

A RECONNAISSANCE OF BREEDING MARINE  
BIRDS AND MAMMALS IN THE EAST-CENTRAL  
ALEUTIAN ISLANDS--KASATOCHI TO THE ISLANDS  
OF FOUR MOUNTAINS--SUMMER 1982,  
WITH NOTES ON OTHER SPECIES

by

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## INTRODUCTION

The Aleutian Islands, separating the Bering Sea and North Pacific Ocean, have been recognized for their tremendously rich biota since the Russians began exploiting the region in 1741. In recognition of the archipelago's profuse and diverse wildlife and to prevent extinction of the sea otter (Enhydra Lutris), the Aleutian Islands were designated as a National Wildlife Refuge in 1913. Because of the region's remoteness and prevalent stormy weather, the first systematic biological reconnaissance of the Aleutians did not occur until Olaus Murie's visits in 1936 and 1937. Murie (1936 and 1959) and Murie et al. (1937) documented most of the larger marine bird and mammal rookeries in the Aleutians and also assessed the devastating impacts of fox farming. Gabrielson (1940) visited some of the Aleutians and Gabrielson and Lincoln (1959) summarized existing information on the region's avifauna. Robert D. Jones, Jr., manager of the Aleutian Islands National Wildlife Refuge from 1947 to 1975, accumulated considerable data on the avifauna of the Aleutian Islands.

Following passage of the National Wilderness Preservation Act of 1964, Palmer C. Sekora surveyed the islands between 1970 and 1972 for their wilderness values, including wildlife. However, like the cursory surveys made earlier on most islands by Murie, Sekora's wilderness report (U.S. Fish and Wildlife Service 1973) was largely based on shipboard observations; few landings were made, and overnight stays on islands were rare. In fact, none of the islands

between Kasatochi and the Islands of Four Mountains were examined for nocturnal nesting seabirds, and brief landings occurred only on Atka and Amlia when this region was surveyed with the M/V Aleutian Tern in June 1972.

Intensive systematic surveys of the Aleutians began in 1973 with Bogoslof Island (Byrd et al. 1980). Island by island scrutiny of breeding seabirds commenced in the west-central Aleutians in 1977 (Day et al. 1978) and expanded to the western end of the archipelago in 1978 (Day et al. 1979, U.S. Fish and Wildlife Service 1980 and 1981). Also, in 1980 and 1981 detailed surveys were conducted in the Fox Islands in the eastern Aleutians (Nysewander et al. 1982). The last segment of the Aleutians requiring intensive surveys, Kasatochi to the Islands of Four Mountains, was completed in the summer of 1982 and is the subject of this report.

The likelihood of offshore oil development north of the eastern Aleutians, burgeoning commercial fishing, and other probable increases in human activity in the region require detailed assessments of the wildlife resources on all the Aleutians. Following acquisition of basic information on species composition, distribution, and abundance of marine birds and mammals, certain key islands should be closely monitored to document long-term population trends and natural variability in productivity. Only with such data can firm correlations be made with depletion of fish stocks, gill-net mortality, pollution, and other aspects of human disturbance of marine ecosystems.

## DESCRIPTION OF AREA

The 21 named islands included in the survey stretch approximately 400 km, roughly one-quarter the length of the Aleutain Chain (Fig. 1). Kasatochi Island at the western end of the survey area lies at 52° 10'N, 176° 30'W, and Kagamil Island at the eastern end is situated at 53° 00'N, 169° 41'W.

The climate is characterized by frequent cloud cover, high winds, and precipitation. Limited and sporadic climatic data are available from Dutch Harbor, 242 km east of Kagamil Island, while complete, uninterrupted records for the past 40 years are available from Adak, 80 km west of Kasatochi Island. The July mean temperature at Adak is 9.6 C (range 0.6 - 22.4 C). Adak receives an average of 162.0 cm of precipitation annually; precipitation is normally greatest in fall and least during spring. The mean wind velocity at Adak is about 19 km/hr, which is probably much less than that in the Islands of Four Mountains where wind channeling between these mountainous islands is severe (National Ocean Survey 1981). The Aleutians average 90% cloud cover.

The islands surveyed range in size from Atka with 106,073 ha and nearly 500 km of shoreline to tiny unnamed islets, sea stacks and rocks smaller than 0.1 ha. Egg Island, the smallest named island in the area, covers only 41 ha. The combined perimeter of all islands in the survey area is about 1087 km.

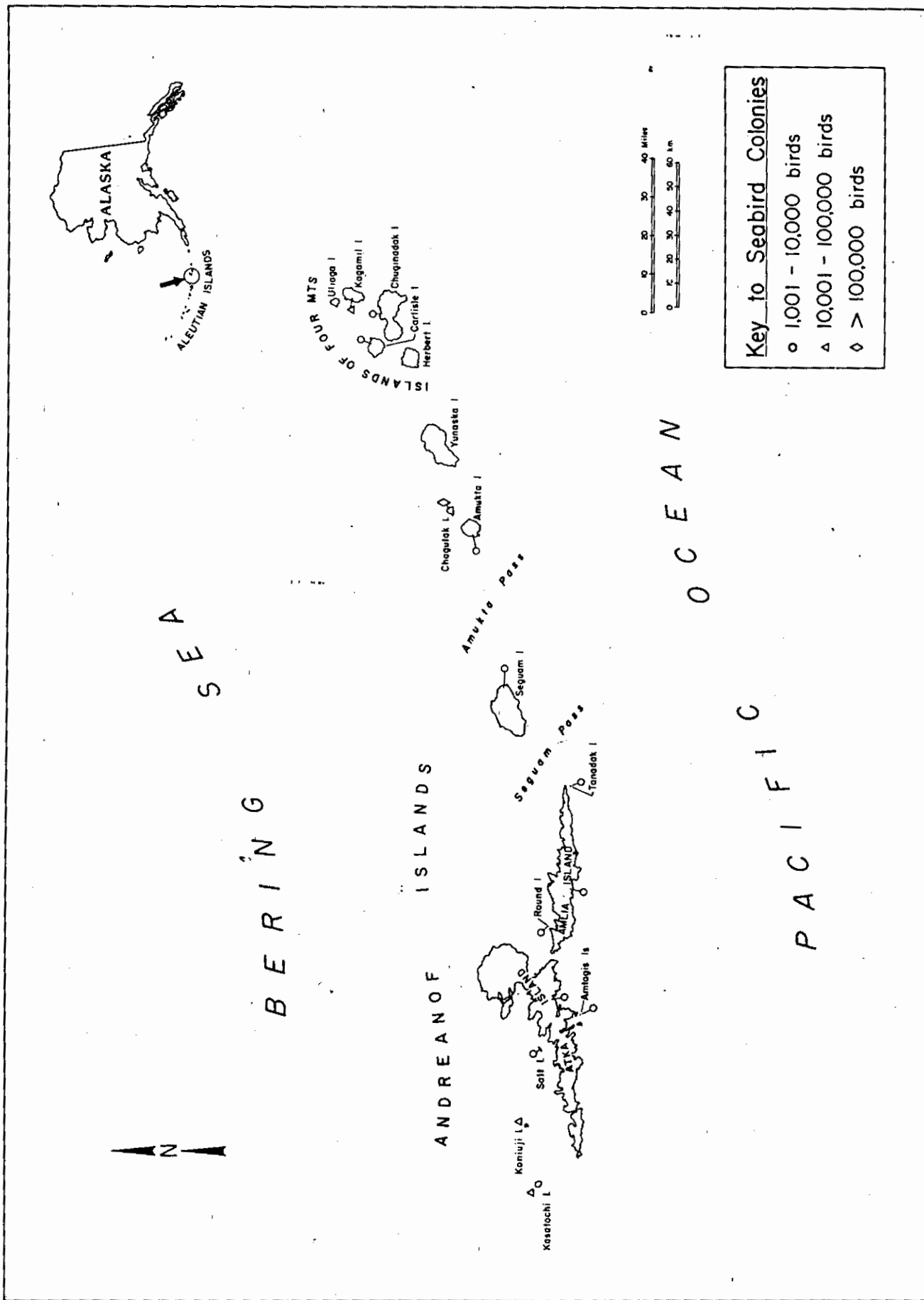


FIGURE 1. OVERVIEW MAP OF AREA ESTIMATED BREEDING SEABIRD POPULATIONS IN THE EAST-CENTRAL ALEUTIAN ISLANDS - ATKA TO ISLANDS OF FOUR MOUNTAINS



All of the islands are mountainous and volcanic in origin. Active volcanoes are found on Atka, Seguam, Amukta, Yunaska, Carlisle, and Chuginadak islands. The highest volcano is Mt. Cleveland on Chuginadak, which rises to 1730 m.

Alpine and moist tundra or recent lava flows dominate most of the islands. Besides volcanism and soil types, vegetation is largely governed by low summer mean temperatures, persistent wind, and precipitation patterns. Low-growing willows (Salix spp.) are scattered along some streams and in sheltered spots adjacent to certain ponds or lakes. On some small islands and in the vicinity of seabird colonies on large islands the flora has been considerably modified by bird excrement. Similar more luxuriant growth due to soil enrichment is found locally on various islands at former Aleut midden sites. Enriched areas exhibit earlier, more vigorous growth, and notable seabird islands such as Chagulak become green earlier than other areas. Besides Elymus arenarius, Calamagrostis spp., and other tall grasses, burrow- and ground-nesting seabird colonies and middens are generally dominated by umbellifers, namely Heracleum lanatum, Angelica lucida, Ligusticum scoticum, and Conioselinum chinense. These umbellifers, plus Geranium erianthum, Claytonia sibirica, Gentiana spp., Sagifraga spp., Ranunculus spp., and other herbs also commonly occur in certain sheltered, well-watered areas. Drier, windier portions of islands at higher elevations generally support Empetrum nigrum, Anemone narcissiflora, Potentilla villosa, Lupinus nookatensis, Geum spp., Cassiope lycopodioides, and other species. Elymus arenarius, Honckenya peploides, Lathyrus maritimus, Mertensia maritima, and Senecio pseudo-Arnica predominate on most beaches. Eel grass (Zostera marina) occurs in a few protected bays, such as at Atka.

Detailed documentation of the flora of the Aleutians is found in Hulten (1968). Additional general descriptive information on most islands is available in U.S. Fish and Wildlife Service (1973) and National Ocean Survey (1981).

## METHODS

The reconnaissance began on 2 June at Kasatochi Island, west of Atka, and proceeded eastward to the Islands of Four Mountains, where the F/V Sea Spray, a 29-m chartered crab boat, left us for 3 weeks. Some islands were only partially circumnavigated enroute to the Islands of Four Mountains, and these were completed for the most part upon returning to Adak on 22 July. Most of the shoreline of the 21 named islands was circumnavigated in a 5-m inflatable boat in search of nesting seabirds. Due to lack of time or rough seas some coastline, particularly along Atka, was surveyed from the F/V Sea Spray. Only the 24 km stretch of shoreline between Cape Shaw and Atka Village on Atka Island was not surveyed.

Because the F/V Sea Spray had to meet previously established schedules at Buldir and other islands in the western Aleutians, we were unable to spend sufficient time on all islands to properly enumerate seabird populations. Ascertaining population sizes of seabirds on Chagulak Island alone, where over 80% of the birds in the survey area nest, would have required much of the summer. Thus, except in a few instances, insufficient time combined with unusually foul weather precluded establishing quadrats to sample burrow- and ground-nesting species.

All but the last 12 days of the reconnaissance were conducted by the authors and volunteer assistants Nina Faust and David McCargo. Biologists Fred Deines

and Douglas Forsell and volunteers Chris Ambroz and Don Dragoo assisted in data collection on the return leg of the expedition.

All named islands were landed on except for Sagigik (a rock south of Amlia Island) and Agligadak (reefs and low-lying rocks on the western side of Seguan Pass). The most thoroughly explored islands were the Islands of Four Mountains, where we operated with inflatables for 19 days without the assistance of the F/V Sea Spray. All named islands except Sagigik, Tanadak, and Agligadak were visited at night either by going ashore or by listening for the calls of nocturnal birds from inflatables with the engine turned off. The powerful sodium deck lights on the F/V Sea Spray also aided in identifying nocturnals at various islands, as all species heard ashore invariably were attracted to the boat's lights and often appeared on deck in considerable numbers. We camped on each of the Islands of Four Mountains. Searches for nocturnal nesters on most of the large islands were limited to talus and cliff areas because of the presence of introduced arctic and red foxes (Alopex lagopus and Vulpes vulpes).

Population estimates for kittiwakes and cormorants were derived from counts of nests. Approximations of breeding populations of murrelets were based on counts of birds seen on and around cliffs used for nesting. Gull estimates were formulated from numbers of nests discovered and from evident pairs at inaccessible colonies. Estimates of pigeon guillemots (Cephus columba), parakeet auklets (Cyclorhynchus psittacula), crested auklets (Aethia

crisatella), and least auklets (A. pusilla) were based on numbers present at talus or boulder nesting areas or immediately offshore. Whenever repeated counts were possible at colonies, the largest was used as an estimate of population size. Numbers should be regarded as minimal indices because many breeders would not be present or visible. Auklets are chiefly evident at a colony during mid-day and evening hours, and possibly the most accurate way to estimate numbers is by noting the net movement of birds to and from a colony, a time consuming procedure (Byrd et al. 1983). Time and suitable weather to employ this census method, which is based on evening counts of birds entering and leaving sample plots in colonies, were only available at Kasatochi Island. Since too few quadrats for nesting scrapes of northern fulmars (Fulmarus glacialis) were established on Chagulak Island to be of value, we used the same guess on numbers present that was made as in 1972. Because of widely fluctuating daily populations and the presence of many nonbreeders (Nettleship 1976), a proper census of fulmars would have required weeks rather than the few days we had.

Populations of nocturnal hydrobatids and alcids were generally not expressed quantitatively but were described as "present" (scattered pairs), "common" (hundreds), or "abundant" (thousands), depending on the intensity of activity and vocalization as well as the extent of habitat used.

Though recorded when observed, no estimates were made for Kittlitz's and marbled murrelets (Brachyramphus brevirostre and B. marmoratum) since they are solitary nesters.

Puffin numbers were derived from a combination of adults repeatedly seen at specific locales and from estimates of burrow numbers in dense colonies. Some quadrats for tufted puffins (Fratercula cirrhata) intermixed with storm-petrels and other burrow nesters were established on Chagulak Island but were too few to be representative for the whole island. Puffin populations, since often largely based on numbers observed, also should be regarded as minimal because colony attendance varies markedly with season, time of day, and weather conditions. Only during short intervals when most pairs are exchanging incubation duties, loafing, or socializing about the colony are most birds visible.

Black oystercatchers (Haematopus bachmani) scoters, eiders, sea ducks, bald eagles (Haliaeetus leucocephalus), peregrine falcons (Falco peregrinus), and other birds were documented on all islands along with Steller's sea lions (Eumetopias jubata), harbor seals (Phoca vitulina), and sea otters. When weather conditions permitted, numbers of all birds and mammals sighted along stretches of coastline from inflatables were recorded to obtain representative densities at different islands. On small islands these incidental shoreline surveys included entire perimeters of islands, whereas on large ones only partial sections of coastline were sampled.

## RESULTS AND DISCUSSION

### Island Accounts

Nearly all of the islands in the Aleutians were used as fox farms. The first foxes were apparently placed on some of the large islands like Atka as early as 1836 by the Russian American Company (Jones and Byrd 1979). The earliest introductions in the central Aleutians consisted of red foxes. Red foxes were originally released on Great Sitkin, Little Tanaga, Adak, and other islands west of Atka. Because arctic foxes achieved higher insular densities and because their pelts became more highly valued, fur farmers removed previously introduced red foxes from most islands before introducing arctic foxes, also known as blue fox.

According to fur farm lease records of the Aleutian Islands NWR and Murie (1936), the only islands in the survey area which had introduced red foxes were Amlia and Chuginadak; arctic foxes were released on these islands in 1930 after a concerted effort to first remove red foxes.

Arctic foxes were released on all of the named islands between Kasatochi and Kagamil, except for Chagulak, Tanadak, Sagigik, Agligadak, Egg, Koniuiji, Amtagis, and the Bolshoi Islets. The last islets, lying just off Atka and the only village in the survey area, probably witnessed some fox introductions, though none were recorded. According to people in Atka, foxes occasionally

reach Sadatanak Island from Atka (Dirks, pers. comm.). Except for precipitous Chagulak, all of the remaining seven islands with no records of fox introductions are less than 220 ha in size. Obviously the vast majority of the islands in this region have been severely affected by introduced predators, and thus the nesting seabirds present today probably reflect relicts of former more diverse, widespread, and numerous seabird populations.

The estimated breeding seabird populations on all islands inventoried are presented in Table 1. Comparisons with data from the cursory reconnaissance in 1972 (U.S. Fish and Wildlife Service 1973, SOWLS et al. 1978) are made in many instances, but these should be viewed with caution because of differences in logistics, methodologies, and observers and their experience. Bailey also participated in the 1972 expedition which spent less than two weeks in the survey area. All data on nocturnal nesters are new, as no work was done at night in 1972; only two brief landings were made then, and they were on large islands virtually devoid of nocturnal birds.

Kasatochi Island. Lying 19 km off the western tip of Atka (Fig. 2), this unique island consists of a caldera whose rim reaches 316 m. The water level inside the caldera is slightly above sea level according to USGS maps; the water in the 0.4-km diameter lake in the crater is reportedly salt water (Murie 1936). Descent to the lake requires a rope. A small sample of water was collected from the deep, green lake; subsequent analysis revealed a



Estimated Breeding Seabird Populations Kasatochi to Islands of Four Mountains, Aleutians

SPECIES	(1) Kasatochi	(2) Koniugi	(2) Salt	(2) Gagchudak	(2) Amtagis	(2) Adatanak	Akka (+ off-shore unamed Islets)	(1) Amila	Round (2 Islets)	Tanadak	(1) Soguan	Amuka	(1) Chagulak	(1) Xunaska	(1) Herbert	(1) Artlale	(1) Ililaga	(1) Kagami	(1) Kuginadak	(1) TOTALS
Northern Fulmar												3,000	500,000							503,000
Fork-tailed Storm-Petrel	P	200,000*	C	C	200*				400*	200*	C	P	500,000*	P	P	P	P	P	P	
Leach's Storm-Petrel	P	50,000*	C	C	100*					400*	P	P	500,000*	P				P		
Double-crested Cormorant																				
Pelagic Cormorant	40	10		30		2	30	46	6		40	40	106	80	26	20	10	34	150	670
Red-Faced Cormorant							60	30			120	50	10	130	30	24		90		944
Parasitic Jaeger				10															16	36
Glaucous-winged Gull	40	40	400	350			190	280	60	10	20		3,000	6		20			120	4,536
Black-legged Kittiwake		2,850										150	6,000							9,000
Common Murre	300										1,300	100	700					7,000		9,400
Thick-billed Murre	P										1,050	1,600	24,000					27,000		53,650
Pigeon Gullmott	10	60		90	10	40	400	980		50	100	170	170	30	100	80	20	52	170	2,492
Ancient Murrelet	P	10,000*	A	A					1,000*	200*			5,000*							
Cassin's Auklet					200*		800*			500*		P?	100,000*							
Parakeet Auklet	1,000	500		20						10	90	P	100			50			40	1,810
Crested Auklet	20,000	5,000											3,000							28,000
Least Auklet	15,000	2,000											100							17,100
Whiskered Auklet	C	A	P	P	500*	P						C	C	C	P	P	P	P	C	
Horned Puffin	P	200	1,200	100			120	900		50	200		3,000	40	130	200	30	P	460	6,630
Tufted Puffin	P	20,000	3,000	200	1,200		5,600	7,100	6,000	1,000	1,160		50,000	60	120	800	10	P	1,040	97,290
Totals	36,390	30,660	4,600	810	1,210	42	6,400	9,336	6,066	1,120	4,080	5,110	590,186	346	406	1,174	90	36,202	2,386	734,614

P-present A-abundant C-common (1) Foxes present (2) Foxes formerly present

\*Not included in Totals

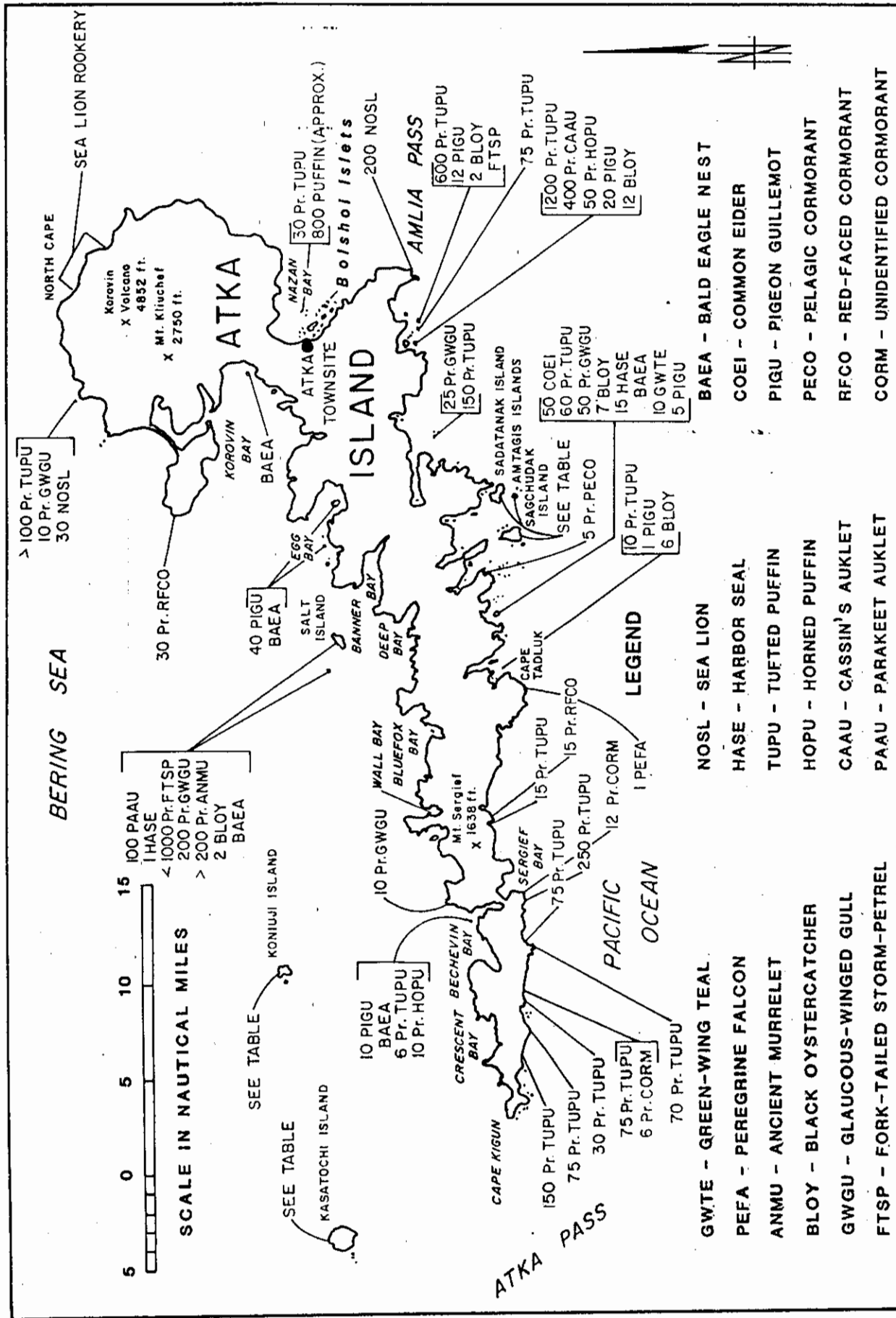


FIGURE 2. SEABIRD COLONIES ON ATKA AND ADJACENT SMALL ISLANDS

salinity of about half that of sea water. In 1899, the lake disappeared and steam rose in its place (U.S. Fish and Wildlife Service 1973).

Kasatochi was circumnavigated with the M/V Aleutian Tern in 1972 and with a Boston Whaler on 13 July 1980 (U.S. Fish and Wildlife Service 1981); nobody went ashore either time or remained off the island after dark. We estimated 36,000 breeding seabirds on this 290 ha island with a perimeter of nearly 10 km. This compares to estimates of 22,000 in 1972 (U.S. Fish and Wildlife Service 1973) and nearly 27,000 in 1980 (U.S. Fish and Wildlife Service 1981). All observers found crested auklets comprised the majority of the diurnal birds. This species, along with lesser numbers of least and parakeet auklets, occurred in talus slopes around the base of the caldera, especially along the northwest side of the nearly circular island. Besides 20,000 crested auklets we estimated 15,000 least auklets. Five nocturnal species nested on the island (Table 1); they were heard scattered about talus areas and also were detected in the ship's lights.

One notable difference between our observations and those made in 1980 was the documentation of over 2000 murrelets in 1980 compared to only 300 estimated in 1982. Sekora (in U.S. Fish and Wildlife Service 1973) did not mention the presence of murrelets in 1972. Both species of murrelets nested on the west and northern part of the island. About 20 pairs of glaucous-winged gulls (Larus glaucescens) nested on inaccessible ledges inside the caldera. A fox trail followed the rim of the caldera, and foxes were heard barking inside the crater.

Many arctic foxes prowled about the auklet colonies, and they had cached numerous birds. Murie (1936) found a cache with over 100 auklets. Since the island is small and the foxes are concentrated in colluvium where the birds nest, removal of foxes from this island would be relatively easy. Toxicants could be placed around the colonies, or sterile red foxes could be released. No well-protected landing areas exist on the precipitous island and no streams are present. A fox farmer's cabin remains high above the beach on the west side. In 1984, 59 foxes were shot in only 5 days on this island, and still a few remained (Zeillemaker, pers. comm.).

Seven peregrine falcons, more than were seen on any other island visited, were noted on Kasatochi. Albeit no eyrie was located, it appears that at least one or more is on the island, probably on the south side. Four bald eagles were sighted.

This island is one of the few in the survey area having a Steller's sea lion rookery. A total of 1450 animals, including pups, was present. Two hundred were reported in 1961 but none were indicated in 1972 (U.S. Fish and Wildlife Service 1973). Other marine mammals observed included 15 sea otters and seven harbor seals (Table 2).

Koniuji Island. Judging from its well-vegetated eroded appearance, one would not suspect that Koniuji was of recent volcanic origin. Yet in 1790 it was reportedly active and rising, and was still smoking as late as 1828 (U.S. Fish and Wildlife Service 1973). This exceedingly rugged island, lying 16 km north

Table 2. Marine mammal observations between Kasatochi and the Islands of Four Mountains in the Aleutians.

Island	Sea Otter	Steller's Sea Lion	Harbor Seal
Kasatochi	15	1450*	7
Koniuji	6		2
Salt	3		1
Sagchudak	74	350	104
Amtagis	13		
Sadatanak	34		
Atka	100	40	36
Amlia	590	1565	110
Round	36		1
Tanadak	220	120	
Agligadak	?	Hundreds**	?
Sagigik	?	Hundreds**	?
Seguam	116	4150*	
Amukta	27	301	77
Chagulak	2	500	7
Yunaska	9	1200*	
Herbert	1	450	13
Carlisle	4	230	46
Uliaga	3	100	2
Kagamil	5		42
Chuginadak	17	1575	110
Total	1275	12,031	558

\*including pups

\*\*not counted because of excessive distance from boat.

of Atka and 26 km east of Kasatochi (Fig. 2), probably had the second largest population of nesting seabirds when nocturnals are considered (Table 1).

Excluding nocturnals, over 30,000 breeding birds were estimated; 13 species nested on the island.

Though the estimates of nocturnals are not based on sample plots and are therefore largely subjective, they are regarded as minimal in relation to the intensity of vocalization and nighttime flights, numbers of burrows and available habitat, and comparisons with islands where populations have been estimated through sampling techniques. Certainly nocturnal nesting birds far exceeded the combined populations of all diurnal nesters on this island. Although nearby Kasatochi had larger auklet numbers, Koniuji had many more nocturnals. Storm-petrels, particularly the fork-tailed storm-petrel (Oceanodroma furcata), occurred in greatest concentrations in talus and other rocky areas. Storm-petrels and other nocturnals swirled about the M/V Sea Spray's lights in huge numbers. We camped on Koniuji on 18-19 July, which is late in the breeding season when the vocalizations of storm-petrels and other nocturnals are much less frequent than earlier in the summer. The island surely would have been even more impressive in May and June. Leach's storm-petrels (O. leucorhoa), which prefer soil burrows, occurred in large but fewer numbers than the Fork-taileds. Ancient murrelets (Synthliboramphus antiquus) appeared more numerous on this island than even on Chagulak.

Whiskered auklets (Aethia pygmaea) also occurred in higher densities on

Koniuji than on other islands. Not only were they abundant in boulders and cliffs around the island's periphery, but the location of calling birds appeared to indicate that they used burrows and crevices throughout its interior as well. They were found in hummocks covered with Festuca rubra and other grasses and were particularly common along steep ridges and near the island's 275-m summit.

Most of the estimated 20,000 tufted puffins also nested on the precipitous mountainsides, especially on the western slopes. The roughness of the rocky terrain, height of the burrow-ridden hummocks, and lushness of the vegetation will make any future attempt to properly census burrow/crevice nesters difficult, but not impossible. Surprisingly few horned puffins (Fraterula corniculata) were noted. Many downy tufted puffin chicks were encountered.

Albeit nearly 3000 black-legged kittiwakes (Rissa tridactyla) attempted to nest at Koniuji, they experienced reproductive failure, as few completed nests were detected. Perhaps the unusually cold, stormy summer contributed to this failure. In 1972, Sekora (in U.S. Fish and Wildlife Service 1973) reported more than 10,000 kittiwakes and 5500 murrelets using the island; Murie (1936) also mentioned colonies of both species there. On 19 July about 4000 murrelets were rafted on the water north of the island, but only three murrelets had been counted on a complete shoreline survey the previous day. Murrelets also seemingly experienced total reproductive failure in 1982.

Over 200 glaucous-winged gulls were recorded around the island, but the only nests we found were on a bench above the beach on the northwest side. All appeared abandoned, and no chicks were found, though they would have been difficult to locate in this area. Obviously paired gulls also were noted on some ledges on the south and east slopes, but no nests were discovered.

According to Aleutian Islands NWR records, Koniuji was leased in 1916 for fur farming by residents of Atka, but no foxes were introduced (Swanson 1982). Since this is a very difficult island to land on, Murie did not go ashore there in 1936. The only possible suggestion that foxes may have once been on the island is the fact that some grassy slopes, which constitute excellent burrow habitat, were unused in 1982, and birds appeared needlessly crowded in rocky areas like on Kasatochi where foxes abound. It is possible that foxes disappeared on Koniuji decades ago, and all of the habitat easily accessible to foxes has not yet been fully recolonized.

The only reasonable landing site is in boulders on the west side below a steep canyon that bisects the island. A well-protected campsite exists in the valley above the beach. No water was located, except for seeps in vugs.

A peregrine falcon eyrie existed on the cliffs above our camp, and Koniuji had an amazing density of bald eagles. On 19 July we saw 17 eagles, mainly immatures, simultaneously from the summit of the 110-ha island. Most were perched on hummocks, but no nests were located. Apparently many eagles from Atka congregated on Koniuji to prey on seabirds.



Like most islands free of foxes, Koniuji was inhabited by many song sparrows (Melospiza melodia), winter wrens (Troglodytes troglodytes), and rosy finches (Leucosticte arctoa), but no snow buntings (Plectrophenax nivalis) were spotted despite their being quite abundant on nearby Kasatochi. One common redpoll (Carduelis flammea), one of few individuals seen on the entire reconnaissance, was on Koniuji. Another oddity was the lack of American black oystercatchers on either Koniuji or Kasatochi.

Atka Island. Atka, 106,030 ha in size and with nearly 483 km of shoreline, is far larger than any other island in the survey area (Fig. 2). The irregular, arcuate island is mountainous and is surmounted by 1,478-m Korovin Volcano. Besides Korovin two other active volcanoes exist. Atka is the most disturbed and the only inhabited island between Adak and Umnak islands. Besides introduced arctic foxes, reindeer (Rangifer tarandus) were released on the island in 1914 (Anonymous 1938) and numbered around 2000 in 1982. Atka's coastline is deeply indented with bays and fjords; the higher northern end of the island is connected to the narrow longer portion by an isthmus, also the site of Atka Village (population 100). The north side of the island was visited on 4-5 June enroute to the Islands of Four Mountains, while the south side was inspected 14-16 July on the return leg to Adak. Coastal surveys of this extensive island were incomplete, but we believe no sizable colonies were missed, except possibly between Cape Shaw and Atka Village on the northeast side, which was not examined at all. Some sections of the shoreline were surveyed by inflatables, whereas other portions were covered as best as possible from the M/V Sea Spray.

As far as is known, no large seabird colonies exist on Atka Island. Atka residents claim, however, that a crested auklet colony exists inland in talus high on the west side of the volcanoes in the Korovin-Klinchef area. Since crested and least auklets do nest inland in rubble and thus can coexist with foxes, such as on St. George, St. Lawrence, St. Matthew, and the Shumagin islands, this matter warrants further investigation. There were numerous flocks of crested auklets at sea below this area from Korovin Bay to North Cape; in fact, over 10,000 were estimated in Korovin Bay along with hundreds of Cassin's auklets (Ptychoramphus aleutica) and parakeet auklets. Whether the crested auklets originated from Atka or nearby Kasatochi and Koniuji is unknown. Although no Cassin's auklets were found at Kasatochi and Koniuji, they were common at nearby Salt Island.

Four small colonies, containing primarily tufted puffins, glaucous-winged gulls, and red-faced cormorants (Phalacrocorax urile) were recorded on the north side of Atka (Fig. 2). The largest of these colonies was on a group of offshore rocks between Cape Korovin and North Cape, but rough seas precluded adequate surveillance. At least 19 small colonies were noted on various headlands, points, and offshore islets and rocks along the south side, which was not entirely covered. Besides the previously mentioned unsurveyed 24 km segment northeast of the village, the last 8 km on the western tip was not examined in sufficient light. The vast majority of the birds found nesting along the south side were tufted puffins, the largest concentration (1200 pairs) being located on an islet south of Cape Utalug near Amlia Pass. Cassin's auklets also bred here, and common eiders (Somateria mollissima) nested on an islet in Explorer Bay. Thirty marbled or Kittlitz's murrelets were seen around Atka.

Salt Island. This 182 ha island, situated near the mouth of Banner Bay, harbored most of the seabirds nesting off Atka's north shore. Arctic foxes were released here in 1916, and 161 pelts worth over \$8000 were taken off the island by 1936. Foxes had since vanished by 1982, and the island had been recolonized by birds (Table 1). Of the five nocturnal birds recorded breeding, ancient murrelets were the most common; nocturnals appeared to outnumber diurnal species considerably. Probably over 4000 ancient murrelets nested here; they, as well as storm-petrels and numerous Cassin's auklets, flew about the boat anchored off this island on 22 July. That night, hundreds of murrelets with chicks were on the water amidst scores of vocalizing, recently-fledged Cassin's auklets. No auklets were found in burrows during our June visit. Nesting seabird populations may still be increasing in response to the absence of foxes, as overall bird density was low. With the exception of perhaps a few remnant birds which may have survived in the limited rocky areas, particularly on the southwest point, most of colonies we found in 1982 would have been easy prey to foxes, as they were located on very accessible, grassy slopes.

Geese, probably Aleutian Canada's (Branta canadensis leucopareia), used the island during spring migration, for we found fresh droppings and evidence of grazing atop the island.

The estimate of 200 pairs of nesting gulls was based on partial coverage of the island and the counting of 109 nests on 3 June; 80 of these were empty, indicating either very poor reproductive success or late egg-laying.

Another observation of interest on Salt Island was the presence of rock ptarmigan (Lagopus mutus). They also occurred on Egg Island, 13 km to the east. A bald eagle nest was found on the northwest side.

Sagchudak Island. This island is located south of Atka near Explorer Bay and covers about 223 ha. It was stocked with arctic fox in 1914, but none were present in 1982. Gulls were the predominate diurnal species, but nocturnals appeared to outnumber all other species. Unlike Salt Island, no Cassin's auklets were recorded. Approximately 100 abandoned gull nests were counted in a random search of the north part of the island on 14 July. Judging from the paucity of egg shell fragments and the absence of chicks, gull productivity was probably negligible on this island too. Storm-petrels, ancient murrelets, and whiskered auklets were concentrated in talus on the west side; calls indicated higher densities of murrelets than on any other island visited. Puffins preferred the sea stacks off the northwest end.

The most interesting feature of this island was the occurrence of apparently-breeding parasitic jaegers (Stercorarius parasiticus). Sixteen were counted, and most behaved as pairs. Though no nests were found, it seems certain that they nested here. The southern end of the island was not explored afoot because of fog, and the minimum jaeger population was probably at least 20; all birds seen were of the dark color phase. We found jaegers breeding on only one other island (Chuginadak). Eight bald eagles, 45 common eiders, 74 sea otters, 104 seals, and 350 sea lions were also noted.

Amtagis Island. Lying 3 km east of Sagchudak, this tiny, rocky island supported small populations of four nocturnal species (Table 1).

Approximately 1200 tufted puffin burrows were counted on 14 July, but few birds were present. This colony apparently failed in 1982, as did many other colonies in the Atka region. No sea lions were recorded, yet 800 were present in 1961 (U.S. Fish and Wildlife Service 1973).

Sadatanak Island. Situated just north of Amtagis and barely separated from Atka Island, Sadatanak is periodically visited by foxes from Atka according to villagers. Thus this 97 ha island had only a few seabirds, but one peregrine falcon eyrie, 3 bald eagles, 40 harlequin ducks (Histrionicus histrionicus), 32 common eiders, and 36 sea-otters were observed.

Bolshoi Islands. Several small islands are located in Nazan Bay just seaward of Atka Village. Though we found these islands devoid of marine birds, except for a few scattered pairs of tufted puffins, notations on maps used in previous surveys (dates unknown) indicated hundreds of puffins nesting here. Since these islands are so accessible to Atka residents, it is possible that subsistence use of these birds has gradually reduced the size of these breeding populations. The paucity of birds in 1982 also may be partly attributable to reproductive failure similar to that experienced on nearby islands. About 30 tufted puffin burrows were found on Uyak Island, the outermost one in the Bolshoi group.

Amlia Island. Amlia, 80 km long and average of only 6.4 km wide, covers nearly 45,730 ha and rises to 579 m (Fig. 3). Unlike all of the other large islands between Atka and the Islands of Four Mountains, no active volcanoes or recent signs of volcanism are present on Amlia.

In contrast to adjoining Atka, where over 1600 foxes were pelted between 1921 and 1936, only about 300 blue foxes were taken off Amlia, which is slightly less than half as large. According to early refuge records, silver foxes, a dark color phase of the red fox, had already been introduced prior to the release of arctic foxes in 1927. Moreover, Atka residents claim that silver foxes still thrive on Amlia (Dirk, pers. comm.), though nobody had a photograph or a pelt of a silver fox in July 1982. The silver and arctic foxes reportedly segregate themselves on the island, and the silvers are said to be much less numerous, exceedingly wary, and difficult to trap. Judging from the descriptions given by natives interviewed, the supposed silver foxes seem to be valid melanistic red foxes rather than odd pelage variations of arctic foxes. Nevertheless, we were told that no silvers had been captured for a couple of years, and we have been unable to secure a specimen despite informing Atka residents that the refuge would purchase a silver fox. If both species are found to coexist on Amlia, it will be only the second known island in Alaska where this occurs. Both species definitely occupy Nunivak, an island exceeding 404,700 ha and connected to the mainland by ice much of the winter. Elsewhere where both species were introduced to an island the dominant red fox eliminated the arctics (Swanson 1982, U.S. Fish and Wildlife Service 1985). The fact that Amlia produced so few arctic fox pelts for its

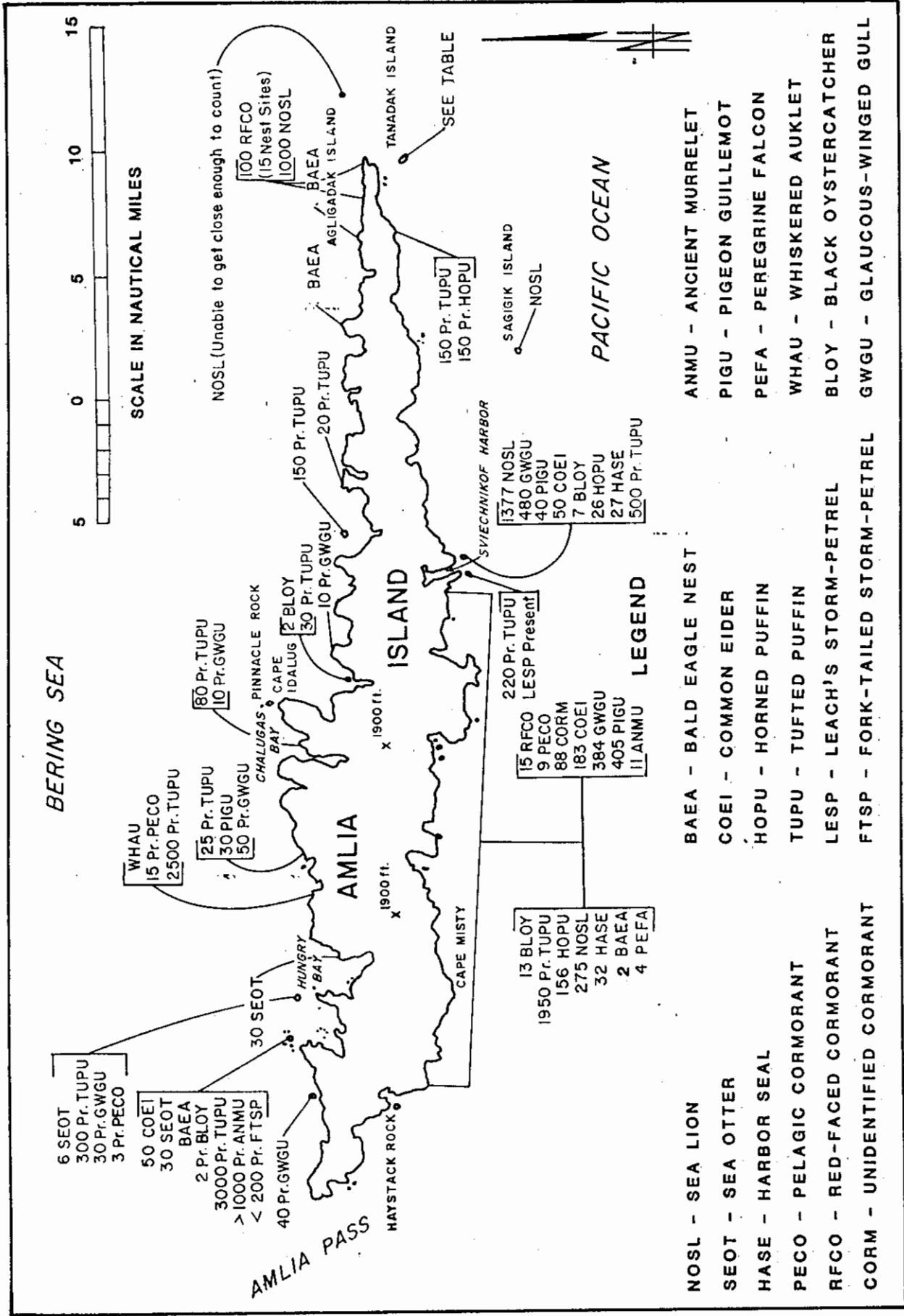


FIGURE 3. SEABIRD COLONIES ON AMLIA ISLAND

large size may be attributable to interspecific competition with a small population of silver foxes. But why were the arctic foxes not eventually extirpated by Vulpes vulpes as on other islands? Recent research by Keeler (1975) has revealed that aggressiveness in red foxes is equated with coat color genes and concomitant endocrinological differences which affect behavior. Normal-pelaged red foxes are the most nervous and aggressive color phase of Vulpes vulpes, while the silver fox and black fox are the least aggressive. These findings may explain how arctic foxes survived on Amlia in the possible presence of silver foxes, but were eliminated on other islands having red foxes. Amlia's large size and 228 km perimeter might have augmented the survival of both species, but the behavioral differences reputedly associated with coat color can not be discounted as a causative factor. If true silver foxes are indeed present on Amlia, the typical red pelage phase will not reappear in successive generations because the melanistic silver and black phases are caused by homozygous recessive genes.

We covered the north shore of Amlia with inflatables in early June and the south side in mid-July. At least 16 different arctic foxes were seen, and sightings occurred on both ends and sides of the long, narrow island. There was a wide variety of pelage phases in the arctic foxes spotted, ranging from tawny to the typical bluish-gray. Atka residents stated that silver foxes generally preferred inland parts of Amlia, especially in boulder-strewn areas east and west of Hungry Bay on the western end of the island. Interestingly, the tawny arctic foxes we encountered were on the western end. Murie (1959) said that silver foxes were being eliminated in the 1930's in favor of the more profitable arctic fox.



As with Atka, most of the seabirds around Amlia nested on offshore rocks and islands. Twenty Brachyrhampus murrelets were sighted, suggesting that a few Kittlitz's and marbled murrelets may nest here. While puffins and guillemots nested in scattered pairs along many sections of coastline, the principal concentrations were at the western end. Nearly 1000 pigeon guillemots were recorded around Amlia, more than at any other island. However, since guillemots nest in loose colonies or as scattered pairs, they often are overlooked and underestimated. Had all of Atka Island been surveyed with inflatables, more guillemots may have been found there than on Amlia, which has less than half as much coastline. Seventy-six percent of the birds recorded at Amlia were tufted puffins (Table 1).

Nearly half of the 1275 sea otters tallied on the survey were off Amlia, mostly on the south side. Most sea lions (Table 2) occurred along the eastern end. Forty-five bald eagles (eight nests), five peregrines (one nest), and over 200 harlequin ducks and common eiders were noted. Many more eagles inhabited Amlia than any other island. Amlia has small salmon (Oncorhynchus spp.) runs. Despite the presence of foxes, ptarmigan and several species of ducks occurred on Amlia.

"Round" Island. "Round" refers to the designation of the USGS bench mark on an unnamed island 5 km northwest of Hungry Bay (Fig. 3). This islet and surrounding rocks supported the largest colonies around Amlia. Besides 6000 tufted puffins, at least 1000 ancient murrelets were believed to have nested here with fewer numbers of four other species.

Tanadak Island. The greatest diversity of nesting seabirds in the Amlia area was noted on Tanadak, a tiny islet off the eastern end. We noted high nesting densities of four nocturnals. Whiskered auklets probably also nested there, but no night visit was made because it is very difficult to land on and is located on the fringe of notoriously rough Seguam Pass. Tanadak was the only island on the reconnaissance having a concentration of nesting northern phalaropes (Phalaropus lobatus). A small pond is located atop the gently sloping island covered with grasses and sedges (Carex spp.). A minimum of 20 pairs of phalaropes was present, and a nest with three eggs was discovered on 12 July. Some Leach's storm-petrels were still incubating on this date, but fork-taileds and Cassin's auklets had chicks. A total of 220 sea otters, the highest density noted anywhere, was observed in extensive kelp beds surrounding this island. Other wildlife on this remarkably productive island included bald eagles, a peregrine falcon, common eiders, and an unusual abundance of winter wrens, song sparrows, and lapland longspurs (Calcarius lapponicus). Sekora (in U.S. Fish and Wildlife Service 1973) reported 700 gulls here in 1972; we estimated 600 but only two empty nests were located, indicating failure of the colony in 1982.

Reefs and rough seas prevented close approaches to nearby Agligadak Island in Seguam Pass or Sagigik Island south of the eastern end of Amlia. Both of these islets are barren, low-lying rocks used by sea lions and loafing gulls and cormorants.

Seguam Island. Seguam, surmounted by 1067-m Pyre Peak, covers 21,449 ha and has 66 km of shoreline. Much of this mountainous island has scanty vegetation because of relatively recent lava flows. This island was stocked with arctic foxes in 1924, and in 12 years almost 700 were harvested. The rugged lava terrain dominating most of this island has permitted remnant populations of fork-tailed and Leach's storm-petrels and some other crevice nesters to survive. Crested auklets, however, apparently were eradicated by foxes, for Murie (1936) reported thousands of them with parakeet auklets on the east side. A volcanic eruption or other changes in habitat also may have caused their demise. Scattered pairs of parakeet auklets were noticed between Finch Cove and Moundhill Point (Fig. 4), but no crested auklets were spotted. Most of Seguam's seabirds nested in the vicinity of Moundhill Point, a basaltic dome. All of the island's murre and most of the cormorants also nested there. Fork-tailed storm-petrels and whiskered auklets were heard calling in the rocks at this point as well as at a rock slide near Warf Point; Cassin's auklets flew about the boat's lights. Murie (1936) cited nesting red-faced and pelagic cormorants at Moundhill Point in 1936 but made no mention of a murre colony. Sekora (in U.S. Fish and Wildlife Service 1973) indicated 600 cormorants at Moundhill Point as the only seabird colony on Seguam. Unless previous observations were made too far offshore to see it, it appears that the murre colony here is of fairly recent origin.

A total of 4,150 sea lions, including 400 pups, was estimated; this agrees closely with Kenyon and King's 1965 count of 4400 (in U.S. Fish and Wildlife Service 1973). Nearly all of the sea lions we saw were just east of

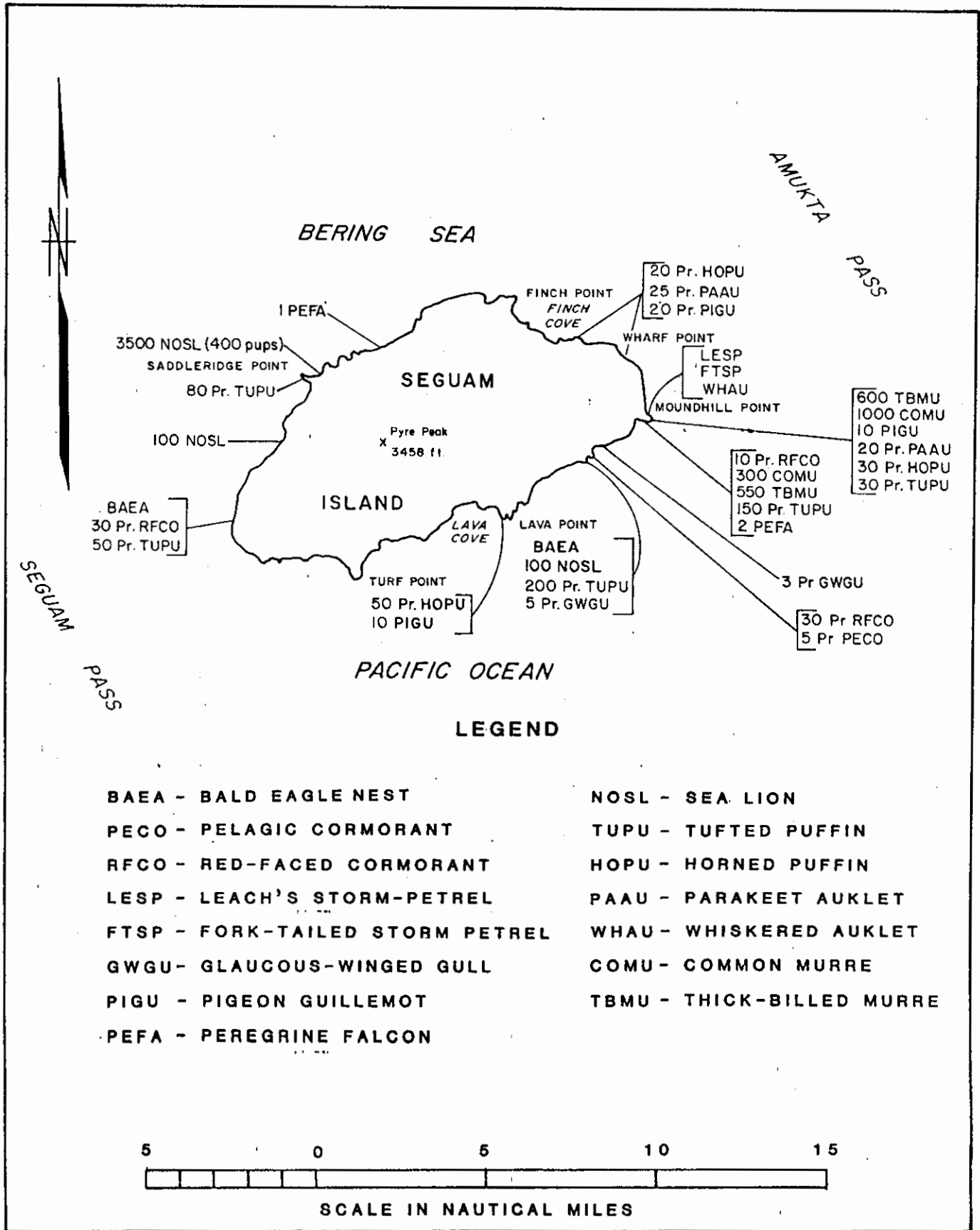


FIGURE 4. SEABIRD COLONIES AND SEA LION ROOKERY ON SEGUAM ISLAND

Saddleridge Point, whereas in 1972 Sekora (in U.S. Fish and Wildlife Service 1973) found most of them near Warf Point. We counted 116 sea otters but saw no seals around the island. Murie (1936) mentioned no sea otters.

Other observations of interest on Seguam were an apparent great knot (Calidris tenuirostris) at about 305 m elevation on the eastern end, water pipits (Anthus spinoletta), and three sandhill cranes (Grus canadensis) flying westward along the shore. There are only two other records of great knots in the Aleutians (Kessel and Gibson 1978). Three peregrine falcons and two bald eagle nests were recorded. No sign of ptarmigan was found; Murie (1936) also failed to find ptarmigan.

The south coast of Seguam between Lava Cove and the western extremity of the island was not surveyed from an inflatable because of rough seas and severe tide rips off the southwestern point. Though no obvious large colony of diurnal birds was missed, a closer examination of this rugged sector of the island probably would reveal additional breeding cormorants and perhaps other species.

Amukta Island. This 5060 ha island with 30 km of shoreline is nearly circular with a 1067 m active volcano near its center. Most of the island is covered by lava and cinders, and Amukta had less vegetation cover than any other island visited. Vast expanses, particularly on the north side, are bare cinders, much of which was still warm to the touch, with steam rising from the cinders at higher elevations on the north side. Closer to shore, Anemone

narcissiflora, Achillea borealis, and Lupinus nootkatensis dot the cinder landscape. Lava ledges or cliffs ring nearly all of the island. A suitable landing beach is in Trader's Cove (Fig. 5) on the south end. A protected small gravel beach on the north side is the best on the island. A fair cobblestone beach exists on the east side at the site of Aleut house pits. Several small ponds occur here; the only other known surface water is a pond beside a lava flow in Trader's Cove and near a cove on the north side. No trace of a cabin reported in Trader's Cove in 1936 by Murie could be found, and it presumably was consumed by a subsequent lava flow. Most of the ridges and old lava flows east and west of Trader's Cove are covered with Elymus arenarius mollis and other grasses.

Only relicts of former populations of seabirds remain on Amukta. Murie's (1936) notes stated that this island furnished an outstanding example of foxes living on birds. During Murie's visit in August the vegetated lava flows on the southeastern portion of the island were used by huge numbers of fork-tailed storm-petrels. As he stated, "The petrels were flying about us (25-50 were in sight at one time where visibility was 100 feet) and we could hear them chirping both above and below ground." The toll of heavy fox predation for nearly 60 years has been dramatic, for in July we spent part of a night in the area described by Marie, but heard only an occasional fork-tailed and Leach's storm-petrel. Moreover, we were on Amukta a month earlier than Murie, and storm-petrels are more active and vocal earlier in the breeding season. Of 114 fox scats collected on Amukta by Murie (1959), 57% contained storm-petrels.

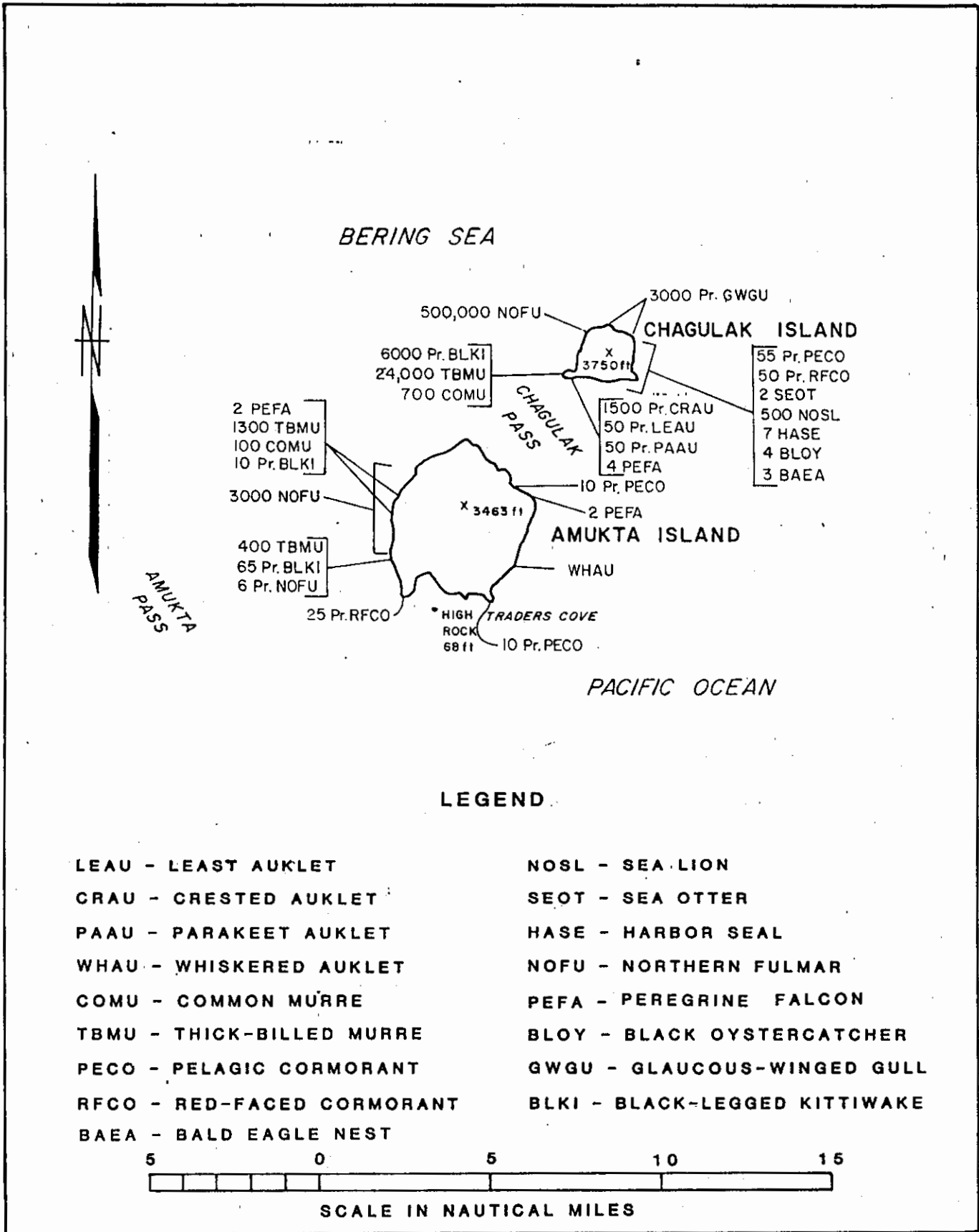


FIGURE 5. SEABIRD COLONIES ON AMUKTA AND CHAGULAK ISLANDS

With the exception of much larger Atka Island, Amukta was the biggest fox producer in the survey area. In fact, on an acreage basis it was the third best source of arctic fox pelts in the Aleutians, exceeded only by the three Semichi Islands and Kavalga in the western part of the archipelago. By 1936, 1164 pelts had been removed since introductions were made 11 years earlier. When foxes were eradicated from Amukta in 1983 by the U.S. Fish and Wildlife Service, roughly one third of the 49 animals trapped and poisoned had white pelage, a recessive color phase of the arctic fox.

About 3000 northern fulmars nested on ledges on Amukta's precipitous west side. Prior to fox releases, numbers on this island may have rivaled those on Chagulak. Most birds were of the dark phase.

An estimated 1700 murrelets, principally thick-billed (Uria lomvia), and some 75 pairs of black-legged kittiwakes (one of only three colonies in the survey area) also inhabited the cliffs on the west side. The entire shoreline was surveyed on 13 June; thick-billed murrelets (2000) accounted for almost four times as many birds as the next most commonly sighted species (northern fulmars) along the shoreline. Of the 14 species believed to nest on Amukta, four are nocturnal. Cassin's auklets flew about the boat in Trader's Cove, and whiskered auklets were regularly heard in lava crevices along the shoreline.

Aleutian Canada geese, were observed in flight over the island several times in June 1982 and 1983 (Bailey and Trapp 1983). Several were seen grazing on



the island in 1984 (Deines, pers. comm.). It seems likely that they will again nest here since foxes have been removed. Other bird observations of interest included two barn swallows (Hirundo rustica), six peregrine falcons, and five bald eagles. Barn swallows are considered casual spring migrants and summer visitants in the Aleutians (Kessel and Gibson 1978).

Bailey and others hiked all over the island for a month in 1983 and found no ptarmigan sign, yet Murie reported sign in 1936. It seems that the former high fox densities and limited cover on this island resulted in the extirpation of ptarmigan on Amukta. Song sparrows and winter wrens were common on old lava flows in the interior of this island, where they undoubtedly nested in lava tubes and crevices to elude foxes which are more numerous along beaches. Winter wrens and song sparrows are largely restricted to strand vegetation on most other islands.

Chagulak Island. Chagulak and Buldir, both spared of fox introductions, have the largest and most diverse marine bird colonies in the Aleutians. These two rugged islands also support the only remaining wild populations of Aleutian Canada geese in the archipelago. According to Day et al. (1978 and 1979) and SOWLS et al. (1978), more diurnal seabirds (650,000) breed on Gareloi (6880 ha) and at Sirius Point on Kiska Island (28,329 ha) than on either Buldir or Chagulak. However, when storm-petrels and other nocturnal nesters are included, Buldir (2023 ha) reportedly has about 2,000,000 breeding seabirds representing 21 species; Chagulak (850 ha), with 19 species, probably conservatively has over a million birds, though no meaningful estimate of

nocturnals has yet been made. Kiska with 1,400,000 birds (nearly all least and crested auklets), and Gareloi both abound with foxes. In 1986 foxes on Kiska were poisoned. Thus, birds are restricted to colluvium, and nocturnals are much less plentiful. Even disregarding nocturnals, over 80% of the nesting seabirds between Kasatochi and Kagamil islands were found on Chagulak (Fig. 5). With about 450,000 northern fulmars, nearly the entire population that nests in the Aleutians (Sowls et al. 1978), the Chagulak colony represents the largest population of fulmars on any single island in Alaska. The total number of fulmars, which we feel exceeds 500,000, are rivaled only by a like number (Hatch 1977) on the nine islands comprising the Semidis and by the 450,000 presumed nesting on St. Matthew and two nearby islands (Sowls et al. 1978). The fourth sizable colony (70,000) in the state is in the Pribilofs.

In June 1972 the population of fulmars on Chagulak was estimated at 450,000 after once circling the island in the M/V Aleutian Tern. In the Semidi Islands, Hatch and Hatch (1980) noted that colony attendance was highly variable prior to the commencement of incubation in early June; thereafter it became more stable. Hatch (1977) found that the proportion of nest sites occupied by breeding birds was around 65%, and he observed that peaks in attendance occurred during stormy conditions and the population lows during fair weather. If the same is true at Chagulak, the number present in 1972 upon which the estimate was based was low because the weather was extraordinarily good for the Aleutians--clear with light winds. Hatch (1978) also observed that the greatest fulmar numbers in the Semidis were

sporadically present in April and May prior to laying, but thereafter no more than 40% of maximum possible attendance was observed during the breeding season. Also, during June and July pairs actively engaged in breeding represented only a minor portion of the total number of pairs occupying nest sites, the majority being failed and non-breeding pairs.

Since less than half of the fulmar population on Chagulak may have been on land at any time once breeding began, as is the case in the Semidis, and since large numbers of non-breeders also are present, population figures for breeding fulmars are simply guesses. The nesting plots which we established were too few to be of any value in extrapolating numbers for the whole island. We believe 500,000 to be a minimal breeding population; much of a summer would be necessary to accurately ascertain the actual breeding fulmar population on Chagulak. Fulmar scrapes occurred on open slopes above snow banks well towards the island's 1140 m summit, and many of the slopes with the greatest density of nests can only be reached by ropes. Besides contending with extremely precipitous slopes and rock slides, establishing transects would entail disturbance of numerous burrow-nesters which are interspersed among the fulmars.

Though the awesome numbers of fulmars overshadowed other species on Chagulak, the island was incredible after dark as well, when thousands of storm-petrels and other nocturnals swirled about. Lacking adequate sample plots, the figures in Table 1 for storm-petrels, Cassin's auklets, and ancient murrelets are merely guesses based on the numbers flying and vocalizing compared with other islands we have been on where population estimates were derived from

quadrats. For example, more storm-petrels surely breed on Chagulak than on 26 ha St. Lazaria Island, which had an estimated 540,000 birds in 1981 (Nelson et al. 1982). Thus, 500,000 fork-tailed and Leach's storm-petrels are considered minimum estimates, and actual populations are probably much higher. Based on vocalizations, fork-taileds appeared to be the most abundant species, but Leach's storm-petrels were considerably more numerous around the boat's deck lights while it was anchored off the southeast point.

Cassin's auklets are comparatively rare in the Aleutians (Sowls et al. 1978, Nysewander et al. 1982), the population on Chagulak appearing to be the largest in the Aleutians and perhaps the state. Comparable populations occur only in the Shumagins, Sandman Reefs, and Forrester Island (Sowls et al. 1978). Though we did not hear birds vocalizing on 17 June 1982, Cassin's auklets circled the boat anchored off the arm on the southwest tip of the island, and eggs and chicks were found in burrows atop the plateau. This area is the only safe camping spot on the island, but no running water is available; it entails ascending 244 m to reach this nearly level arm. Cassin's auklets were calling atop this arm when we were camped there in June 1983. Ancient murrelets and whiskered auklets are not nearly as common as the aforementioned nocturnal species.

More than half the puffins in the survey area probably also nested at Chagulak, and the smallest of the three colonies of crested and least auklets was encountered here. Approximately 25,000 murrelets, mainly thick-billeds, were recorded in 1982 compared with 111,500 reported 10 years ago (U.S. Fish and

Wildlife Service 1973). Either a drastic decline had occurred, or the 1972 estimates were exaggerated grossly. The 1982 counts from inflatables are believed to be more accurate than the previous ones from the M/V Aleutian Tern. In 1972, 11,400 parakeet auklets, 1600 red-faced cormorants, and 28,500 black-legged kittiwakes also were recorded, but we found far fewer of these birds.

Four peregrine falcons and at least one eyrie existed on the island. Only three bald eagles and no nests were located. Approximately 500 sea lions but no pups were seen. Twenty common ravens (Corvus corax) inhabited Chagulak.

The most fascinating discovery on Chagulak Island was the presence of Aleutian Canada geese. In 1982 we saw 62 geese in one flock atop the plateau at the southwest end plus smaller groups and territorial pairs. On 10 July, a nest with five eggs was located. More geese, including a color-banded bird from California, were seen when the island was revisited in 1983. Further details and the significance of this find are discussed in Bailey and Trapp (1984).

Yunaska Island. This 17,600 ha island (Fig. 6) is largely devoid of birds. Arctic foxes were introduced in 1919, but only 308 were pelted before 1936, suggesting that this island never had large bird colonies. One fox was so tame that it sniffed our boots and jumped in our Zodiac. The whiskered auklet, heard chattering in lava crevices along much of the coastline, probably is the most abundant species. About 2500 whiskered auklets were observed in tide rips off the southwest end of the island in June 1982; a

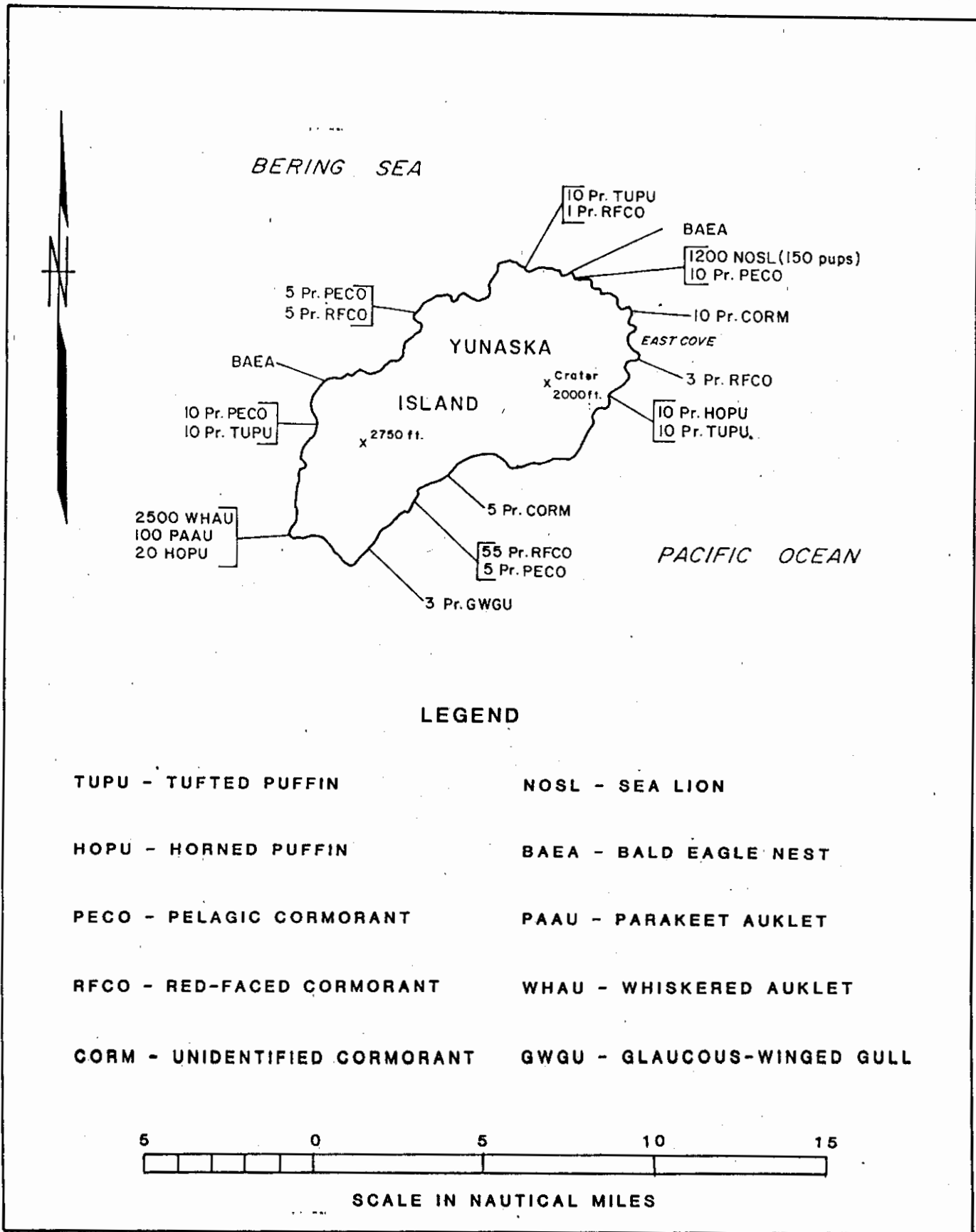


FIGURE 6. SEABIRD COLONIES AND SEA LION ROOKERY ON YUNASKA I.

similar number was recorded in the same area 10 years earlier (U.S. Fish and Wildlife Service 1973). Fork-tailed and Leach's storm-petrels flew about the boat at night while we were anchored on the north and east sides; a few fork-taileds were heard with many whiskered auklets in rocks west of Crater Anchorage.

Approximately 1200 sea lions, including 150 pups, were counted on a beach on the northeast side. Estimates of 895, 350, and 800 animals were made on Yunaska in 1972, 1965, and 1961, respectively (U.S. Fish and Wildlife Service 1973).

Five bald eagles (two nests) and one peregrine falcon were noted on this island, which for its size had the lowest seabird density in the survey area. Rock ptarmigan were still abundant despite the presence of foxes; Gabrielson and Lincoln (1959) recognized the Yunaska rock ptarmigan (L. m. yunaskensis) as a distinct subspecies.

A major volcanic eruption in 1937 evidently destroyed several cabins reportedly on the island.

Herbert Island. Herbert, nearly 5670 ha in size and with a circumference of 31 km, rises to over 980 m elevation. The summit is a large, inactive crater. A fox farmer's cabin and Aleut house pits are located above a bight on the north side; several small ponds exist west of this bight. The only small streams were noted on the south side where landings are very difficult.

Over 500 arctic foxes were trapped on this island after releases were made in 1920. Murie (1936) found little birdlife on the island, and we found only six species of seabirds nesting. Murie reported a parakeet auklet colony on the south side and stated that it was doomed to foxes. He was apparently correct, for we saw no parakeet auklets there. However, contrary to Murie's prediction, whiskered auklets did persist, as we heard them among jumbled rocks on the north side (Fig. 7).

Approximately 450 sea lions were hauled out primarily on rocks off the west side. No peregrine falcons, and only four bald eagles and one nest, were encountered. A rock ptarmigan nest with six eggs was found in tall grass above a headland near the fox farmer's cabin.

Carlisle Island. This island proved disappointing because, according to Murie's notes (1936), no foxes had been released here. However, arctic foxes were apparently introduced after Murie's visit (Swanson 1982), and the thousands of nesting horned and tufted puffins reported by Murie had been decimated by 1982. The gull colony and most of the once numerous parakeet auklets also were gone. We saw more foxes here in a short duration than on any of the other Islands of Four Mountains. The only other island surveyed that seemed to have more fox activity was Kasatochi. Since the release of foxes on Carlisle was more recent than releases on the other islands, and since the island formerly supported large seabird colonies, the fox population on this 4450 ha island may still be comparatively large. Moreover, for its



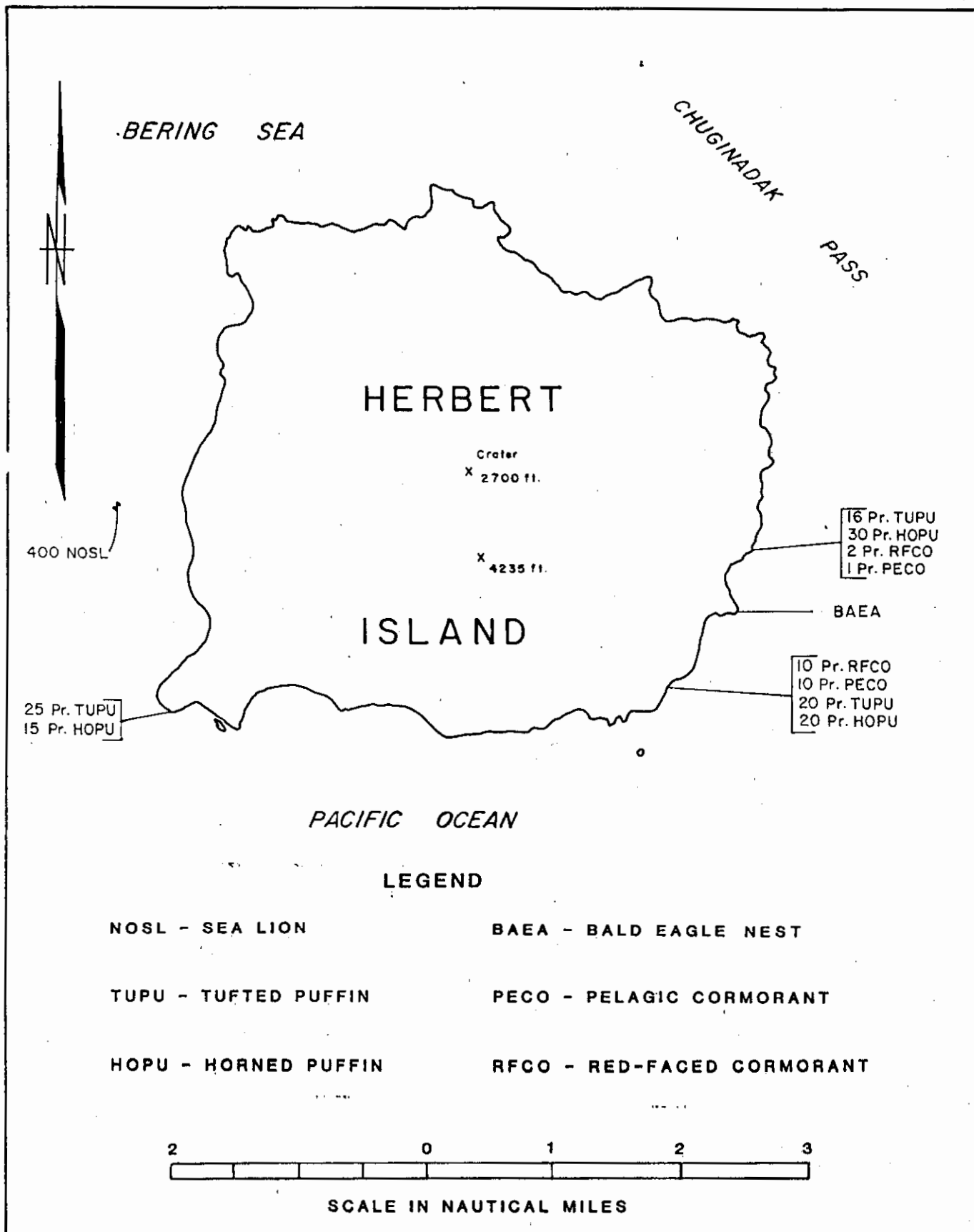


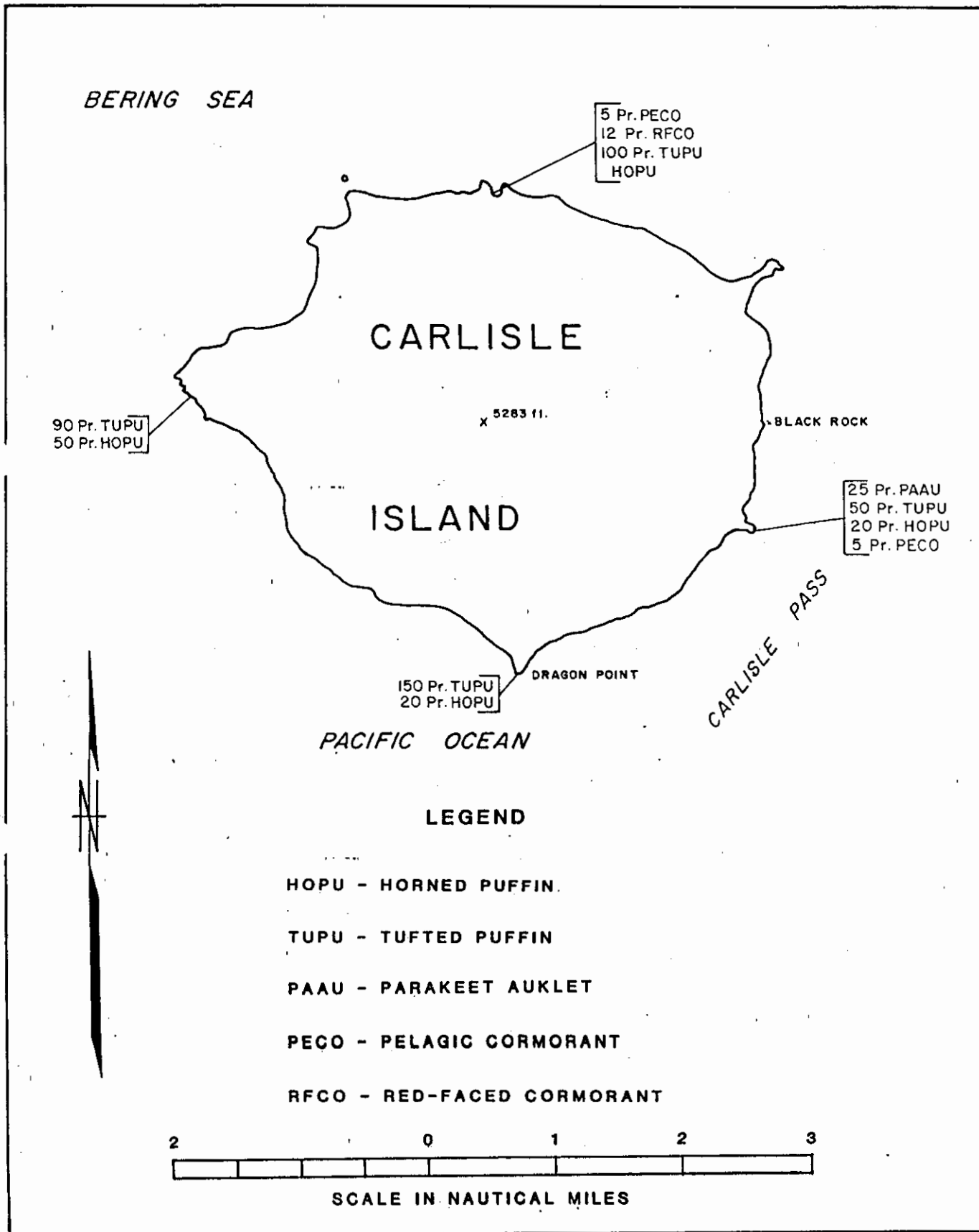
FIGURE 7. SEABIRD COLONIES ON HERBERT ISLAND  
(ISLANDS OF FOUR MOUNTAINS)

size more puffins continued to nest on Carlisle than any of the surrounding islands. Like Kasatochi, this island should be one of the first slated for fox removal. Whiskered auklets, fork-tailed storm-petrels, and ptarmigan still survived on Carlisle.

The best landing site is on the east side where the remains of a cabin and many large house pits exist (Fig. 8). A small creek also occurs at this locale which once was a large village site facing spectacular Mt. Cleveland across Carlisle Pass. Behind the midden site rises Carlisle Volcano (1616 m), which was last recorded smoking in 1838 (U.S. Fish and Wildlife Service 1973).

Most of the island's 250 sea lions were at Dragon Point.

Uliaga Island. Practically no birds were observed on this 930 ha island, which surprisingly still had arctic foxes (Fig. 9). Murie (1936) regarded Uliaga as an "outstanding" bird island. He related that the storm-petrels and puffins were being exploited by foxes, and indeed they have been, as we saw fewer than 100 seabirds. Murie (1959) analyzed 132 fox scats on Uliaga and found that nearly 60% and 14% contained tufted puffins and fork-tailed storm-petrels, respectively. Murie also noted small colonies of cormorants, including double-crested (Phalacrocorax auritus); we found only a few pelagic cormorants. The "many thousands" of tufted puffins nesting on high grassy slopes during Murie's visit evidently were eliminated years ago, for we did not find even old burrows. Sekora (in U.S. Fish and Wildlife Service 1973) reported 20,000 puffins using the island in 1972, but no landing was made.



**FIGURE 8. SEABIRD COLONIES ON CARLISLE ISLAND  
(ISLANDS OF FOUR MOUNTAINS)**

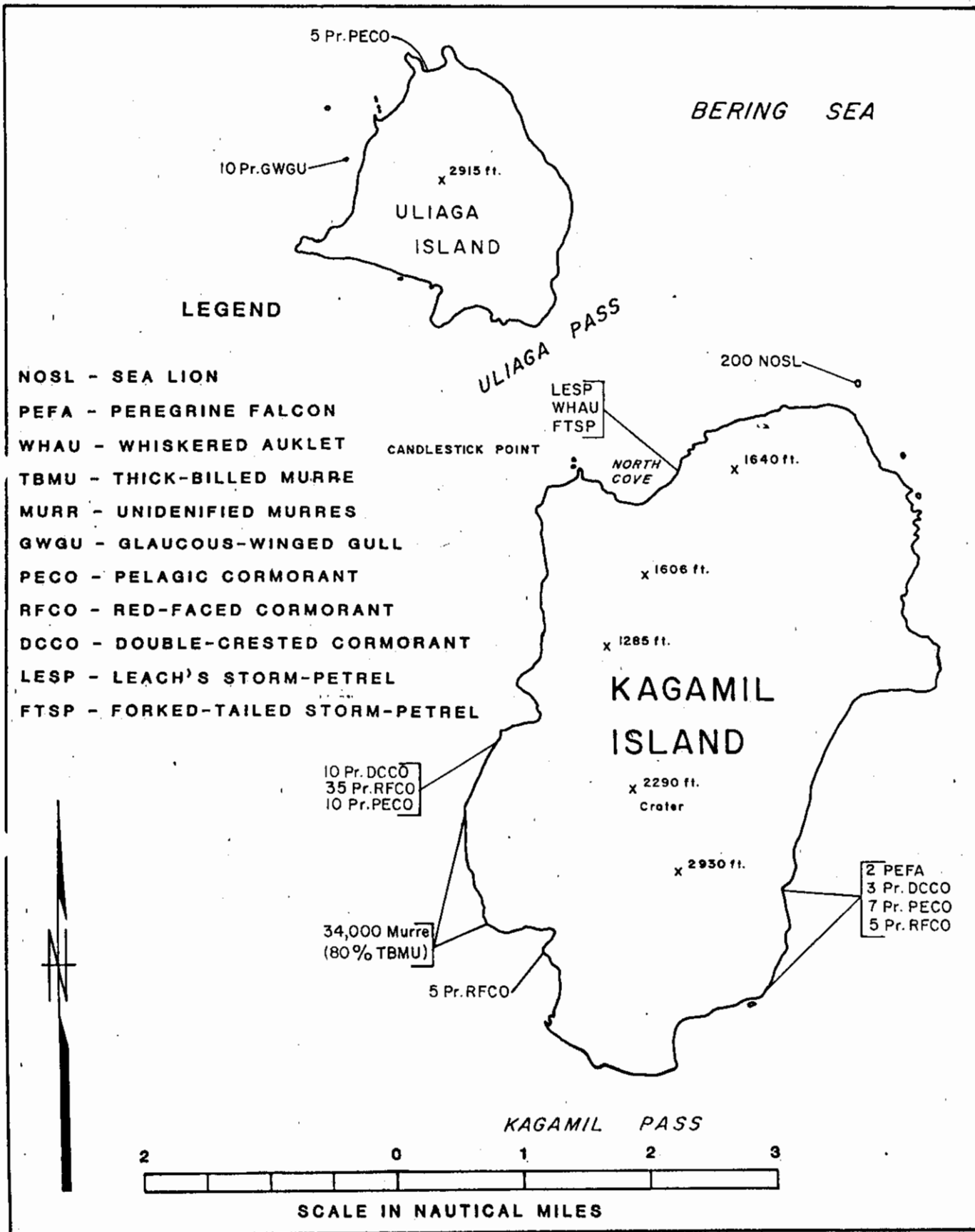


FIGURE 9. SEABIRD COLONIES ON KAGAMIL AND ULIAGA ISLANDS (ISLANDS OF FOUR MOUNTAINS)

Most of the birds seen in 1972 were horned puffins, and it is not known whether they were actually observed on land or offshore. Horned Puffins also were common all around the island during Murie's survey, but unless our two visits, including camping on the island, occurred when virtually all of the birds were away, we believe that the birds reported by Sekora originated from another island. Surely foxes were not responsible for the demise of 20,000 puffins in only 10 years; besides, large colonies of horned puffins in colluvium can persist despite many foxes (Bailey 1978).

Both fork-tailed storm-petrels and whiskered auklets were heard in cliffs on the east side, and 10 pairs of glaucous-winged gulls nested on rocks off the west shore. Two rock ptarmigan were spotted above 245 m elevation, and a bank swallow (Riparia riparia) flew about a lake situated near 305 m. No permanent streams were located near our campsite on the east shore, the only good landing spot. Although extensive kelp beds existed along the east side of Uliaga, only three sea otters were sighted.

The 1982 fox population seemed very low, perhaps reflecting Uliaga's small size, rugged terrain, lack of extensive beaches, and low seabird populations. We saw only one fox, which was carrying a harlequin duck. It would be comparatively easy to remove the remaining foxes and allow this island to be recolonized by seabirds. Since Uliaga is an excellent candidate for experimental introductions of sterile red foxes to see if they would eliminate arctic foxes, five vasectomized male and five female red foxes were translocated from Umnak Island in May 1984.

On the evening of 23 June, intermittent flocks of whiskered auklets streamed northward through Uliaga Pass. Thousands flew by before dark. They must have originated from neighboring islands to the south.

Kagamil Island. Lying 3.2 km south of Uliaga, this interesting island (Fig. 9) has hot springs and steam vents; 915 m Kagamil Volcano was reported to be intermittently steaming in 1929 (U.S. Fish and Wildlife Service 1973). Blue foxes were placed on this 4210 ha island in 1922, and fair numbers remained in 1982. Except for Chagulak and Kasatochi, more diurnal birds nest on Kagamil than on any other island (Table 1). Nearly all of the seabirds on this island used cliffs. One of two double-crested cormorant colonies found in the survey area was located here.

On 26 June we enumerated nearly 20,000 murres (80% thick-billed) along the southwestern cliffs; on 8 July these cliffs were reexamined, and approximately 34,000 murres were counted. Murie (1936) mentioned that thousands of murres nested along this 4 km stretch of cliffs, and Sekora (in U.S. Fish and Wildlife Service 1973) indicated that 285,000 murres and 1000 red-faced cormorants were using the cliffs. The 1972 data may be somewhat exaggerated, but in 1982 massive nesting failure of thick-billed murres and kittiwakes occurred 418 km to the north in the Pribilofs (Roseneau, pers. comm.); hence, the Kagamil murre colony may be considerably larger in other years. This decline in murres also may be reflecting a general decline noted at other colonies in the eastern Bering Sea (Roseneau, pers. comm.).

Complete surveys of the 27 km of shoreline around Kagamil revealed fewer than 500 puffins on the water. Tufted puffins were more numerous than horned puffins, and scattered pairs probably nested in cliff crevices around the island. Sekora (in U.S. Fish and Wildlife Service 1973) cited 1000 tufted puffins, and Murie (1936) stated that they were numerous along the cliffs at the northern end. Though not as abundant, horned puffins also used these cliffs, especially those on the west side (Murie 1936). Amidst the puffins on the northern cliffs he noted nesting parakeet auklets. We saw few puffins and no parakeet auklets; 60 years of fox predation had evidently taken a severe toll. We noted prominent fox trails along outcrops of rocks and above cliffs at over 300 m elevation. Also, only two ptarmigan were sighted during several hours of hiking in typical ptarmigan habitat.

Both species of storm-petrels and whiskered auklets were heard along cliffs in North Cove where we camped. Though this site, which has many Aleut house pits, has a good sand beach and ample stream water, it is subject to violent williwaws.

Murie's (1959) investigations at Kagamil revealed that foxes were eating skin from Aleut mummies in caves. We entered both the reported warm and cold caves near steam jets on the south end but, except for remains of grass mats, both were empty. The mummies were removed years ago and taken to the Smithsonian Institution. We could not find the cave marked on Hrdlicka's map near North Cove.

Chuginadak Island. Since we spent 2 weeks on Chuginadak, it was the most thoroughly investigated island on the survey. This spectacular island, encompassing over 17,000 ha, is the second largest of the Islands of Four Mountains. Mt. Cleveland, an active volcano reaching a height of nearly 1830 m, dominates the island and is the highest volcano between Umnak and Great Sitkin islands in the Aleutians. Mt. Cleveland comprises the western half of the island while lower volcanic mountains constitute most of the eastern part. Steam vents exist in at least six different places on the eastern side. Many large streams cascade off the eastern portion, and a lake, not shown on any maps, is located above 300 m on the north side; no water was found on the western side of the island. Extensive sand beaches occur at Applegate and Lava coves (Fig. 10), and an Aleut village site and shacks erected by the military during World War II are present beside a stream in Applegate Cove. Another barabara was found in the cove south of Kagamil Pass where our base camp was established. The wreckage of a WW II fighter aircraft also lies southeast of this unnamed cove, which has a striking waterfall for a backdrop. More Aleut house pits and WW II ruins are located near Concord Point.

Chuginadak is the only island in the Aleutians west of Umnak that positively still has red foxes. Fur farming records indicate that they were on the island prior to the granting of fur farming leases and, like the silver foxes reported on Amlia, probably were introduced by Russians in the 1800's. According to Murie (1936), an attempt was made to eliminate the red foxes in 1929 so that the island could be stocked with arctic foxes; 59 were killed,



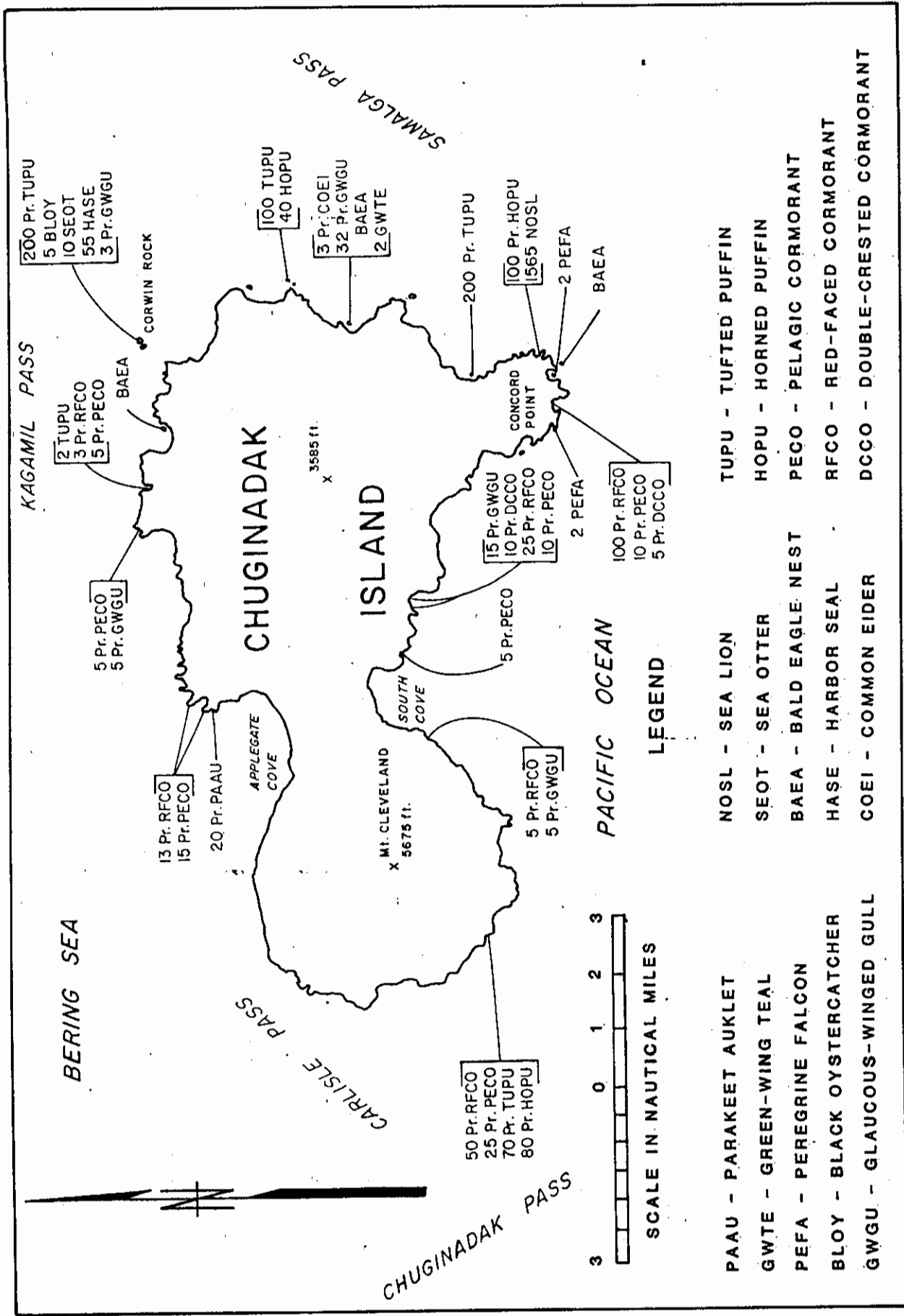


FIGURE 10. SEABIRD COLONIES AND SEA LION HAUL-OUTS ON CHUGINADAK ISLAND (ISLANDS OF FOUR MOUNTAINS)

but it was believed that the island was too mountainous to get all of them. In 1930, arctic foxes were released, but they apparently did not survive because we found only red foxes in 1982. Both red and arctic foxes were trapped in 1931, the last year of trapping according to refuge records. The disappearance of arctic foxes reinforces the hypothesis that the two species will not coexist on the same island and that sterile reds may be used as control agents against arctics. Despite its large size only 95 red foxes reportedly were removed from Chuginadak, and the 1982 population was very low, as even with extensive hiking on the island we saw only three animals. The three red foxes encountered were extremely wary and dashed off after spotting us. Elsewhere, red foxes we have observed usually were not wary, and many were actually curious. Two abandoned fox dens were found near Concord Point, and tracks and trails ringed the island. The total estimated population of 100 foxes reported during the fox farming era (Murie 1936) is probably still valid.

The fact that fewer than 100 red fox pelts were reported taken from this large island attests to the relative lack of nesting seabirds. However, more nesting cormorants of all three species (Table 1) were observed here than on any other island surveyed; Chuginadak was one of the two islands in the survey area that was used by double-crested cormorants. Burrow-nesting seabirds were scarce and were located only in inaccessible places. Fork-tailed and Leach's storm-petrels and whiskered auklets were heard in cliffs east and west of our base camp; the latter species was also heard in considerable numbers in the lava headlands around Concord Point on the south side. Over 400 tufted puffin

burrows were counted on Corwin Rock off the northeast end, but most of the burrows were abandoned. Thirty-two glaucous-winged gull nests were counted on an islet off the eastern side along with nesting common eiders. Most of the gull nests were empty.

Parasitic jaegers appeared to nest near ponds north of Concord Point, as 16 dark-plumaged birds were seen there on 7 July. Though no nests were found, they behaved like territorial pairs. Murie (1936) saw eight jaegers in what was apparently the same locale. A sandhill crane walked about this area where four peregrine falcons also were sighted. A total of eight peregrines and two eyries was noted on this island, which has over 67 km of shoreline. Thirteen bald eagles and two nests were located. Ptarmigan and harlequin ducks were especially abundant.

We saw 1565 sea lions hauled out on Concord Point, more than on any other island except Seguam. Harbor seals also were more abundant on Chuginadak than other islands surveyed, when length of coastline is considered (Table 2).

It was surprising to discover mosquitoes on this island. They may have been introduced incidentally with the foxes.

## MIGRATORY BIRD ACCOUNTS

A minimum of 735,000 diurnal seabirds were estimated to be breeding on the islands between Kasatochi and the Islands of Four Mountains in 1982 (Table 1). Although no estimates were made for nocturnal-nesting seabirds, our impression was that they vastly outnumbered birds active about colonies during daylight. Twenty-one species nested in the survey area, and two additional species were suspected of breeding.

Northern Fulmar. Over 500,000 fulmars were believed nesting on Chagulak Island, and a small population used the west side of nearby Amukta. Excluding nocturnal species, two thirds of the breeding seabirds in the survey area were fulmars. The colony on Chagulak, which appears to be the largest on any single island in Alaska, constitutes roughly 25% of the state's total nesting population (Sowls et al. 1978). Albeit exceedingly difficult, quadrats could be established to obtain an accurate estimate of the fulmar population on Chagulak. Since no more than 40% of the birds using the Semidi Islands were present at the colonies after May (Hatch 1978), Chagulak's actual population may be considerably greater than our guess. Quadrats would also reveal the proportion of nest site holders that are actual breeders.

Fork-tailed Storm-Petrel. Though no numerical estimates were made of storm-petrel populations on most islands, fork-taileds were probably the most abundant species in the survey area. They nested on at least 15 islands, and

if more cliff and talus areas had been visited at night on large islands, such as Atka, Amlia, and Herbert, small colonies probably would have been found on these, too. Most of the fork-tailed storm-petrels occurred on Chagulak and Koniuji. On Chagulak, they probably equaled fulmar numbers; the population there may exceed a million, which, if true, would make it the state's largest for this species. When one considers that sampling revealed over 500,000 fork-tailed and Leach's storm-petrels breeding on 26 ha St. Lazaria Island, the possible magnitude of the population on Chagulak, with a planar area of 850 ha and an elevation of 1140 m, taxes the imagination.

Leach's Storm-Petrel. This species apparently is the second most common nesting bird between Kasatochi and the Islands of Four Mountains. Like their congener, Leach's storm-petrels were most numerous on Chagulak, where we believe they exceeded 500,000. Buldir, with more than 800,000 birds, is supposedly the largest colony (Sowls et al. 1978). Again, sampling may divulge an actual population several times greater. We found Leach's storm-petrels nesting on 11 islands. Since this species prefers soil burrows instead of talus and cliffs, which are more frequently used by fork-taileds, it would be expected to be less numerous and widespread on volcanic islands which generally are also inhabited by introduced foxes. With limited sampling of burrows, numbers of Leach's storm-petrels surpassed fork-taileds only on tiny Tanadak Island (Table 1).

Cormorants. The double-crested cormorant was scarce and bred only on Kagamil and Chuginadak islands, the easternmost in the survey area. The Islands of Four Mountains represent the western extremity of the breeding range of this

species. Nysewander et al. (1982) reported 2000 double-crested cormorants breeding in the Fox Islands to the east, where they were more numerous than pelagic cormorants. SOWLS et al. (1978) indicated that double-crested cormorants did not nest west of Unalaska, but Murie (1936) found them at Kagamil, and Gabrielson (in Gabrielson and Lincoln 1959) twice visited a colony on Carlisle in 1945. We did not see double-crested cormorants at Carlisle Island in 1982.

The pelagic cormorant was the most widespread species, nesting on 16 islands. The red-faced cormorants, totalling nearly 1000 birds, was the most abundant of the three breeding species. All three species were most numerous on Chuginadak.

Parasitic Jaeger. This species appeared to nest only on Sagchudak and Chuginadak, at each end of the survey area. Jaegers were not found in the Fox Islands to the east (Nysewander et al. 1982); Murie (1936) noted them on three islands (Seguam, Herbert, and Chuginadak). We recorded 16 on the latter island, but only small portions of Seguam and Herbert were covered on foot.

Glaucous-winged Gull. Gulls bred on 13 islands, but two-thirds of the estimated breeding birds were at Chagulak. Moderately large colonies also were found at Salt and Sagchudak islands, the only other sizable ones free of foxes. Gulls seemed to have experienced a disastrous breeding season, as most nests located were abandoned and poorly constructed. Temperatures at Adak were below average in June and July, and precipitation and wind were greater than normal. These factors may have contributed to the poor nesting success.

Kittiwakes. Kittiwakes nested on three islands, totalling 9000 nesting pairs; two-thirds of the nests were at Chagulak. Kittiwakes also appeared to have had a pronounced reproductive failure in 1982. Only a few abandoned nests and 2850 birds were present at the previously reported large colony at Koniuji. Reproductive failure also occurred in the Pribilof Islands and at St. Matthew Island (Roseneu, Springer, and Murphy, pers. comm.) in 1982. Kittiwakes are uncommon in the eastern Aleutians; Nysewander et al. (1982) recorded 1600 breeding birds in the Fox Islands. The estimated 3000 pairs at Chagulak constitutes the largest kittiwake colony in the Aleutians east of Buldir. Sekora (in U.S. Fish and Wildlife Service 1973) reported much higher populations on both Koniuji (10,000) and Chagulak (28,500) 10 years earlier, which we attribute partly to exaggeration and partly to reproductive failure in 1982. However, we can't discount the possibility that a real decline may have occurred.

Two red-legged kittiwakes (Rissa brevirostris) were sighted in Amukta Pass, but no nesting birds were detected during careful examination of the black-legged kittiwake colonies on Chagulak and Amukta. The nearest known red-legged kittiwake colony is at Bogoslof, 274 km to the northeast (Sowls et al. 1978).

Murres. We noted murre colonies on five islands; thick-billed murres greatly outnumbered common murres everywhere but Seguam Island. Nearly all murres were on Kagamil and Chagulak. With the exception of Bogoslof, where about 80,000 murres nested 10 years ago (Sowls et al. 1978), and Buldir [43,000

(U.S. Fish and Wildlife Service 1980)], more murre use Kagamil than any other island in the Aleutians. The colony on Chagulak ranks as the fourth largest in the Aleutians (Sowls et al. 1978). We estimated 34,000 murre on Kagamil and 25,000 on Chagulak in 1982, yet Sekora (in U.S. Fish and Wildlife Service 1973) reported 285,000 and 112,000 murre on these respective islands 10 years earlier! Bailey participated in the 1972 survey which occurred in ideal weather and on almost the same day in June. Such gross discrepancies can not be explained as mere vagaries in estimates; a marked population decline apparently had occurred. A colony on Koniuji recorded by both Murie (1936) and Sekora (in U.S. Fish and Wildlife Service 1973, 5500 birds) failed entirely in 1982, as no murre were seen on the cliffs during our July visit. Reproduction by thick-billed murre was also disastrous in the Pribilof Islands and at other colonies in the Bering Sea in 1982 (Roseneau, Springer, and Murphy, pers. comm.). Unusually cold and stormy conditions at the onset of breeding may be responsible, and excessive commercial fishing may be implicated in a long term decline of murre in the Bering Sea.

Pigeon Guillemot. Since guillemots nest in scattered pairs along rocky coastlines of virtually all islands, the 2500 recorded is undoubtedly a minimum estimate of the actual numbers present. As would be expected, Atka and Amlia, the islands with the most coastline, had the largest numbers of guillemots. The highest density (number of guillemots/km of shortline surveyed) was at Tanadak Island.



Brachyramphus Murrelets. A total of 51 marbled and Kittlitz's murrelets was sighted; with the exception of one marbled murrelet at Carlisle, all were in bays along the south side of Atka and Amlia islands. Marbled murrelets were more abundant than their congener, but both species probably nested in the mountains on Atka and Amlia. A Kittlitz murrelet nest was found on the north end of Atka in 1980 (Day et al. 1983). Most birds were in Vasilief and Kobakof bays, deep fjords on the south side of Atka. Marbled murrelet calls were heard as they flew into Vasilief Bay just after dark on 14 July. Similar vocalization of murrelets flying between land and sea was heard in the Kenai Fjords (Bailey 1977).

Ancient Murrelet. These birds nested on seven islands; more birds were believed to be using Koniuji and Chagulak than any other islands. Judging from the frequency of vocalization, the highest density of murrelets was encountered on the southwest side of Sagchudak; the 14 July visit to this island may have coincided with the period when many chicks were going to sea. If our guess of 10,000 birds breeding on Koniuji is not excessive, this would be the largest murrelet colony in the Aleutians (Sowls et al. 1978, Nysewander et al. 1982). Most of the larger colonies are in the Fox Islands.

Cassin's Auklet. Though no census plots were delineated, the numbers of Cassin's auklets flying about the M/V Sea Spray on the night of 16 June and the density of burrows (containing both chicks and eggs) along parts of the southwest arm of Chagulak Island suggest that as many as 100,000 birds may have been present. Certainly more birds of this species nest here than on

Castle Rock in the Shumagins, where sampling revealed 46,000 auklets (Sowls et al. 1978). Even if our guess is excessive, Chagulak Island certainly possesses the largest Cassin's auklet colony in the Aleutians. An estimated 30,000 breed at several colonies in the Fox Islands (Nysewander et al. 1982). Besides Chagulak, Cassin's auklets nested on five other islands in the survey area. The birds noted at Amukta Island may have originated from nearby Chagulak. A small population on Buldir and on Tower Island off Agattu constitute the only known colonies west of Salt Island (Sowls et al. 1978, Forsell and Ambroz 1983). The western center of abundance for this species is in the Sandman Reefs south of the Alaska Peninsula (Bailey and Faust 1980).

Parakeet Auklet. Nearly 2000 birds were observed nesting on 10 islands. More than half of the parakeet auklets were at Kasatochi Island, where they were interspersed with much larger numbers of crested and least auklets. A substantial population also existed at Koniuji. The species is comparatively scarce in the eastern Aleutians, as only 600 were documented in the Fox Islands (Nysewander et al. 1982). The largest concentration in the Aleutians (43,000 birds) is at Gareloi Island (Sowls et al. 1978).

Crested Auklet. Approximately 90% of these auklets nested at Kasatochi. Since net-movement counts (Byrd et al. 1983) were not used to detect the actual number of birds entering and leaving the boulder fields, the real breeding population may have been considerably higher there. Smaller colonies also occurred on Koniuji and Chagulak. Foxes preyed heavily on the auklets at Kasatochi, but it would be simple to remove foxes from this small island.

Compared to huge colonies in the western Aleutians, such as those on Segula, Buldir, Gareloi, and Kiska, populations in the eastern Aleutians are small. No crested auklets nest in the Fox Islands east of the survey area (Nysewander et al. 1982). The only colony in the Pacific Ocean east of Chagulak is in the Shumagins (Sowls et al. 1978).

Least Auklet. This species nested in colluvium with crested auklets on three islands. Like its congener, most least auklets used Kasatochi Island. Also, the colonies in the eastern Aleutians are dwarfed by the enormous concentrations in the western portion, such as nearly 600,000 birds at Kiska (Day et al. 1979). No least auklets were found in the Fox Islands, and they are not known to breed further east than the Semidi Islands off the Alaska Peninsula (Hatch 1978).

Whiskered Auklet. The whiskered auklet, which breeds exclusively in the Aleutians, was once thought to number only 20,000 birds at 10 known nesting sites (Sowls et al. 1978). Later, Byrd and Gibson (1980) summarized observations and suggested a minimum population of 25,000 birds. Recent surveys of the Fox Islands (Nysewander et al. 1982) revealed them nesting on at least 33 islands, and additional sites have been located in the central and western Aleutians (U.S. Fish and Wildlife Service 1981,1980; Day et al. 1978, 1979). Nevertheless, this species remains one of the least common nesting seabirds. The largest nesting population known (7000 birds) is on Buldir (U.S. Fish and Wildlife Service 1980).

Whiskered auklets were heard on all islands visited at night; they appeared most plentiful at Koniuji, Kasatochi, Amukta, Yunaska, and Chuginadak. Pairs usually were scattered along cliffs and boulder beaches rather than being in discrete colonies. They were more colonial at Koniuji than elsewhere and nested inland there as well as along the coast. In the Fox Islands, these birds also were noted in loose colonies or in scattered pairs and were strictly nocturnal on land (Nysewander et al. 1982). The largest number of birds we saw at sea was about 2000 off the southwest end of Yunaska. Murie (1936) also mentioned large numbers of auklets feeding in the tide rips west of Yunaska, and concentrations of up to 10,000 birds were documented there in 1972 (Kessel and Gibson 1976). Byrd and Gibson (1980) tallied 12,100 whiskered auklets in the Islands of Four Mountains, in 1972, and recorded 2519 birds there in 1974. There seems no way to enumerate populations other than estimations from numbers of calls heard around the entire perimeter of a given island having suitable rocky habitat. Nysewander et al. (1982) estimated 14,000 in the Fox Islands based on numbers observed feeding in passes and relative abundance along the cliffs censused.

Horned Puffin. This species nested on at least 16 islands, with the largest numbers located on Chagulak, Salt, and Amlia. On most islands horned puffins nested in small colonies or solitarily much like pigeon guillemots, and the total population in Table 1 probably is far too low. The same scattered nesting pattern is evident in the Fox Islands (Nysewander et al. 1982). Sekora (in U.S. Fish and Wildlife Service 1973) reported several thousand horned puffins at Uliaga, but we found only a few scattered about the island.

Tufted Puffin. Roughly 100,000 tufted puffins, surpassed in numbers of diurnal nesters only by fulmars, were believed to be breeding between Kasatochi and the Islands of Four Mountains. Though they occurred on almost all islands, 70% of the total birds estimated were at Chagulak and Koniuji. Practically all of the birds reported for Atka and Amlia (Table 1) actually used nearby small islets. The substantial colony on "Round" Island north of Amlia was first noted years ago (Sowls et al. 1978). All islands with significant numbers of puffins lacked foxes. The tufted puffin population, like other burrow-nesters in this region, was probably much greater before foxes were introduced. Muñie (1936) specifically relates that thousands were using Carlisle and Uliaga in the 1930's. Until census plots are established, the size of the large populations on Chugulak and Koniuji will remain merely best guesses. None of the puffin colonies in the survey area compare with the enormous ones to the east in the Fox Islands, where populations exceed 100,000 each on six small islands (Nysewander et al. 1982). Over a million tufted puffins, 40% of all known breeders in the state, inhabit small fox-free islands between Unimak Pass and Umnak Island.

Shorebirds and Cranes. A total of 120 black oystercatchers was recorded on 11 islands. Half of the birds were on Amlia, and it seems odd that no oystercatchers were noted at several large islands, such as Herbert, Carlisle, and Yunaska, despite the presence of foxes. More oystercatchers certainly would have been encountered if all stretches of shoreline had been closely inspected on foot or from an inflatable boat. For example, all of Amlia's 228

km coastline was surveyed from inflatables and 60 oystercatchers were sighted. On the other hand, the majority of Atka's 475 km shoreline was examined from the charter vessel, and only 26 oystercatchers were recorded.

Rock sandpipers (Calidris ptilocnemis) nest in interior tundra on Amlia, Seguam, Yunaska, Kagamil, Carlisle, and Chuginadak islands. They undoubtedly also nest on other large islands. Other observations of shorebirds included a least sandpiper (Calidris minutilla) on Amlia, whimbrels (Numenius phaeopus) on Chuginadak, semipalmated plovers (Charadrius semipalmatus) on Yunaska and Chuginadak, a great knot on Seguam, and northern phalaropes nesting on Tanadak. Shorebirds may have been more numerous in this region prior to the introduction of foxes, as foxes generally are more numerous on islands with extensive beaches, the preferred habitat of many shorebirds.

A sandhill crane was observed on Chuginadak, and three were seen in flight off Seguam.

Waterfowl. A second wild breeding population of Aleutian Canada geese was found on Chagulak Island (Bailey and Trapp 1984). Approximately 1000 harlequin ducks were recorded, being seen at all islands except Koniuji and Tanadak. We observed 520 common eiders on a dozen islands; the largest numbers occurred at Amlia, Atka, Sagchudak, and Chuginadak. Nests were located on an islet off the latter island. A few oldsquaws (Clangula hyemalis) were seen at Amlia and Atka.

Because of the abundance of foxes on islands like Amlia, where marshes and ponds are common, and because most other islands are volcanic and thus lack suitable habitat, other species of ducks were scarce. A few green-winged teal (Anas crecca minima), mallards (A. platyrhynchos), and red-breasted mergansers (Mergus serrator) were spotted on Amlia; five common mergansers (M. merganser), a red-breasted merganser, and northern pintails (A. acuta) were on Chuginadak; a bufflehead (Bucephala albeola) and two greater scaup (Aythya marila) at Seguam; and a white-winged scoter (Melanitta fusca) at Amukta.

Raptors. We recorded a total of 135 bald eagles and 19 active nests. Though we saw eagles at all islands, a third of them inhabited Amlia, where eight nests also were found. An extraordinary 17 eagles, mostly immatures, congregated on tiny Koniuji to prey on puffins, auklets, and other seabirds.

Forty-four peregrine falcons were sighted on 13 islands; eyries were evident on at least five islands. The highest density of falcons was at Kasatochi, the island having most of the crested and least auklets in the survey region. Likewise, 10 peregrines were at Amukta and adjacent Chagulak; several fulmars apparently killed by falcons laid on talus slopes on Chagulak. Concord Point on Chuginadak was another principal area used by falcons, though no large seabird colonies existed there.

Twenty common ravens preyed on fulmar eggs and other seabirds at Chagulak.

Ptarmigan. Rock ptarmigan inhabited all of the larger islands, except Seguam and Amukta. Murie (1936) did not mention ptarmigan on Seguam, and it is not known whether they were formerly there and subsequently succumbed to introduced foxes. We found no trace of ptarmigan on Amukta, but they were present there in 1936 (Murie 1936). Thus, they had evidently been extirpated by foxes. Foxes reportedly also eliminated ptarmigan from Agattu Island in the western Aleutians (Jones, pers. comm.). Amukta and Agattu appear to be the only large islands where ptarmigan have been eliminated in the Aleutians. Following the disappearance of foxes on Salt Island, ptarmigan have apparently recolonized it from nearby Atka. Despite numerous foxes, ptarmigan have survived on all of the Islands of Four Mountains, including 930 ha Uliaga. The key to their continued existence on these islands probably is that all are exceedingly rugged and attain considerable altitude. The absence of ptarmigan on Seguam, Amukta, and Chagulak constitutes the biggest gap in ptarmigan distribution in the 1770 km Aleutian archipelago. Eight subspecies are recognized in the Aleutians. The rock ptarmigan on Yunaska and Atka are both supposedly different from the race on the Islands of Four Mountains (Gabrielson and Lincoln 1959). The Atka variety (L. m. atkhensis) also inhabits Amlia. L. m. nelsoni is the subspecies reportedly on the Islands of Four Mountains. Willow ptarmigan (L. lagopus) are reported to occur on Atka along with the more common rock ptarmigan (Murie 1959). We encountered neither species despite hiking across the island in two places. Murie considered them abundant there. The only other islands in the Aleutians supposedly having willow ptarmigan are Unalaska and Unimak to the east. Ptarmigan appeared most numerous on Amlia and Chuginadak.



Passerines. Rosy finches, song sparrows, and winter wrens inhabited practically all islands large enough to support vegetation. Rosy finches were not seen on Tanadak or Yunaska, but Murie (1936) saw them on the latter island. Song sparrows were noted everywhere but on Carlisle, an island with a particularly high density of foxes. Winter wrens were recorded on all islands but Kagamil, where Murie (1936) saw several. Lapland longspurs and snow buntings were not so ubiquitous, occurring on 14 and 11 islands, respectively. Oddly, neither Murie (1936) nor our party saw snow buntings on Yunaska. The latter two species generally preferred Empetrum nigrum associations at higher elevations, whereas rosy finches, song sparrows, and winter wrens preferred shoreline habitats.

Savannah sparrows (Passerculus sandwichensis) occupied at least five islands from Seguam eastward. Gabrielson and Lincoln (1959) regarded them as breeders as far west as Amukta; they become progressively more abundant in the Islands of Four Mountains, Fox Islands, and eastward. At Cold Bay, on the tip of the Alaska Peninsula, savannah sparrows are by far the most numerous species in riparian shrubs (Bailey 1974).

Besides the six aforementioned frequently observed species, we encountered only four other passerines: water pipits at Seguam and Uliaga, common redpolls at Chagulak and Koniuji, barn swallows at Amukta, and a bank swallow at Uliaga Island. Water pipits and redpolls breed east of the Islands of Four Mountains (Gabrielson and Lincoln 1959); Murie (1959) considered them to be scarce west of the Fox Islands. Barn swallows nested on Unalaska (Murie 1959)

but are rare to the west, with only two other published sightings on Agattu (Kessel and Gibson 1976). Only three other records of bank swallows in the Aleutians are known (Kessel and Gibson 1978, Nysewander et al. 1982). Our 24 June observation on Uliaga is the only Aleutian record during the breeding season, except for an earlier sighting in 1981 at Akutan (Nysewander et al. 1982). The furthest west positive breeding locale is at Cold Bay (Bailey 1974).

#### MARINE MAMMAL ACCOUNTS

Sea Otter. We recorded a total of 1275 sea otters and observed them at all islands, but only 68 (5%) of the otters were found east of Amukta Pass (Table 2). Nearly 850 (67% of the total) were off Amlia and nearby islets, and 220 otters were counted around tiny Tanadak Island off the eastern tip of Amlia. The fact that only 100 sea otters were spotted around Atka largely reflects the inadequate survey effort there rather than a paucity of animals.

Villagers from Atka also harvest some sea otters. In 1972 no otters were seen anywhere in the Islands of Four Mountains despite ideal weather (U.S. Fish and Wildlife Service 1973). Including Yunaska, we counted 39 in this area, where water depths are generally too great (more than 70 m) for them to feed in. In contrast, the extensive shoals surrounding Amlia and Atka afford excellent kelp habitat for sea otters. Much of Segum Pass is less than 70 m deep. Nysewander et al. (1982) counted 740 otters in the Fox Islands, compared to an estimate of 300 in 1972 (U.S. Fish and Wildlife Service 1973). It appears that sea otter populations are expanding westward from the large

concentrations in the Sanak and Sandman Reefs region into the Fox Islands, with a few reaching the Islands of Four Mountains Group. The 17 sea otters observed around Chuginadak suggest a permanently established population, but limited shoals will markedly restrict further expansion. The total estimated population of sea otters in the Aleutian archipelago ranges from 55,000 to 74,000 (Frost et al. 1982).

Steller's Sea Lion. More than 12,000 Steller's sea lions were noted on 13 islands. The largest population (4150) was at Seguam, and over 1000 were seen on Kasatochi, Amlia, Yunaska, and Chuginadak islands (Table 2). We saw pups at all the above islands except Chuginadak. The number of sea lions indicated for Atka Island (40) is undoubtedly much too low because most of the coastline was not examined closely from an inflatable. A reconnaissance of the Aleutians by Kenyon and King in 1965 (U.S. Fish and Wildlife Service 1973) recorded 4900 sea lions on the north end of Atka, more than on any other island in the Aleutians west of the Fox Islands. We failed to cover any of the coast north of Atka Village by inflatables, and part of this section was not even viewed from the M/V Sea Spray. In 1965, 4400 animals were reported on Seguam (Sekora 1973), about the same number as we estimated. In 1982, nearly all sea lions, including about 400 pups, were congregated at Saddleridge Point. Sea lion numbers reportedly have declined in the eastern Aleutians in the last 30 years (Braham et al. 1980). Substantial decreases have been recorded throughout Alaska, with a 79% population decline in the eastern Aleutians since the 1950's being the greatest (Merrick et al. 1986).

Harbor Seal. Seals were evident at all but five islands but totaled only 558 animals (Table 2). Approximately 76% were located on Chuginadak, Amlia, and Sagchudak. The largest concentration (104) was on Sagchudak, which has less than 6 km of shoreline. A thorough survey of Atka's 480 km coastline certainly would have revealed more than 36 seals. In March 1960, 140 seals were estimated in the Islands of Four Mountains (U.S. Fish and Wildlife Service 1973). Seals usually prefer water depths of less than 55 m. Nysewander et al. (1982) reported 2500 seals in the Fox Islands.

## SUMMARY

Between 2 June and 22 July 1982 a reconnaissance of marine birds and mammals breeding between Kasatochi and the Islands of Four Mountains in the eastern Aleutians was conducted from a 29 m fishing boat and with 5 m inflatables. The primary purpose of the survey was to locate seabird colonies and estimate populations. The only previous systematic surveys in this region were in 1936-37 and 1972.

The 21 named islands that we visited stretch about 400 km, roughly one quarter the length of the Aleutian archipelago. The combined shoreline of these volcanic islands is nearly 1130 km. Landings were made on practically all islands, and most were camped on or visited at night to search for nocturnal nesting seabirds.

All of the sizeable islands in the Aleutians were used for fur farming until about 1940. In the survey area arctic foxes were released on all but eight small islands in the early 1900's; red foxes were introduced to Amlia and Chuginadak probably before 1900. Foxes have disappeared from only two small islands. Red foxes have eliminated arctic foxes on Chuginadak Island. Because of sustained fox predation only relict numbers of burrow- and ground-nesting seabirds remain on most islands.

At least 735,000 diurnal seabirds are believed to have nested in the survey area in 1982. Twenty-one species of seabirds utilized the islands, and two additional species were suspected breeders.

Approximately 80% of the diurnal seabirds were found on Chagulak, an exceedingly rugged island which escaped fox introductions. This island with an estimated 500,000 northern fulmars, also had enormous numbers of nesting fork-tailed and Leach's storm-petrels and Cassin's auklets. At least 18 species nest on Chagulak, and nocturnal nesters appeared to considerably outnumber diurnal species on this island as well as throughout the region.

Kasatochi, Koniuji, and Kagamil had diurnal seabird populations exceeding 30,000, but each of the remaining islands probably had fewer than 10,000 breeding birds. Koniuji, another fox-free island, was used by tens of thousands of four species of nocturnals and is the second most important colony in the survey area. Marine birds were scarce on most of the larger islands because of numerous foxes. Crested and least auklets were abundant on Koniuji and neighboring Kasatochi.

The fork-tailed storm-petrel, which nested on 15 islands, was probably the most abundant of the breeding seabirds. Based on our subjective impressions of birds flying about at night and the intensity of vocalizations, we speculate that the total population may have exceeded one million birds. Leach's storm-petrels were found on 11 islands and seemed to be the next most abundant species. In decreasing order, northern fulmars, Cassin's auklets, tufted puffins, thick-billed murrelets, crested auklets, least auklets, and ancient murrelets comprised the remaining sizeable populations of breeding seabirds. All other diurnal species for which estimates were made totaled fewer than 5000 pairs. The Cassin's auklet colony at Chagulak, though not

censused, is probably the largest for this species in the Aleutians. Although no estimates were made, thousands of whiskered auklets nested in scattered colonies along lava cliffs and boulder beaches on virtually all islands. Kittiwakes, murre, and gulls appeared to have experienced a widespread nesting failure in 1982, and murre and kittiwake populations may have declined between 1972 and 1982.

Except for harlequin ducks, common eiders, and black oystercatchers, waterfowl and shorebirds were generally scarce because of the lack of ponds and marshes on the volcanic islands and because of prevalent foxes. Chagulak Island was a notable exception, as Aleutian Canada geese were discovered breeding there. This remnant population, which totaled at least 90 birds in 1982, is the only other site in the Aleutian Islands besides Buldir Island where a wild population of this subspecies survived. Elsewhere they were extirpated by introduced foxes. Several nests were found, and the island may support 200 to 300 birds.

A total of 135 bald eagles and 19 nests plus 44 peregrine falcons and five eyries was located. A great knot, only the second record for this species in the Aleutians, was sighted on Segvam Island. Unusual observations of some passerine birds were also made.

A total of 1275 sea otters, 558 harbor seals, and 12,031 Steller's sea lions was recorded. Sea otters apparently are slowly expanding westward from the Fox Islands into the Islands of Four Mountains. Most sea otters occurred in

extensive shoals surrounding Amlia and Atka islands. A majority of the seals were on just three islands, and sea lions were concentrated on Seguam and three other islands where pups were also noted. Like possibly certain seabird populations, sea lion numbers have decreased in the eastern Aleutians.



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