FINAL REPORT

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SEABIRDS AND THEIR NESTING HABITATS ON WESTERN NUNIVAK ISLAND, ALASKA

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INTRODUCTION

The avian resources of Nunivak Island, including its large colonial seabird populations, have never been adequately described. Swarth's (1934) annotated checklist of birds represents the most intensive ornithological research there, and first mentions large seabird colonies near Cape Mohican. Lantis (1946) in her anthropological treatise, also refers to the abundance and distribution of seabirds. Dr. Peter Stettenheim in 1954, was the first to visit these colonies to observe seabirds, and later compared them to those he saw on the Pribilofs (pers. com.). The first numerical estimate was derived from a circuit of the coast (USFWS, unpubl. files, Colony Status Report, Anchorage, Alaska). It was estimated that the colonies contained approximately one million indivduals.

Due to the paucity of information and the potential magnitude of Nunivak's colonies, Alaska Biological Research, in cooperation with the U.S. Fish and Wildlife Service (USFWS) undertook field studies in 1978 in order to map and describe colonial seabird habitats, determine species composition, identify suitable sample plots for future comparisons, and estimate numbers of principal species including common murres, Uria aalge, thick-billed murres, Uria lomvia, black-legged kittiwakes, Rissa tridactyla, horned puffins, Fratercula corniculata, tufted puffins, Lunda cirrhata, pelagic cormorants, Phalacrocorax pelagicus, and parakeet auklets, Cyclorrhynchus psittacula. The results of this study should help establish criteria and baseline information for future surveys, and combined with ongoing research in the Bering Sea, provide a more complete picture of its seabird resources.

Funding for this research was provided by the U.S. Fish and Wildlife Service, Contract No. 72100-0122, and Alaska Biological Research. I am grateful to Dr. Peter Stettenheim for making unpublished data available to me. I would especially like to acknowledge the assistance of Tim Smith, USFWS Biologist, Nunivak Island. His support was essential to the successful completion of this project.

STUDY AREA

The study area (Figure 1) includes those cliffs along the west coast of Nunivak Island, specifically from Mikisagimiut (60°14'N, 167°16'W) west to Cape Mohican, then southeast to Dahloongamiut Lagoon (59°59'N, 167°07'W), a total of 46 km (28 miles). Miscelaneous observations were gathered in a larger area between Mekoryuk and VABM Cliff. Descriptive summaries of the island's climate, geology, flora and fauna are found in Bos (1967); descriptions for this region of the Bering Sea are located in Selkregg (1977) and Brower et al. (1977).

METHODS

Surveys were conducted between 1 and 29 July. Transportation was provided by a 17' Boston Whaler and 50 h.p. outboard. Due to inclement weather, surveys often depended on ground-based observations. Camps were established at Mikisagimiut, Binaksbak Bluff, Dooksook Lagoon and Dahloongamiut Lagoon. Field itineraries have been summarized in Appendix A.

Habitat and colonies were mapped from ground and boat surveys (USGS 1:63,360 maps). Key topographical features not distinguishable on these maps were added to describe locations of sub-colonies. All coastal cliffs between Cape Mohican and Dahloongamiut Lagoon were described. A series of black and white photos of this section of coastline was taken with a 35 mm camera.

Census techniques were similar to other extensive Bering Sea surveys (Day et al. 1978, DeGange and Sowls 1978). Standard surveys (Nettleship 1976) were modified to meet local sea and weather conditions. Species were enumerated either by 1) counts of individuals (both puffins, auklets), 2) nest counts (cormorants), or 3) estimates of individuals (kittiwakes by 10's, murres by 10's and 100's). Compensation factors such as attendance features (Swartz 1966) or observer handicaps (Springer and Roseneau 1977) were not calculated.

Miscelaneous observations including phenology and daily avian counts have been summarized in the text and appendices.

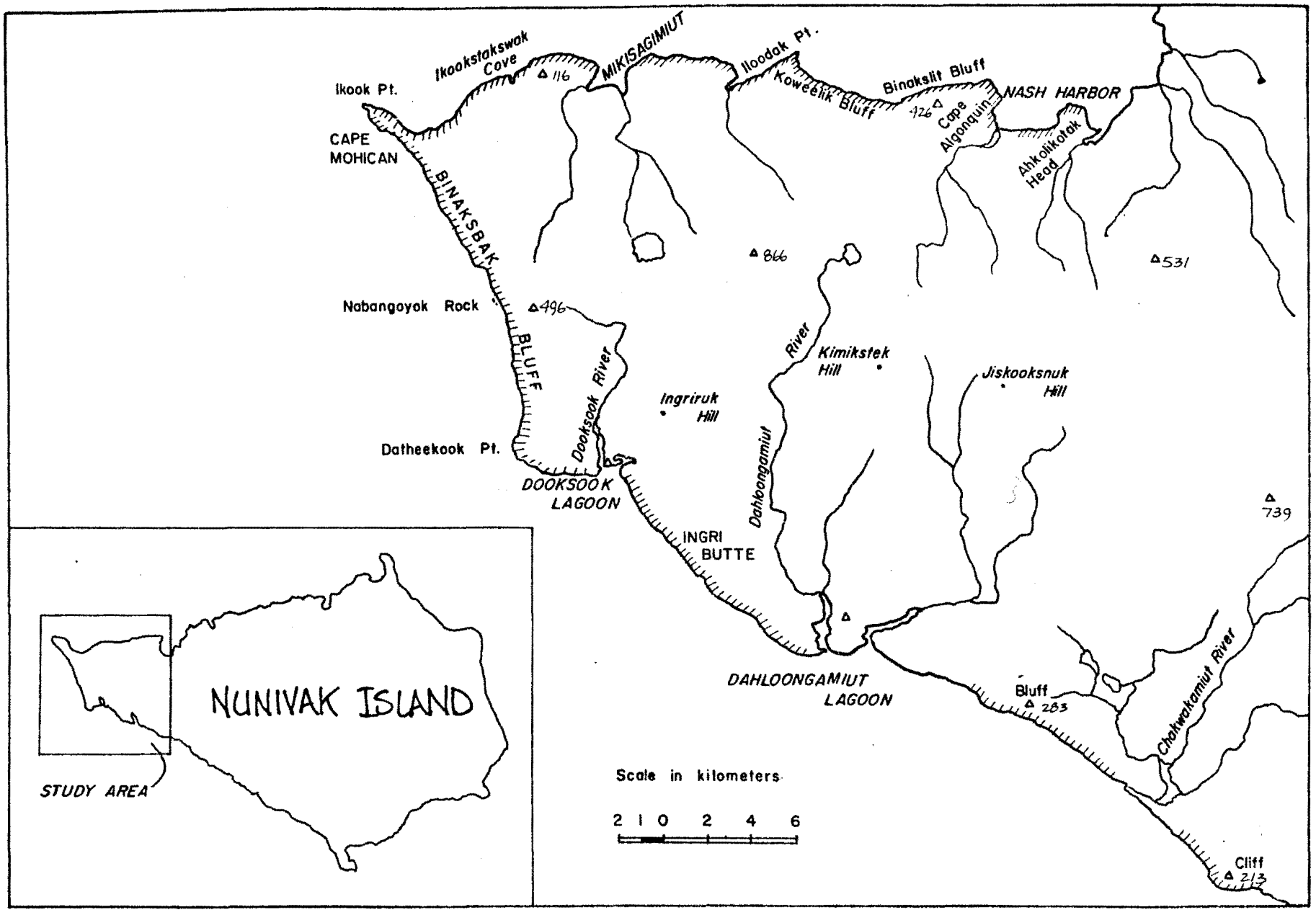

FIGURE 1. Western Nunivak Island study area and cliff distribution there

RESULTS AND DISCUSSION

Habitat Description

Cliff habitat extends approximately 100 km (60 miles) from Ahkolikotak Head in Nash Harbor west to Cape Mohican and then southeast to VABM Cliff (near Chakwakamiut River). These cliffs are interupted by streams and their associated lagoons and coincide with the approximate extent of tertiary volcanic rocks (Beikman 1974).

Cliffs range in height from approximately 15 m (50 feet) to 150 m (450 feet). Most are steep with nearly vertical faces, but moderately sloping rubble, talus and soil slopes do occur. A narrow boulder beach lies below cliff faces, except where headlands project into the sea. A community dominated by celery, Angelica lucida, and roseroot, Sedum rosea, exists along the cliff slopes. Cliff tops are less homogenous in cover, ranging from damp Carex sp. and rye, Elymus mollis, to dry alpine association.

Substrates available for seabirds, listed in the order of their occurrence, include small fractured rock faces (Fig. 2), soil-boulder mixes (Fig. 3), large rock faces and columns (Fig. 4), boulder beaches and talus slopes (Fig. 5) and soil slopes (Fig. 6). Habitats located on these substrates, include broad and narrow ledges, fissures, caves and burrows. Table 1 describes substrates and associated habitats as they pertain to cliffs in the area. Figure 1 has been keyed to this table.

Cliff properties such as substrate stability, distance to the sea and its wave action, vegetative cover and accessibility for mammalian predators, probably influence the distribution of seabirds in the area, and suggest reasons for noticeable gaps in the Nunivak colonies. Red fox, Vulpes fulva, for instance, have reduced the value for nesting of the more accessible slopes. Their influence in shaping other colonies has been documented (Fay and Cade 1959). Fox sightings have been summarized in Appendix B.

Finally, low coastal bluffs and islands, not described above, provide nesting and loafing activities for seabirds outside of the study area.

Table 1. Substrates and associated cliff habitats, western Nunivak Island

Geographic Area	Habitat Descriptions	Species Present[1]
Cape Algonquin Binakslit/Koweelik Bluffs	50-80 m, north exposure, steep fractured columnar rock and soil-boulder mix; talus in Cape Algonquin area	PG, HP, TP, PC, GWG
Iloodak to Ikookstakswak Cove	15-30 m, north and west exp., steep, sparse vegetated rubble, with occassional rock faces	PG, HP, TP, PC, GWG, PA
Ikookstakswak to Ikook Point	30-75 m, north exp., steep terraced and irregularly fractured rock; broad boulder beach and talus at Cape Mohican	PG, HP, TP, PC, GWG, PA MU, CA
Binaksbak Bluff	30-150 m, west exposure	
	a) north Binak, 50-70 m, continuous boulder beach, low ½ of cliffs composed of fractured rock faces, topped by vegetated, soil,rubble slopes	PG, HP, TP, PC, CMU, BLK, PA, GWG
	b) mid Binak, 70-130 m, cont. boulder beach, front 2-3 bands of rock faces, separated by vegetated slopes (40°-60°); lower bands comprised of irregular fractures and narrow to broad ledges; if third band exists, rock habitats less fractured	HP, TP, PA, CA, GWG, GG, CMU,TBMU, BLK PC
	c) Nabangoyak Rock, 100-140 m, steep sandy and grassy slopes, topped by rock and soil mix; talus, at southern extent	HP, TP, PA, PC
	d) south Binak, 30-70 m, indented headlands and rock faces lower ½, upper mainly fract. rock and soil	CMU, HP, TP, PC, PA, BLK

Table 1. continued

Geographic Area	Habitat Descriptions	Species Present[1]
Datheekook Point to Dooksook Lagoon	15-30 m, south exposure, tapering of south Binak habitats to east, reduced to crumbling soil-rock mix	HP, TP, PC, CMU, BLK
Ingri Butte	15-100 m, southwest exposure	
	a) north Ingri, comprised of blocky fract. faces, regular horizontal fractures, producing broad ledges	HP, TP, PA, CMU, BLK, PC
	b) south Ingri, cliffs become increasingly vegetated and broken by gradual slopes of talus and rubble; low bluffs of rock-soil mixes occur east of Dooksook and west of Dahloongamiut	HP, TP, PA, PC, CMU, PG, BLK, GWG
Chakwakamiut	50-80 m, southwest expos., vertical columnar faces, footsloped by broad vegetated soil or talus; fronted by dunes in central region	HP, TP, PA, PG, PC

[1] refers to the species present; those underlined are common, while others are present; abbreviations are: HP=horned puffin, TP=tufted puffin, PC=pelagic cormorant, PG=pigeon guillemot, PA=parakeet auklet, CA=crested auklet, GWG=glaucous-winged gull, GG=glaucous gull, MU=murre, CMU=common murre, TBMU=thick-billed murre, BLK=black-legged kittiwake

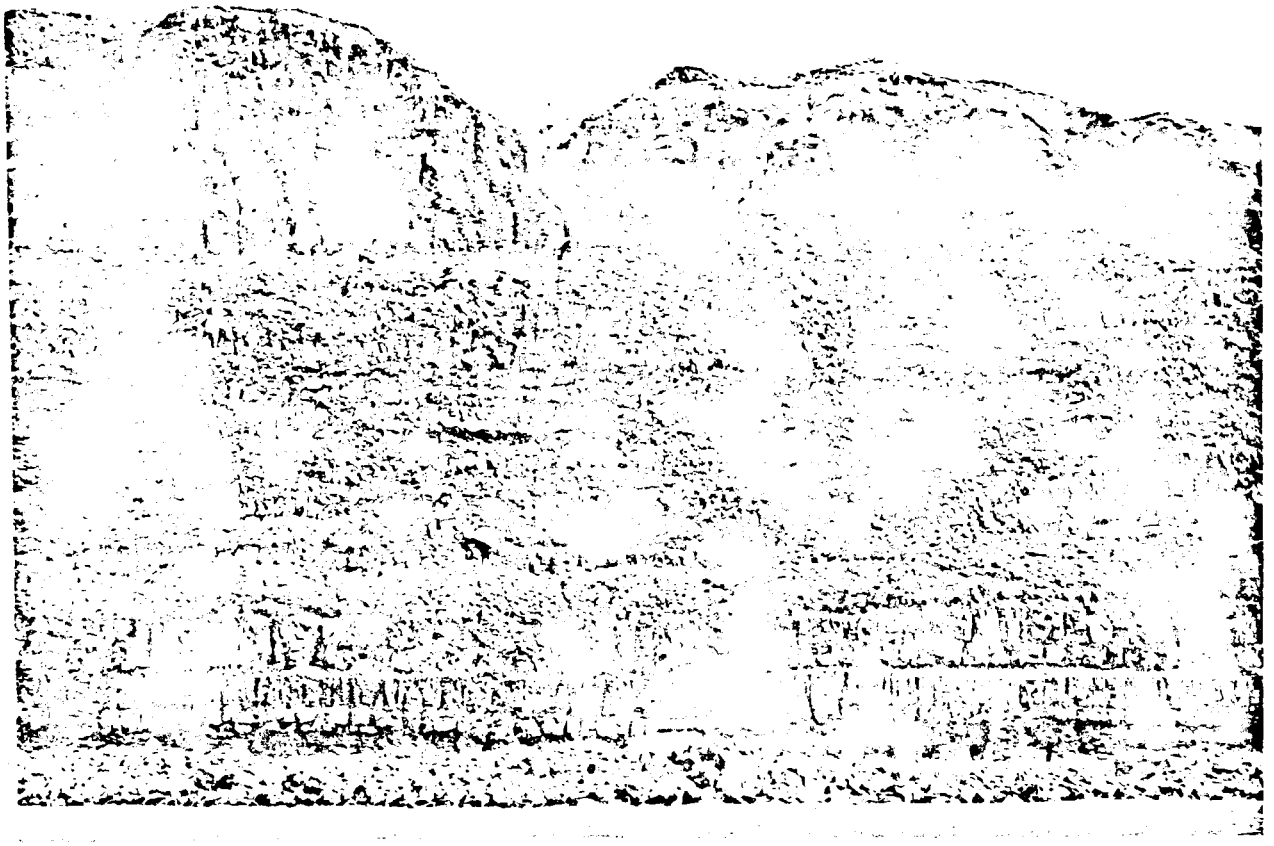

FIGURE 2. Mid Binaksbak Bluff, depicting irregular rock faces.

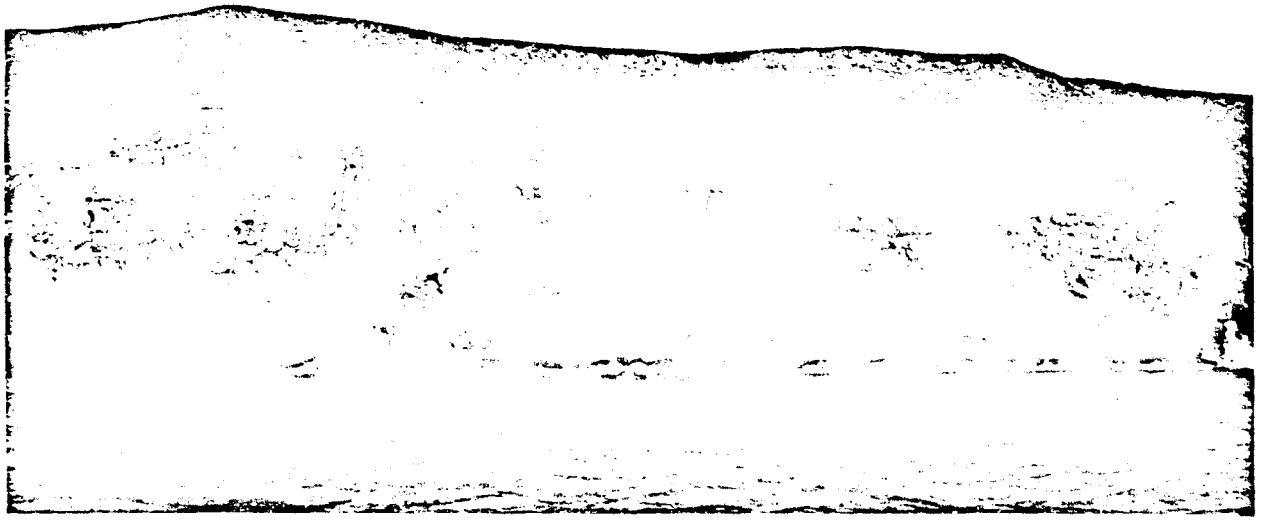

FIGURE 3. Datheekook Point, depicting boulder-soil mix habitat.

FIGURE 4. Ingri Butte, large rock face and horizontal strata habitat.

FIGURE 5. Mid Binaksbak Bluff, talus and boulder beach habitat

FIGURE 6. Mid-Binaksbak Bluff, soil slopes (Nabangoyak Rock)

Species Accounts

The science of counting seabirds and equating these counts with population estimates is made difficult by attendance patterns of each species, climatic conditions occurring near the sea cliffs, observer variability and a myriad of other factors. We recognize these limits and admit, that at best our counts will be difficult to reproduce.

Although we were primarily interested in mapping habitat and the distribution of seabirds, incidental observations were made regarding the breeding biology of the principal species. This phenological data is summarized in Table 2. It is the general consensus of many investigators that spring was early in the Bering and Chuckchi Seas (Dau pers. com., Schamel pers. com., Norton pers. com.). Consistent with this, Nunivak's seabirds probably nested earlier than average years (Williams pers. com.).

Table 3 summarizes our most complete counts for each species. Counts ranged between 284,964 and 331,384 birds (two observers). The actual seabird population is larger than these indices might infer, if one could consider compensatory data such as attendance patterns. From these counts and an awareness of the great number of birds in the air and water during these counts, an estimate of nearly one half million breeding birds may still be conservative. Although it is doubtful that this estimate can be used to detect any but major changes in numbers, it provides the best description to date.

Finally there are no ways to compare our numbers with the previous numerical estimate of approximately one million birds (USFWS, unpub. files, Colony Status Report, Anchorage, Alaska). However, it should be noted that this previous estimate was based general impressions of the authors, and not actual counts. The differences between these survey results, then, should not be construed as population changes.

The results of many partial counts, incomplete counts and counts determinded to be undesirable, are listed in Appendix C. Circumstances, such as time and weather, are listed for each survey.

Table 2. Phenology of principal seabird species, western Nunivak Island[1]

Species	Incubation Dates	Hatching Dates[2]	Fledging Dates
common murre[3]	early June	mid July (12 July)	early August
black-legged kittiwake[4]	early June	early July (5 July)	mid August
pelagic cormorant[5]	late April-mid May	mid June (3 July, 2 wk yg)	late July-early Aug.
horned puffin[6]	late June-early July	late July (12 July, develop. embryo)	early September
glaucous-winged gull[7]	early May	mid June (3 July, 2 wk yg)	late July-early Aug.

[1]data extrapolated from known dates and accepted incubation and fledging periods below
[2]date in parentheses refers to first young found, unless otherwise described
[3]incubation period (30-35 days), nestling period (18-25 days), (Tuck 1960)
[4]incubation period (25-31 days), nestling period (32-53 days), (Swartz 1966)
[5]incubation period (27-37 days), , nestling period (52-60 days), (Swartz 1966)
[6]incubation period (38 days), nestling period (36-42 days), (Swartz 1966)
[7]similar to glaucous gull, incubation period (27-28), nestling period (42-47), (Swartz 1966)

Table 3. Species counts and population estimates for seabirds, Cape Mohican to Ingri Butte, Nunivak Island

Species	Count[1]	Estimate[2]
Murres[3]	231,430-277,850	400,000
Black-legged kittiwakes	42,360	60,000
Puffins[4]	8,134	20,000
Cormorants[5]	1,070	1,200
Parakeet auklets	1,870	5,000
Crested auklets	100+	100+
Pigeon guillemots	-	200
Glaucous-winged gulls	-	200
Glaucous gulls	-	50
Total	284,964-331,384	486,750

[1] most complete counts, under best survey and observer conditions chosen; range for murres due to variation between two observers;

[2] based on subjective appraisal of birds observed on cliffs, due to great number of birds in sea and air during counts;

[3] murres refer to all murres on the cliffs; presently data suggests that these numbers are primarily common murres;

[4] puffins refers to horned and tufted puffins;

[5] cormorants refers to all cormorants; data suggests these numbers are primarily pelagic cormorants.

Murres

Murres were the most abundant species in the study area. Estimates in late July ranged from 231,430-272,850 birds on the cliffs. Nettleship (1976) recommended counts late in incubation, and therefore ours may have been late for an ideal count. July is known in Eskimo lore as the monthe "murres go away" (Lantis 1946). Richard Davis (pers. com.) supported this theory, and mentioned that we probably observed only part of the population since many have departed by mid July. Our late counts may have reduced the number of breeding, as well as non-breeding birds tabulated.

Concentrations of common murres were located along mid-Binaksbak Bluff and northern Ingri Butte, where broad ledges seemed to preferred. Common murres are often associated with broad ledges (Tuck 1960). Less than 50 murres were seen on cliffs east of Cape Mohican. Murre distribution is delineated in Figure 7.

The first newly hatched young was observed on 12 July. By 22 July most young appeared to have hatched. Peak laying probably occurred in early to mid June. Fledging, although not observed prior to our departure at the end of July, should have occurred by mid August (Table 2).

Attempts to evaluate productivity on selected ledges provided few usable data. Upper ledges we observed had few visible eggs or young. A ledge on Ingri Butte contained 12 young, for at least 45 adults on 24 July. Observations of numerous broken eggs beneath cliffs along Binaksbak Bluff suggested greater breeding along lower portions of the cliffs than that observed along upper ledges. Peterson and Sigman (1976) suggested that about 20% of murre pairs successfully raised young at large common murre colonies at Cape Pierce, southeast of the study area.

Attempts at compositioning revealed a lack of thick-billed murres. We were not able to observe representative habitats throughout the colony, however we scrutinized over 5000 murres along Binaksbak and Ingri; all but approximately 200 birds, located along less than 200m of low cliff, were common murres. All other evidence supports this observation: only common murres were observed on the water and in a beached bird census at Dookssk Lagoon. Furthermore, thick-billed murres were not observed by Stettenheim (pers. com.) in 1954, Hout in 1965 (USFWS, unpubl. files, Bethel), or Knutson (pers. com.) in 1970. Large common murre colonies exist at Cape Pierce, 300 km (180 miles) southeast (Peterson and Sigman 1976), while thick-billed murres predominate on St. Paul Island, 300 km (180 miles) southwest (Hunt 1976).

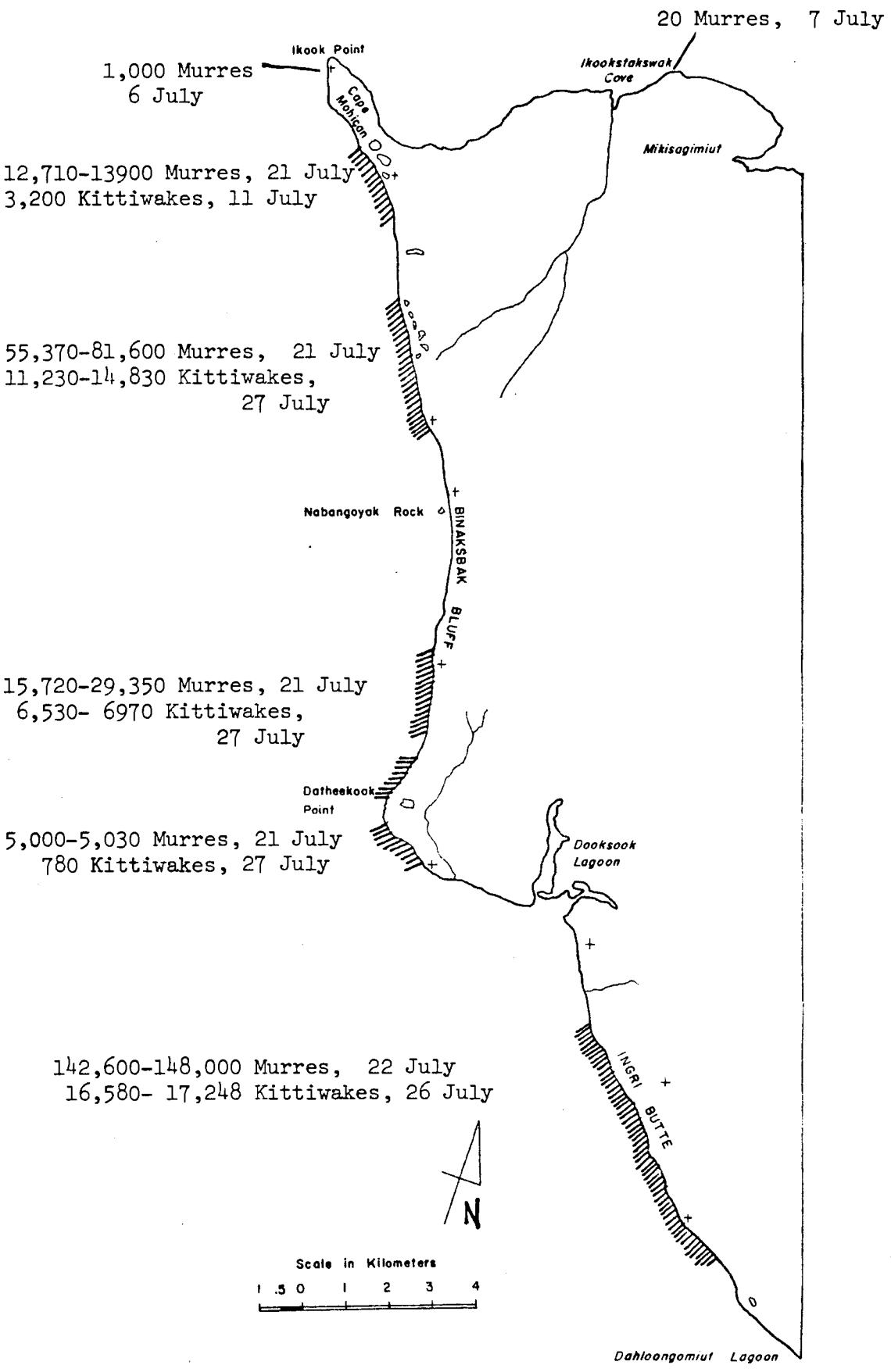

FIGURE 7. Murre and Black-legged Kittiwake distribution, and survey counts of Table 3 (range of counts due to two observers)

Black-legged kittiwakes

Black-legged kittiwakes were the second most abundant seabird species in the study area. Counts in late July recorded a minimum of 42,360 birds. Recent investigation have derived breeding estimates for kittiwakes from counts of active nests (Springer and Roseneau 1977, Day et al. 1978). We chose to count individuals on cliff faces, after attempts to count nests produced too great a variation between observers. Drury (1977) however used factors of .66 and .75 to estimate nests, from samples of birds and nests counted on cliffs. Within our study area, there were 67 nests for 106 adults on a sample cliff along Ingri (within Permanent Plot No. 3), and 34 nests for 56 adults for an area on mid Binaksbak Bluff. Combined, these equal a factor of approximately .62 for a nest to individual ratio. Using this factor, nearly 27,000 nests can be inferred from our individual counts.

Although it would be difficult to compare data from previous investigations in the area, some incidental observations need documentation. Hout mentioned that kittiwakes appeared to be the most common colonial bird in July 1965 (USFWS, unpubl. files, Bethel); murres were more abundant during our study. Furthermore, Stettenheim calculated that approximately 40% of the birds in his study area along Ingri Butte were kittiwakes (pers. com.). Fewer than 10% of the birds observed there briefly during 1978 were kittiwakes, while murre numbers were similar to Stettenheim's counts. Finally, Tim Smith remarked upon the absence of kittiwakes near Chakwakamiut cliffs, where he observed some in 1973. The first two observations may be partially explained by the timing of a murre exodus or attendance patterns, while the third suggests change. More time should be spent in the area.

The greatest concentrations of kittiwakes were along Binaksbak Bluff and the periphery of Ingri Butte murre colonies (Fig. 7). None were observed on cliffs east of Ikook Point or south of Dahloongamiut Lagoon. It appeared that kittiwakes were most abundant on lower cliffs, often occupying more vegetated alcoves, recesses and cliffs than murres.

The first kittiwake chicks were observed 5 July. Most nests observed had two eggs at this time and adults were sitting very tightly. By 12 July most kittiwakes were brooding recently hatched young. Observations of 107 active nests on 25 July revealed 97 young, all single broods. Phenology has been summarized in Table 2.

Red-legged kittiwakes, Rissa brevirostris, were not observed during the study, nor have they been recorded by previous observers.

Kittiwakes were frequently observed bathing, resting or gathering nesting materials from fresh water lakes and brackish lagoons (Fig. 7). Feeding melees were noted 2-5 km from the coast.

Cormorants

A total of 843 cormorant nests were counted between Cape Algonquin at Nash Harbor and VABM Cliff. Half of these were located in the study area. Cormorant numbers closely parallel these nest counts. Sheer rock faces with overhangs or large columnar rocks appeared to be preferred habitat; few cormorants were observed within dense aggregations of other cliff-nesters or above 50 m (150 ft.).

Cormorants nested in small, loose aggregations, especially near Mikisagimiut, Cape Mohican and south Ingri Butte in the study area. Nests have been located in Figure 8.

Nests with young birds and others with eggs were noted when we arrived at Mikisagimiut on 1 July. Fledged cormorants were noted as early as 17 July at Idookak Point; most nests, however, still had large young when we left the study area in late July. Most cormorant nests observed had 2-3 young. A sample of pelagic cormorant nests at Mikisagimiut (n=11) averaged 2.27 young per nearly fledged brood.

Concentrations of cormorants near Mikisagimiut, Cape Mohican and north Ingri Butte were searched for red-faced cormorants, Phalacrocorax urile. Only one individual of this species was definitely observed at a nest near Cape Mohican; all other birds observed closely were pelagic cormorants. Red-faced cormorants have not previously been recorded for Nunivak Island (Dau, pers. com.).

Puffins

Puffins show greater variation in attendance at colonies than other species (Searing 1977, Dau pers. com.). We therefore counted individuals at an assumed peak attendance in the late afternoon, recommended by Sealy (1973). In late July, on two successive evenings, we counted a total of 8,134 horned and tufted puffins between Dahloongamiut Lagoon and Mikisagimiut. These counts probably represent less than half of the area's nesting puffins. An estimate of 20,000 birds does not seem excessive. In August 1970, when puffins would be obvious on the cliffs at Cape Mohican, Knutson estimated that there were thousands of puffins there (USFWS, unpubl. files, Bethel).

Puffins were abundant near blocky rock faces and in the boulder-soilsubstrates, where burrow and natural crevice opportunities abound. Tufted puffins appeared to be more common at the interface of vegetated soil and rock. Most crevices were inaccessible and a single horned puffin nest with one egg was discovered on the 12 July.

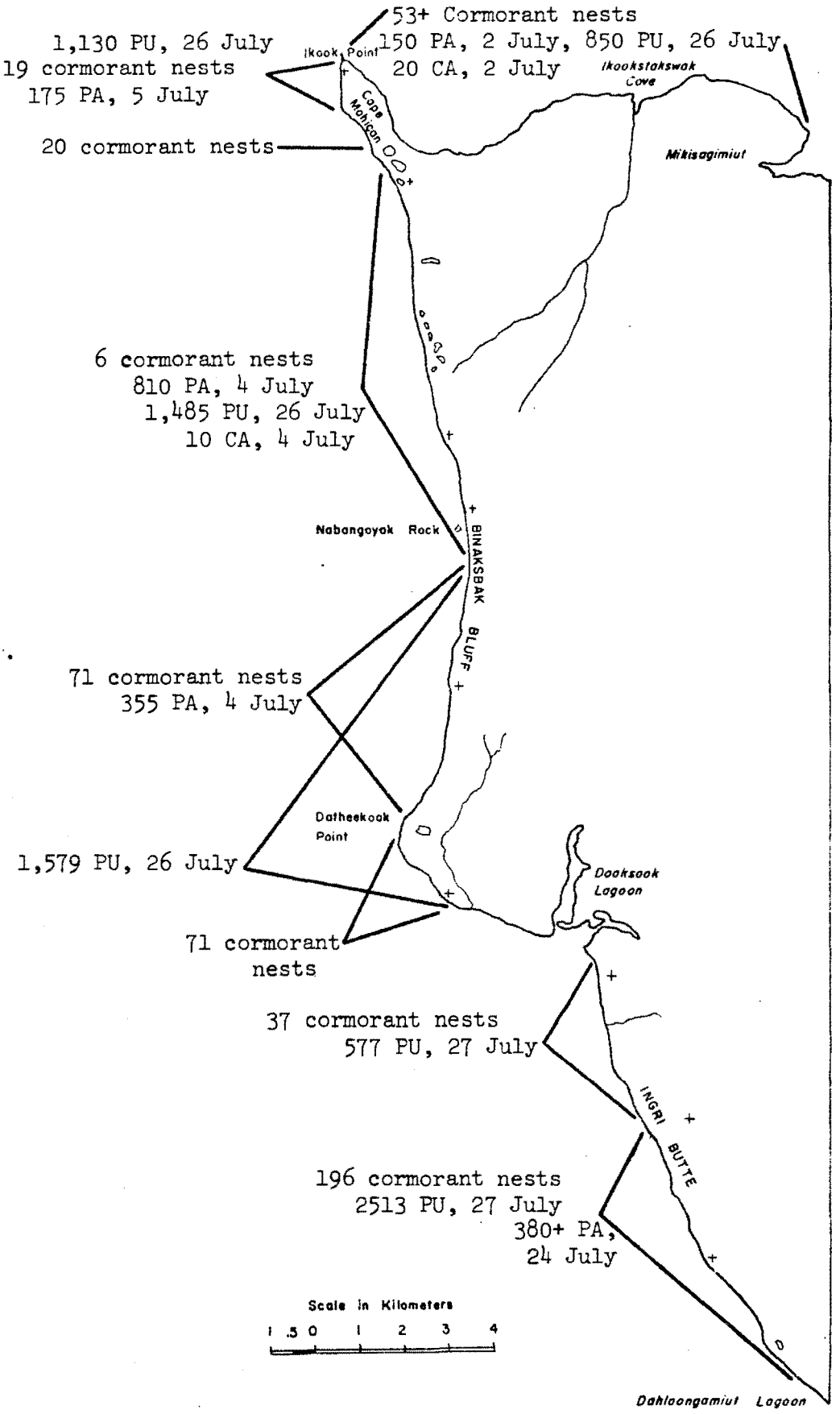

FIGURE 9. Distribution and count data for cormorants, puffins (PU), parakeet auklets (PA), and crested auklets (CA)

Although puffins were not separated by species during the above counts, compositioning through the summer (Table 4) revealed that horned puffins comprised over 90% of all puffins in those areas. In 1970, Knutson (USFWS, unpubl. files, Bethel) estimated a ratio of 10 horned puffins to each tufted puffin.

Auklets

Parakeet auklets were observed in small groups in the study area. Approximately 1870 parakeet auklets were counted in front of cliffs near Mohican, south of Nabangoyak Rock and south Ingri Butte, where talus slopes are common. Plot counts employed by Bedard (1969) or Day et al. (1978), or flight counts used by other investigators (Drury 1977, Hickey and Craighead 1976) seem more compatible with large, homogenous talus habitat and high auklet numbers. The parakeet auklet population probably does not exceed 5000 birds.

Crested auklets, Aethia cristatella, were only observed at two locations and never in numbers exceeding 20 individuals. Stettenheim did not record them at Ingri Butte in 1954 (pers. com.) and they were not listed in the reports of survey work done by Hout and Cline in the 1960's (USFWS, unpubl. files, Anchorage, Alaska, Colony Status Report). Their presence, even in these low numbers, was preceded by an unusual scent, and this assisted their detection.

Breeding status was not established for either auklet species. Parakeet auklets, however, were frequently observed at burrows.

Auklet observations have been summarized in Figure 8.

Other seabirds

Pigeon guillemots, Cepphus columba, were occassionally observed along the coast near boulder piles, especially east of Cape Mohican. Although all birds were not identified as to species, no black guillemots, Cepphus grylle, were observed. Black guillemots may have been observed by Hout in the Mohican area (pers. com.).

Glaucous, Larus hyperboreus, and glaucous-winged gulls, Larus glaucescens, probably nest more frequently outside the study area. Glaucous-winged gull nests were observed at headlands near Mohican and Mikisagimiut and on Nabangoyak Rocks. Glaucous gulls were rarely seen near the cliffs. Near Mikisagimiut, only one of 10 nests of glaucous-winged gulls had apparently escaped fox predation; red foxes have seriously affected the productivity of other gull colonies (Swartz 1966).

Table 4. Horned:tufted puffin ratios on cliffs in the study area

Date	Location	#HP	#TP	Ratio
1 July	Mikisagimiut	128	16	8:1
2 July	Mikisagimiut	130	2	65:1
3 July	Mikisagimiut	44	3	15:1
5 July	Binaksbak Bluff	208	8	26:1
12 July	Binaksbak Bluff	24	4	6:1
23 July	Ingri Butte	107	4	27:1
25 July	Ingri Butte	336	30	11:1
27 July	Ingri Butte	733	62	12:1
		1,710	129	13:1

The lateness of our work precluded proper surveys of gull nests. Large numbers of subadult gulls of these two species were observed in the lagoons and along cliffs of the study area.

A single ancient murrelet, Synthliboramphus antiquum, was observed with three parakeet auklets east of Mohican, 2 July. Two other unidentified brown murrelets, were observed near Kikalik Rocks west of Mekoryuk.

Although we did not observe fulmars, Fulmaris glacialis, on the cliffs, a light-phased fulmar was identified on a beached-bird census near Dooksook Lagoon. Fulmars nest in large colonies south and west of Nunivak Island (DeGange and Sowls 1978).

A dark shearwater was observed near Cape Mohican, 11 July. Slender-billed shearwaters, Puffinus tenuirostris, have been observed in the area.

Finally, a number of other birds were associated with the cliffs or the sea adjacent to them including: harlequin ducks, Histrionicus histrionicus, steller's, Polysticta stelleri, and common eiders, Somateria mollissima, arctic, Gavia arctica, and red-throated loons, Gavia stellata, gyrfalcons, Falco rusticolus, ravens, Corvus corax, water pipits, Anthus spinoletta, and snow buntings, Plectrophenax nivalis. Buntings were sighted on three occassions which appeared to have characteristics of McKay's buntings, P. hyperboreus.

Permanent Study Plots

Five areas were selected for consideration as permanent study plots. Each was photographed and censused. Figure 9 locates these plots, while Table 5 describes counts there. Photographs of each have been included in Appendix E.

Permanent Study Plot No. 3 on north Ingri Butte was selected because Dr. Stettenheim gathered number and composition data there in 1954 (pers. com.). A copy of a photograph taken by him has been included in Appendix E.

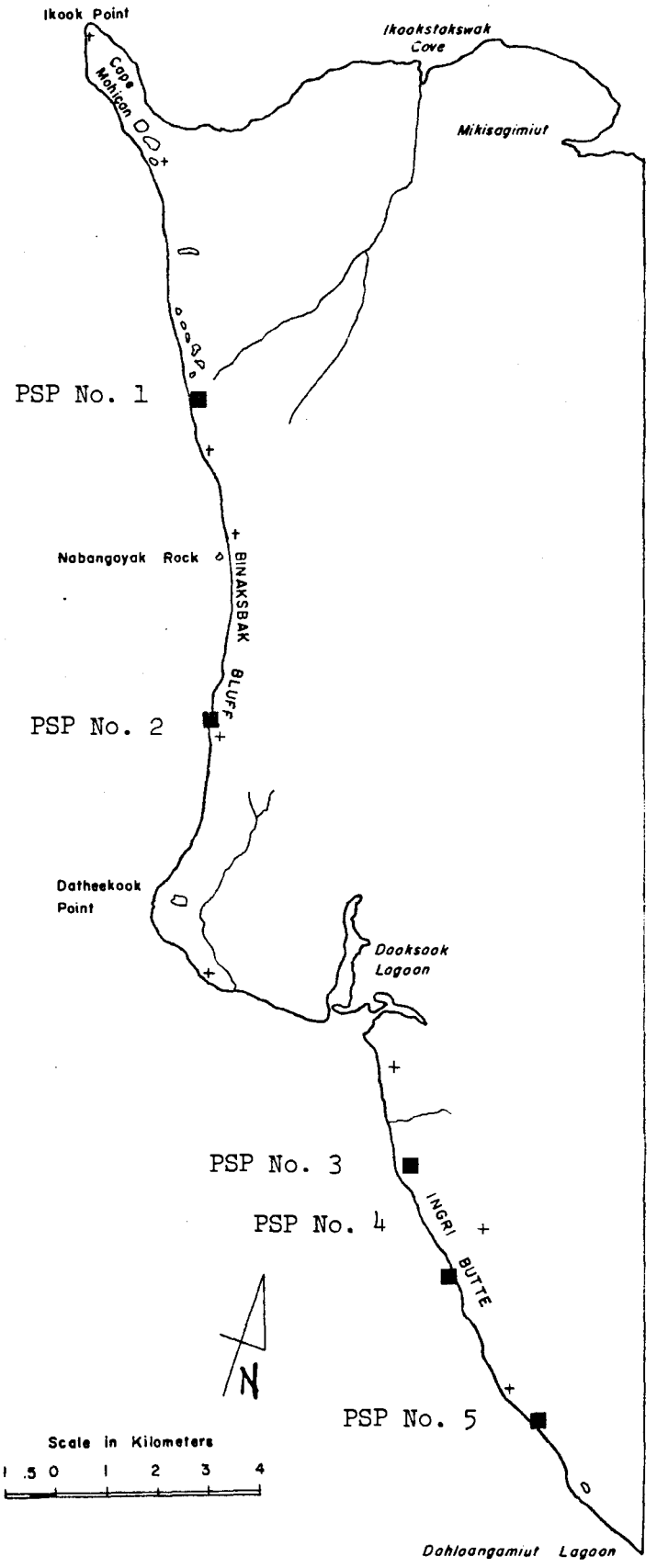

FIGURE 9. Location of Permanent Study Plots (PSP), Nunivak Island

Table 5. Description of permanent study plots

No.	Location	Description	Count Summaries
1	mid Binaksbak Bluff (60°09'N,167°23'W)	350' (120 m), vertical rock face, with three major strata; grey upper strata with pinnacles, lower strata cream color; observe from a point on a ridge south of plot, marked with rock cairn and 2"x2" wooden stake	5 July (1020-1120 hrs): 875 kittiwake nests, 4020 murres, 16 puffins
2	south Binaksbak (60°06'N,167°20'W)	south of Nabangoyak Rock 4 km (2.5 miles) north most headland of rock jutting into sea, approximately 30 m (100 feet) high; composed of small rock faces and narrow ledges; observe from a boat	21 July (1500 hrs): 300 kittiwake nests 750 murres
3	north Ingri Butte (60°02'30"N, 167°13'30"W)	walk south along cliff top to first cove and concentrations of murres; top shaped like "w"; look down and north from south most tip of "w"; 2"x2" stake marks observ. point; 40 m (125') cliffs; lower portions broad ledges.	25 July (1230-1300 hrs): 67 kittiwake nests (106 adults) 1900 common murres 15 puffins, 3 p.auklets
4	mid Ingri Butte (60°02N,167°11'W)	observed from boat; west of Ingri Butte peak and south of prominent twin slides on seaward slopes of Ingri; oval face of fractured rock, surrounded by vegetation and scree, approx. 100 m long by 20 m high; apart from other seabird concentrations	26 July (1700 hrs): 220 kittiwakes 1600 murres
5	south Ingri Butte (60°01'N,167°09'W)	"bastion" like cliff near south most, beginning of murre concentrations, 70 m high by 200 m long; lower ½ large basalt columns topped by vegetation; upper ½ distinct horizontal fractures; observe from boat	26 July (1530 hrs): 580 kittiwakes 72 puffins 31 cormorant nests 22 July (2015 hrs): 3600 murres

SUMMARY

1) Cliff habitat extends approximately 100 km from Nash Harbor to VABM Cliff, along Nunivak Island's western shore. Cliffs range in height from approximately 15 m to 150 m. Most dense concentrations of seabirds exist along Binaksbak Bluff and Ingri Butte.

2) Total counts of seabirds on the study area ranged from 284,964 to 331,384. An estimate of one half million breeding birds may be conservative.

3) Common murres were the most abundant species (estimate 400,000). Thick-billed murres were only observed at one locality along Binaksbak Bluff.

4) Black-legged kittiwakes numbered approximately 60,000. Some observations suggest that this species population may have changed since observations were made in 1954. Further investigations are necessary.

5) Pelagic cormorants were estimated at 1,200. One red-faced cormorant was observed.

6) Tufted and horned puffins were recorded at 20,000. Horned puffins comprised over 90% of the total (n=1,839).

7) Parakeet auklets were estimated at 5,000 from counts of approximately 1800. Crested auklets, which had not been recorded by other observers, were noted in small numbers (less than 200) near Cape Mohican.

8) Five permanent study plots (PSP) were photographed, described and mapped for future monitoring studies. PSP No. 3 was originally described by Dr. Peter Stettenheim.

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APPENDIX A. Field itineraries and weather records

Date	Time	Location/Activity[1]	Temp.[2]	Winds	Cover/Prec.[6]	Sea[3]
6-25	1300	arrive Mekoryuk	48°	NE,< 30	10,fog	3
6-26	0800	Mekoryuk	46°	W-NW,10-20	10,fog	3
6-27	0808	Mekoryuk	44°	W,10-15	10,fog	3
6-28	0850	Mekoryuk	47°	W-SW,5	8,fog	3
6-29	0835	Mekoryuk	50°	0[4]	10,rain	3
6-30	0815	attempt. departure	48°	SW,10-20	10,rain	3
7-1	0930	Mekoryuk to Nash Hbr.	48°	SW,+[5]	10,rain	2
	1425	@Nash Harbor	0	SW,25	10	2
	2000	@Mikisagimiut	0	SW,25	10	2
7-2	0815	Mikisagimiut, walked to Cape Mohican	46°	E-NE,15-20	10,rain	3
7-3	0800	Mikisagimiut	49°	N-NE,5-12	7	3
	1540	" " " " "	54°	N,5	2	3
7-4	1000	walked to Binak.Bluff	50°	N,+	5	3
7-5	0850	camped above Binaksbak	46°	N,+	5,fog	2
	2000	" " " " " " " " " "	55°	NE,5	clear	2
7-6	0745	" " " " " " " " " "	50°	N,+	clear	2
	1030	Mikisagimiut, attempt. to boat to Mohican	0	SW,10	10,rain	3
7-7	1700	Mikisagimiut	55°	E,35	3,	3
7-8	1000	" " " " "	48°	E,50	10,rain	3
7-9	0900	attempt to boat to Mohican	46°	E-SE,10-15	10	2
7-10	0850	Mikisagimiut	48°	S-SE,20	10,fog	3
7-11	1010	" " " " "	49°	N-NE,+	10,fog	1
	1130	Mikisagimiut to Dooksook	55°	N-NW,0-10	clear	2
	1545	return to Mikisagimiut	50°	N-NW,10	10,fog	2
7-12	0910	Mikisagimiut to Binak	49°	NW,20	8	0
	1445	camped over Binaksbak	50°	NW,10	2	2
7-13	0840	Binaksbak	43°	NE,15-20	10,fog	1
	1100	" " " "	50°	E,7-10	5	1
7-14	0940	Mikisagimiut to Mohican	48°	E-SE,5-15	5,fog	2
	1400	" " " " " " " " " "	60°	0	clear	2
7-15	0845	Mikisagimiut to Dooksook	49°	SE,5	5	1
7-16	1210	Mikisagimiut	48°	N-NW,5-15	10,fog	0
7-17	1100	" " " " "	48°	NE,10-20	10,fog	3
	1900	return to Mekoryuk to supply	48°	0	5,rain	3
7-18		Mekoryuk	0	0	0	0
7-19	1000	Mekoryuk	55°	N-NW,+	5	0
	1300	to Nash Harbor	60°	N,5	clear	1
	1600	to Mikisagimiut	50°	NW,15	10,rain	3
7-20	0830	Mikisagimiut	47°	SW,10-15	10,fog	3

APPENDIX A. continued

Date	Time	Location/Activity	Temp.	Winds	Cover.Prec.	Sea
7-21	0745	Mikisagimiut	47°	0	10,rain	1
	1300	to Dahloongamiut	0	NE,10	10,rain	2
7-22	0900	camped Dahloongamiut	53°	N-NE,15	10,fog	2
	1100	Dah. to Dooksook	60°	0	clear	1
7-23	1215	Dahloongamiut	55°	NE,20	clear	3
7-24	0900	Dahloongamiut	50°	N,0	10,fog	3
	1520	walked to Dooksook	48°	N,15+	10,rain	3
7-25	0930	Dooksook	60°	S,5	5,fog	2
7-26	0800	Dahloongamiut	49°	W-NW,5	10,fog	0
	1500	ret. to Mikisagimiut	55°	0	5	2
7-27	0830	Mikisagimiut	50°	+	0	3
	1500	Mikisagimiut to Ingri	50°	+	5	2
7-28	0830	Mikisagimiut	50°	SE,10	clear	3
7-29	1600	ret. to Mekoryuk	49°	SE,10-20	10,fog	3

[1]unless specified movements between points done by boat
[2]temp in °F
[3]Sea, 1=calm (relatively), 2=light swell or chop, 3=moderate swell or chop
[4]0 denotes no data
[5]+ denotes slight wind
[6]cover ranges from 1 (10% clouds) to 10 (100% cover)

APPENDIX B. Mammal observations, July, 1978, Nunivak Island.

Species	Date	Locality	Remarks
whale (grey?)	28 June	Mekoryuk River, mouth	villagers saw it and described it as 20+ feet, grey with white splotches on back
muskoxen	30 June	10 km sw Mekoryuk	3 adults, one calf and one yearling
harbor seals	2 July	Ikookstakswak Cove	45+ sunning on exposed rocks
reindeer	2 July	Cape Mohican	15 bulls
harbor seals	3 July	Mikisagimiut	observed frequently after this date
reindeer	3 July	Mikisagimiut	125 bulls
muskoxen	3 July	Mikisagimiut	4
reindeer	4 July	Binaksbak Bluff	11 bulls
red fox	2 July	Cape Mohican	near den (see accompanying figure)
steller sea lion	4 July	Nabangoyak Rock	10
red fox	4 July	Mid-Binaksbak	1
red fox	5 July	Mid-Binaksbak	1, with freshly killed horned puffin
red fox	5 July	south Binaksbak	1
reindeer	6 July	Mikisagimiut	135 bulls, 2 cows with calves

Appendix B. continued

Species	Date	Locality	Remarks
harbor seals	6/9 July	Ikookstakswak Cove	20+
s. sea lions	11 July	Nabangoyak Rock	35
		Datheekook Point	7
		Cape Mohican	1
reindeer	12 July	Cape Mohican	20 bulls
red fox	12 July	Binaksbak Bluff	1 beneath the colonies
red fox	13 July	Binaksbak Bluff	on lower talus slopes
muskoxen	11 July	Dooksook Lagoon	1 bull
reindeer	16 July	Mikisagimiut	33 west of camp
whale (s)	mid July	Dahloongamiut	John David reported 20' black whales off coast (pers. com.)
reindeer	17 July	Nash Harbor	180
		Abaramiut	40, crowded on small peninsula, backed up to sea
red fox	22 July	Dooksook	on beach
red fox	23 July	Ingri Butte	above colonies
red fox	26 July	Ingri Butte	above colonies

APPENDIX C. Murre and kittiwake count summaries.[1]

Cliff Section	Murres	Kittiwakes
Mikisagimiut to Mohican	400+ (6 July, 1130 hrs.)	-
Binaksbak Bluff		
North Binaksbak	12,710-13,900 (21 July, 1300 hrs.) 18,000 (11 July, 1700 hrs.) 16,300 (15 July, 1700 hrs.)	3,200 (11 July, 1215 hrs.)
Mid Binaksbak	55,370-81,600 (21 July, 1330 hrs.) 90,000 (11 July, 1600 hrs.) 87,900 (15 July, 1630 hrs.)	11,230-14,830 (27 July,1545 hrs.) 18,990 (11 July,1300 hrs.)
South Binaksbak	20,750-29,350*(21 July, 1500 hrs.) 17,800 (15 July, 1600 hrs.) 24,300 (11 July, 1700 hrs.)	6,530-6,970 (26 July,1900 hrs.) 9,780 (11 July, 1400hrs.)
Datheelook Point	5,030 (21 July, 1600 hrs.) 8,000 (15 July, 1530 hrs.) 4,900 (11 July, 1630 hrs.)	780 (26 July, 2100 hrs.) 1,650 (11 July, 1415 hrs.)
Ingri Butte	142,600-148,000 (22 July, 1730-2030 hrs.)	16,580-17,250 (27 July, 1500-1800 hrs.)

[1] underscored count used in discussion of estimates and count data Table 3.
* includes Datheelook Point in 29,350 estimate

APPENDIX D. Daily bird counts

Species (common name)	June 25	27	29	July 1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	Notes
unid. loon				X								X	X	X				X	
red-throated loon	X	X	X	X	X	X	X	X	X	X		X	X	X				X	
arctic loon		X		X	X	X		X					X			X			
fulmar														X					dead bird
shearwater									X										single dark bird
pelagic cormorant				X	X	X	X	X		X	X	X			X	X	X	X	X	
red-faced cormorant					X														at nest
unid. cormorant		X		X		X		X				X	X		X	X	X	X	X	
whistling swan							X												
canada goose		X		X	X		X		X			X						X	
brant					X			X							X				
pintail		X		X		X			X						X	X			
green-winged teal				X		X			X										
greater scaup				X															
oldsquaw		X	X	X	X		X	X	X	X	X	X	X				X		
harlequin					X	X	X	X	X	X	X	X	X		X				
steller's eider						X				X		X							
common eider				X	X		X		X	X		X			X	X			
king eider					X				X										
white-winged scoter					X														
common merganser				X															pair
red-breasted merganser						X						X							
gyrfalcon					X		X	X			X	X							nest
willow ptarmigan				X					X										
sandhill crane					X		X	X	X		X	X			X	X	X	X	
golden plover				X			X			X	X								
semi-palmated plover	X	X			X	X		X		X	X		X		X	X			
ruddy turnstone												X	X						
black turnstone					X								X						
common snipe		X		X															
whimbrel			X																single bird
rock sandpiper				X	X		X	X	X		X	X	X						
dunlin	X	X			X		X	X	X			X							
long-billed dowitcher				X			X	X											

APPENDIX D. continued

Species (common name)	June 25	26	27	28	29	30	July 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	Notes
western sandpiper	X	X				X	X	X		X		X	X		X	X	X	X	X	X	X	X		X		X	X	X	X	X	X		X	X	X	
red phalarope							X								X		X															X	X			
northern phalarope	X	X	X			X	X				X				X	X	X	X								X										
pomarine jaeger	X		X														X																		X	
parasitic jaeger		X	X														X								X		X		X							
long-tailed jaeger	X		X			X						X			X	X		X				X			X											
unid. jaeger		X																																X		
glaucous gull							X			X	X								X										X							
glaucous-winged gull			X		X	X	X	X	X	X	X		X			X			X	X	X	X	X	X			X		X						X	
mew gull								X																												immature
black-legged kittiwake	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	
unid. gull	X	X	X												X		X	X					X				X	X		X					X	
sabine's gull								X				X																								
arctic tern	X	X		X	X				X				X		X	X	X		X			X	X	X		X		X	X	X	X					
aleutian tern	X	X		X																			X													adults
unid. tern			X																				X													
common murre										X	X				X		X	X	X		X					X	X	X	X	X	X	X				
thick-billed murre										X								X																		
unid. murre	X	X	X	X			X	X	X	X	X	X			X		X		X		X		X		X		X	X	X	X	X	X			X	
pigeon guillemot							X	X	X			X			X	X				X	X				X	X										
unid. guillemots		X																			X						X		X							
parakeet auklet								X		X	X	X					X	X	X		X					X	X	X	X	X	X	X				
crested auklet								X										X	X													X				
horned puffin							X	X	X	X	X	X			X		X	X	X	X	X		X		X	X	X	X	X	X	X	X			X	
tufted puffin							X	X	X	X	X	X			X		X	X	X	X	X		X		X	X	X	X	X	X	X	X			X	
ancient murrelet							X																													no previous rec.
unid. brown murrelet																									X											marbled?
common raven							X				X																	X								breeding
yellow wagtail										X																										
water pipit								X		X	X							X																		
common redpoll					X	X				X						X																				
savannah sparrow	X	X				X	X	X			X		X		X	X		X	X								X		X	X					X	
lapland longspur	X	X				X	X	X		X	X	X	X		X	X		X				X					X		X	X	X					
snow bunting							X	X	X	X	X		X		X	X		X	X			X							X						X	

APPENDIX E. Photographs

Slide Catalogue

Nun-1-Ritchie, looking north, south of Nabangoyak Rock, Binaksbak Bluff
Nun-2-Ritchie, looking south, north of Nabangoyak Rock, Binaksbak Bluff to Datheekook Pt.
Nun-3-Ritchie, Ikook Point, Cape Mohican
Nun-4-Ritchie, north Binaksbak Bluff
Nun-5-Ritchie, mid Binaksbak Bluff
Nun-6-Ritchie, mid Binaksbak Bluff
Nun-7-Ritchie, mid Binaksbak Bluff, "twin rocks"
Nun-8-Ritchie, mid Binaksbak Bluff, beneath PSP No. 1
Nun-9-Ritchie, looking north at PSP No. 1, Binaksbak Bluff
Nun-10-Ritchie, looking up at Binaksbak Bluff from boulder beach
Nun-11-Ritchie, looking north near Nabangoyak Rock, soil slopes
Nun-12-Ritchie, talus slopes south of Nabangoyak Rock, Binaksbak
Nun-13-Ritchie, looking north from talus, listed above
Nun-14-Ritchie, looking south along Binaksbak near Datheekook Pt.
Nun-15-Ritchie, south Binaksbak Bluff, PSP No. 2
Nun-16-Ritchie, south Binaksbak Bluff
Nun-17-Ritchie, east of Datheekook Point
Nun-18-Ritchie, broad ledges, mid Binaksbak Bluff
Nun-19-Ritchie, talus and boulder habitat (Nun-12/13 above)
Nun-20-Ritchie, boulder-soil mix, upper slopes of cliffs
Nun-21-Ritchie, NW ½ Ingri Butte colonies, taken from 5 km offshore
Nun-22-Ritchie, SE ½ Ingri Butte colonies, taken from 5 km offshore
Nun-23-Ritchie, looking north at beginning of Ingri colonies, south end
Nun-24-Ritchie, south east end of Ingri Butte
Nun-25-Ritchie, Ingri Butte, PSP No. 5
Nun-26-Ritchie, Ingri Butte, looking south at mid colony
Nun-27-Ritchie, large cliff-face habitat, Ingri Butte
Nun-28-Ritchie, talus footslopes and terraces of mid Ingri Butte
Nun-29-Ritchie, looking south along Ingri, near mid section of cliffs
Nun-30-Ritchie, Ingri Butte, "twin slides"
Nun-31-Ritchie, Ingri Butte, PSP No. 4
Nun-32-Ritchie, looking south along dense murre ledges, Ingri Butte
Nun-33-Ritchie, Ingri Butte, dense Murre ledges
Nun-34-Ritchie, Ingri Butte, dense Murre ledges, north end
Nun-35-Ritchie, looking south from Ingri above PSP No. 3
Nun-36-Ritchie, broad ledges along north Ingri Butte
Nun-37-Ritchie, Ingri Butte, PSP No. 3
Nun-38-Ritchie, looking north from Ingri Butte, to Dooksook Lagoon
Nun-39-Ritchie, looking south along northern terminus of Ingri Butte
Nun-40-Ritchie, looking west from northern end of Ingri Butte, toward Dathleekook Point

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