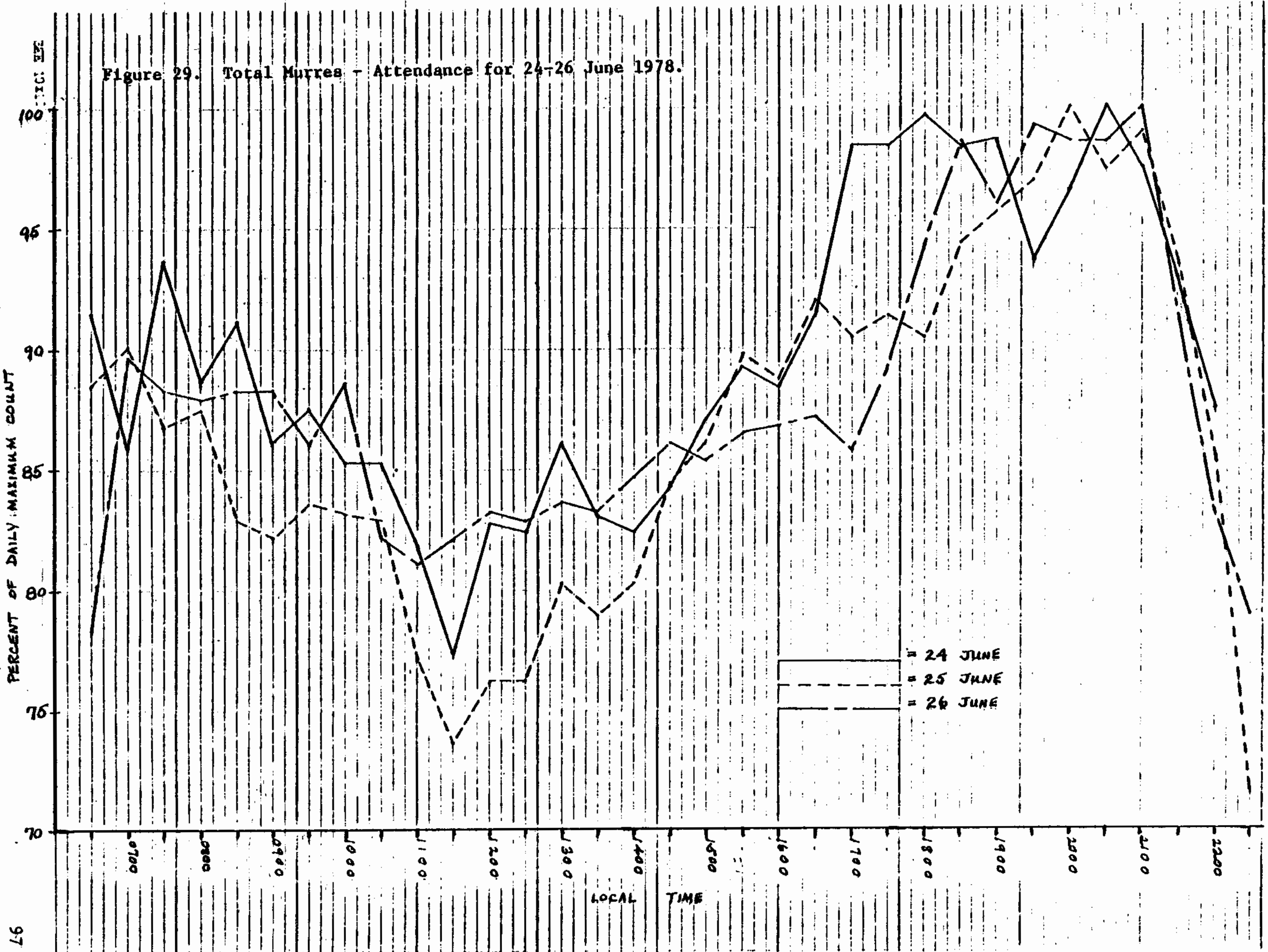


Figure 29. Total Murres - Attendance for 24-26 June 1978.

Fig. 30 - Once again we compare Common and Thick-billed Murres, this time with "mean percent of daily maximum count" as the ordinate variable. Both curves shows essentially the same pattern as in Fig. 26; however, these curves peak below 100%, since they represent mean percentages of counts that did not peak simultaneously. Increasing variation among counts will cause the curve to be depressed more and more, and this is apparently the reason that the Thick-billed curve is lower than the Common curve; and examination of coefficients of variation shows higher values for the former species. [Appendix III, Tables 6 and 8 contain the base data for these curves.]

Fig. 31 - The "mean percent of daily maximum count" curves for high and low density Common Murre ledges show the same pattern as those in Fig. 27. As in Fig. 30, variation between counts caused a lowering of curves, having the greatest effect on the low density ledges' curve. [Data upon which this figure is based are presented in Appendix III, Table 7.]

Arrivals and departures

In addition to the graphical analyses presented above, we tabulated the data on arrivals and departures for two high-density Common Murre ledges (Table 16 and Figs. 32 and 33). Birds landing on and departing these ledges were counted during the 15-minute period following each time listed in the table, and the net change was noted. These data provide information on two aspects of diurnal attendance patterns: first, they indicate the periods of greatest turnover of birds on the cliffs; and second, they serve as a check on the attendance curve generated for Fig. 27. Due to the low numbers involved, net changes are quite variable and can indicate only general relationships.

Turnover of individuals was greatest around the evening peak and somewhat lower for the early morning peak, with lowest levels occurring about the time of lowest attendance in late morning. A crude approximation of the number of birds involved may be obtained by summing the absolute values of the "in" and "out" columns for each count. This calculation ignores net change, since the net will be zero if a bird arrives for every one that departs, thus giving no indication of the turnover that is occurring. A crucial assumption for this approach, however, is that each bird has an equal probability of coming and going; this condition is almost assuredly not met, as non-breeders would be likely to move around the colony much more

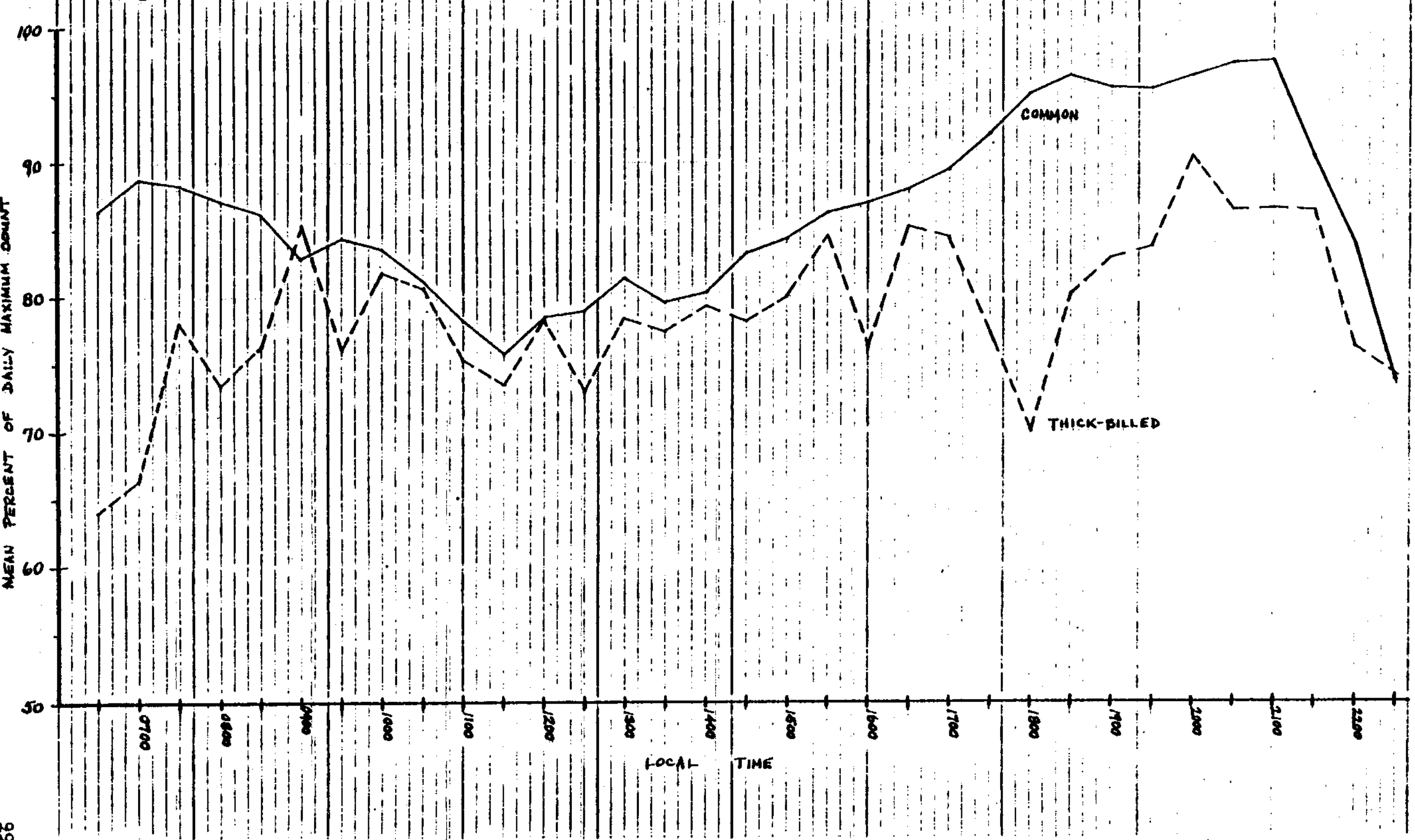


Figure 30. Total Common Murre and Total Thick-billed Murre, 24-26 June 1978.

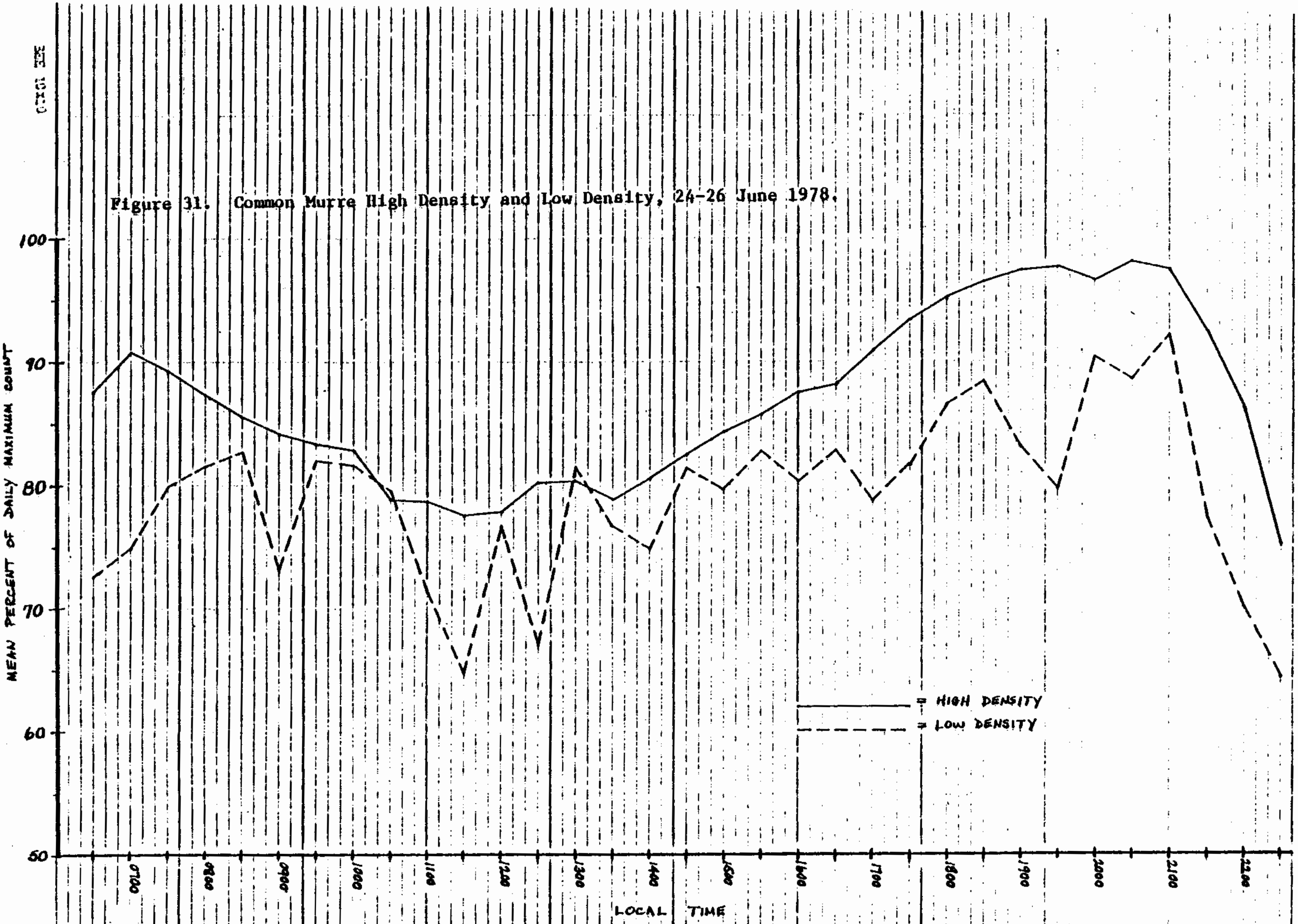


Figure 31. Common Murre High Density and Low Density, 24-26 June 1978.

than breeders, and would therefore be more likely to come and go during the same count period. Nevertheless, the higher number of comings and goings at peak attendance periods strongly suggests higher turnover at that time, presumably representing incubation shift changes for breeding pairs.

Another aspect of turnover of individuals is suggested by the total arrivals and departures for each ledge. These totals, when summed as absolute values and doubled to approximate the remainder of the day not covered by counts, are roughly three to four times the maximum number of birds observed on the ledge that day. This fact suggests an average of one and one-half to two comings and goings per bird per day, but this is only speculative given our data.

A comparison of the net change values with the high-density curve in Fig. 27 indicates that there is generally agreement between net values and trend of the graph, but it is sufficiently tenuous to discourage further discussion.

Number of breeding pairs

In the course of the attendance and arrival/departure counts, we recorded the number of breeding pairs per ledge. This was done by closely observing the ledges with a spotting scope and noting the presence of an egg, chick, or adult bird in incubation posture. The inference of breeding status for all birds in incubation-type postures was not foolproof, as several individuals that subsequently were confirmed as having neither egg nor chick were seen exhibiting such postures; it is possible, however, that such birds were failed breeders acting "broody" or that they had lost the egg to predation between observation periods (as was observed to happen). The figures for number of breeding pairs per ledge in Table 17 take such uncertainties into account and represent our best estimate of the actual situation.

We used the "k" value of Birkhead (1978) (i.e., the number of breeding pairs per 100 individuals on the colony) as our estimator of the proportion of breeding birds in the plot; these data are presented in Table 17. The k value was calculated using three different denominators: the maximum single count of individuals, the mean of the maximum daily counts for six days, and the mean of the minimum daily counts for four days. This was done because, as Birkhead (1978) points out, "the ratio could be affected by (a) the number of off-duty mates present, and (b) the number

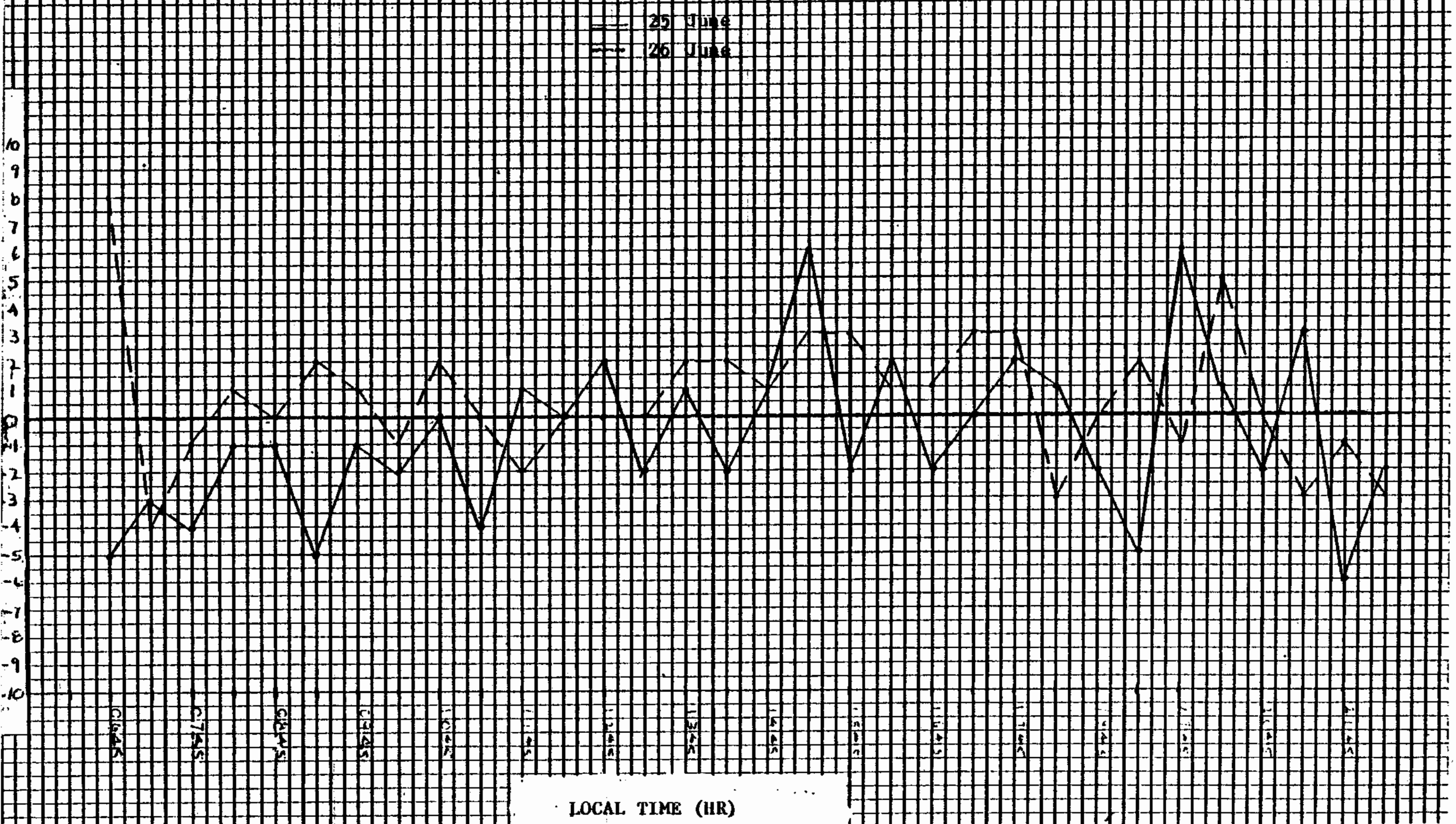
-A COVE
OT #2
1978

Table 16. DEPARTURES

	25 JUNE LEDGE B			26 JUNE LEDGE B			25 JUNE LEDGE C			26 JUNE LEDGE C		
TIME	IN	OUT	NET	IN	OUT	NET	IN	OUT	NET	IN	OUT	NET
0645	3	8	-5	13	5	+8	1	1	0	1	1	0
0715	0	3	-3	2	6	-4	0	0	0	1	2	-1
0745	5	9	-4	6	7	-1	2	1	+1	2	1	+1
0815	4	5	-1	3	2	+1	0	3	-3	1	2	-1
0845	1	2	-1	2	2	0	0	1	-1	2	1	+1
0915	0	5	-5	3	1	+2	0	2	-2	4	2	+2
0945	3	4	-1	1	0	+1	0	0	0	1	2	-1
1015	2	4	-2	2	3	-1	0	2	-2	0	0	0
1045	1	1	0	4	2	+2	0	0	0	0	1	-1
1115	0	4	-4	2	2	0	0	8	-8	0	-0	0
1145	2	1	+1	0	2	-2	0	0	0	2	0	+2
1215	1	1	0	1	1	0	1	0	+1	0	0	0
1245	5	3	+2	3	3	0	2	2	0	0	1	-1
1315	0	2	-2	2	2	0	1	1	0	0	1	-1
1345	2	1	+1	3	1	+2	0	0	0	0	0	0
1415	0	2	-2	5	3	+2	1	1	0	1	0	+1
1445	3	2	+1	1	0	+1	2	3	-1	2	0	+2
1515	7	1	+6	4	1	+3	2	0	+2	1	0	+1
1545	4	6	-2	3	0	+3	0	0	0	0	0	0
1615	5	3	+2	2	1	+1	0	0	0	1	0	+1
1645	2	4	-2	3	2	+1	1	0	+1	0	1	-1
1715	4	4	0	6	3	+3	1	0	+1	2	1	+1
1745	6	4	+2	8	5	+3	0	2	-2	2	0	+2
1815	6	5	+1	6	9	-3	1	0	+1	2	0	+2
1845	7	9*	(-2)	4	4	0	3	1	+2	2	4+	(-2)
1915	5	10	-5	4	2	+2	1	3	-2	0	2	-2
1945	11	5	+6	5	6	-1	2	4	-2	1	1	0
2015	5	4	+1	9	4	+5	2	3	-1	1	0	+1
2045	0	2	-2	5	5	0	0	1	-1	1	1	0
2115	3	0	+3	7	10	-3	2	2	0	2	2	0
2145	1	7*	(-6)	3	4	-1	0	0	0	1	3	-2
2215	2	4	-2	0	3	-3	0	1	-1	0	0	0
TOTALS	100	125	-25	122	101	+21	25	42	-17	33	29	+4
NUMBER OF OBSERVED THIS DATE		123			114			47			42	

* 4 chased off by Glaucous-winged Gull, + 2 chased by

Figure 32. Common Murre Ledge B - net arrivals and departures.



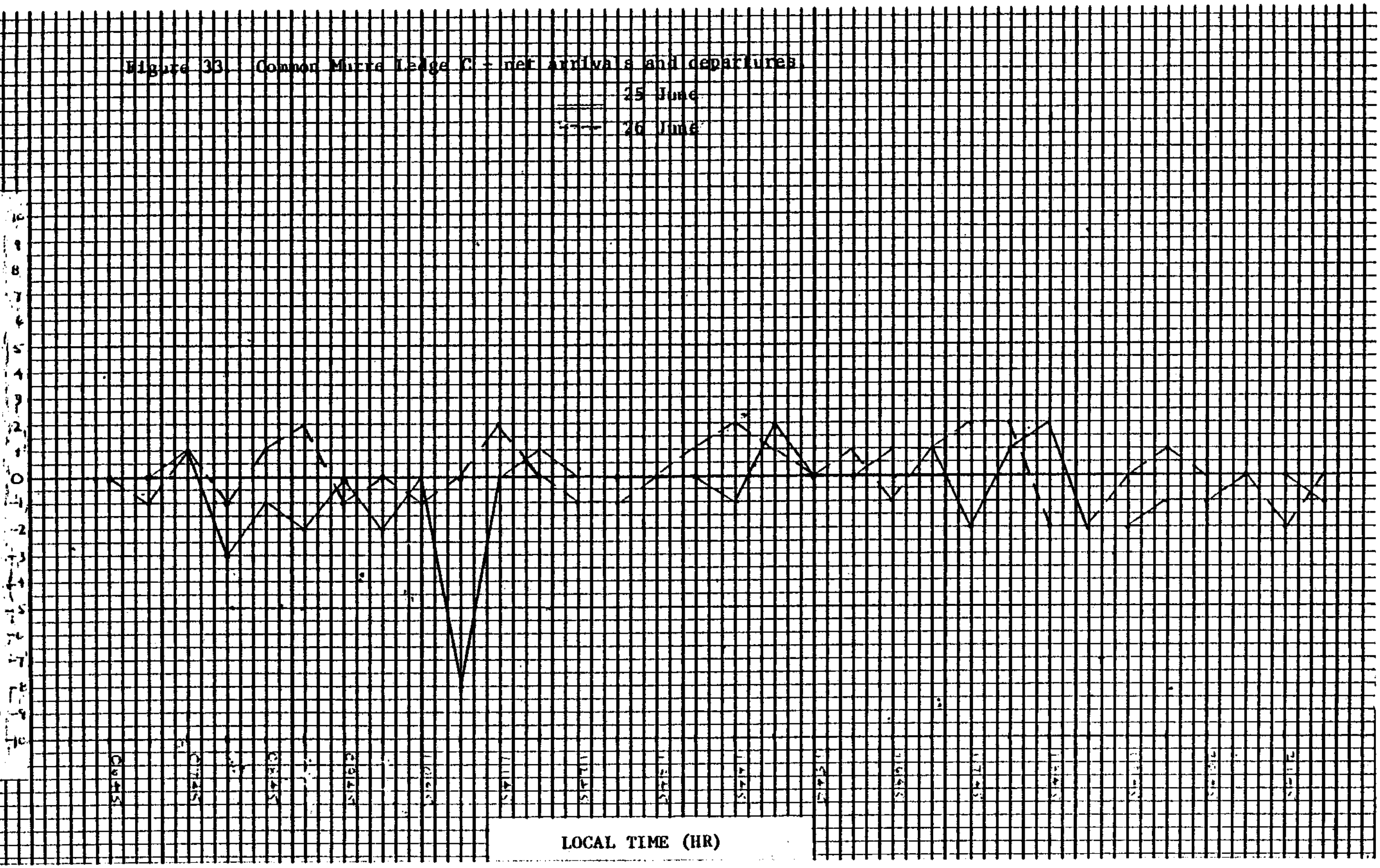


Figure 33. Common Murre Ledge C - net arrivals and departures.

Table 17. Calculation of k values* for Common (COMU) and Thick-billed (TBMU) Murres on plot #2, Aga Cove.

		LEDGE/SUBPLOT					
		A	B	C	D	E	TOTAL
(a) Maximum Count of Individuals-	COMU:	64	143	53	10	59	329
	TBMU:	2	-	-	21	19	42
(b) Mean of Maximum Daily Counts- (for 6 days)	COMU:	57.3	124.2	46.3	7.7	48.2	283.7
	range:	53-64	104-143	42-53	5-10	35-59	
	TBMU:	(2)	-	-	20	17	39
	range:	-	-	-	18-21	13-19	
(c) Mean of Minimum Daily Counts- (for 4 days)	COMU:	39.8	86.2	33.6	3.2	26.8	189.6
	range:	33-46	84-91	30-36	3-4	22-30	
	TBMU:	(1)	-	-	10.2	6.2	17.4
	range:	-	-	-	9-12	3-9	
(d) Estimated Number of Breeding Pairs-	COMU:	30	60	20	4	14	128
	TBMU:	1	-	-	10	5	16
(e) "k" Values*-							$\bar{X}$ **
(d)/(a)	COMU:	0.47	0.42	0.38	0.40	0.24	0.40
	TBMU:	0.50	-	-	0.48	0.26	0.41
(d)/(b)	COMU:	0.52	0.48	0.43	0.52	0.29	0.46
	TBMU:	0.50	-	-	0.50	0.29	0.43
(d)/(c)	COMU:	0.75	0.70	0.60	1.25	0.52	0.69
	TBMU:	1.0	-	-	0.98	0.81	0.93

* ratio of breeding pairs to individuals [Birkhead, 1978].

** weighted average (weighted by ledge size).

of non-breeders," and thus depends on the time of day at which the counts of birds on colony are made.

During the relatively brief segment of the incubation period observed, we assumed that the number of incubating birds present on the colony remained constant throughout the day. As the foregoing sections have demonstrated, however, the same cannot be said of non-breeders and off-duty mates; their numbers are subject to wide diurnal variation. The k value varies inversely with the number of birds on colony; that is, k is greatest when computed using the "mean of minimum daily counts", and least when the "maximum count of individuals" is used. The difference, of course, is that a greater proportion of non-breeders and off-duty mates is present during the period of peak attendance than during the daily low. The implications of this variation in k for censusing will be discussed later.

Subplot E provides an interesting contrast with the remainder of the plot by exhibiting lower k values overall for both species. The two most likely reasons are related to the low nesting density in this subplot on the margins of the main study ledges. First, in such a situation we would expect a higher proportion of prospecting and inexperienced birds (at least for Common Murres) which would have lower reproductive success than experienced breeders on high-density ledges. Second, such nest sites are more vulnerable to predation by gulls and ravens. The effect of these factors, then, is to reduce the value of k, either by inflating the number of nonbreeders in relation to breeders, or by reducing the numbers of breeders we counted on the ledges (due to the presence of failed breeders). As Birkhead (1978) points out, the method we used will tend to underestimate the breeding population somewhat because of egg and chick losses that occur prior to the period of observation. It is unclear why ledge D had k values that were comparable with the remainder of the plot rather than with subplot E, given ledge D's status as a low-density site (although the small sample size may have exerted some influence).

Small sample size was definitely the reason for the k value of 1.25 for ledge D, because one pair that was known to be breeding lost its egg partway through the count period.

An alternative method of estimating the percentage of breeding birds on the cliffs has subsequently been developed by Day and is presented here. In both methods the k value is computed following Birkhead (1978) and data are presented in Appendix III, Tables 10-16.

The first consideration is the similarity in minimum numbers of Common Murres observed on individual ledges throughout the count period (Table 18). Note that the larger ledges tended to "lose" a few birds in the 13-day count period, indicating that some eggs were lost (as was observed). Ledge D, a low-density ledge, retained its eggs throughout the period. One could conclude either that there were more non-breeders present early in the period, or that eggs were lost during this period. The latter factor is known to some extent, but the impact of the former is unknown.

Therefore, instead of using the minimum number of birds as an estimate of the true number of pairs (not necessarily breeding) present, the actual count of birds on eggs or chicks will be used as an estimate of the number of breeding pairs. This also follows Birkhead (1978) who is extremely sketchy about this aspect of his estimation. He essentially used a ratio composed of numbers of birds known on eggs and mean minimum numbers of birds on ledges at a time when daily attendance is at its minimum (p. 225), both also used in Day's alternative method. However, instead of picking a uniform time near the low, Day chose the actual minimum number recorded that day, which may not fall at the same time each day. This yields a slightly higher k value than Birkhead's.

Table 19 lists estimates of breeding pairs made on 6 July and estimated k values for individual ledges. The k value was computed using the mean of minimum counts on 5 and 6 July. The spread of k values was large, from 62.5 to 133.3; however, the latter figure was probably the result of an egg being laid (or relaid, if one had been lost) that day. The overall k value indicates 71.5% of the minimum number of birds present are breeding birds. However, this figure does not take into account the relative proportion of k values from different-sized ledges. Thus, weighted estimates of k values are presented in Table 20.

Note that the overall k estimate is 73.8%, a figure slightly higher than the figure from Table 19. This latter estimator, however, gives equal weighting to ledges of different size. The weighted k value (73.8%) compares favorably, although slightly high, with that of 67% presented by Birkhead (1978).

Data for Thick-billed Murres are higher in k values than are Commons (Tables 21-23). Unfortunately, sample sizes were small, so the results must be qualified. It appears that the Thick-billed Murre has a higher percentage of breeding birds that are on the cliffs (89.6%). Whether this is a result of small sample size, different breeding behavior and colony set-up, or different attendance patterns is unknown.

Table 18. Minimum counts of Common Murres on individual ledges[a].

LEDGE	24 JUNE	25 JUNE	26 JUNE	2 JULY	4 JULY	5 JULY	6 JULY
A	46	39	41	51?	39?	33	35
B	91	84	84	98?	91?	84	86
C	36	34	34	34?	35?	34	30
D	3	4	3	4?	3?	3	3
E	30	27	28	36?	27?	22	28

[a] Numbers with question marks indicate that they came from partial-day counts and may not actually represent true minimum numbers.

Table 19. Estimates of numbers of breeding pairs of Common Murres and "k values" for individual ledges.

	LEDGE/SUBPLOT					
	A	B	C	D	E	TOTAL
a) count/estimate (6 July)	30	60	20	4	14	128
b) $\bar{X}$ minimum (5-6 July)[a]	34	85	32	3	25	179
c) "k value" (a/b) (X 100%)	88.2	70.6	62.5	133.3	56.0	71.5

[a] From Table 18.

Table 20. Weighted estimates of numbers of breeding pairs of Common Murres in terms of "k values" (from Table 19).

LEDGE/SUBPLOT				
A	B	C	D	E
30X88.2	60X70.6	20X62.5	4X133.3	14X56.0
2646	4236	1250	533.2	784

A-C: $\frac{8132}{110} = 73.9$

D-E: $\frac{1317.2}{18} = 73.2$

A-E (Total): $\frac{9449.2}{128} = 73.8$ weighted $\hat{k}$

Table 21. Minimum counts of Thick-billed Murres on individual ledges.[a]

LEDGE	24 JUNE	25 JUNE	26 JUNE	2 JULY	4 JULY	5 JULY	6 JULY
A	1	1	1	1	1	1	1
D	12	11	9	13?	12?	9	11?
E	6	9	3	12?	9?	7	8

[a] Numbers with question marks indicate that they came from partial-day counts, and may not actually represent true minimum numbers.

Table 22. Estimates of numbers of breeding pairs of Thick-billed Murres and "k values" for individual ledges.

	LEDGE/SUBPLOT			
	A	D	E	TOTAL
a) count/estimate (6 July)	1	10	5	16
b) $\overline{X}$ minimum (24-26 June)[a]	1	10	7.5	18.5
c) "k value"(a/b) (X 100%)	100	100	66.7	86.5

[a] From Table 21.

Table 23. Weighted estimates of numbers of breeding pairs of Thick-billed Murres in terms of "k values" (from Table 22; after Birkhead 1978).

	LEDGE/SUBPLOT			
	A	D	E	TOTAL
weighted $\hat{k}$	1 X 100 100	10 X 100 1000	5 X 66.7 333.5	$\frac{1433.5}{16} = 89.6$

This is especially perplexing, considering Birkhead's Common Murres were breeding in a dispersion much like Thick-billed Murres ordinarily exhibit. Thus, it is possible that the latter species has evolved a different attendance pattern from the former, in that fewer non-breeding birds are present on the cliffs in general. However, more work needs to be done on this particular point to gain a sufficient sample size for determining its validity.

From the above statements, it appears that estimating the actual number is extremely difficult or even impossible. True numbers of nonbreeders will be masked by varying colony attendance throughout the day and by varying numbers of off-duty breeders present. Thus, at best, all that can be done is to double the number of breeding pairs and subtract this from the highest count made. This figure will be biased toward underestimating the number of non-breeders, but will at least give an indication of the minimum known number of non-breeders.

Day's method is another interpretation of data and estimates in the "Permanent Plots" section were made using this method. The discussion should provide a starting point for future studies of colony attendance patterns and their implications for murre censusing.

Discussion

Anyone who has visited a murre colony can attest to Tuck's (1960:119) observation that "the size of a murre colony is not static at any time". Variation in attendance is the rule, both on a seasonal basis (depending on phenological stage), and on a diurnal basis. The following description of the general patterns of seasonal variation in numbers of birds at the colonies and diurnal variation at different stages of breeding has been extracted and condensed from Birkhead (1978), Hickey and Craighead (1977), Lloyd (1975), Steele and Drury (1977), Swartz (1966), and Tuck (1960).

In the pre-laying period, numbers of birds at the colony are subject to dramatic fluctuations over the course of several days; one day may find a majority of the colony on the cliffs, while the next may reveal only a very few. After the birds have become accustomed to land following a winter at sea and have built up sufficient energy reserves prior to laying, they begin to remain at the colony overnight. Laying ensues shortly thereafter, with a high percentage of birds (including early prospectors) present throughout the day. Up to 90% of the maximum population (breeders plus non-breeders) may be present during this period.

During incubation daily attendance is much less variable than during pre-laying. By this point some early prospectors have left, leaving perhaps 80% of the maximum population. A pattern of diurnal attendance becomes established, with either two peaks and lows during the day (as in our observations), or at high latitudes, only one peak or even no variation. By mid-incubation younger, inexperienced breeders are thought to expand the population to about 90% of maximum again. The variation in numbers at this stage is apparently due to the patterns of colony attendance by off-duty mates.

Following hatching, attendance remains relatively stable overall (perhaps even more so than during incubation), but there appears to be higher turnover of mates as they feed nestlings. During the nestling period an influx of non-breeding, prospecting birds occurs, swelling the total population to maximum levels. By the time chicks begin fledging, numbers decrease steadily and daily fluctuations become large once again.

The proximate factors responsible for diurnal fluctuations have been discussed by several workers. Tuck (1960) stated that light intensity was an important determinant of activity, with the period of greatest inactivity occurring during the period of lowest light levels. Weather has been recognized as a very important factor by Birkhead (1977, 1978), Slater (1976), and Tuck (1960): colony attendance is significantly lower during periods of stormy weather and high seas, presumably because food is more difficult to find. Our observations corroborate these findings; maximum daily counts were highest on mild, sunny days. Tuck (1960) and Slater (1976) also found indications that tidal rhythms were important. Slater found that early in the breeding season numbers of birds on colony were highest during high tides; later in the season, however, no such effect could be found.

The ultimate factor controlling diurnal attendance patterns is the availability of food (Birkhead 1978, Steele and Drury 1977, Tuck 1960): foraging is more difficult under conditions of low light, stormy weather, and unfavorable tides. Birkhead (1977) found that the rate at which murres fed chicks dropped during periods of stormy weather, indicating that food was less available at such times. Slater (1976) was unable to demonstrate a tidal effect on colony attendance once Ammodytes (sand launce) became abundant at all times. Tuck (1960) stated that "diurnal activity with regard to feeding is locally dependent on oceanic phenomena, such as tides and the occurrence of schools of fish."

The most obvious source of error in a census of murres is the failure to recognize the seasonal and diurnal variation in colony attendance discussed above. Lloyd (1975) pointed out that even during the least variable period of colony attendance, single daily counts could vary by as much as 26% from the mean number in the colony; this error could be greatly reduced by conducting between five and ten counts (one per visit) at the colony.

Another source of error is introduced by the presence of varying numbers of non-breeders and off-duty mates; the ratio of breeders to nonbreeders is thus variable throughout the day and the season. The presence of an unknown percentage of off-duty mates on colony during the incubation and nestling stages masks the percentage of non-breeders present as well. The ratio of breeders to nonbreeders is a good indication of colony status (Birkhead 1978), since a high proportion of non-breeders should be indicative of an expanding colony. In this case, perhaps the best that can be hoped for is to obtain a good estimate of the number of breeding pairs in the colony, since that is the parameter of greatest import to the population at the time the survey is done. Subjective estimates of the proportion of non-breeders may then be made, but it should be remembered that the concept of a "total" figure for a murre colony is essentially meaningless in light of the range of variation observed in colony attendance.

The suggested technique for censusing murre colonies in future work, based on the foregoing analysis and discussion, is as follows:

1) At each major colony, establish the diurnal pattern of attendance and phenological stage through all-day counts of well-defined observation plots.

2) Determine the number of breeding pairs present in the study plots by mapping nest (i.e., egg and chick) locations.

3) Use the number of breeding pairs obtained to calculate "k" values for high and low count periods during the day. Time of day does not affect the number of breeding pairs on the study plots, but will affect the estimated number of breeding pairs in the entire colony when extrapolated.

X. BEACHED ANIMAL SURVEYS

A useful way to gather information on natural mortality of marine mammals and birds is to conduct a series of beached animal surveys in a specified geographic area. It is best to repeat these surveys at regular intervals throughout the year, but even one-time surveys are of some qualitative (and perhaps quantitative) value if done over a large enough area.

The beach selected should be at least one mile (1.6 km) long, be easily delineated, and have much wrack washed up onto it; this will insure a large enough sample area and a beach on which there is a high probability of finding animals. If there are natural scavengers (such as foxes or bears) in the area, only a large die-off of animals will be evident, but this information is valuable. If possible, any animals that are found should be identified to species, sex, and age, and should be checked for the cause of death. Much of this information may be difficult to ascertain, but one can generally identify animals at least to species.

Caution should be used to not count animals that have been killed by predators. This is especially important in areas of high bird densities where predators leave many prey remains on the beach. For example, 37 birds were found on Buldir Island that definitely had been killed by predators; if we had interpreted this as natural mortality, our results would have been biased. Cause of death cannot be determined in all remains, but identification can at least remove the bias of obviously-killed prey organisms. This identification helps where a preferred prey species, such as Crested or Least Auklets or Ancient Murrelets, are present in abundance.

We conducted a total of seven beached animal surveys this summer, including two that had been initiated in 1977. The new surveys were: Karab Cove (Agattu Island), Aga Cove (Agattu Island), the southwest shore of Alaid Island, the north shore of Nizki Island, and Jeff Cove (Kiska Island). The second-year surveys were: North Bight Beach (Buldir Island) and the west shore of Little Kiska Island. Results from all surveys are presented in Table 24.

Agattu Island survey #1 at Karab Cove (Fig. 34) start from the cliffs on the west side of the cove and end at a rocky outcrop at the beach edge on the east side. Both prevent further easy passage along the beach. A series of impassible sea cliffs were omitted from the center

Table 24. Results of beached animal surveys on six islands in the Western Aleutians, 1978.

	# 1 KARAB COVE (AGATTU)	# 2 AGA COVE (AGATTU)	# 1 SW SHORE (ALAID)	# 1 N SHORE (NIZKI)	# 1 NORTH BIGHT (BULDIR)	# 1 JEFF COVE (KISKA)	# 1 W SHORE (LITTLE KISKA)	TOTAL
DATE RUN	30 June	4 July	8 July	9 July	15 July	9 August	12 August	
Northern Fulmar				1				1
Short-Tailed Shearwater			1					1
Cormorant sp.								
Unknown		6	1		3			10
Immature	2							2
Pelagic Cormorant								
Adult	2		1					3
Red-Faced Cormorant								
Adult	1		1					2
Emperor Goose								
Adult	1							1
Mallard			1					1
Gull	1							1
Glaucous-Winged Gull								
Unknown					6			6
Immature					25			25
1-yr old					2			2
2-yr old			1					1
3-yr old					1			1
Adult	2	1	1		7		1	12

Table 24. Results of beached animal surveys on six islands in the Western Aleutians, 1978 (cont'd).

	# 1 KARAB COVE (AGATTU)	# 2 AGA COVE (AGATTU)	# 1 SW SHORE (ALAID)	# 1 N SHORE (NIZKI)	# 1 NORTH BIGHT (BULDIR)	# 1 JEFF COVE (KISKA)	# 1 W SHORE (LITTLE KISKA)	TOTAL
DATE RUN	30 June	4 July	8 July	9 July	15 July	9 August	12 August	
Black-Legged Kittiwake								
Immature	1	1						2
Adult		2						2
Murre sp.								
Unknown	2	6	1		1			10
Breeding	2			1				3
Thick-Billed Murre								
Breeding	1		2					3
Winter			1					1
Ancient Murrelet								
Adult		2		1	4			7
Downy					1			1
Crested Auklet				1	2			3
Tufted Puffin	1	1	1					3
Bird sp.	2						1	3
Sea Otter								
Adult						1		1

Table 24. Results of beached animal surveys on six islands in the Western Aleutians, 1978 (cont'd).

	# 1 KARAB COVE (AGATTU)	# 2 AGA COVE (AGATTU)	# 1 SW SHORE (ALAID)	# 1 N SHORE (NIZKI)	# 1 NORTH BIGHT (BULDIR)	# 1 JEFF COVE (KISKA)	# 1 W SHORE (LITTLE KISKA)	TOTAL
DATE RUN	30 June	4 July	8 July	9 July	15 July	9 August	12 August	
Harbor Seal								
Unknown		1			1			2
Pup				1				1
Seal/Sea Lion					1			1
Sea Lion ?	1							1
Steller Sea Lion								
Unknown	1				1	1		3
Pup					6			6
Yearling/Small Lion					12			12
Cow					4			4
Bull				2	4			6

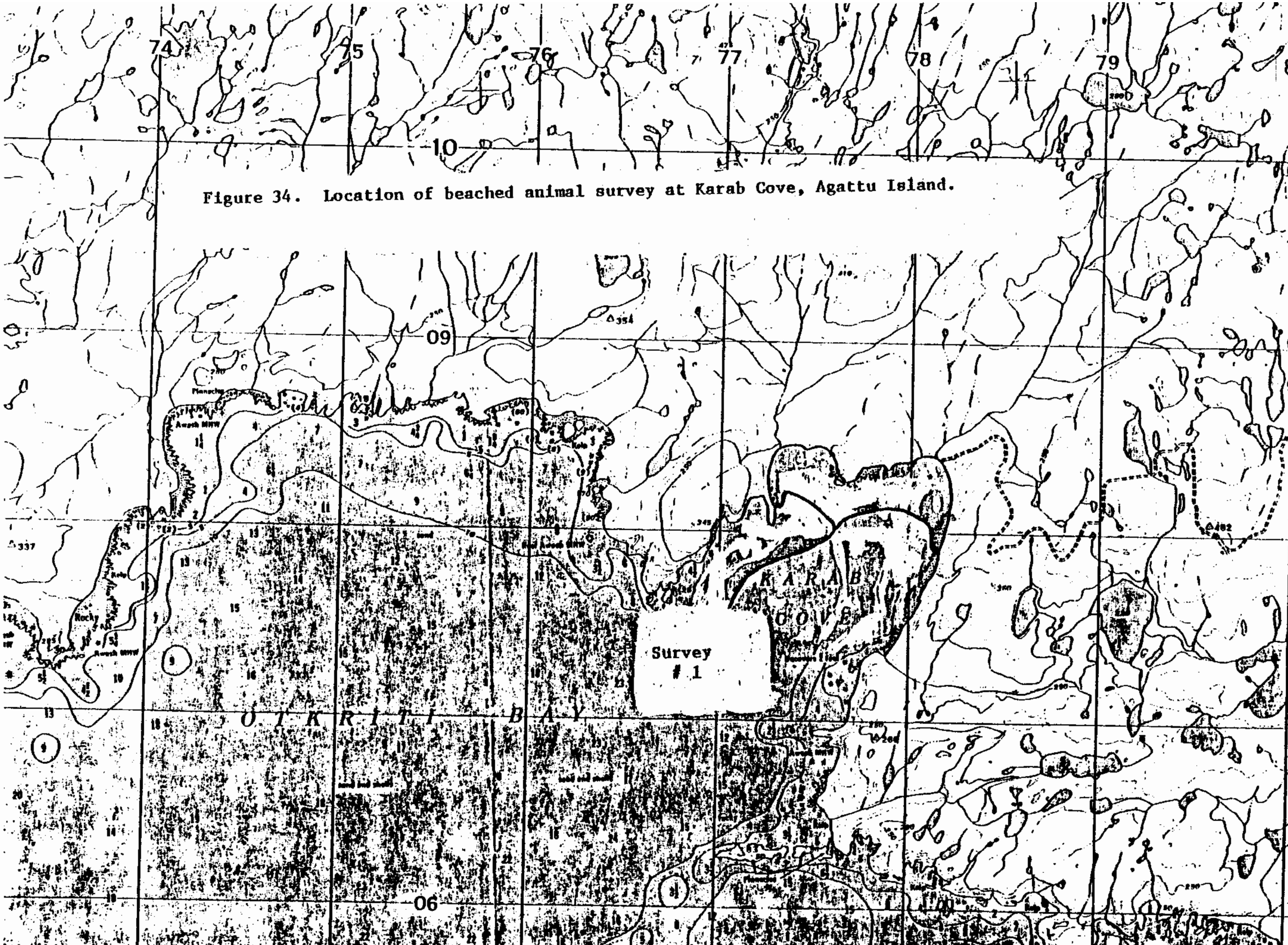


Figure 34. Location of beached animal survey at Karab Cove, Agattu Island.

of the survey. The Karob Cove beach is sand on the west and sand and gravel on the east. Little of interest was noted on this survey other than the head of an adult Emperor Goose. Considering the proximity of this survey to large kittiwake and murre colonies on the west side of the cove, it was surprising to see how few murres and kittiwakes were washed up.

Agattu Island survey #2 at Aga Cove (Fig. 35) extends to the base of the sea cliffs at both the north and south edges of the cove. The beach is sand on the south and small gravel on the north. More cormorants were found here than on any other transect. This reflects the large number of cormorants nesting in the vicinity of Aga Cove. Six dead murres were found, and three were in two separate fishing nets; they apparently had drowned. The nets were of large mesh polypropylene used for trawling by Japanese and Russian fishermen off the shores of the Aleutian Islands; they account for hundreds of thousands of seabird deaths each year, especially in deep-diving species such as murres (Evans and Waterston 1976). Remains were found of two Ancient Murrelets, a nocturnal species that probably does not breed on Agattu. One of the carcasses was that of an immature bird that was probably wandering

Alaid Island survey #1 (Fig. 36), on the southwest shore, follows the same stretch of beach as beach passerine survey #2. The shore here is low and flat, and the entire beach is sand. It is bordered by a sea lion colony on the west and by low sea-cliffs on the east. The most interesting find was a fairly fresh Short-tailed Shearwater. Because shearwaters are pelagic, most carcasses don't reach shore, so this bird presumably died close to the island. A pair of Mallard wings was found on this survey; no direct evidence indicated a raptor kill, so it was included in the results.

Nizki Island survey #1 (Fig. 37), on the north shore, covers the same stretch of beach as beach passerine survey #1. The shore is fairly high and rocky, and there are many offshore reefs and islets. The few beaches present occur between cliffs and are all composed of rocks varying in size from gravel to cobble. There were few animals on this survey, but a Crested Auklet and an Ancient Murrelet were notable. That auklet does not nest in the Near Islands, but does occur in very low numbers offshore (unpub. notes). A few Ancient Murrelets were recorded off the north side of the Semichis this summer, so it is not unusual that a bird was washed up. There is a strong probability that they nest somewhere in the Semichis. The Northern Fulmar found was a fully dark-phase bird in fresh condition.

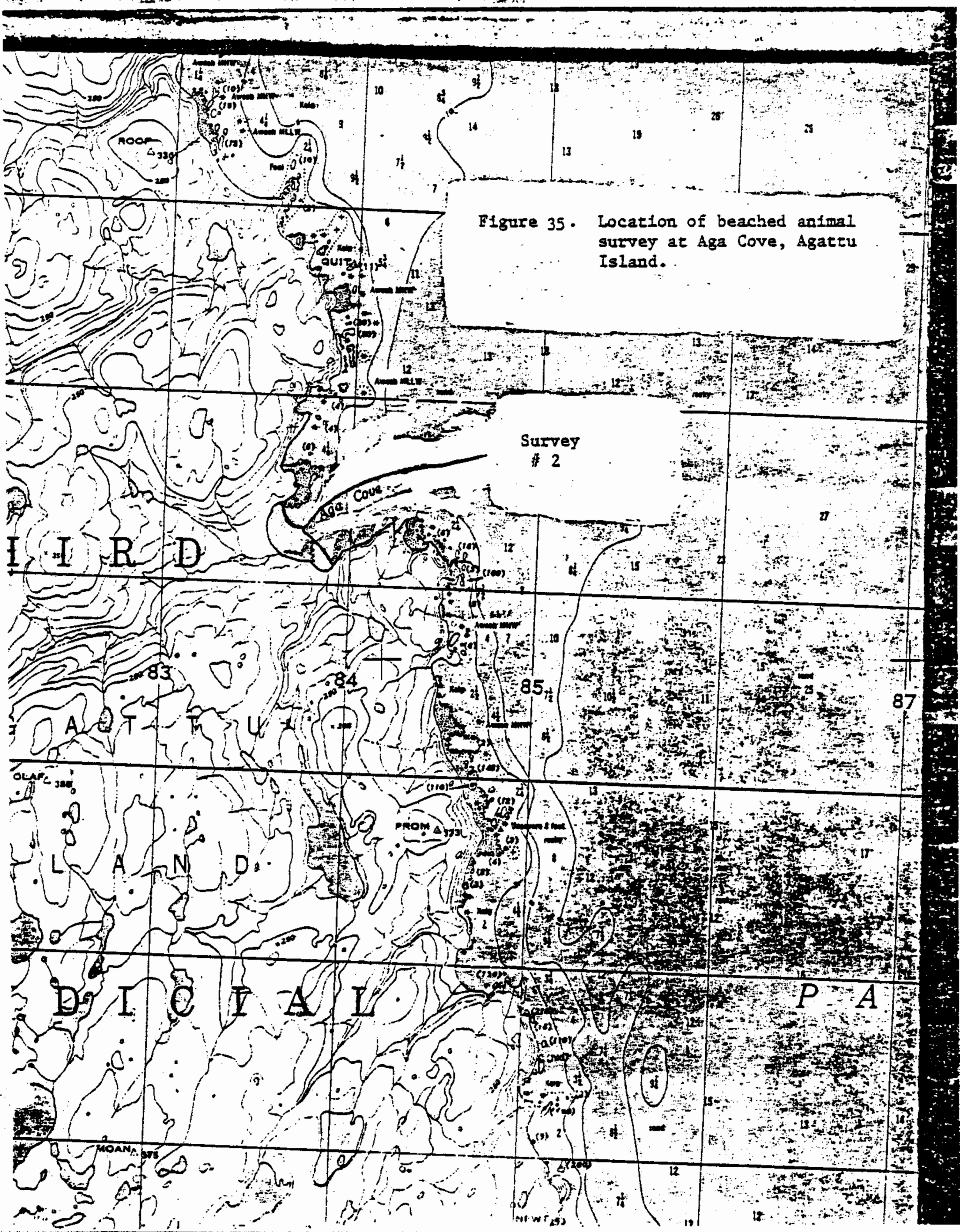


Figure 35. Location of beached animal survey at Aga Cove, Agattu Island.

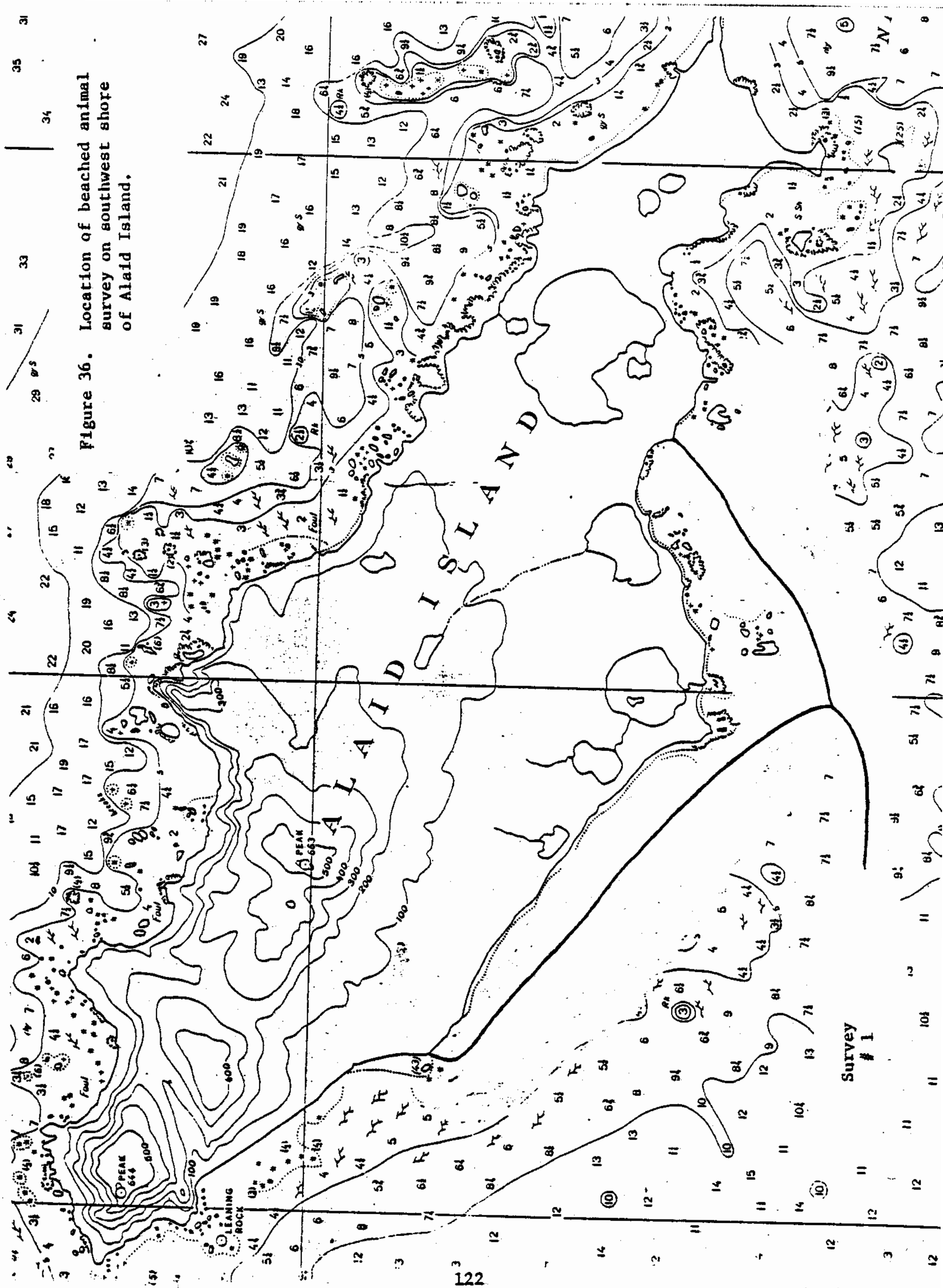


Figure 36. Location of beached animal survey on southwest shore of Alaid Island.

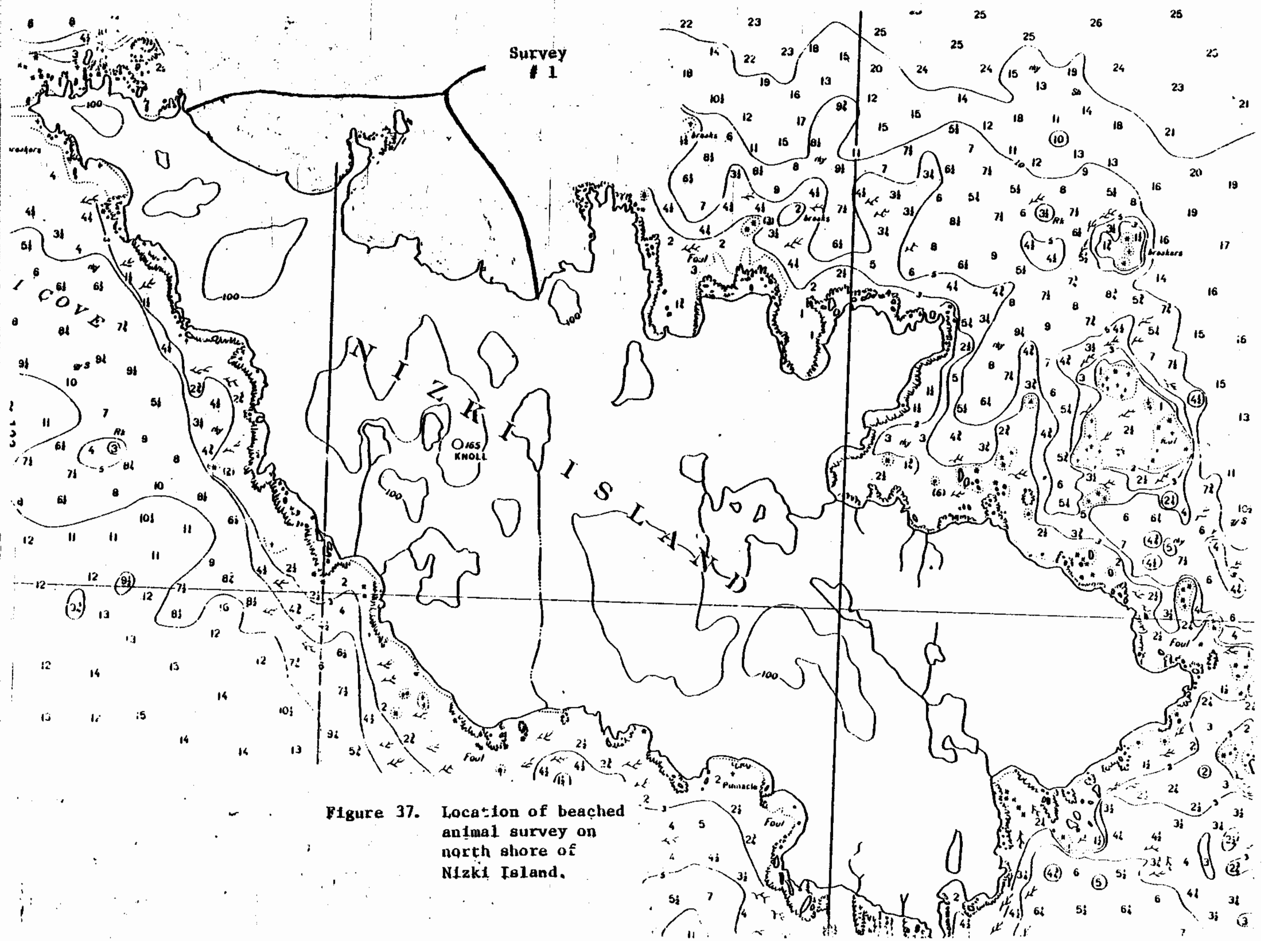


Figure 37. Location of beached animal survey on north shore of Nizki Island.

Buldir Island survey #1 (Fig. 38) was run for the second year, during mid-July. Again, it had the greatest number of animals of all the transects, due probably to the island's tremendous marine bird and marine mammal populations. The survey extends from the base of Northwest Point directly in front of camp eastward to the large rocks at the west edge of Main Talus. The beach is entirely large cobbles. Besides the numbers presented in Table 24, we recorded 37 birds that definitely had been killed by predators; these were not counted in the totals.

As shown in Table 24, large numbers of Glaucous-winged Gulls were found on Buldir this year. Almost all were quite weathered, and most were immatures. These birds were difficult to age, but they appeared to be primarily fledglings from last year. It appeared that a major storm hit the beach sometime during the winter of 1977-78, for much of the beach drift was gone; also, the log jams at the mouths of Stint and Tattler Creeks were pushed back into each stream approximately 20 feet from their previous locations. There appears to be a small but regular die-off of fledglings each year (pers. obs); perhaps this major storm, by reducing available food, caused abnormally high mortality of fledglings (and immatures). This regularly happens to murres during protracted storms (Tuck 1960). However, it is impossible to determine whether this was the actual cause of these deaths.

Another interesting aspect of the gull remains was a carcass of a third-winter bird (band #707-36480) that was banded between PON and Kittiwake Lake on 16 July 1975. The remains of at least six pups and 12 yearlings or small cow Steller sea lions were found on North Bight Beach, also. The latter combination was too difficult to differentiate considering the condition of the remains. A few cows must have begun pupping on the main part of the beach, away from the colony on Northwest Point; they may have abandoned the beach on their own or may have been disturbed too frequently by some of the many bachelor bulls hauled out on this beach. Farther down the beach at Crested Point one cow was found that had died when a large piece of polypropylene netting, which was tangled around its neck, caught on some boulders leaving the animal to starve and/or choke to death. Two other sea lions with their heads caught in this type of netting were seen during the 1977 field survey. One was at Cape Miga (Kanaga Island) and the other was at Hasgox Point (Ulak Island); both animals were on colony and still alive, although the extreme constriction in the neck of the former animal probably led to its demise shortly thereafter. The nets were of the same type that caused the deaths of the murres found at Aga Cove, Agattu Island.

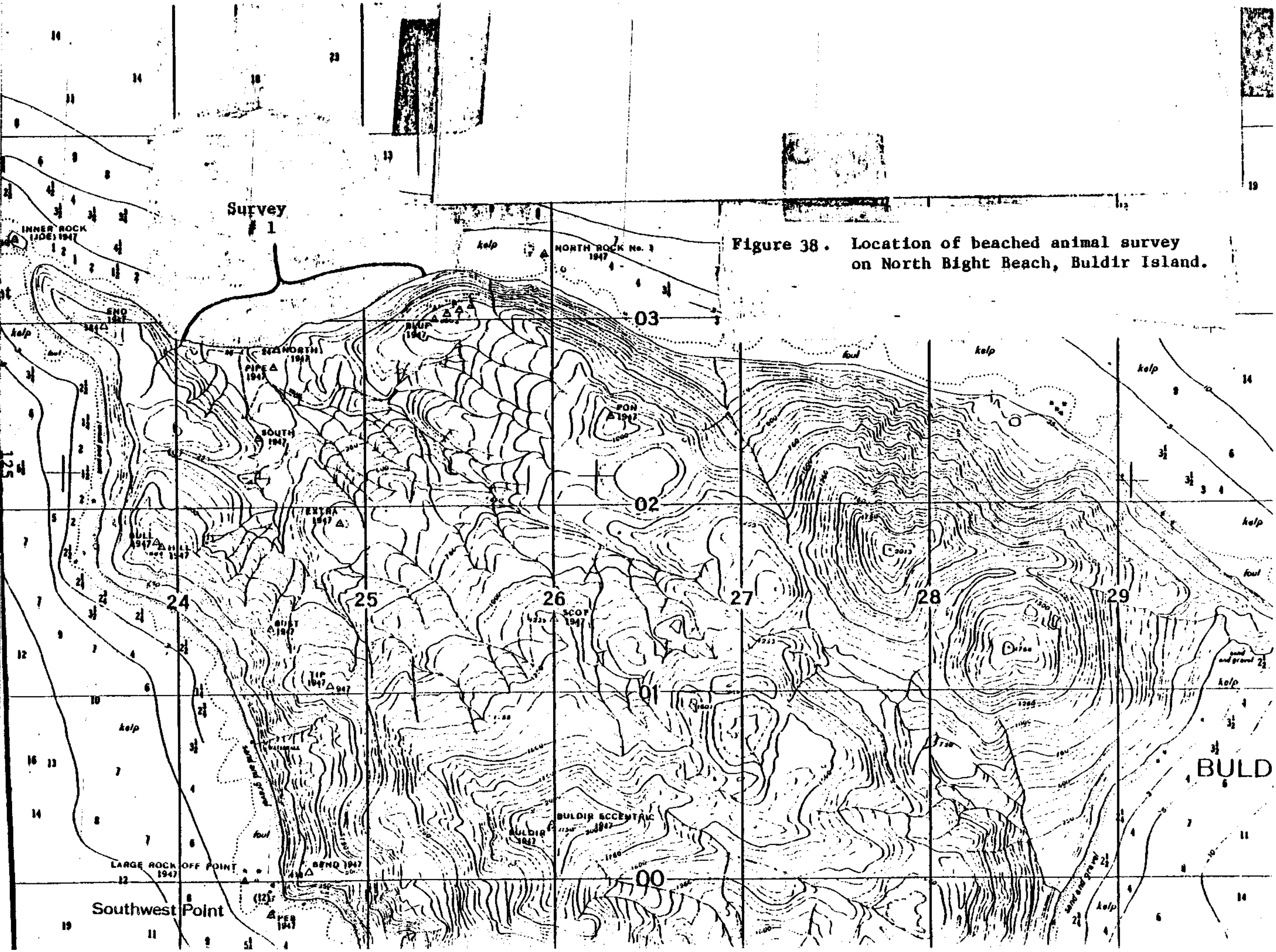


Figure 38. Location of beached animal survey on North Bight Beach, Buldir Island.

Kiska Island survey #1 (Fig. 39) runs the length of the beach in Jeff Cove on the southeastern shore of the island. The southern boundary is a sea-cliff at the water's edge, and the northern boundary is the outfall of the stream draining several lakes just behind the beach. The beach is sand and very small gravel for its entire length. There is a small stretch of cobble beach just north of the northern boundary, but it was not included in the survey. Only a sea lion scapula and a sea otter skeleton were found on this survey.

Little Kiska survey #1 (Fig. 40) was run in early August, approximately the same time as last year. The only remains found were the wing of an adult Glaucous-winged Gull and the vertebral column of an unidentified bird. These represent fewer carcasses than last year.

In summary, seven beached animal surveys were conducted on six islands this summer. Most surveys produced nominal results; Buldir Island again had the most beached animals, presumably because of the tremendous populations of marine birds and mammals present there. Abnormally high numbers of remains were recorded at Buldir for Glaucous-winged Gulls and Steller sea lions; the former were thought to be the result of a severe storm and its accompanying "food crunch" in the fall or winter, and the latter appeared to be the result of a failed attempt at extending the Northwest Point sea lion colony onto North Bight Beach itself. In contrast to 1977, no oiled birds or mammals were found.

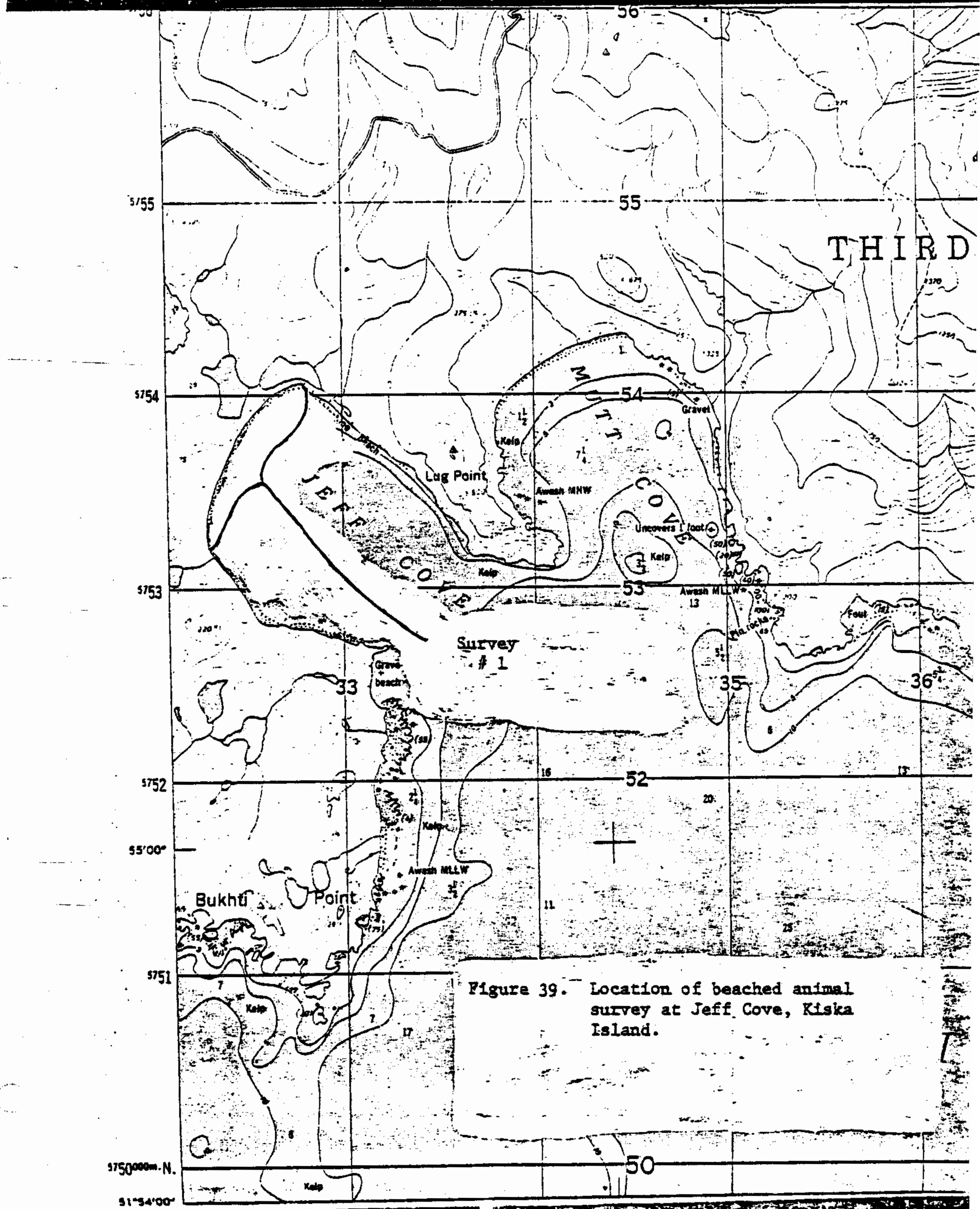


Figure 39. Location of beached animal survey at Jeff Cove, Kiska Island.

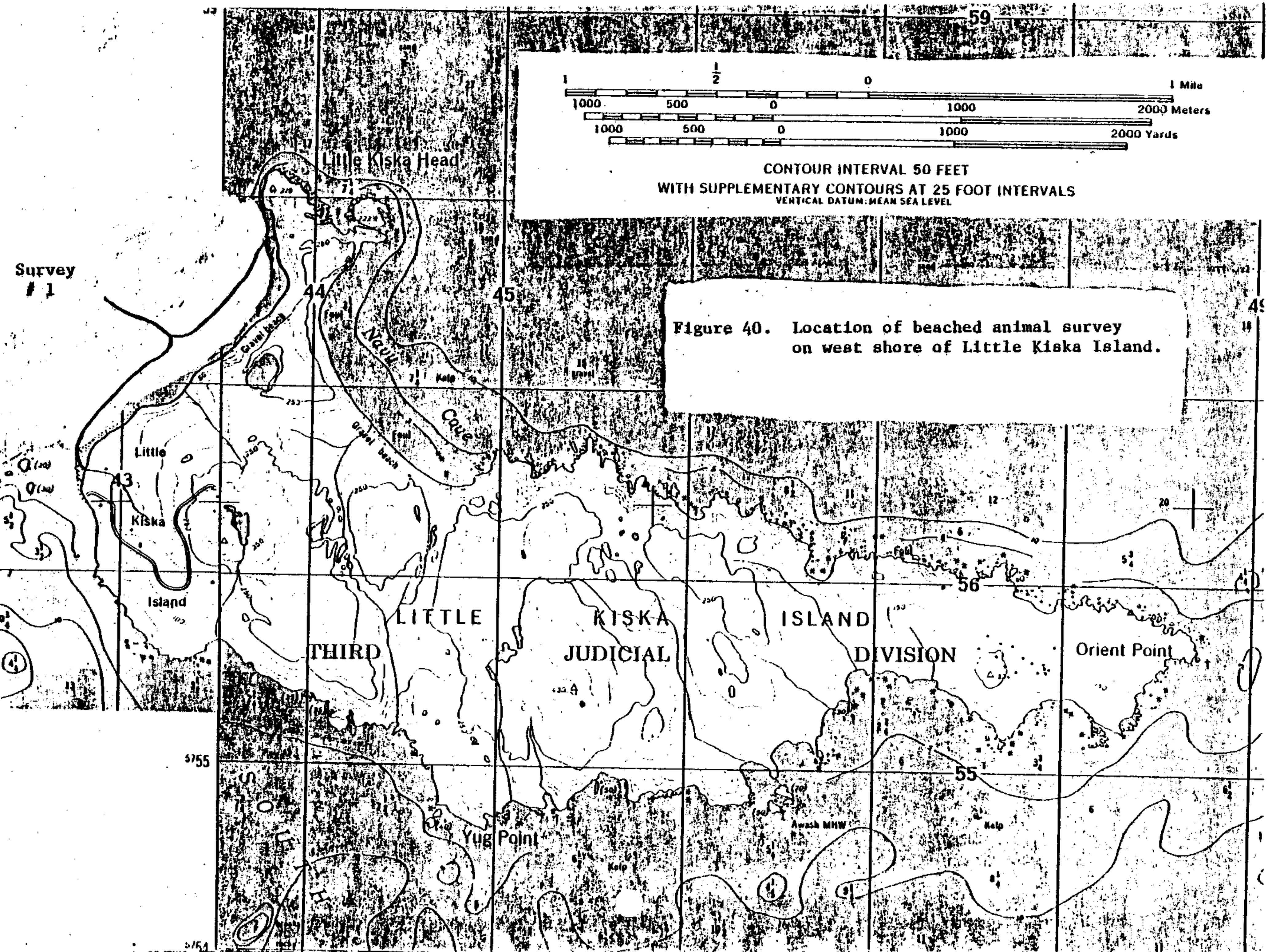


Figure 40. Location of beached animal survey on west shore of Little Kiska Island.

XI. PERMANENT PLOTS

Permanent plots were established on the following islands during the 1978 field season: Agattu, Nizki, Buldir, and Kiska. Each is described by island in the following discussions.

Agattu Island

A total of five permanent plots were set and worked on Agattu Island: four on the east side of the island near Aga Cove, and one at Karab Cove on the south shore. Locations of plots and observation posts are shown in Figs. 41 and 42. Photos of all plots except plot #5 are shown in Figs. 43, 44, 45 and 46. Detailed information on all plots are in the files in the refuge office.

Plot #1 featured Black-legged Kittiwakes, but also contained Common and Thick-billed Murres in about equal proportions. The kittiwake colony was censused on 23 June and murres were counted there on 28 June and 1 July. Plot #2 contained Black-legged Kittiwakes and Common and Thick-billed Murres, with the former murre species outnumbering the latter approximately 7 to 1. Three all-day counts and a number of partial-day counts were made on this plot between 24 June and 6 July. The data from this plot are discussed in depth in section IX "Murre Study Plots." Plot #3 is a 300m^2 area of hillside on the north side of Aga Cove; this is primarily for monitoring population trends in Tufted Puffins and detection of expansion in their nesting area in light of recent fox removal. This plot was laid out and worked on 28 June. Plot #4 is the face of a small offshore rock, and the Red-faced and Pelagic Cormorants nesting on it were counted on 3 July. Plot #5 is a large Common and Thick-billed Murre colony on a narrow peninsula in Karab Cove. Counts were made in the early afternoon (between 1230 and 1350 hours) on 29 June and 1 July.

Plots #1-4 were photographed on 110 or 220 black-and-white film with a Honeywell Pentax 6x7cm medium-format camera. The negatives and enlargements are on permanent file at the Refuge Headquarters. Inclement weather and scheduling problems prevented photography and further counts on plot #5.

Plot #1 contains 169 ± 2 Black-legged Kittiwake nests (=pairs). A nest was defined as a structure appearing large enough to contain eggs.

Figure 41. Locations of permanent plots around Aga Cove, Agattu Island. Number on shore indicates the place to sit and count a plot of the same number.

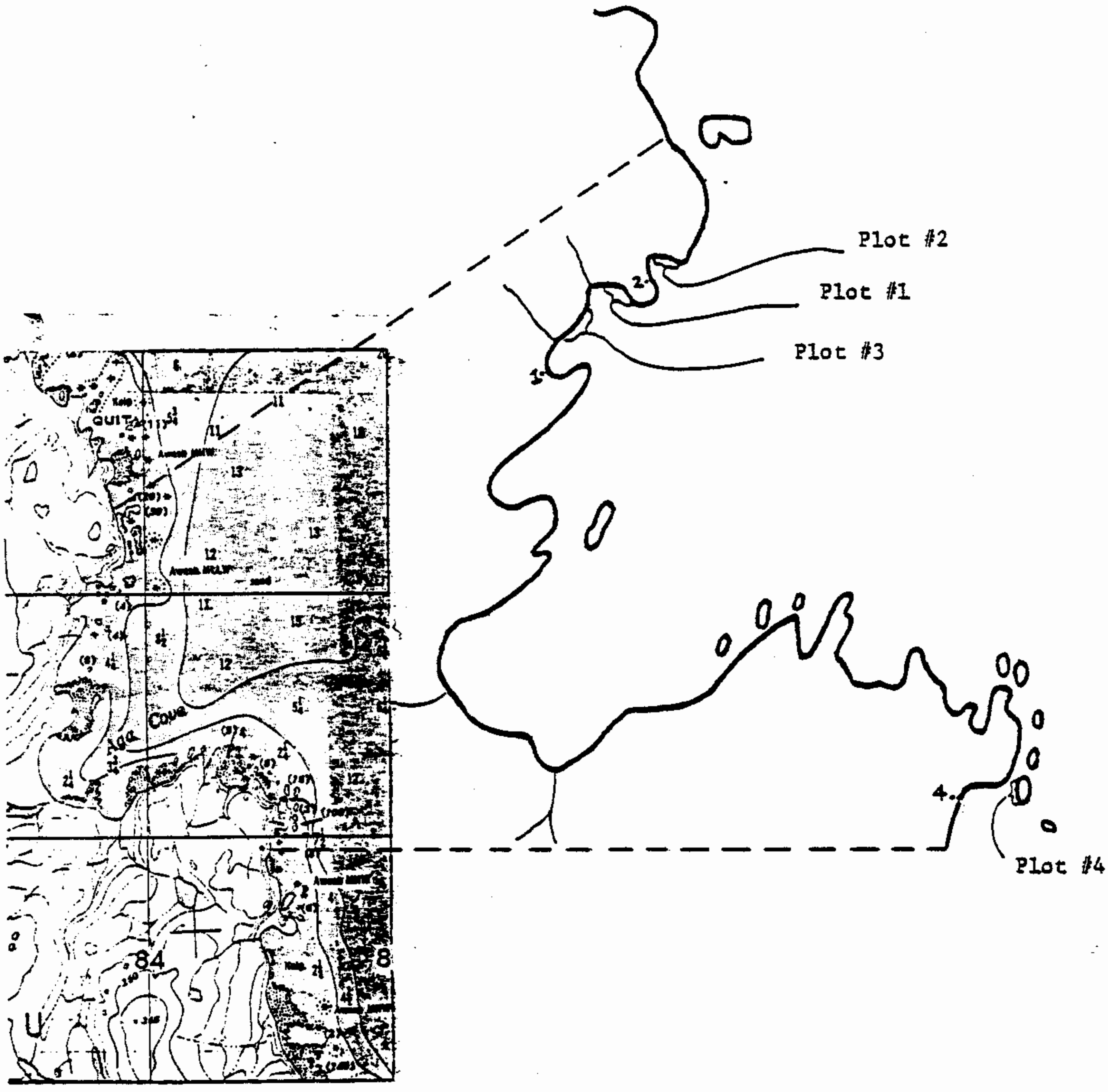


Figure 43. Photograph of Plot #1 in Aga Cove, Agattu Island from observation point looking northeast. Black lines indicate boundaries of plot. (22 June, 1978)

Figure 43

Figure 44. Photograph of Plot #2 in Aga Cove, Agattu Island. The plot lies within the black line drawn on the photo and extends slightly more to the left than the photo indicates. The location of subplots A to D are indicated also. (23 June, 1978)

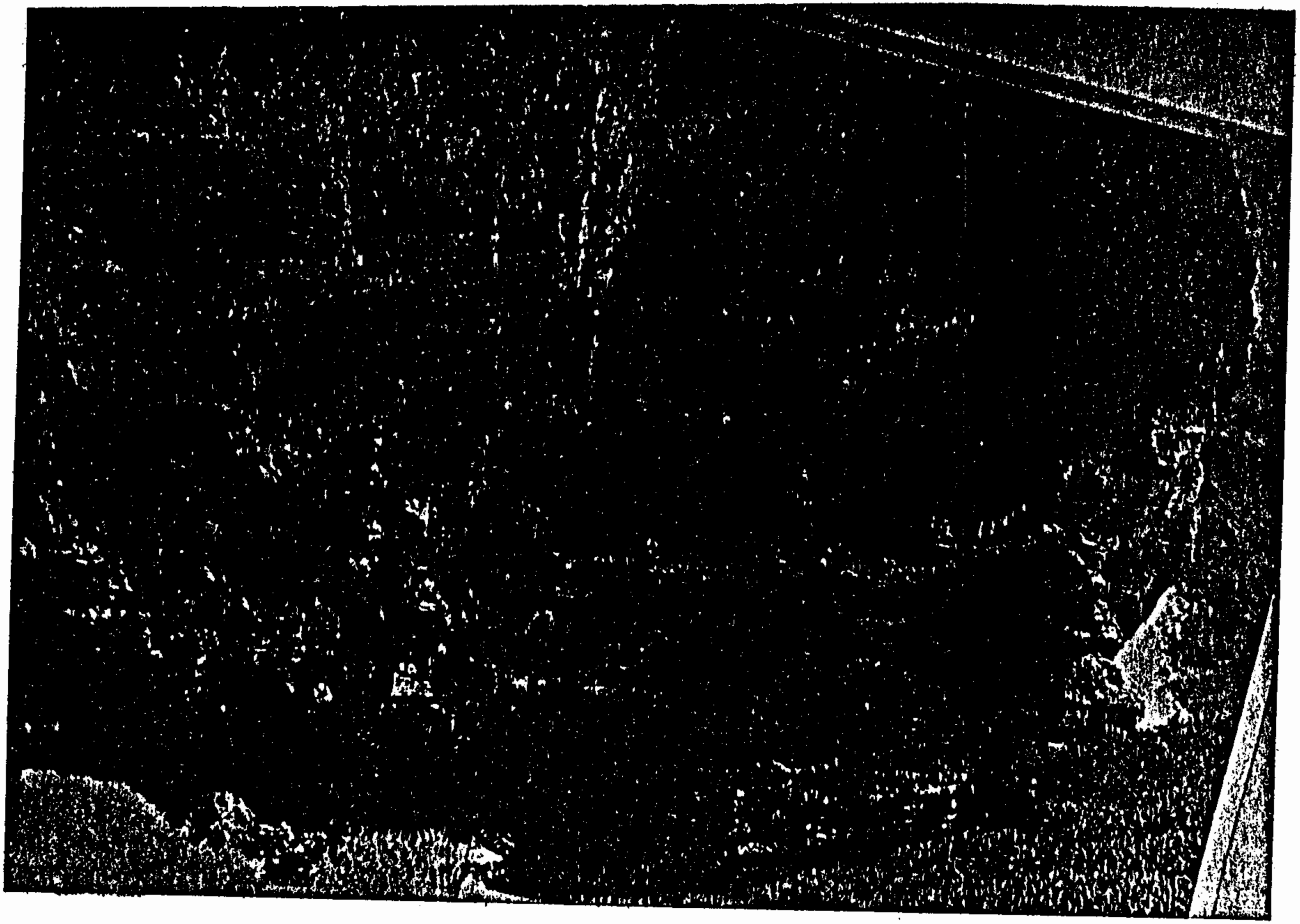


Figure 44.

Figure 45. Photograph of Plot #3 in Aga Cove, Agattu Island. The plot is located within the black lines drawn on the photo. (The lower poles of the plot can be seen.) (1 July, 1978)

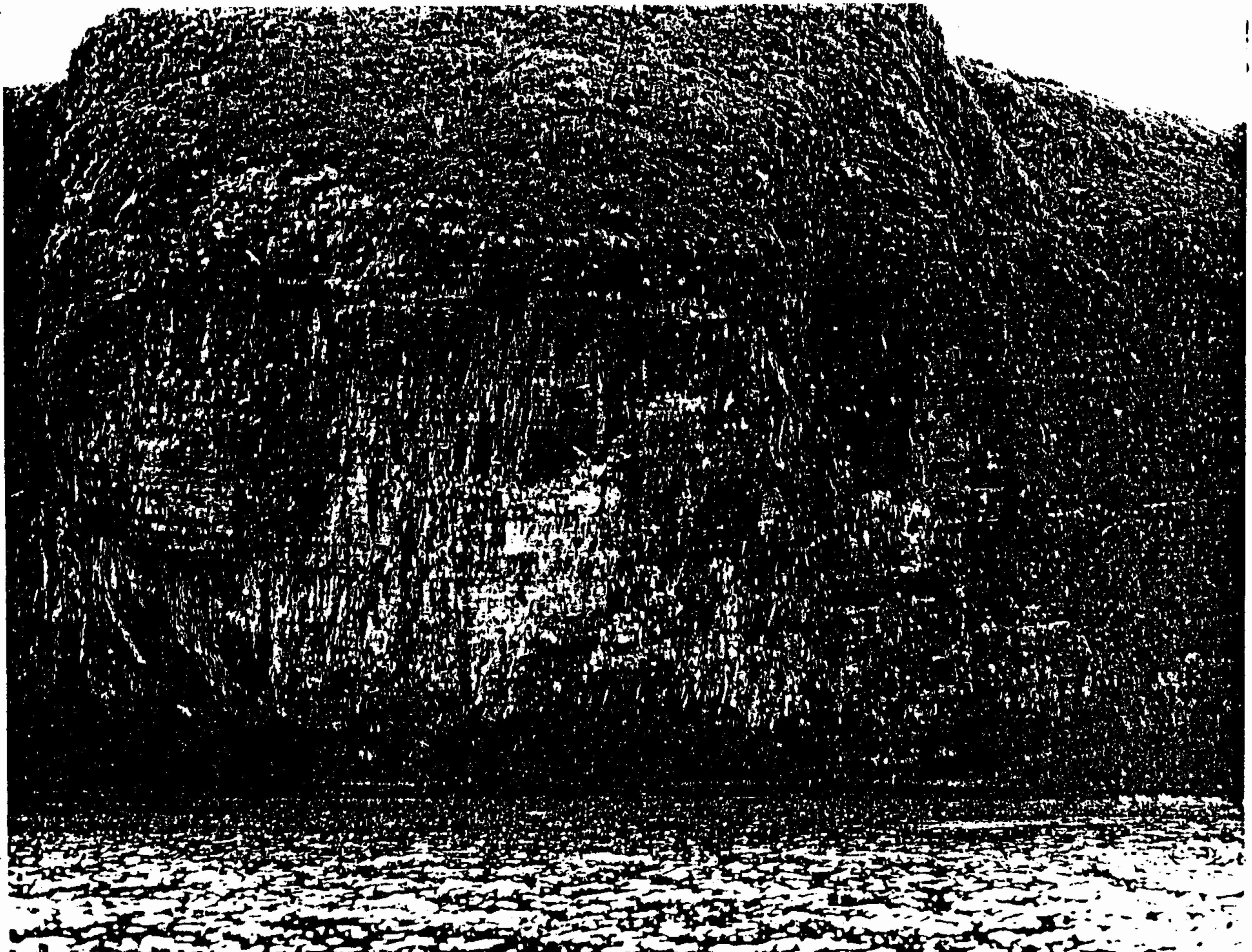


Figure 45.

Figure 46. Photograph of Plot #4 just to south of Aga Cove, Agattu Island from near observation point. Black lines indicate boundaries of plot. (6 July, 1978)

Figure 46.

Since all the nests in this plot were attended by adults, there was no problem with abandoned or unused nests. Any unoccupied nests would have been noted and kept as a separate total. The plot covers a large area of cliff-face and contains enough available habitat for expansion, should this population increase. Utilizing the data presented in the section "Murre Study Plots", the estimated number of Common Murres here is 56 pairs; the estimated number of Thick-billed Murres is 67 pairs. Observation post for Plot #1 is on the hill southwest of the plot (Fig. 41 and 43) and is marked with an aluminum pole with number 74 glued near the top.

Plot #2 has three high-density ledges used by Common Murres and two low-density areas used by both Common and Thick-billed Murres. The number of Common Murres in this plot is 128 pairs and at least 65 non-breeders; there are approximately 16 pairs and at least 9 non-breeding Thick-billed Murres in this plot. The data from this plot are discussed extensively in "Murre Study Plots." In addition, there are 16 Black-legged Kittiwake nests in the plot. Plot #2 has an observation point approximately 200m to the southwest, on a hill-side above the cliffs; it is marked with an aluminum pole (number 64).

Plot #3 is a rectangular-shaped area marked out on the hillside just southwest of Plot #1. It contains two inactive Tufted Puffin burrows and is accessible to foxes. In the future, the plot should be checked while on a rope belay, for the slope of the plot is 50°. The plot is marked on all four corners and pole #29 is at the northwest corner.

Plot #4 is located on the cliff-face of a small offshore rock. It contained 77 nests of which 74 were active Red-faced and three were active Pelagic Cormorant nests. No unused nests were observed. Of the 56 nests containing chicks 70% of the young were 3/4 adult size or larger with primary wing feathers present. Approximately 20% were half adult size with no evidence of primary development and 10% were smaller than 1/2 size. Only one chick seen appeared several days old, the rest were larger. No Pelagic Cormorant chicks were observed, however, one Pelagic nest contained several eggs. The observation post for this plot is to the southwest, next to a sea cliff and is marked with aluminum pole #46.

Plot #5 has large numbers of both Common and Thick-billed Murres nesting on the cliff-face. Lacking a spotting scope, we were unable to get species ratios; however, there were large areas of Thick-billed Murres on the smaller ledges near the base of the peninsula, and also some large ledges used extensively by Common Murres near the outer end of the peninsula. Based on count information and data from Section IX, there were an estimated 1556 pairs of murres (using k value of 73.8% for both species) and the estimated maximum number of murres here is 2709 ± 115 individuals. No observation point markers are present at this plot, but the best observation spot is above the cliff-edge to the west of this plot.

Nizki Island

Only one permanent plot, for puffins, was established on Nizki Island (Fig. 47). Due to inaccessibility, it is almost impossible to set up plots where active puffin burrows can be reached. Several active burrow sites were observed, but were either on extremely steep cliffs or on offshore islands inaccessible to man or fox. It is important that permanent monitoring plots be established on Nizki and Alaid since foxes were eradicated in 1976 and population trends should show expansion in several years.

Plot #1 is located where habitat and terrain are such that puffin burrows should be found after expansion takes place. No puffin burrows were present when it was checked on 9 July. The plot is roughly square-shaped and is 201.5m^2 in area. All four corners are marked with numbered aluminum poles. Starting at the east corner and rotating clockwise the poles are #86, #34, #43, and #39. Approximately 60% of the vegetation within the plot is beach rye (Elymus arenarius) and 40% is a combination of cow parsnip (Heracleum lanatum) and Angelica (Angelica lucida).

Buldir Island

The populations of marine birds on Buldir are some of the most spectacular in the North Pacific. Although there has been extensive previous work at Buldir, few permanent plots have been set aside for monitoring long-term population changes. The exceptions to this are permanent petrel plots, auklet plots, and kittiwake census areas established there by G.V. Byrd. The lack of plots is unfortunate in many ways, especially considering the island's tremendous populations of birds. Also, since foxes were never introduced to Buldir, most populations of burrow-nesting seabirds are accessible; this is in distinct contrast to most other islands in the Chain.

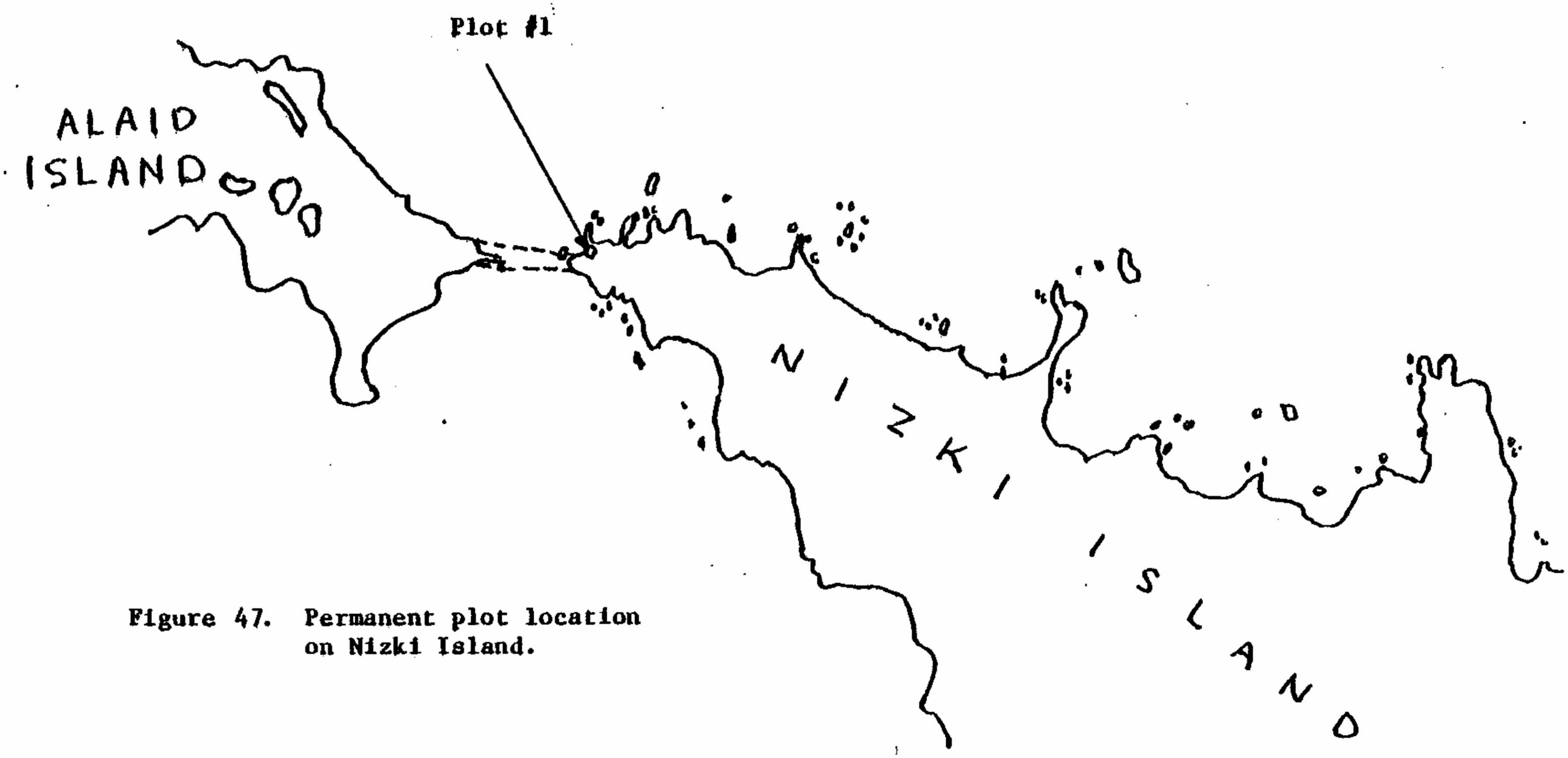


Figure 47. Permanent plot location on Nizki Island.

The major share of our 12-day stay at Buldir was spent setting up plots and gathering data on burrow-nesters. Six plots, comprising a total area of $575m^2$, were staked and worked. Of these, four had been used previously in research on the breeding biology of Leach's and Fork-tailed Storm-Petrels. Many birds in these plots had been banded and are reported on in Byrd and Trapp (in prep.). Further information on the biology of these two species was gathered during our work. Recapture of banded birds is discussed in the section "Buldir Island Band Returns."

Plots were located in high-density burrow-nester areas in order to gather information from as many burrows as possible. A major assumption in this work is that any population change will affect birds nesting in high-density areas in the same proportion as birds nesting in low-density areas. Therefore, it would be "easier" (i.e., less time-consuming) to determine population changes in a small, but densely-populated plot than in a large, sparsely-populated plot. This assumption may not be entirely true: a great population increase may force birds into low-density areas in a greater proportion than would enter a high-density one because of the limiting effects of territoriality; in contrast, a great population decrease will most certainly effect changes in the same proportion between the two densities. Thus, our assumption may bias the results toward detecting downward changes. Our knowledge of this aspect of marine bird biology is unfortunately lacking, so we must believe at this point that our assumption is correct for both population decreases and increases.

Locations of plots are shown in Fig. 48 and photos of plots are shown on Figs. 49-51. Mensural characteristics of each plot are presented in Table 25. All plot boundaries were marked with long bamboo, wooden or metal poles, and polypropylene rope was run along the ground to mark the exact edge of each plot (except in plot #6). Hopefully this will make plots easier to relocate and make the corner markers less susceptible to washout, as has happened in the past.

Plots #1 and 2 were worked on 14 and 17 July, plots #3 and #4 were worked on 15 and 18 July, plot #5 was worked on 16 July, and plot #6 was worked on 19 July. Data from all plots are presented in Appendix II and are on file at the Refuge Headquarters. Data from band returns are given in Section VII. Copies have been sent to G.V. Byrd to provide a fifth year of data for the monograph being written on the comparative biology of Leach's and Fork-tailed Storm-Petrels.

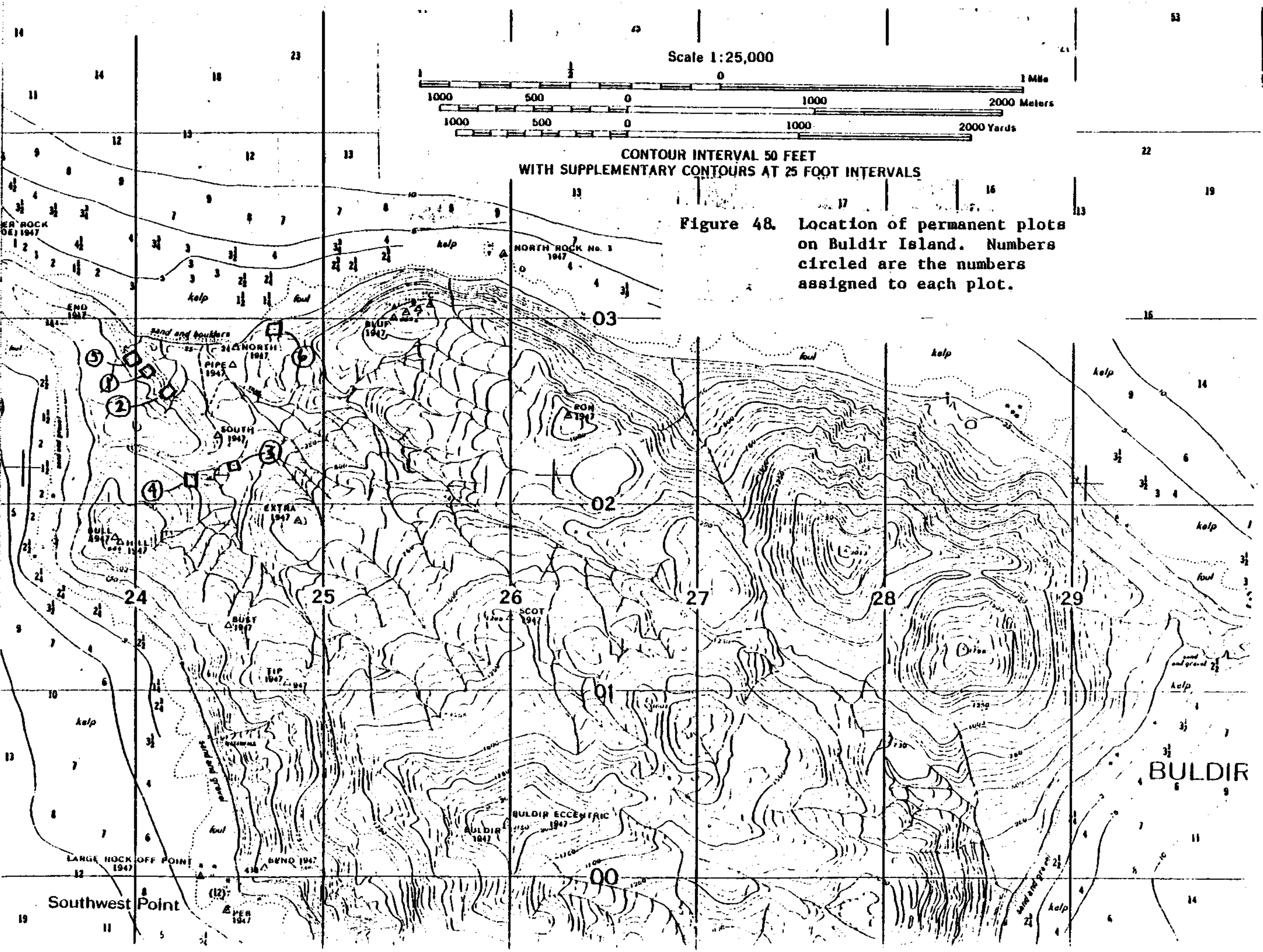


Figure 48. Location of permanent plots on Buldir Island. Numbers circled are the numbers assigned to each plot.

Figure 49. Photograph of Plots #1, #2 and #5 just above main camp at Buldir Island. Locations are approximate. (23 July, 1978)

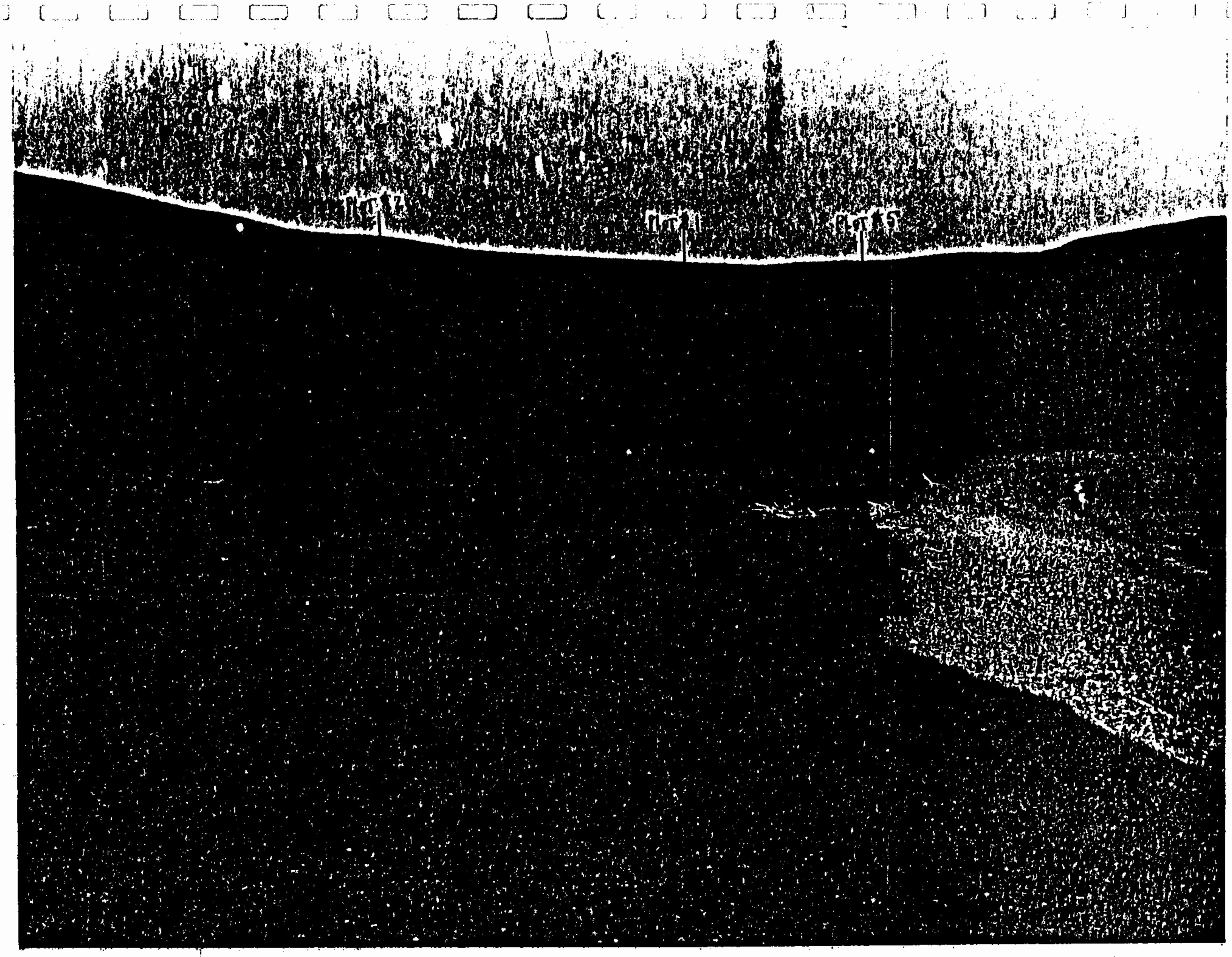


Figure 49.

Figure 50. Photograph of Plot #3 near Stint Creek, Buldir Island. (23 July, 1978)

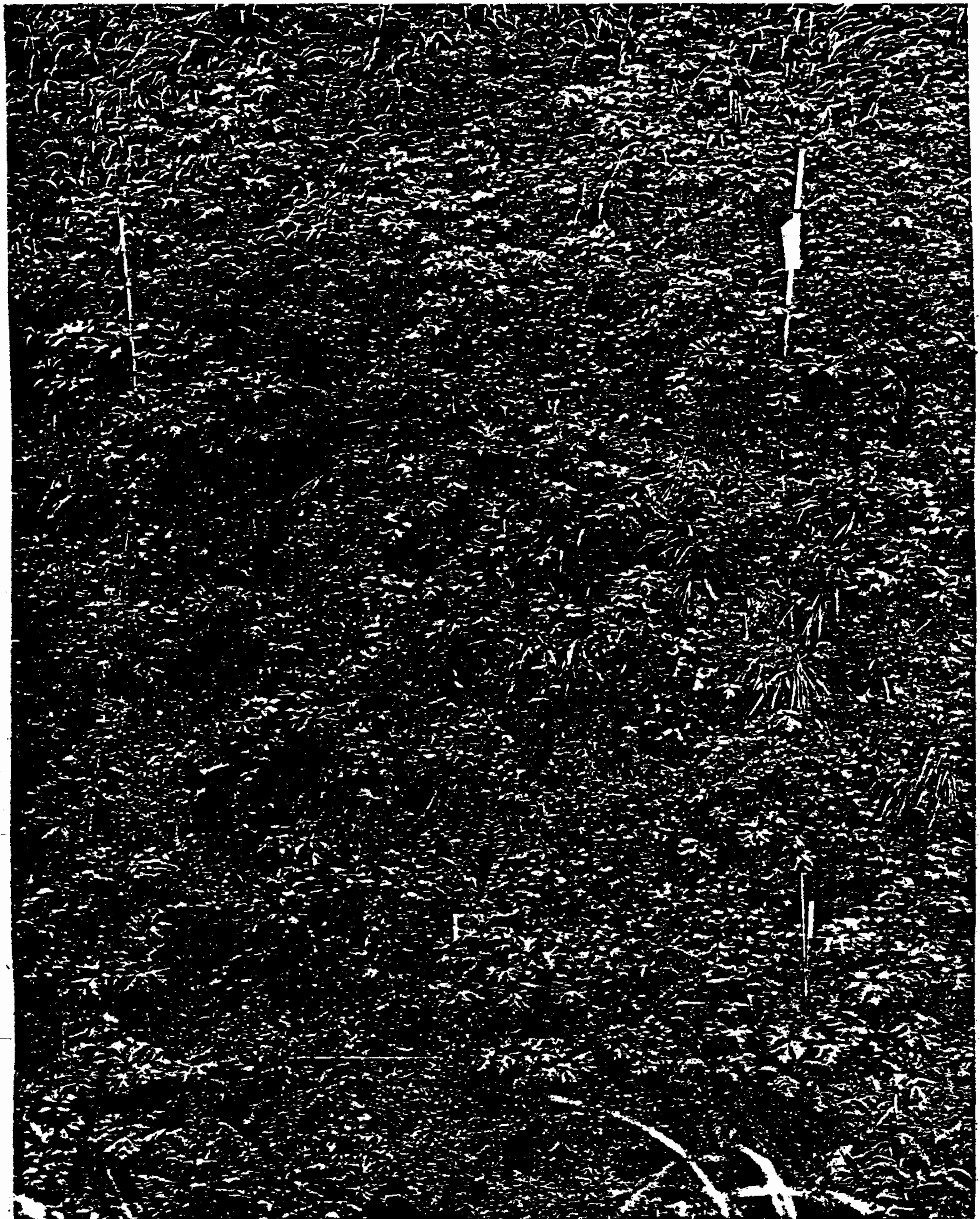


Figure 50.

Figure 51. Photograph of Plot #4 on northwest side of South Marsh, Buldir Island. (23 July, 1978)

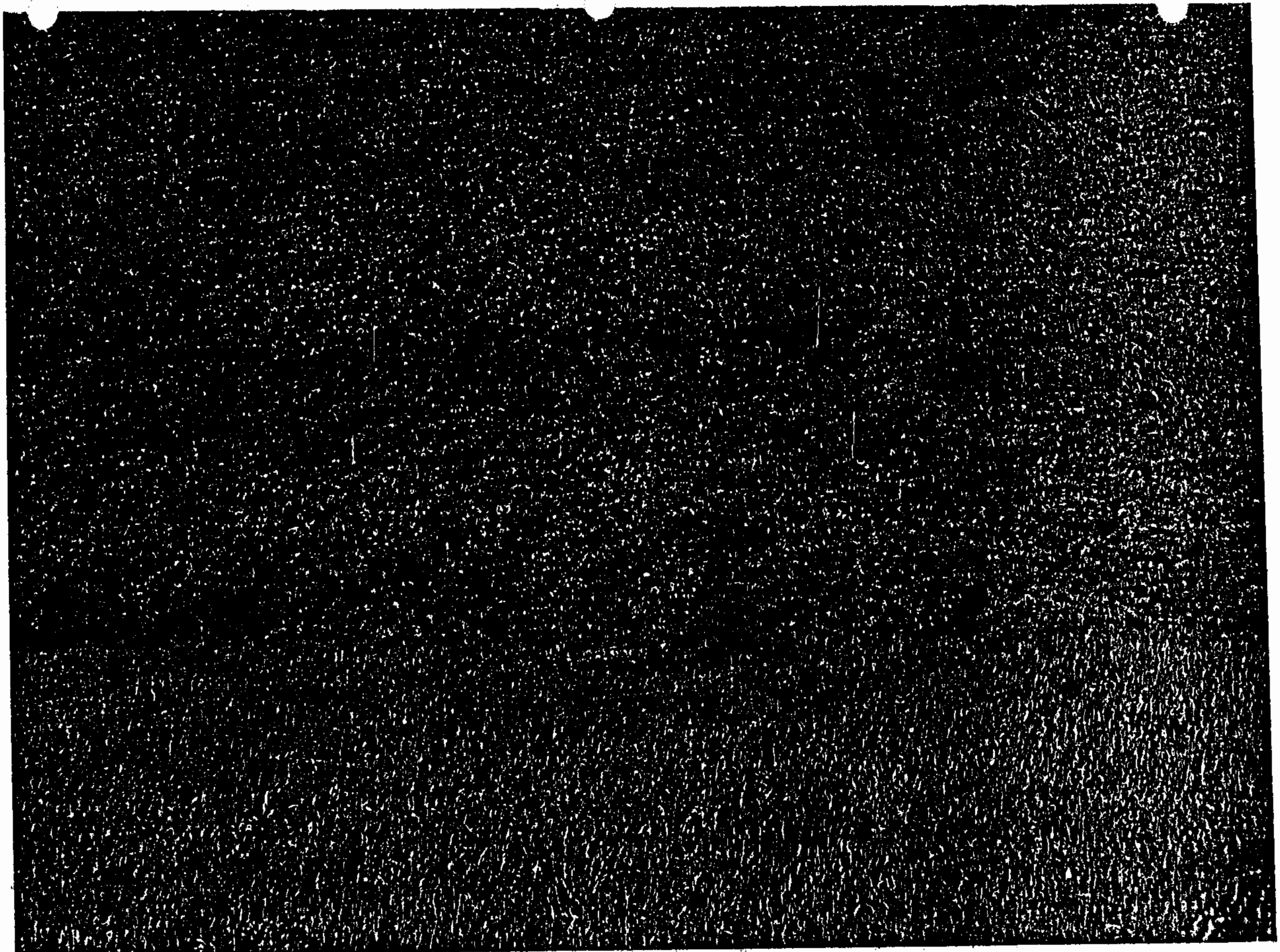


Figure 51.

Data on the status of burrows in each permanent plot are presented in Table 26 and are summarized for all plots in Table 27. A dead-end burrow was one which appeared incomplete; this included everything from burrows that were just a few inches deep to nearly-completed burrows without a nest chamber. A slumped burrow was one that appeared to have caved in on itself; that was especially important in plot #3 which was severely damaged by an earthquake in February 1975. A burrow was classified inactive when it had a fully-completed nest chamber, but had no birds using it. This included burrows used in previous years but vacant this year. An active burrow with birds but no eggs was found only with petrels, where young birds were probably "prospecting". An active burrow was defined as one with egg(s) and/or young; this included Ancient Murrelets and auklets, which had already fledged young.

Exceptions to this were found in Tufted Puffin burrows and burrows used by unknown species. In the former, evidence of recent digging, wear of grass around the burrow entrance, and/or feces at the burrow entrance indicated that a burrow was active. In almost all cases the burrow was too deep to check for the presence of an egg or chick. An inactive puffin burrow did not exhibit any of these characteristics. The same characteristics applied to an inactive burrow of an unknown species.

To monitor populations, each plot should be worked by checking the status of each burrow. Then, a comparison of plots between years and a comparison of all plots together may be made. Note that although the plots contain more than 600 burrows, that total is a minute fraction of the burrows present on the island. This is especially true for storm-petrels with a breeding population between one and two million pairs! The chances of detecting population changes (other than crashes) are slim with this sample size. More plots must be established in order to have a greater sampling intensity of the burrows of these species.

When working plots #1 through #4 in the future, biologists should band all unbanded birds in the plots and reband birds with worn bands. This will provide valuable long-term data on storm-petrels, even if the plots are only checked once every five years. In addition, there should be a 3 or 4-day space between visits to a plot to allow the petrels to change incubation duties so that the band numbers of both mates can be recorded.

Table 25. Mensural characteristics of permanent plots at Buldir Island.

PLOT #	DIMENSIONS (m)	SLOPE (°)	ASPECT (°T)	CENTER ELEVATION (m)
1	5 x 10	30	109	50
2	5 x 10	35	030	50
3	5 x 5	45	300	40
4	5 x 10	30	039	60
5	15 x 20	30	104	55
6	10 x 10	35	004	40

Table 26. Data on burrows and their status in permanent plots at Buldir Island.

	DEAD END	SLUMP	INACTIVE	ACTIVE WITH JUST BIRDS	ACTIVE WITH EGG/ YOUNG	TOO DEEP TO TELL	TOTAL	DEAD END	SLUMP	INACTIVE	ACTIVE WITH JUST BIRDS	ACTIVE WITH EGG/ YOUNG	TOO DEEP TO TELL	TOTAL
			Plot #1								Plot #2			
FT SP				1	16		17					11		11
LE SP					16		16				1	14		15
Petrel	7	1	9				17	8		23				31
AN MU					3		3					2		2
CA AU							–							–
PA AU							–							–
Auklet/Murrelet							–							–
TU PU					3		3					3		3
Unknown Species							–							–
Total	7	1	9	1	38	–	56	8	–	23	1	30	–	62
			Plot #3								Plot #4			
FT SP					11		11					13		13
LE SP					6		6				1	12		13
Petrel	3	12	9				24	13		15				28
AN MU							–							–
CA AU							–							–
PA AU							–							–
Auklet/Murrelet							–							–
TU PU							–							–
Unknown Species							–							–
Total	3	12	9	–	17	–	41	13	–	15	1	25	–	54
			Plot #5								Plot #6			
FT SP					17		17					4		4
LE SP				2	68		70				2	19		21
Petrel	49		31			10	90	27	1	26			19	73
AN MU			5		33		38			3		11		14
CA AU							–					3		3
PA AU							–					1		1
Auklet/Murrelet							–			11		23		34
TU PU			3		13		16	3		1		15		19
Unknown Species			2			3	5	5						5
Total	49	–	41	2	131	13	236	35	1	41	2	76	19	174

NOTE: FT SP=Fork-Tailed Storm-Petrel; LE SP=Leach's Storm-Petrel; AN MU=Ancient Murrelet; CA AU=Cassin's Auklet, PA AU=Parakeet Auklet; TU PU=Tufted Puffin.

Table 27. Summary of status of burrows in all permanent plots at Buldir Island.

		NUMBER	% OF TOTAL
Total # burrows	=	623	100.0
Total FT SP*	=	73	11.7
Total active FT SP (w/egg or young)	=	72	11.6
Total LE SP	=	141	22.6
Total active LE SP (w/egg or young)	=	135	21.7
Total petrel (unknown species)	=	263	42.2
Total of all petrels (FT, LE, & Petrel)	=	477	76.6
Total AN MU	=	57	9.1
Total active AN MU (w/aggs or young)	=	49	7.9
Total inactive AN MU	=	8	1.3
Total CA AU (all active-w/egg or young)	=	3	0.5
Total PA AU (all active-w/egg or young)	=	1	0.2
Total auklet/murrelet	=	34	5.5
Total active auklet/murrelet	=	23	3.7
Total inactive auklet/murrelet	=	11	1.8
Total TU PU	=	41	6.6
Total active TU PU	=	34	5.5
Total inactive TU PU	=	7	1.1
Total unknown species (all inactive)	=	10	1.6

* symbols are the same as in Table 26.

Nesting season was well advanced when we worked the burrows. By 15 July, one of 48 (2.1%) of the Leach's Storm-Petrels had hatched and by 18 July two of 42 (5.0%) eggs were hatched or hatching. More advanced, Fork-tailed Storm-Petrels had 24 of 51 (47.1%) eggs hatched or hatching on 15 July and 27 of 46 (58.7%) eggs hatched by 18 July. Ancient Murrelets were at their peak of hatching and fledging at this time: by 16 July birds in 23 of 32 (71.9%) burrows had fledged, and the remainder were still on eggs or young.

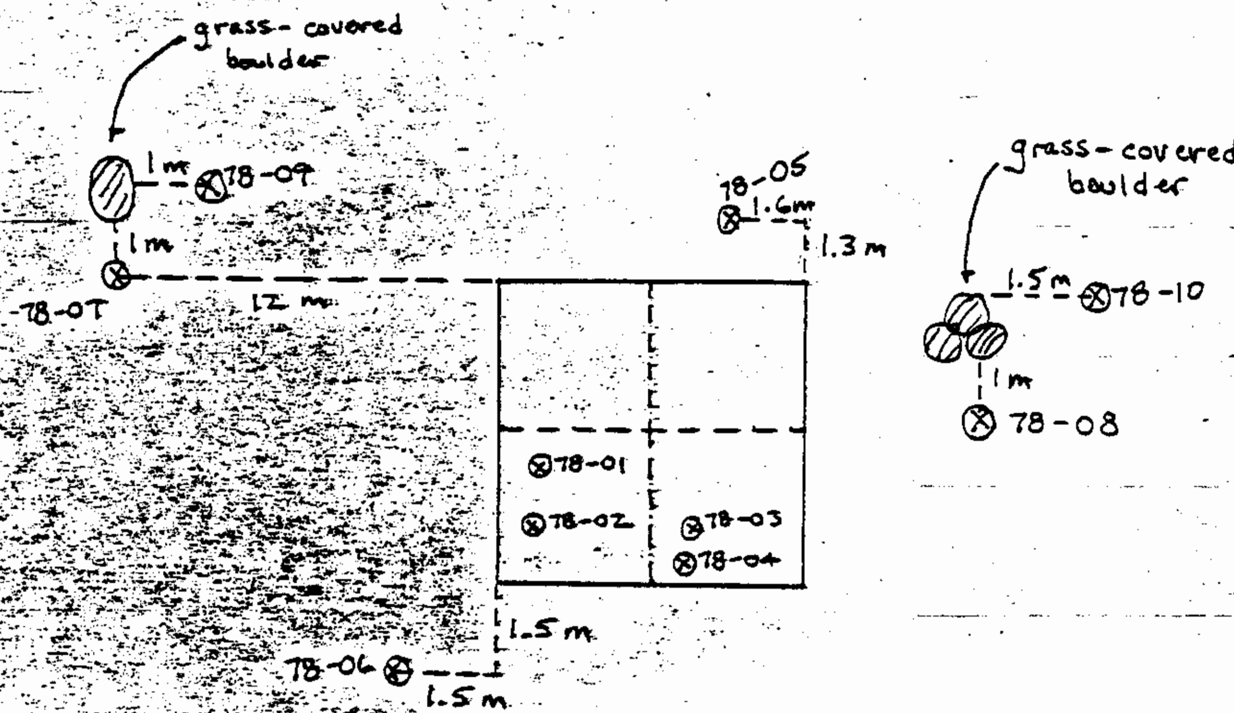
The most exciting discovery of the summer was that of a Cassin's Auklet colony at Buldir. These are the first Cassin's Auklet burrows to be found in the Aleutians since foxes were introduced. This colony has probably been on Buldir all along, but this is the first time it was physically located although breeding was previously suspected.

In addition to the three burrows with chicks found in plot #6, we located six more burrows with chicks adjacent the plot; we also located a Parakeet Auklet burrow with chick within the plot. Unfortunately, no banding was done. All ten burrows were marked and a map is presented (Fig. 52) to show the locations of each. Since there are no other known Cassin's Auklet burrows in the Aleutians and accessible Parakeet Auklet burrows are also difficult to locate, it is recommended that the status of each burrow be checked each time biologists visit Buldir and that any birds should be banded.

Mensural data on all Cassin's and Parakeet Auklet chicks are presented in Table 28. According to Dr. David Manuwal (pers. comm.), the first eggs were laid in the first week of May, and the last egg was laid on about 15 June, as evidenced by the sizes of the oldest and youngest chicks, respectively. Birds which had already been fledged would indicate egg-laying in the last week of April.

Since most Tufted Puffin burrows were too deep to check for eggs or chicks, records only note whether a burrow appeared active or not. Recent work on Ugaiushak Island (D.H.S. Wehle, pers. comm.) indicates that only about 50% of active burrows have pairs of birds which lay eggs. This obviously has implications for the permanent plots, for this means that there may be only about 17 burrows with birds that are actively reproducing. This is far too small a sample size for long-term population monitoring, so more Tufted Puffin plots should be located.

Figure 52. Location of marked Cassin's and Parakeet Auklet burrows near Plot #6 at Crested Point, Buldir Island. Plot #6 is 10 meters on a side.



All burrows are of Cassin's Auklets except for burrow #78-04, which is a Parakeet Auklet.

Table 28. Mensural data on Cassin's and Parakeet Auklet chicks at Buldir Island. Measurements taken on 22 July 1978.

BURROW #	SPECIES	WEIGHT (gm)	EXPOSED CULMEN (mm)	DIAGONAL TARSUS (mm)	WING FLAT (mm)
78-01	Cassin's	84.	12.2	21.8	28.
78-02	"	116.	14.8	25.2	83.
78-03	"	182.	17.7	27.6	116.
78-04	Parakeet	254.	13.4	32.3	115.
78-05	Cassin's	88.	14.2	22.4	43.
78-06	"	114.	14.3	22.8	55.
78-07	"	162.	17.8	26.6	127.
78-08	"	205.	17.1	25.2	120.
78-09	"	23.	7.8	10.0	22.
78-10	"	208.	17.8	24.8	125.

In addition to the burrow-nester work, we planned to count murres and kittiwakes at East Cape for monitoring purposes, but poor weather conditions and scheduling conflicts precluded it.

In summary, six long-term population monitoring plots for burrow nesters were worked on Buldir Island, four of which had been used previously for studies on the biology of storm-petrels. Approximately 625 burrows were checked, of which more than 75% were storm-petrels. The remainder was divided among Ancient Murrelets, Tufted Puffins, and Cassin's and Parakeet Auklets. The first Cassin's Auklet colony of the Aleutians in recent years was discovered at Buldir during our work, and the nine known burrows were marked to be checked in future years.

Kiska Island

The only permanent plots located on Kiska Island were those associated with the census of the large auklet colonies (see section on "Auklet Census"). These plots play an important double function by being used both for long-term population monitoring and for population estimation of auklets on various colonies.

A total of 15 plots were located on the old lava flow of Sirius Point; however, as discussed in "Auklet Census", we were only able to work 10 of them.

Sirius Point has three readily-definable lava flow colonies (Fig. 53): (1) a large flow that is "...one to several centuries old..." (Coats et al. 1961); (2) a small, inaccessible flow or talus area approximately three km east of the point; and (3) a large new lava flow which emerged from the sea in 1965. No plots were staked on the last colony although we attempted to do so but found the rock too unstable to hold marker poles. The only permanent plots were located on the large old flow (colony #2). The photograph of (1) and (3) above is shown in Fig. 54.

As discussed in the section on "Auklet Census," plots were set up on a compass bearing traversing the longest part of the colony. We laid out three of these compass lines this year, and five plots were located along each bearing line. This was primarily for ease in relocating plots. Fig. 55 shows the location of the plot lines, and Table 29 contains the mensural data on each plot. Only plots on plot lines #1 and #3 were worked this year due to two major factors: (1) fledging

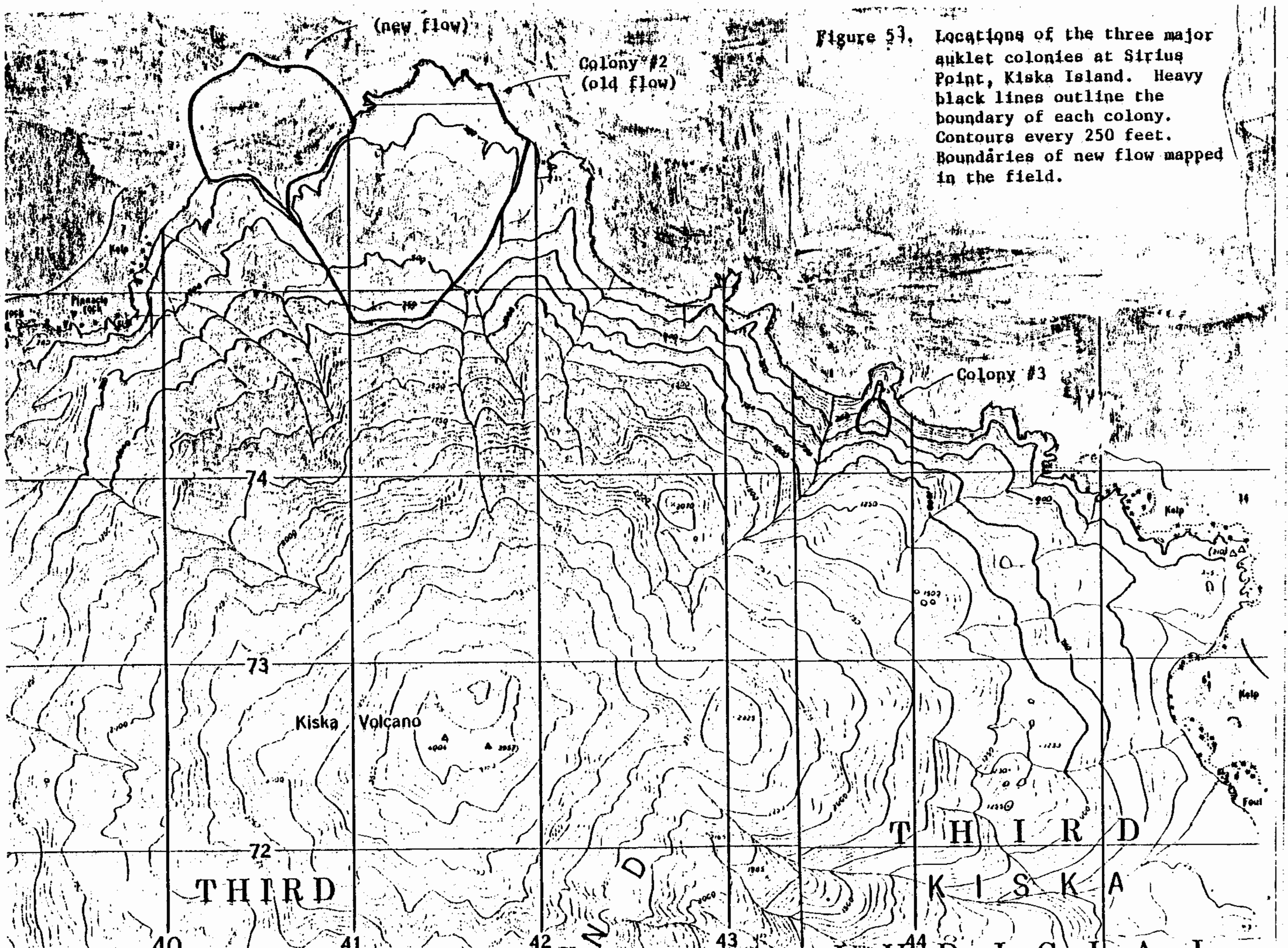


Figure 53. Locations of the three major auklet colonies at Sirius Point, Kiska Island. Heavy black lines outline the boundary of each colony. Contours every 250 feet. Boundaries of new flow mapped in the field.

Figure 54. Photograph looking north across the large auklet colony on Sirius Point, Kiska Island. The dashed line to the left points out the area of the new lava flow and the remainder is the old flow. Our tent camp can be seen at the far right side of the photograph.

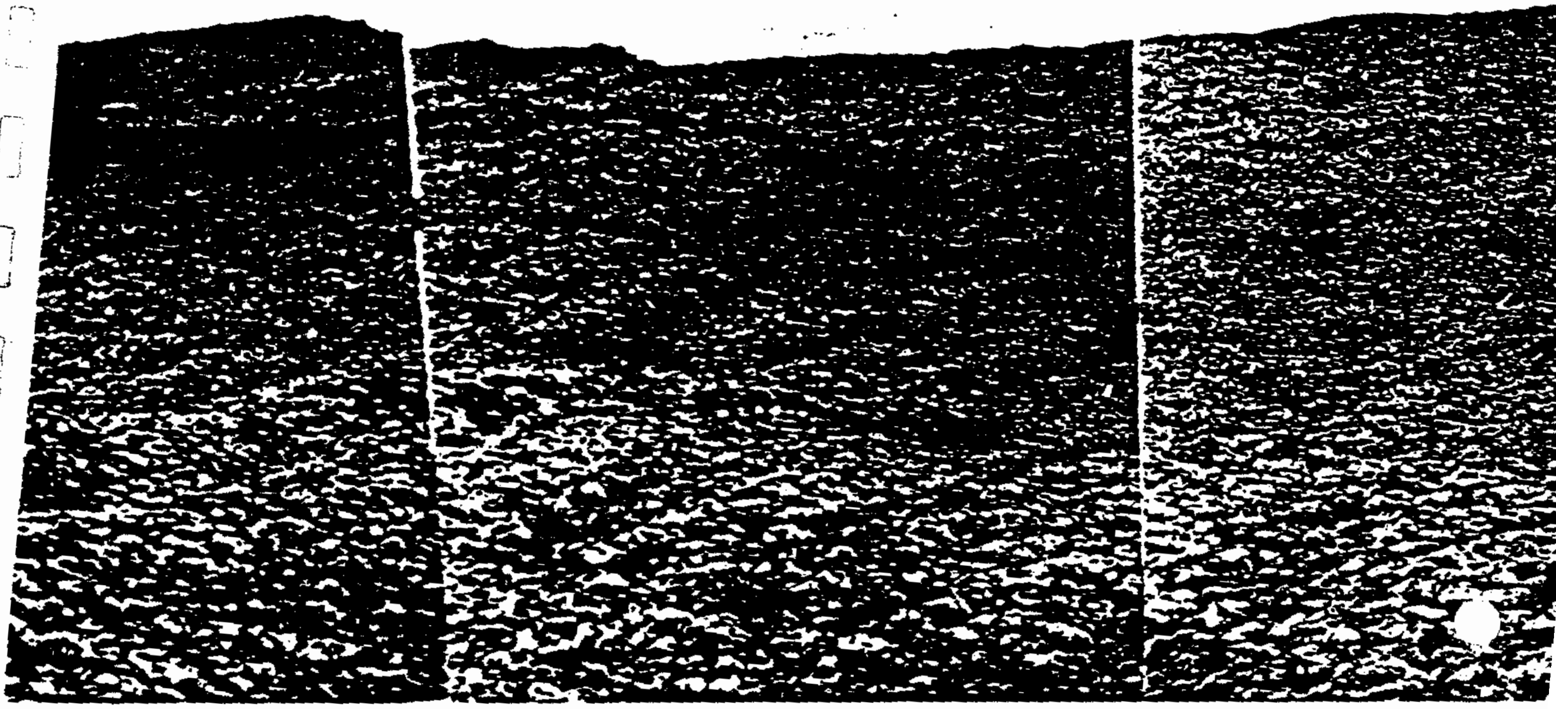
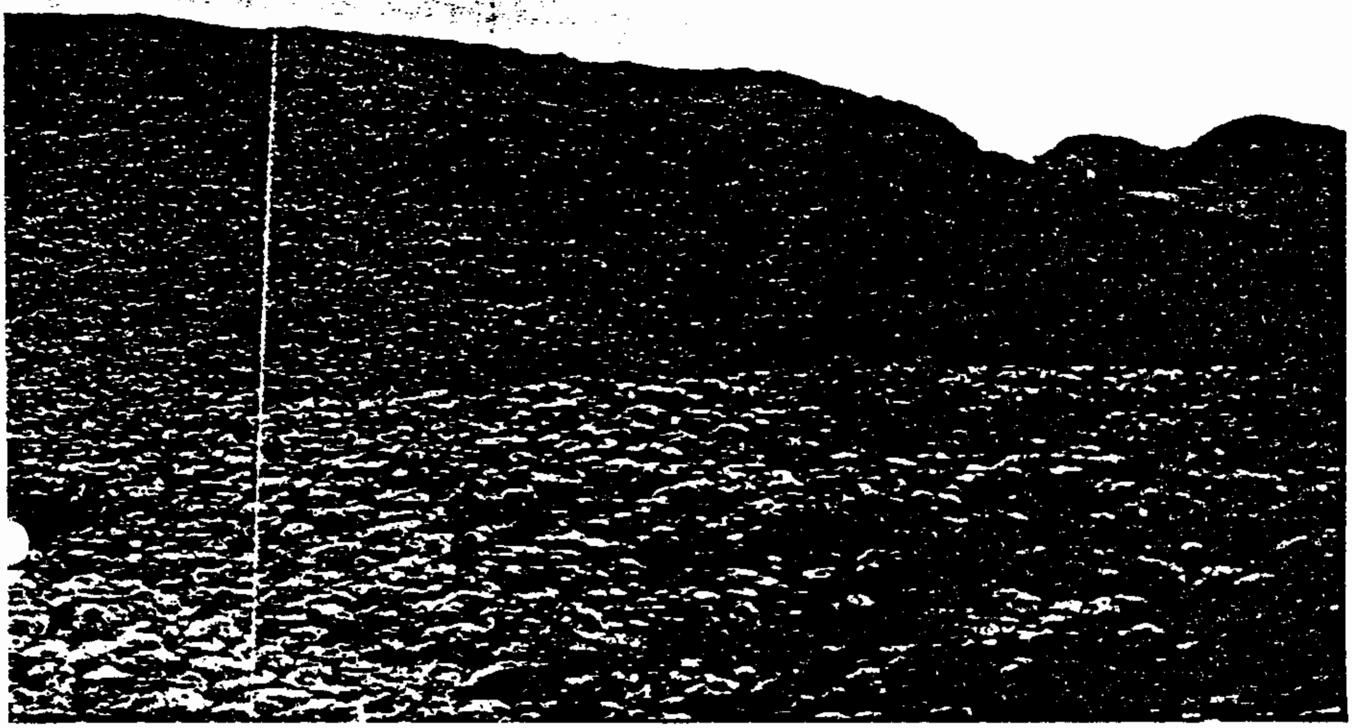


Figure 54.



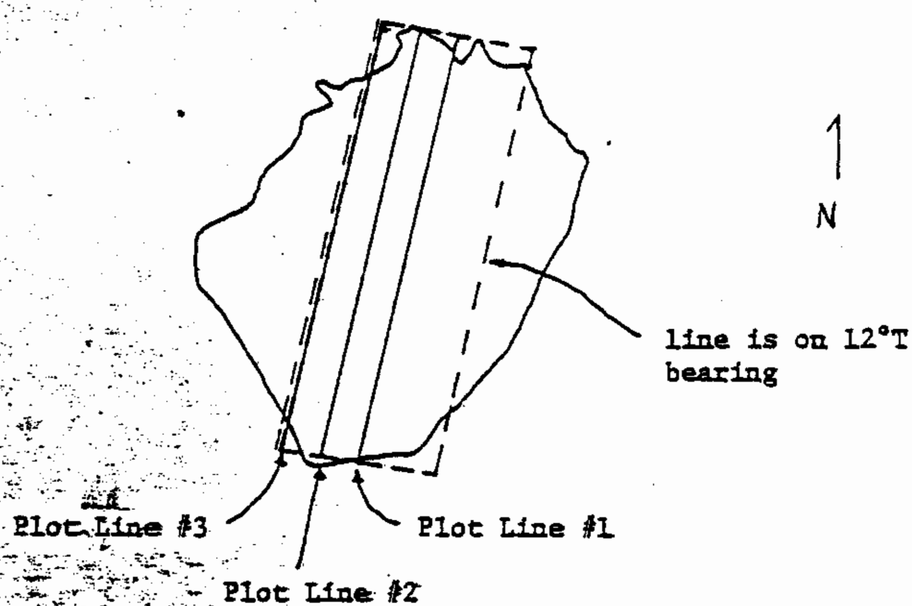


Figure 55. Locations of plot lines on old lava flow, Kiska Island. Plot lines form the eastern edge of each plot.

Table 29. Mensural data on auklet plots in old lava flow (Colony #2), Kiska Island.

PLOT #	1	2	3	4	5
	INLAND ——→ SEAWARD				
Plot Line #1					
Pole #	26	47	90	89*	-
Distance from "top" of Colony (m)	210	490	770	1050	1330
Elevation (ft)	575	390	280	300	220
Aspect (°T)	5	0	354	10	10
Distance from water (m)	800	690	460	230	75
Slope (°)	29	5	4	0	2
Plot Line #2					
Pole #	72	71	83*	98*	49
Distance from "top" of Colony (m)	123	363	603	843	1083
Elevation (ft)	750	460	425	370	300
Aspect (°T)	335	354	18	-	30
Distance from water (m)	1020	850	640	420	210
Slope (°)	25	8	5	0	3
Plot Line #3					
Pole #	36	65	61	67	40
Distance from "top" of Colony (m)	48	288	528	768	1008
Elevation (ft)	770	610	305	340	365
Aspect (°T)	15	15	20	94	30
Distance from water (m)	1050	850	650	430	210
Slope (°)	5	10	15	5	3

* pole # glued on upside-down

had peaked so populations of auklets on colony were decreasing steadily; and (2) extremely poor weather forced us to hibernate much of the time. Plot line #2 was laid out just before we left so that the plots need only to be relocated in order to be run. In addition, we left 15 poles at the camp site to be used for marking new plots next season.

Data on the average numbers of birds per plot are presented in Table 15 ("Auklet Census"). Since we were only able to work the colony after the birds started fledging, we believe that many of the birds had already left. To avoid this in future surveys, the field crew should return to Kiska earlier in the breeding season and work all the plots again, plus put in 15 more plots. This should give better data for long-term population monitoring, as well as yield better data for a population estimate.

XII. PELAGIC TRANSECTS

A total of 93 pelagic transects were logged during the summer from the R/V ALEUTIAN TERN. Fifty transects were recorded east of Adak Island during the period 27 May to 4 June. The remaining 43 transects were run west of Adak Island from 9 June to 13 August.

Highest bird densities were found in areas of upwellings (e.g., the Baby Islands) or near large bird colonies (e.g., Kiska Island). The highest individual transect density was near Sirius Point, Kiska Island, adjacent to the large auklet colony. Mean density for all the counts was 76.7 birds/km^2. The Rat Islands averages 125.7 birds/km^2, the Andreanof Islands 88.4, the Fox Islands 67.1, and the Near Islands 25.8. The results are summarized graphically in Figs. 56-63 and listed by species in Tables 31-38.

Method for Calculating Pelagic Transects

Given:

1 nautical mile (nm) = 1.852 kilometers (km)
300 meters (m) = 0.300 km
Area = length x width

Then:

$$\text{Length of Transect} = \frac{\#\ \text{nm}}{\text{hour}} \times \frac{1.852\ \text{km}}{\text{nm}} \times \frac{1\ \text{hr}}{6\ (10\ \text{min. transects})}$$

$$\text{Width of Transects} = 300\text{m} \times \frac{1\ \text{km}}{1000\text{m}} = 0.300\text{km}$$

Therefore:

$$\text{Area Covered per transect} = \left(\frac{0.30867\ \text{km}\ (X\ [\text{nm}])}{\text{transect}}\right)(0.300\text{km})$$

$$= \left(\frac{0.0926\ \text{km}^2}{\text{transect}}\right)(X\ [\text{nm}])$$

or, simply multiply ship's speed by 0.0926 km^2 to find area covered by the transect. But because each transect covers less than 1 km^2 and it is easier to relat in km^2, convert by using the simple algebraic expression:

$$\frac{N_{\circ}\ \text{birds}}{X_{\circ}\ km^2} = \frac{N,\ \text{birds}}{1\ km^2}$$

<u>Where</u>: N° birds = # birds seen in transect

X° km^2 = area of transect at given speed

N, birds = # birds per km^2 in transect area

<u>Solving for N,:</u>

$$N, = (N^{\circ}\ \text{birds}) \left(\frac{1\ km^2}{X^{\circ}\ km^2}\right)$$

And the quantity $\frac{1\ km^2}{X_{\circ}\ km^2}$ is the

<u>area reciprocal</u> for ship's speed listed in Table 30.

Therefore, to obtain number of birds per km^2 just multiply the number seen in the 10-minute transect by the area reciprocal listed for the ship's speed at the time of the transect.

All transects are on file at the Refuge Headquarters for eventual compilation and analysis with previous years' data.

Table 30. Conversion table for area covered (km^2) in 10-minute pelagic transects and area reciprocals for various ship speeds.

Ship Speed (kts)	Area Covered (km^2) in a 10-min. period	Area Reciprocal
8.5	0.788	1.269
8.6	0.797	1.255
8.7	0.806	1.241
8.8	0.816	1.225
8.9	0.826	1.211
9.0	0.834	1.199
9.1	0.844	1.185
9.2	0.853	1.172
9.3	0.862	1.160
9.4	0.871	1.148
9.5	0.881	1.135
9.6	0.890	1.124
9.7	0.899	1.112
9.8	0.908	1.101
9.9	0.918	1.089
10.0	0.927	1.079
10.1	0.936	1.068
10.2	0.946	1.057
10.3	0.955	1.047
10.4	0.964	1.037
10.5	0.973	1.028

Table 31. Pelagic transects in the eastern Fox Islands. ($n = 19$, $\overline{x} = 89.2$ birds/km^2)

SPECIES	FREQUENCY OF OCCURRENCE (IN PERCENT)
Murre sp.	89
Tufted Puffin	63
Auklet sp.	42
Cormorant sp.	42
Glaucous-winged Gull	37
Shearwater sp.	32
Pigeon Guillemot	21
Kittiwake sp.	16
Common Loon	16
Ancient Murrelet	5
Phalarope sp.	5

Figure 56. Pelagic transects in the eastern Fox Islands, 1978. (Month/day transect run indicated after each symbol.)

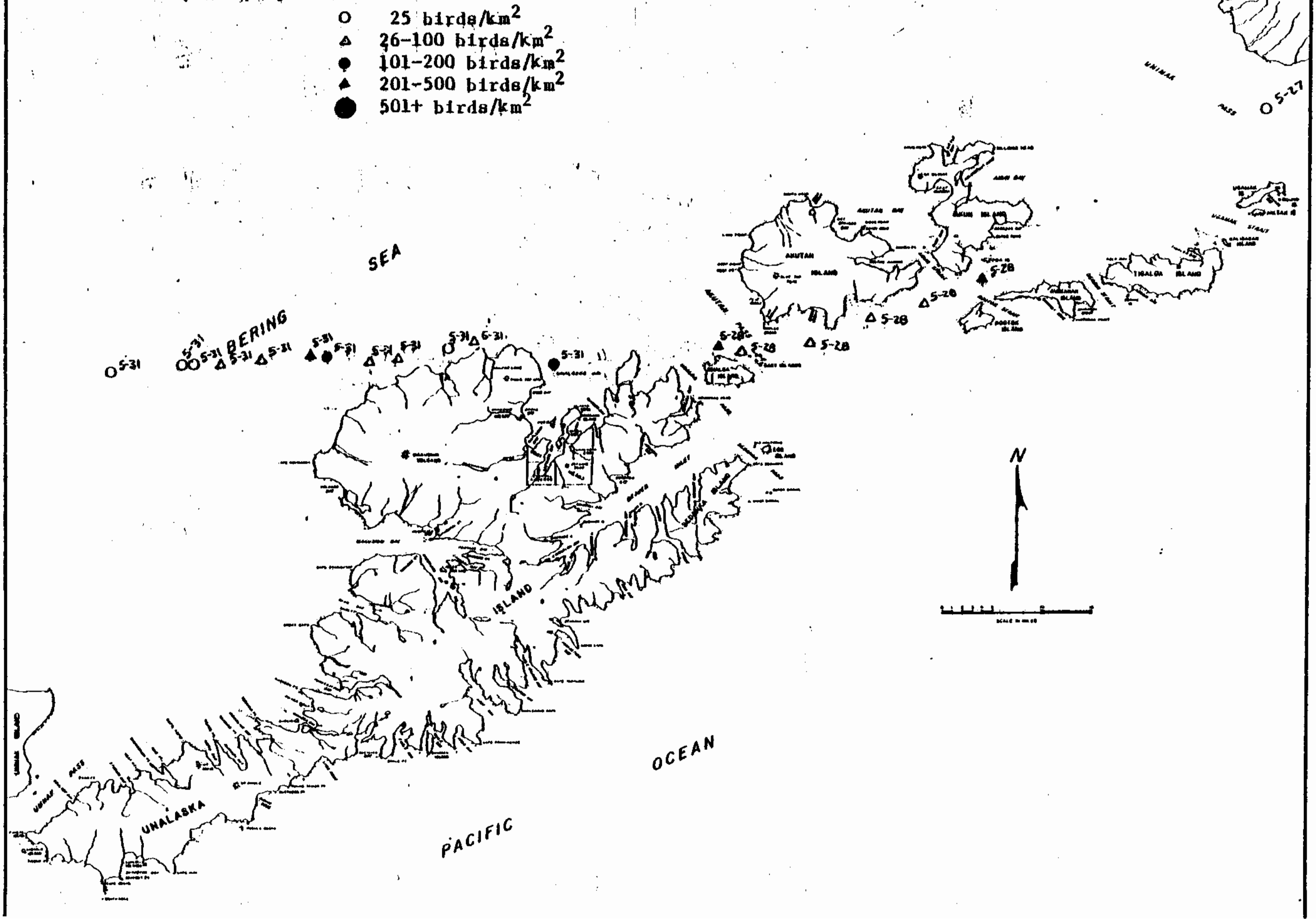


Table 32. Pelagic transects in the western Fox Islands. ($n = 18$, $\bar{x} = 43.8$ birds/km^2)

SPECIES	FREQUENCY OF OCCURRENCE (IN PERCENT)
Murre sp.	83
Northern Fulmar	72
Tufted Puffin	50
Glaucous-winged Gull	44
Shearwater sp.	17
Auklet sp.	17
Kittiwake sp.	17
Horned Puffin	17
Ancient Murrelet	11
Phalarope sp.	6
Albatross sp.	6
Cormorant sp.	6
Common Loon	6
Unk. Passerine sp.	6

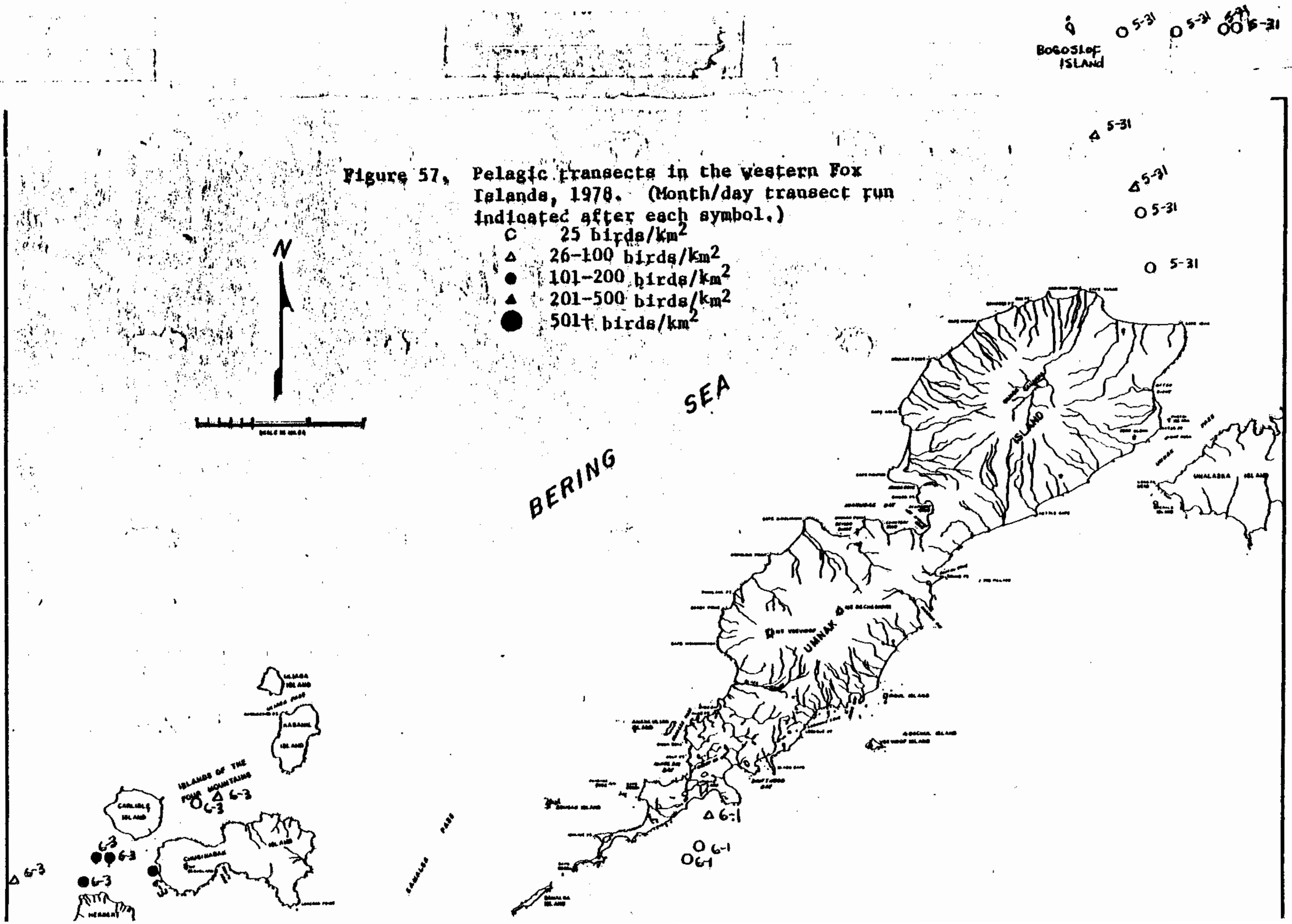


Figure 57, Pelagic transects in the western Fox Islands, 1978. (Month/day transect run indicated after each symbol.)

- C 25 birds/km^2
- △ 26-100 birds/km^2
- ● 101-200 birds/km^2
- ▲ 201-500 birds/km^2
- ⬤ 501+ birds/km^2

Table 33. Pelagic transects in the eastern Andreanof Islands. ($n = 11$, $\bar{x} = 123.8$ birds/km^2)

SPECIES	FREQUENCY OF OCCURRENCE (IN PERCENT)
Ancient Murrelet	82
Tufted Puffin	82
Auklet sp.	55
Murre sp.	55
Glaucous-winged Gull	55
Northern Fulmar	55
Black-legged Kittiwake	45
Horned Puffin	36
Laysen Albatross	27
Cormorant sp.	18
Pigeon Guillemot	18

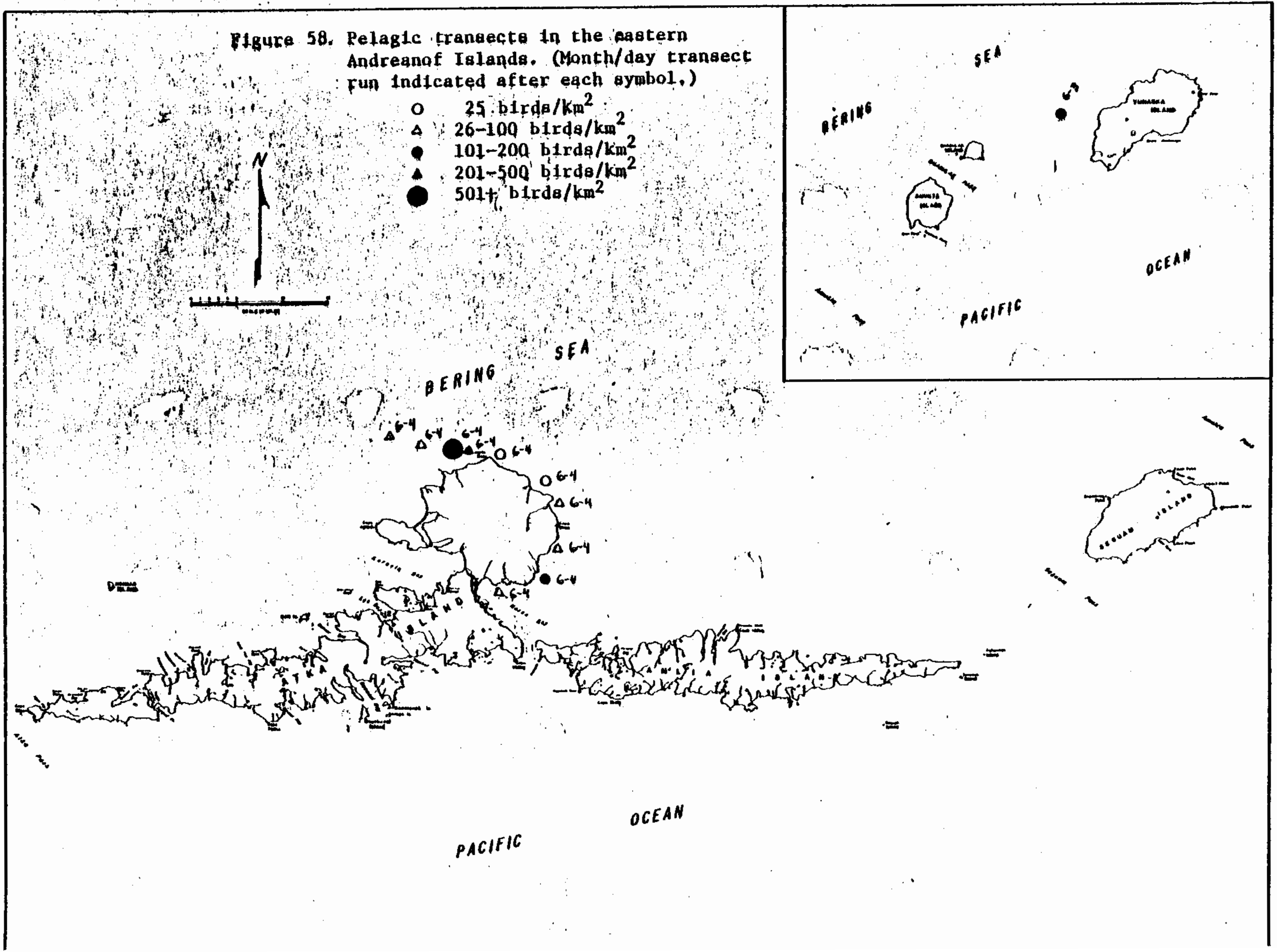


Figure 58. Pelagic transects in the eastern Andreanof Islands. (Month/day transect run indicated after each symbol.)

- O 25 birds/km^2
- △ 26-100 birds/km^2
- ● 101-200 birds/km^2
- ▲ 201-500 birds/km^2
- ⬤ 501+ birds/km^2

Table 34. Pelagic transects in the western Andreanof Islands ($n = 3$, $\bar{x} = 27.6$ birds/km^2)

SPECIES	FREQUENCY OF OCCURRENCE (IN PERCENT)
Tufted Puffin	67
Horned Puffin	67
Glaucous-winged Gull	67
Murre sp.	33
Cormorant sp.	33
Tern sp.	33
Pigeon Guillemot	33
Northern Fulmar	33
Murrelet sp.	33

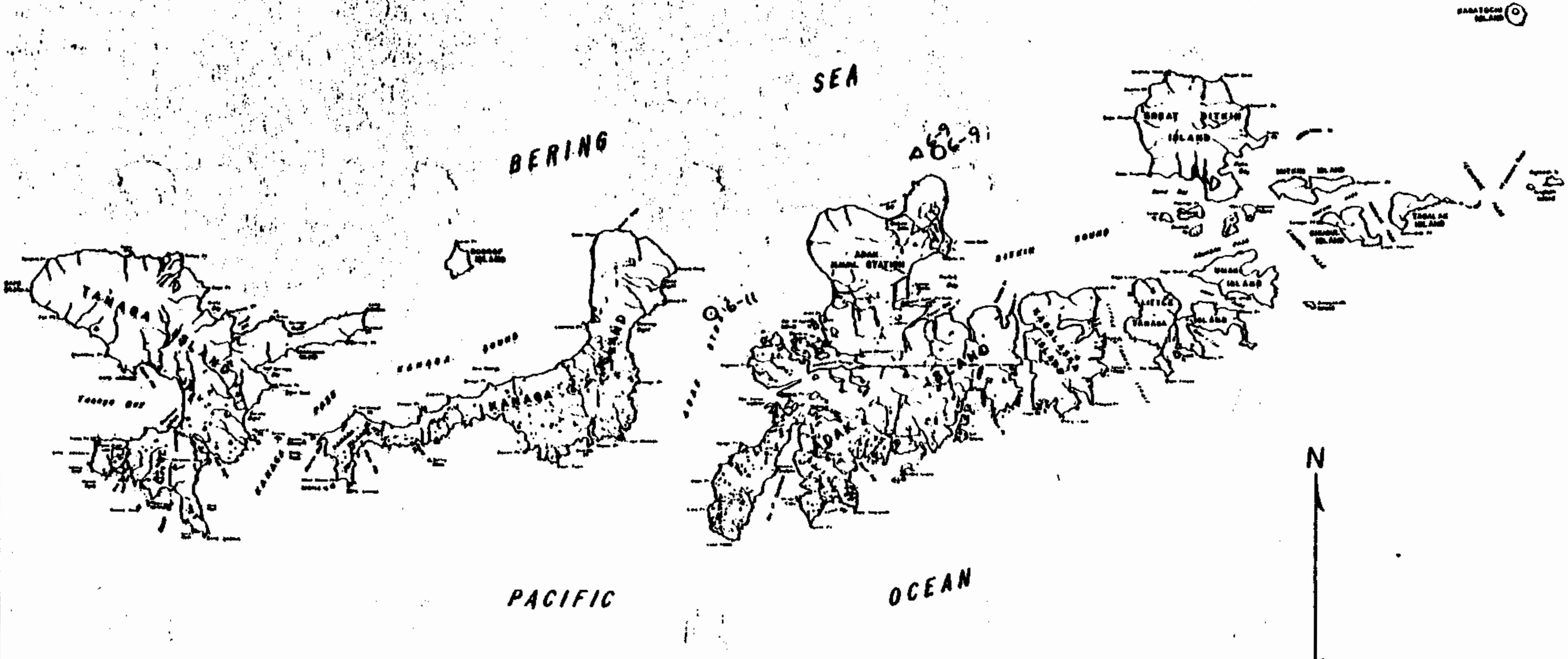


Figure 59. Pelagic transects in the western Andreanof Islands, 1978. (Month/day transect run indicated after each symbol.)

- ○ 25 birds/km^2
- △ 26-100 birds/km^2
- ● 101-200 birds/km^2
- ▲ 201-500 birds/km^2
- ⬤ 501+ birds/km^2

Table 35. Pelagic transects in the Delarof Islands. (n = 3, $\bar{x}$ = 19.3 birds/km^2)

SPECIES	FREQUENCY OF OCCURRENCE (IN PERCENT)
Northern Fulmar	100
Kittiwake sp.	67
Tufted Puffin	67
Shearwater sp.	33

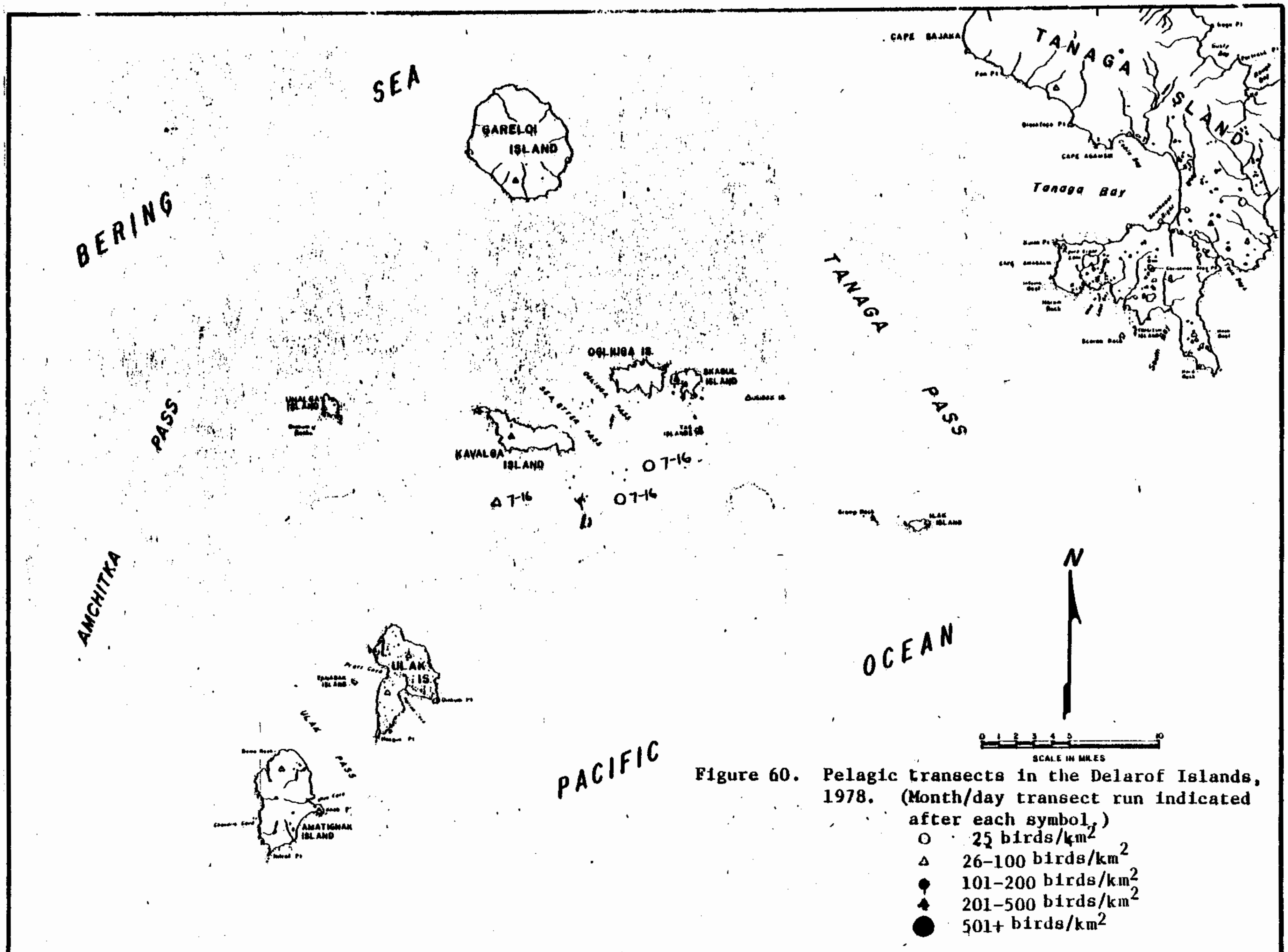


Figure 60. Pelagic transects in the Delarof Islands, 1978. (Month/day transect run indicated after each symbol.)

- O 25 birds/km^2
- Δ 26-100 birds/km^2
- 101-200 birds/km^2
- 201-500 birds/km^2
- 501+ birds/km^2

Table 36. Pelagic transects in the Rat Islands.
(n = 8, $\bar{x}$ = 60.4 birds/km^2)

SPECIES	FREQUENCY OF OCCURRENCE (IN PERCENT)
Northern Fulmar	100
Glaucous-winged Gull	100
Tufted Puffin	100
Shearwater sp.	50
Kittiwake sp.	38
Albatross sp.	25
Auklet sp.	25
Jaeger sp.	13
Horned Puffin	13

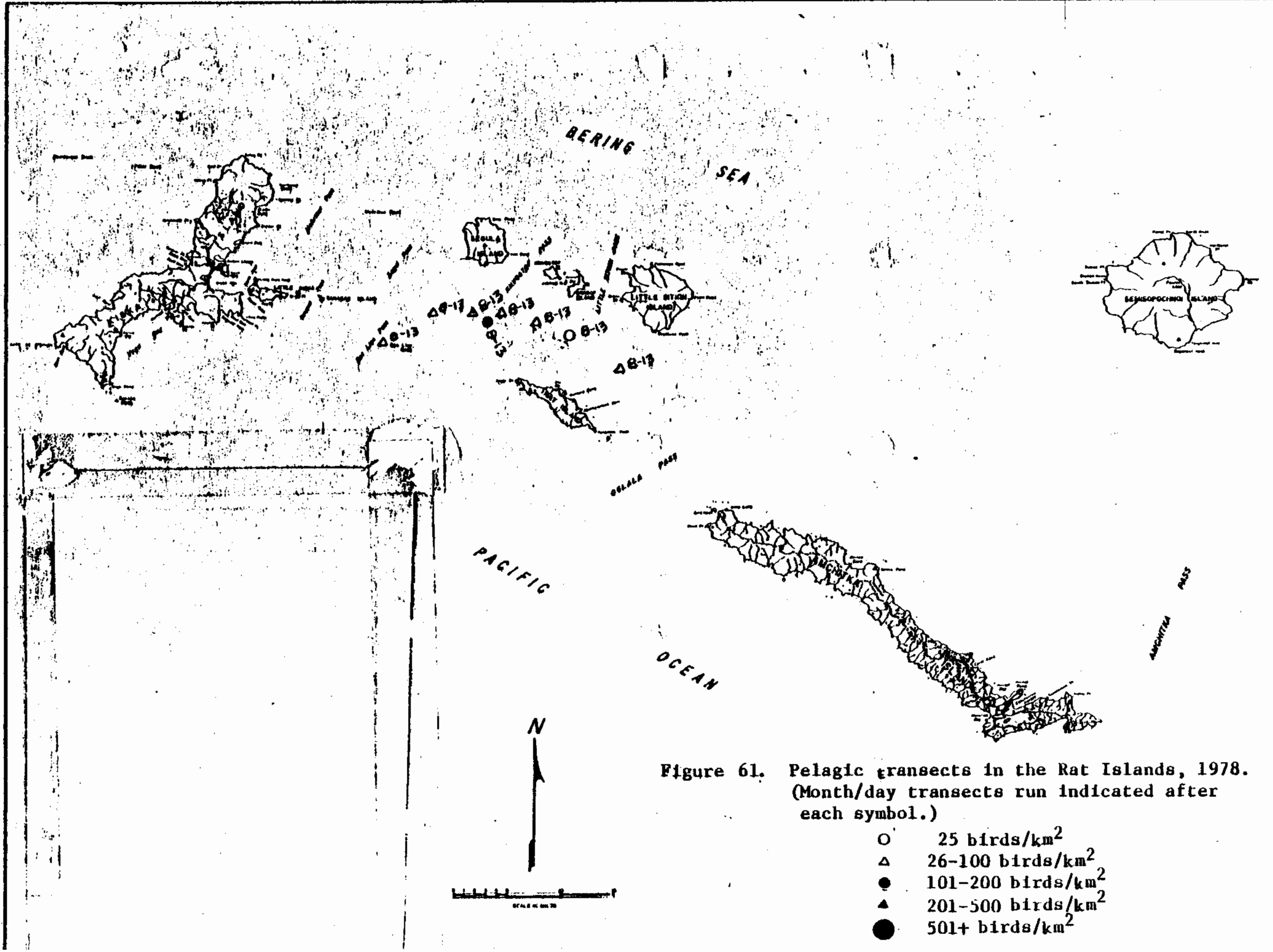


Figure 61. Pelagic transects in the Rat Islands, 1978. (Month/day transects run indicated after each symbol.)

O	25 birds/km^2
Δ	26-100 birds/km^2
●	101-200 birds/km^2
▲	201-500 birds/km^2
⬤	501+ birds/km^2

Table 37. Pelagic transects from Kiska to Shemya Island. ($n = 23$, $\bar{x} = 135.5$ birds/km^2)

SPECIES	FREQUENCY OF OCCURRENCE (IN PERCENT)
Northern Fulmar	96
Albatross sp.	74
Petrel sp.	74
Glaucous-winged Gull	70
Kittiwake sp.	48
Auklet sp.	39
Tufted Puffin	35
Shearwater sp.	26
Jaeger sp.	22
Horned Puffin	13
Murre sp.	13
Murrelet sp.	4
Phalarope sp.	4
Cormorant sp.	4

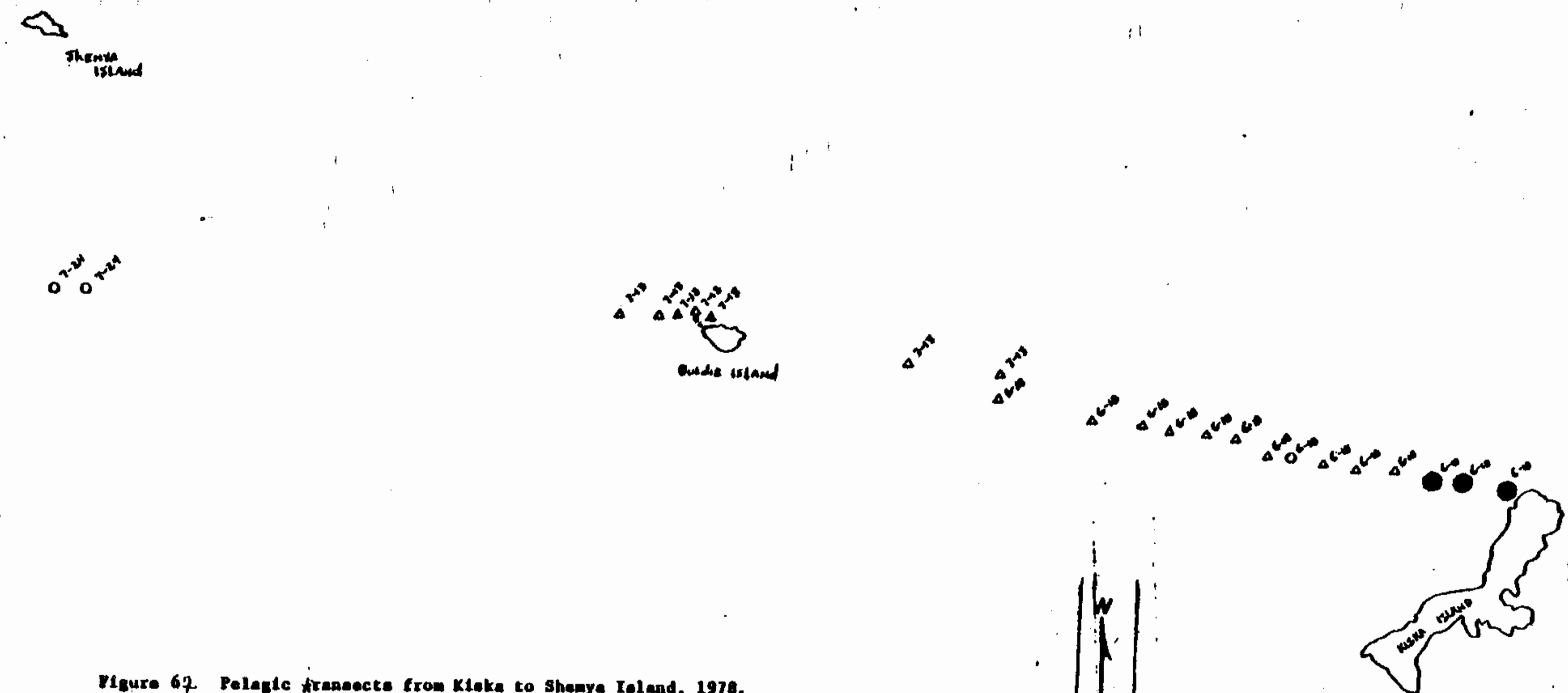


Figure 62. Pelagic transects from Kiska to Shemya Island, 1978. (Month/day transect run indicated after each symbol.)

- ○ 25 birds/km^2
- △ 26/100 birds/km^2
- ● 101-200 birds/km^2
- ▲ 201-500 birds/km^2
- ⬤ 501+ birds/km^2

Table 38. Pelagic transects in the Near Islands.
($n = 6$, $\bar{x} = 25.3$ birds/km^2)

SPECIES	FREQUENCY OF OCCURRENCE (IN PERCENT)
Northern Fulmar	83
Tufted Puffin	83
Fork-tailed Storm-Petrel	67
Glaucous-winged Gull	67
Phalarope sp.	33
Murrelet sp.	33
Murre sp.	17
Horned Puffin	17
Cormorant sp.	17
Jaeger sp.	17

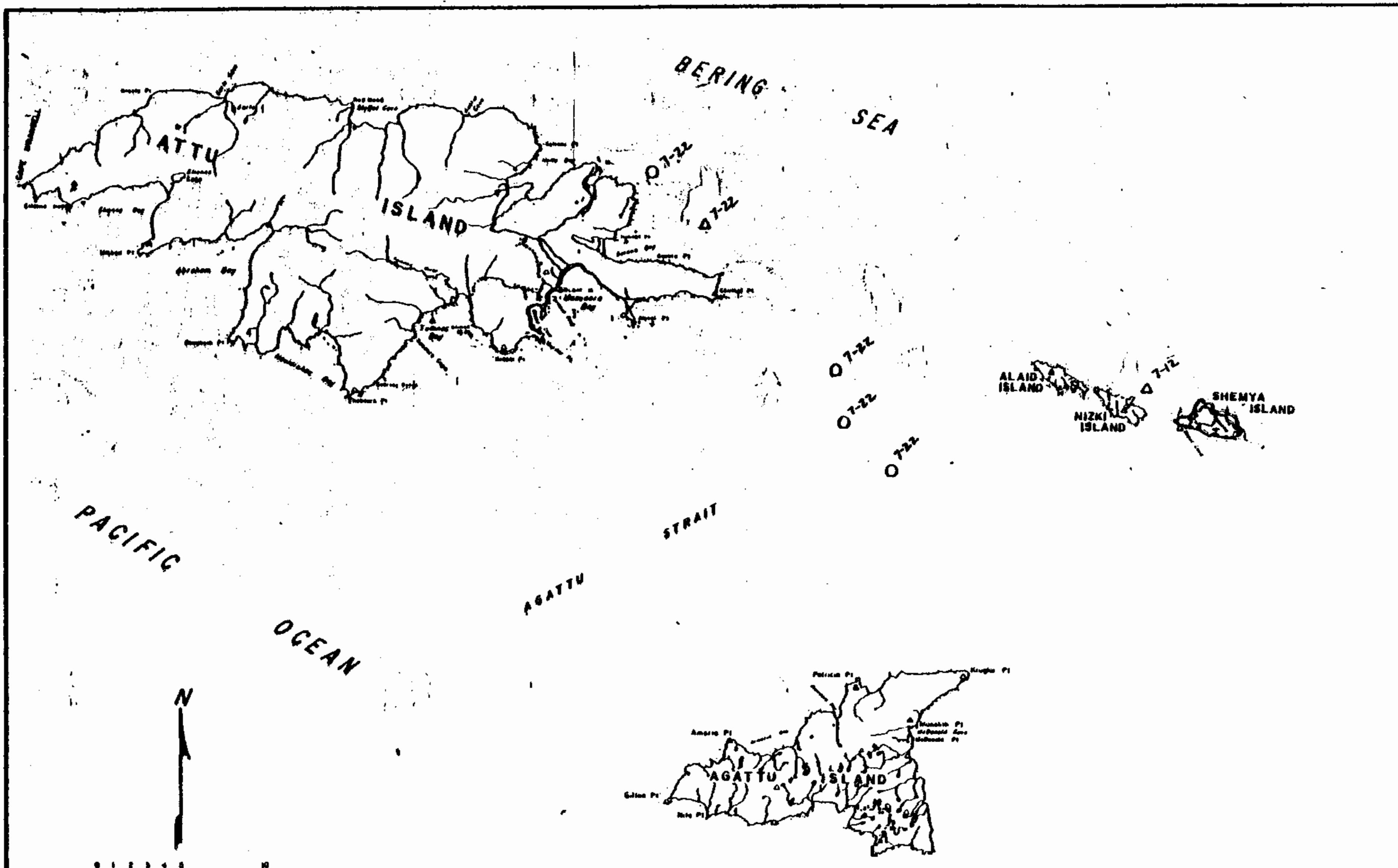


Figure 63. Pelagic transects in the Near Islands, 1978.
(Month/day transect run indicated after each symbol)

○ 25 birds/km²
△ 26-100 birds/km²
● 101-200 birds/km²
▲ 201-500 birds/km²
⬤ 501+ birds/km²

XIII. TERRESTRIAL TRANSECTS

Inland Bird Transects

Eight inland bird transects were run this season on three different islands. Three were run on Alaid Island, two on Nizki Island and three on Agattu Island (Figs. 64, 65, and 66). Transects on Agattu Island were run by D. Woolington and D. Yparraguirre. Transect #4 on Agattu Island was discontinued this year as the Aleutian Canada goose release site was located on a large portion of the transect.

Arctic foxes were removed from Alaid/Nizki Islands in 1976 and we are confident that a maximum of one or two foxes remain on Agattu. Control work is still being continued on Agattu and with this work accomplished information can be gathered on bird recovery after predator removal. The refuge staff will attempt to run transects every year for several years, if possible, to gain information on species recovery.

Methods of transect calculations are discussed in Day et al (1978). These transects were run last year but data from years previous to 1977 are presently not available. Transect results are on Table 39.

The transects on Alaid and Nizki Islands were run the same day when weather conditions were favorable. Transect #1 on Alaid was run the following day with 6 Lapland Longspurs less seen in the critical distance (50 ft) but only four less seen in the entire transect width. Weather data for all transects are given with the particular transects in Appendix IV.

New aluminum poles were placed at each end of practically all transects for ease of relocation and identification. All data is included with the individual transect information in the Appendix and on permanent file in the refuge office.

Beach Transects

Seven beach transects for terrestrial birds were run this season. The data is summarized in Table 40. Locations of transects on Alaid and Nizki Islands are presented in Figs. 65 and 66 and Little Kiska transect in Fig. 67. Refer to Appendix V for specific information on individual transects. Beaches are walked by one or preferably two individuals between mean high tide and storm tide line and all birds or pairs of birds on territory are counted.

All surveys conducted this year were established and run in previous years. When data from transects prior to 1977 are received we will consolidate all the information in Refuge files.

A total of 606 individual birds were observed in all transects and Little Kiska accounted for 35% of the total. The cobble beach on Little Kiska is ideal habitat for winter wrens and glaucous-winged gulls use the northwest end for a loafing area.

Table 39. Projected numbers* of each species seen in inland transects on three islands in the Near Island group, 1978.

	ALAID #1	ALAID #2	ALAID #3	NIZKI #1	NIZKI #2	AGATTU #1	AGATTU #2	AGATTU #3
DATE RUN	8 Jul	8 Jul	8 Jul	8 Jul	8 Jul	16 Jul	16 Jul	16 Jul
Lapland Longspur	106.6	98.4	90.2	139.4	106.6	180.4	164.0	287.0
Snow Bunting	0	0	0	0	0	8.2	16.4	0
Rock Sandpiper	24.6	0	0	8.2	8.2	0	32.8	24.6

* Projected Number - Number of birds observed in critical distance multiplied by width of transect divided by critical distance (after Emlen, 1971).

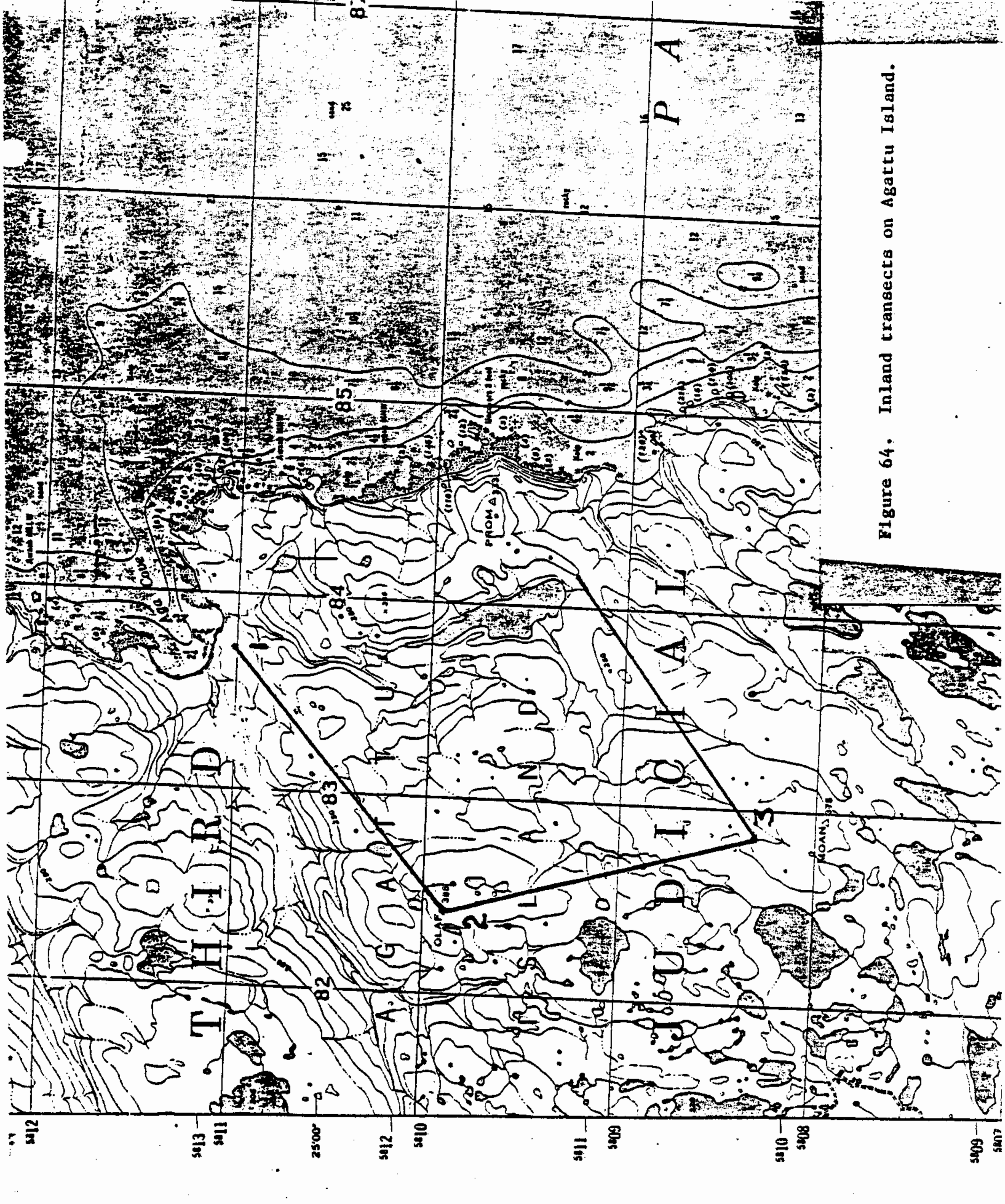


Figure 64. Inland transects on Agattu Island.

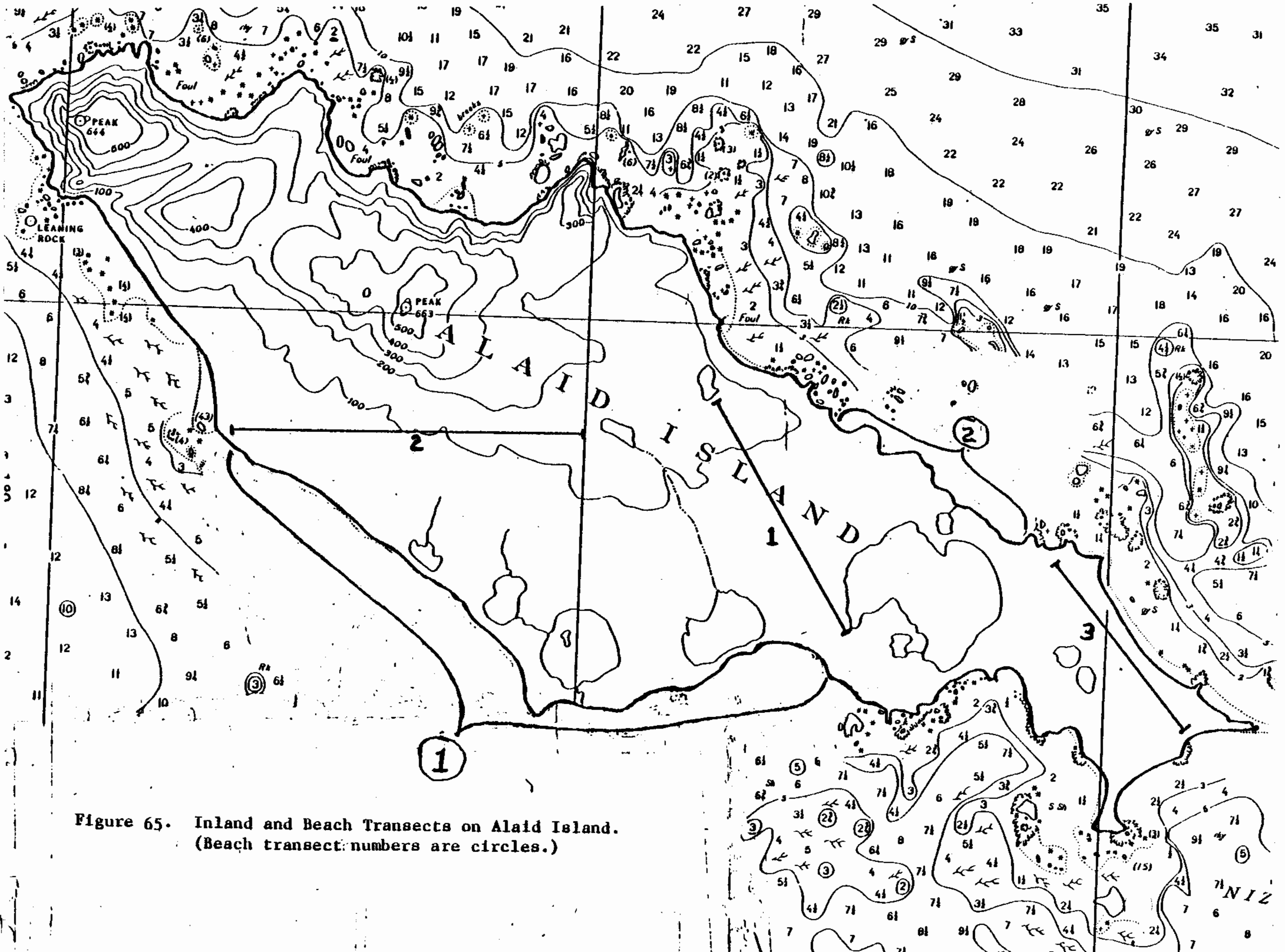


Figure 65. Inland and Beach Transects on Alaid Island. (Beach transect numbers are circles.)

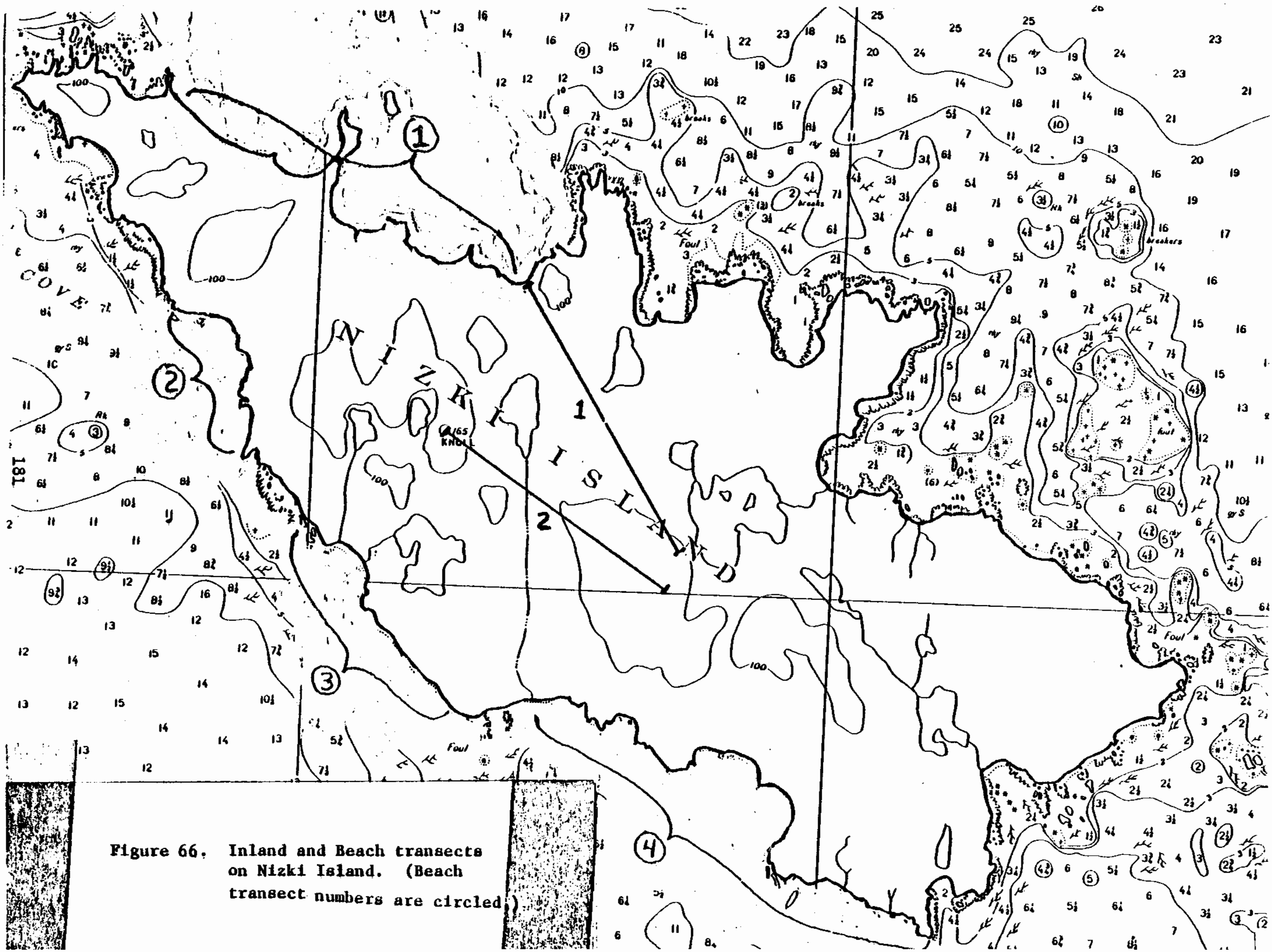


Figure 66. Inland and Beach transects on Nizki Island. (Beach transect numbers are circled.)

Table 40. Results of beach transect counts.

DATE RUN	ALAID #1 8 Jul	ALAID #2 8 Jul	NIZKI #1 8 Jul	NIZKI #2 8 Jul	NIZKI #3 8 Jul	NIZKI #4 8 Jul	LITTLE KISKA #1 12 Aug	TOTAL
Harlequin Duck	7	0	0	0	0	0	10	17
Common Eider	42	10	0	12	0	0	19	83
Black Oystercatcher	0	0	0	0	0	0	2	2
Rock Sandpiper	0	0	0	0	1	0	0	1
Glaucous-winged Gull	7	0	0	0	0	0	60	67
Winter Wren	4	6	21	9	3	9	80	132
Gray-crowned Rosy Finch	0	0	0	0	0	0	2	2
Song Sparrow	29 pr	6 pr	21 pr	11 pr	6 pr	19 pr	33	217
Lapland Longspur	0	1	3	0	4	5	0	13
Snow Bunting	8 pr	7	8 pr,5 i	9	4	12	3	72
	134	36	87	52	24	64	209	606

pr = # pairs observed
i = # individuals observed
Numbers alone indicate # individuals.

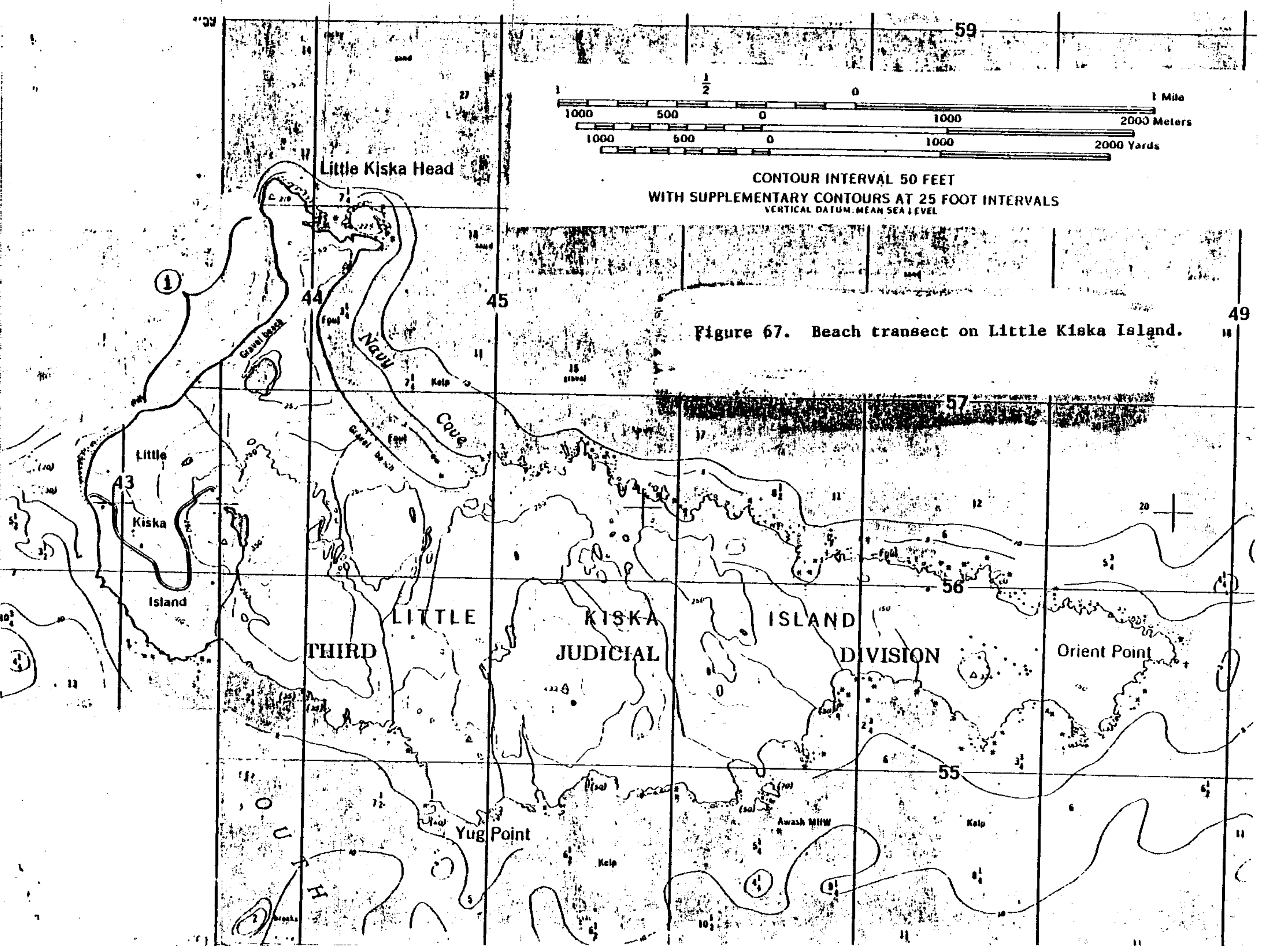


Figure 67. Beach transect on Little Kiska Island.

XIV. RECOMMENDATIONS

As a result of the 1978 field season of the survey crew for the Aleutian Islands National Wildlife Refuge, the following actions are recommended.

1) The Refuge should make a firm commitment to the survey or abandon it until management is prepared to make that commitment. We essentially lost an entire summer's work this field season, at great expense to the taxpayer. The frustrations of such a summer were extremely destructive psychologically on the field crew. To avoid such working conditions and waste in the future, the Refuge must either commit itself fully to the project or abandon it.

2) Much more work needs to be done on census technique for all seabird species and marine mammals. The census problems associated with murres are presented in this report, and similar unknowns could be listed for all the Aleutian species since so few answers have been found. Since censusing is a major goal of the survey, the problems and questions must be resolved so census efforts will be knowledgeably directed and not in vain.

3) In future censusing of raptors, care should be taken to accurately mark the locations of aeries on maps. Eventually this will provide good long-term data. Clutch sizes of all birds should be noted also, when possible.

4) The sea lion colonies on Kiska, Tanadak, and Agattu Islands need to be censused again. Permanent plots should be established: Agattu appears to be a good place for this as well as Buldir Island.

5) All birds in the permanent burrow-nester plots on Buldir Island should be banded each time the plots are checked. This will provide excellent long-term information on survival and population dynamics at little cost in time.

6) As recommended last year, more work needs to be done to refine auklet census techniques: Auklets are the major breeding sea birds within the refuge. All plots in Kiska colony #2 should be run earlier in the season and another 15 permanent plots should be set up in the colony. More plots should also be worked on the new lava flow, colony #1, to improve the estimate of birds in that colony.

7) More work needs to be directed at murre activity patterns and census techniques: Agattu Island would be an excellent place to continue such work considering the meager, but good information gathered this year. As far as we know, our k values for Thick-billed Murres are the first ones ever presented. Although sample sizes were small, those k values are decidedly different from that of Common Murres and could have serious ramifications for censusing.

8) Continuation of the Aleutian Canada Goose project on Agattu Island should allow rechecking of beached animal surveys, perhaps on a monthly basis throughout the summer. Biologists at Amchitka Island have established and run similar surveys on a monthly schedule.

9) Much more permanent plot work is needed, especially on Buldir Island. Significant population trends for storm-petrels could not be detected there through existing plots. Since Buldir has the only known Cassin's Auklet colony within the Refuge, more effort should be directed to its study. Also, murre and kittiwake plots should be established and worked at East Cape on Buldir.

10) The Refuge should institute computer-coding of pelagic transects so data for particular areas can be reanalyzed quickly as new data are gathered each season.

11) A botanist/pelagic observer should be stationed on the R/V ALEUTIAN TERN both to run pelagic transects and to survey islands for endemic plant species found in the Refuge.

12) The schedule for the next season's survey work should be approximately that proposed in the recommendations of the field report from summer 1977.

LITERATURE CITED

Bedard, J. 1969. The nesting of Least, Crested, and Parakeet Auklets at St. Lawrence Island, Alaska. Condor 71(4):386-398.

Birkhead, T.R. 1978. Attendance patterns of guillemots *Uria aalge* at breeding colonies on Skomer Island. Ibis 120:219-229.

Birkhead, T.R. 1977. Effects of sea conditions on rates at which guillemots feed chicks. Brit. Birds 69:490-492.

Bishop, R.H. 1967. Reproduction, age determination, and behavior of the harbor seal, *Phoca vitulina* L., in the Gulf of Alaska. Unpubl. M. Sc. thesis, Univ. of Alaska, Fairbanks. 121 pages.

Braham, H.W., C.H. Fiscus, and D.J. Rugh. 1977. Marine mammals of the Bering and southern Chukchi Seas. Pp. 1-99 *In*: Environmental assessment of the Alaskan continental shelf; vol. 1. Receptors-mammals. Environmental Res. Lab., NOAA, Boulder, Colo. 708 pages.

Brun, E. 1971. Breeding distribution and population of cliff-breeding seabirds in Sol-Varanger, North Norway. Astarte 4:53-60.

Byrd, G.V. and E.P. Knudtson. (in prep.). Comparative biology of *Aethia* auklets at Buldir Island, Aleutian Islands, Alaska.

Byrd, G.V. and J.L. Trapp. (in prep.) The status and biology of Fork-tailed and Leach's Storm-Petrels at Buldir Island, Aleutian Islands, Alaska.

Coats, R.R., W.H. Nelson, R.Q. Lewis, and H.A. Powers. 1961. Geological Reconnaissance of Kiska Island, Aleutian Islands, Alaska. U.S. Geol. Survey Bull. 1028-R:563-581.

Coats, R.R. 1953. Geology of Buldir Island, Aleutian Islands, Alaska. U.S. Geol. Survey Bull. 989-A. 26 pages.

Cramp, S., W.R.P. Bourne, and D. Saunders. 1974. The seabirds of Britain and Ireland. Taplinger, New York. 287 pages.

Day, R.H., E.P. Knudtson, and T.J. Early. 1978. A bird and mammal survey of the West-Central Aleutians-Summer 1977. Aleutian Islands Nat. Wildlife Refuge Annual Report. 205 pages.

Day, R.H. 1976. Birds of the Shumagin Islands, with special reference to the Koniuji Group. U.S. Fish and Wildlife Ser. - OBS Annual Report. 62 pages.

Dott, H.E.M. 1975. Fulmars at colonies: time of day and weather. Bird Study 23:255-259.

Evans, P., and G. Waterston. 1976. The decline of the Thick-billed Murre in Greenland. Polar Record 18(114):283-293.

Hatch, S. 1978. Breeding and population ecology of Fulmars at Semedi Islands, Alaska, with observations on the reproduction of sympatric seabird species. NOAA-OCSEAP Report 01-5-022-2528. 68 pages.

Hatch, S. 1977. Breeding biology of Fulmars at Semedi Islands, Alaska. NOAA-OSCEAP Report 01-022-2538. 39 pages.

Hickey, J.J. and F.L. Craighead. 1977. A census of seabirds on the Pribilof Islands. Pp. 96-195 In: Environmental assessment of the Alaskan continental shelf; vol. II. Receptors-birds. Environmental Research Lab., NOAA, Boulder, Colo. 574 pages.

Kenyon, K.W. 1969. The sea otter in the eastern Pacific Ocean. U.S. Dept. of the Interior. N. Am. Fauna No. 68.352 pages.

Kenyon, K.W. 1969. The sea otter in the eastern Pacific Ocean. N. Am. Fauna No. 68. BSF&W, Washington, D.C. 352 pages.

Kenyon, K.W. and J.G. King. 1965. Aerial survey of sea otters, other marine mammals, and birds, Alaska Peninsula and Aleutian Islands, 19 April to 9 May 1965. Processed rep., BSF&W, Seattle, WA. 61 pages.

Kenyon, K.W. and D.W. Rice. 1961. Abundance and distribution of the Steller sea lion. J. Mammal. 42(2):223-234.

Kenyon, K.W. and D.L. Spencer. 1960. Sea otter population and transplant studies in Alaska, 1959. Spec. Sci. Rep. - Wildl. No. 48, USF&WS, Washington, D.C. 29 pages.

Lensink, C.J. 1960. Status and distribution of sea otters in Alaska. J. Mammal. 41(2):172-182.

Lensink, C.J. 1958. Report on sea otter surveys, 6 May to 28 September 1957. Processed rep., BSF&W, Seattle, WA. 61 pages.

Lloyd, C. 1975. Timing and frequency of census counts of cliff-nesting auks. Brit. Birds 68:507-513.

Mathisen, O.A. and R.J. Lopp. 1963. Photographic census of the Steller sea lion herds in Alaska, 1956-58. Spec. Sci. Rep. - Fisheries No. 424. USF&WS, Washington, D.C. 20 pages.

Mathisen, O.A., R.T. Baade, and R.J. Lopp. 1962. Breeding habits, growth, and stomach contents of the Steller sea lion in Alaska. J. Mammal. 43(4):469-477.

Moe, R.A. 1976. A study of three predator species near seabird colonies. U.S. Fish and Wildlife Ser. - OBS Annual Report. 32 pages.

Murie, O.J. 1959. Fauna of the Aleutian Islands and Alaska Peninsula. U.S. Dept of the Interior. N. Am. Fauna No. 61. 406 pages.

Nelson, R.W. and M.T. Myres. 1976. Declines in the populations of Peregrine Falcons and their seabird prey at Langara Island, British Columbia. The Condor 78:281-293.

Nettleship, D.N. Census techniques for seabirds of arctic and eastern Canada. Canadian Wildlife Ser. Occasional Paper Number 25. 31 pages.

Sandegren, F.E. 1970. Breeding and maternal behavior of the Steller sea lion (Eumetopias jubatus) in Alaska. Unpubl. M. Sc. thesis, Univ. of Alaska, Fairbanks. 138 pages.

Schneider, K. 1978. Sex and age segregation of sea otters. Alaska Fed. Aid Wildl. Rest., Final rep., Proj. W-17-4 through W-17-8. 45 pages.

Schneider, K. 1976. Distribution and abundance of sea otters in southwestern Bristol Bay. Pp. 359-369 In: Environmental assessment of the Alaskan continental shelf; vol. 1 - marine mammals. Environmental Res. Lab, NOAA, Boulder, Colo. 430 pages.

Sekora, P.S., G.V. Byrd, and D.D. Gibson. (in press). In J.C. Bartonek (Ed.). First International Symposium on Marine Birds. Seattle, Washington. (1975).

Sekora, P.S. 1973. Aleutian Islands National Wildlife Refuge Wilderness Study Report. U.S. Fish and Wildlife Ser. 409 pages.

Sherrod, S.K., C.M. White, and F.S.L. Williamson. 1976. Biology of the Bald Eagle on Amchitka Island, Alaska. The Living Bird. 15:143-182.

Slater, P.J.B. 1976. A tidal rhythm in a seabird. Nature 264: 636-638.

Southern, H.N., R. Carrick, and W.G. Potter. 1965. The natural history of a population of guillemots (Uria aalge Pont.). J. Anim. Ecol. 34:649-664.

Steele, B.B. and W.H. Drury. 1977. Birds of coastal habitats on the south shore of the Seward Peninsula, Alaska. Pp. 1-178 In: Environmental assessment of the Alaskan continental shelf; vol. III. Receptors-birds. Environmental Res. Lab., NOAA, Boulder, Colo. 638 pages.

Swartz, L.G. 1966. Sea-cliff birds. Pp. 611-678 In: N.J. Wilimovsky, and J.N. Wolfe (Eds.). Environment of the Cape Thompson region, Alaska. U.S. AEC, Div. of Tech. Info., Oak Ridge, Tenn. 1250 pages.

Trapp, J.L. 1976. Report on a brief biological survey of Davidof, Khvostof, and Little Kiska Islands: 1-2 July 1976. Unpublished manuscript on file at Aleutian Is. NWR office. 15 pages.

Trapp, J.L. 1975. Birds and mammals of Alaid and Nizki Islands, Aleutian Islands, Alaska - summer 1975. Unpubl. rep. in Aleutian Is. NWR files.

Tuck, L.M. 1960. The murres. Can. Wildl. Series, No. 1, Queen's Printer, Ottawa. 260 pages.

White, C.M., F.S.L. Williamson, and W.B. Emison. 1977. Avifaunal investigations. In M.L. Merritt and R.G. Fuller (Ed.) The Environment of Amchitka Island, Alaska. Energy Research and Development Adm. pages 227-267.

Williamson, F.S.L. and W.B. Emison. 1969. Amchitka Bioenvironmental Program: studies of the avifauna on Amchitka Island, Alaska; Annual Progress Report, June 1968 - June 1969. U.S. Atomic Energy Com. Report BMI-171-125. Battelle Memorial Institute.