Environmental
Studies
Research
Funds

# 102 The Common Eider of Eastern Hudson Bay: A Survey of Nest Colonies and Inuit Ecological Knowledge

Canada

November 1988

The correct citation for this report is :

Nakashima, D. J. and Murray, D. J. 1988. The Common Eider (*Somateria mollissima sedentaria* ) of eastern Hudson Bay : A survey of nest colonies and Inuit ecological knowledge. Environmental Studies Revolving Funds Report, no. 102, Ottawa, xxiv + 174 pp.

Published under the auspices of the
Environmental Studies Revolving Funds.
ISBN 0-921652-02-X

Environmental Studies Revolving Funds
Report No.102

November 1988

# The Common Eider (*Somateria mollissima sedentaria*) of eastern Hudson Bay: a survey of nest colonies and Inuit ecological knowledge

## PART I: Breeding population size and distribution

by D.J. Nakashima and D.J. Murray

## PART II: Eider ecology from Inuit hunters

by D.J. Nakashima

Research Department
Makivik Corporation

In addition to financing from the Environmental Studies Research Funds, this study was supported by:

The Hunter Support Program of the Kativik Regional Government; and

The Economic Development Board of the Government of the Northwest Territories.

The Scientific Adviser was Dr. A. Reed, Canadian Wildlife Service

## TABLE OF CONTENTS

Page

Page

LIST OF TABLES

LIST OF FIGURES

## ACKNOWLEDGEMENTS

During the course of this study we have benefited from the enthusiasm and expertise of numerous individuals, North and South. The peoples of Sanikiluaq, Inukjuak and Kuujjuarapik have contributed immensely to the success of this study. Their unflagging interest and concern, their intimate familiarity with the vagaries of the northern environment, their generous hospitality in the community and in camp and their patience in relating their knowledge provide both the foundation and the heart to this research. P. Inukpuk directed the Inukjuak survey crew with dedication and attention to detail. W. Fleming, Moses Inukpuk, Mark Inukpuk, A. Ippak Jr., D. Kasudluak, S. Qingalik, M. Sala and J. Umarualuk ensured the success of the field work. J. Arragutainaq, A. Fleming, L. Inuktaluk, L. Kittosuk, G. Kudlu, S. Nalukturuk, M. Niviaxie, Z. Novalinga and W. Tooktoo provided invaluable support in the communities. Ecological knowledge was provided by many dedicated individuals who are too numerous to mention here. Regretfully, one of these elders, N. Arragutainaq, recently passed away. Expert translation and interpretation was provided by M. Novalinga, S. Emikotailuk, N. Annanack, L. Arragutainaq Sr., B. Epoo, S. Fleming, J. Iqaluk, A. Kasudluak, D. Kavik, H. Kumarluk, J. Kutchaka, C. Meeko, S. Napartuk, E. Okpik, the late J. Oweetaluktuk, C. Takatak and M. Weetaluktuk.

Our scientific advisor, A. Reed of the Canadian Wildlife Service (CWS) provided wise biological advice and assisted on the field census. We also benefited from the experience and support of G. Chapdelaine and C. Drolet.

B. Worbets of Canterra Energy Ltd, P. Ernerk, Chairman of the Hudson Bay Oil and Gas Committee and M. Alt of COGLA were instrumental in obtaining major funding from the Environmental Studies Revolving Fund. S. Ekomiak and M. Barrett provided funds from the Hunters' Support Program of the Kativik Regional Government. M. Appaqaq, N. McBride and L. Simpson organized funding from the Economic Development Branch, GNWT. J. Pattimore and the Baffin Regional Inuit Association provided valuable harvest statistics.

E. Tukkiapik of the Kuujjuaq Research Centre helped us through the tough early phases of project development. J. Galler kept our complicated accounts under meticulous supervision. P. Wilson worked on programming and R. Fisk helped organize digitizing. M. Abraham, M. Carrier, J. Cookie, A. Gordon, E. May, C. Murray, A. Okpik, T. Shipaluk, J. Tukkiapik and T. Weetaluktuk key-punched the census data. C. Murray and C. Youngs coded the map data and B. Secondi digitized them. Tape transcription was provided by H. Milberg and J. Waldorf. P. Lamarche word-processed our texts and patiently endured endless corrections. Cartographic work was provided by B. Doherty, M. Portnoff, N. Annahatak and N. Pépin with M. Brown verifying. Place names were provided by L. Muller-Wille in conjunction with the Avataq Cultural Institute. As the research on Inuit ecological knowledge is part of an on-going PhD program for D. Nakashima, Part II of the report has benefited from constructive criticism and facilities provided by staff members of the Department of Geography, McGill University.

Finally on the home front, L. Brooke and W.B. Kemp of Makivik Research Department have provided unlimited support in numerous facets of the work. A. Oliva dealt with administrative headaches. Logistical and moral support has always been forthcoming from the Kuujjuaq Research Centre.

# EXECUTIVE SUMMARY

The Hudson Bay Eider (*Somateria mollissima sedentaria*) is one of the least known subspecies of the Common Eider. Prior to the present study, no reliable estimates of breeding population size could be produced, as no systematic and large-scale ground surveys of nest colonies had been done. In response to the threat posed by oil exploration in central Hudson Bay, this study was designed to provide information on the numbers, breeding distribution and ecology of Common Eiders in the eastern part of the bay. The east shore of the bay is of particular concern as the prevailing west and northwest winds render it the most susceptible to oil damage (Davidson 1985). The results of this study establish a quantitative basis for monitoring the eider population and provide baseline ecological information for appropriate oil spill response planning.

**PART I: BREEDING POPULATION SIZE AND DISTRIBUTION**

Seven subregions were selected for intensive ground surveys. Three of these subregions are nearshore archipelagos: Long Island Sound, the Nastapoka Islands and the Koktac River area. The other four subregions are located offshore: Salikuit Islands, Laddie Island, Split Island and Sleeper Islands. From the survey results, we estimate the size of the breeding population of *S. m. sedentaria* for the eastern Hudson Bay region (from the Akulivik area in the north to the junction of Hudson and James Bays in the south) to be 41,490 breeding pairs ± 15,060 (±36.3%) or about 83,000 individuals. This total estimate can be subdivided into nearshore and offshore components. The islands close to the Quebec mainland are estimated to support 10,670

breeding pairs ± 3,350 (±31.3%). This nearshore estimate is based upon a mean of 3.5 nests per island calculated from the pooled nearshore survey data.

The offshore islands are estimated to harbour a much larger breeding population of 30,820 pairs ± 11,720 (±38.0%). The mean number of nests per island for offshore subregions was 13.25. The difference between the nearshore and offshore means was highly significant ($T = 3.43$; $P < 0.01$).

The population estimate of 83,000 breeding eiders for eastern Hudson Bay is 84% larger than a recent estimate by Abraham and Finney (1986) for the entire *sedentaria* population. Based upon the new estimate, the Reed-Erskine (1986) population model predicts a 7.2% annual increase in the *sedentaria* population, rather than the 5% decline predicted from Abraham and Finney's estimate. Although there are some indications that the breeding population may have declined in some nearshore areas, it appears that as a whole the *sedentaria* population is healthy and stable.

Common Eider clutch size was significantly larger on nearshore islands ($T=6.997$; $P < 0.01$). Long Island Sound had an exceptionally large mean clutch size, 5.58 eggs (S.D.=0.98) and was the only surveyed subregion with a mode of six eggs. The mean clutch size for 5,666 active nests in eastern Hudson Bay was 4.24 (S.D.=1.38). Down samples from 107 nests yielded on average 12.44 grams of cleaned product per nest. Offshore islands averaged higher yields than nearshore islands.

Herring and Glaucous Gull population size was estimated at 4,302 breeding pairs for the entire Hudson Bay coast from the junction of James Bay and Hudson Bay to the area of

Akulivik. An estimated 13,856 Arctic Tern nests occurred in the same region. No Arctic Tern nests were found on the Nastapoka Islands.

## PART II: EIDER ECOLOGY FROM INUIT HUNTERS

Data on Hudson Bay Eider ecology were collected during 134 hours of semi-directive interviews with 41 individuals from the communities of Sanikiluaq, N.W.T., and Inukjuak and Kuujjuarapik, northern Québec. Extensive information was compiled on eider taxonomy, biogeography, behaviour, diet, life history and breeding and wintering ecology.

Precise descriptions by Sanikiluaq hunters suggest that female and young Northern Eiders, *S. m. borealis*, wander into southeastern Hudson Bay in late summer and fall and leave before winter. In the Belcher Islands, some hunters subdivide the local Hudson Bay Eider population into northern and southern components. Eiders of polynyas are distinguished from those of the ice edge, based upon a complex character set which includes behaviour, diet and gizzard size.

Biogeographical data, collected on 1:250,000 scale map overlays, reveal the seasonal pattern of eider movement and distribution. In February and March, at the sea ice maximum, Hudson Bay Eiders are concentrated into large flocks along the landfast ice edge west of the Belcher, North Belcher and Sleeper Islands and in nearby polynyas most notably those near Agiaraaluk, southwest of the mouth of Robertson Bay. In April and early May, the eiders disperse from these winter concentrations, moving to areas of open water as they appear in the landfast ice. When open water permits, the eiders move to the vicinity of their future nest islands. Major migration pathways include a movement eastwards along the ice edge north of the Salikuit Islands ice bridge and then northwards along the coast in the Inukjuak region, and a northwards movement along the coast from the mouth of James Bay.

Nesting occurs in late June and July. Eider colonies are widely distributed throughout the offshore islands of southeastern Hudson Bay. More eiders nest in areas remote from present day communities and major nest areas include the archipelagoes south of the Belcher Islands, the North Belcher and Sleeper Islands, the Salikuit Islands, the northern Nastapoka Islands and the coastal islands north of Inukjuak.

From mid-summer to the fall, eiders are widely scattered and secretive. Adult females and their broods disperse from the nest areas and the drakes migrate to remote locations near the outermost islands to moult their feathers. The drakes regain their ability to fly in October, followed by the females and young in November. They form large flocks which course back and forth along the coastlines of islands and the mainland. The fall migration follows the Québec coastline southwards. As ice forms along the mainland coast and among the nearshore and offshore archipelagoes, eiders are restricted to a diminishing area and by mid-winter, concentrate along the outermost leads.

Inuit observe that eiders are subject to age-specific mortality imposed by the rigours of winter. In many years, young, inexperienced eiders are entrapped by the advancing ice cover and their frozen bodies are often discovered along the eastern perimeters of Tukarak Island and the Bakers Dozen Islands. Adult drakes rarely suffer such a fate.

The main component of eider diet is blue mussels although other organisms are also consumed. These include other types of mollusks, sea urchins, sea cucumbers, gastropods, sculpin and capelin.

In summary, the information collected from Inuit during the course of this study substantially advance scientific knowledge of eider ecology in southeastern Hudson Bay. These data, which have no counterpart in the scientific literature, provide environmental baselines required for oil spill response planning.

The implications of this study, however, go beyond the accomplishment of these specific objectives. Its combination of biological survey techniques with ecological information from Inuit, generates a unique data set, at once quantitatively precise and yet rich in qualitative detail. Studies which complement scientific and Inuit knowledge hold considerable promise for environmental impact assessment and renewable resource management.

# <u>RÉSUMÉ</u>

L'Eider de la baie d'Hudson *(Somateria mollissima sedentaria)* est l'une des sous-espèces les moins connues de l'Eider commun. Avant la présente étude, il n'existait aucune estimation fiable de la population reproductrice d'Eiders dont les nids n'avaient jamais été systématiquement inventoriés sur une grande échelle. D'abord préparée en vue de contrer la menace que pose l'exploration pétrolifère dans le centre de la baie d'Hudson, la présente étude a été conçue pour fournir des données sur le nombre, la distribution de la population reproductrice et l'écologie de l'Eider commun dans le secteur est de la baie d'Hudson. On se préoccupe en effet particulièrement de la côte est de la baie du fait que les vents dominants du nord et du nord-ouest rendent le secteur plus susceptible à d'éventuels déversements de pétrole (Davidson, 1985). Les résultats de l'étude ont permis d'établir une base quantitative de données en vue de la surveillance de la ressource que constitue l'Eider ainsi qu'une base de données écologiques afin de planifier une action appropriée en cas de déversements de pétrole.

**PARTIE I : IMPORTANCE ET DISTRIBUTION DE LA POPULATION REPRODUCTRICE**

Nous avons choisi sept zones pour la réalisation d'inventaires intensifs. Trois d'entre elles sont des archipels côtiers : il s'agit du groupe d'îles Long Island, des îles Nastapoka et des îles de la rivière Koktac. Les quatre autres sont situées au large des côtes : ce sont les îles Salikuit, Laddie, Split et Sleeper. Suivant les résultats de ces inventaires, nous estimons que la population reproductrice de *S. M. sedentaria* de l'est de la baie

d'Hudson (depuis la région d'Akulivik, au nord, jusqu'à la jonction de la baie d'Hudson et de la baie James, au sud) atteint 41 490 couples reproducteurs ± 15 060 (±36,3%) ou environ 83 000 individus. Cette estimation totale peut être répartie en deux composantes, selon que la population niche près de la côte ou au large. Ainsi, nous estimons que les îles à proximité de la côte du Québec abritent 10 670 couples reproducteurs ± 3 350 (±31,3%), estimation qui s'appuie sur une moyenne de 3,5 nids par île, calculée d'après les données d'inventaires des zones côtières regroupées.

Par ailleurs, la population reproductrice nichant sur les îles au large des côtes est beaucoup plus importante; elle atteint 30 820 couples ± 11 720 (± 38%), chaque île comptant en moyenne 13,25 nids. La différence entre les moyennes pour les zones côtières et les zones au large des côtes est très significative (T= 3,43; P 0,01).

Estimée à 83 000 individus, la population reproductrice de l'est de la baie d'Hudson est de 84 % plus élevée que l'évaluation récemment effectuée par Abraham et Finney (1986) et visant l'entière population de *sedentaria*. En appliquant le modèle Reed-Erskine à ces nouvelles estimations, on peut prévoir une augmentation annuelle de 7,2 % de la population de *sedentaria* contrairement à la diminution de 5 % prévue d'après l'évaluation d'Abraham et Finney. Malgré qu'il existe certains signes de déclin de la population reproductrice dans les secteurs côtiers, la population de *sedentaria* paraît saine et stable dans l'ensemble.

Les couvées d'Eiders communs sont beaucoup plus importantes sur les îles côtières (T= 6,997; P 0,01), notamment dans l'archipel Long Island, où la moyenne des couvées est exceptionnellement élevée alors qu'elle atteint 5,58 oeufs (S.D.+ 0,98); parmi les secteurs inventoriés, c'est le seul qui présente un mode de 6 oeufs. La moyenne des couvées pour les 5 666 nids actifs dans l'est de la baie d'Hudson est de 4,24 oeufs (S.D.= 1.38). Des échantillons de duvet prélevés dans 107 nids ont produit en moyenne 12,44 grammes de duvet propre par nid. Les îles au large des côtes ont donné un rendement moyen encore plus élevé que les îles côtières.

La population de Goéland argenté et de Goéland bourgmestre a été estimée à 4 302 couples reproducteurs pour toute la côte de la baie d'Hudson à partir de la jonction de la baie James et de la baie d'Hudson jusqu'à Akulivik. La même région compte environ 13 856 nids de Sternes arctiques; cependant, aucun nid de cette espèce se trouve sur les îles Nastapoka.

## PARTIE II : ÉCOLOGIE DE L'EIDER SELON LES CONNAISSANCES DES INUITS

Des données sur l'écologie de l'Eider de la baie d'Hudson ont été recueillies au cours de 134 heures d'interviews semi-dirigées, effectuées auprès de 41 personnes de Sanikiluaq, dans les Territoires du Nord-Ouest, ainsi que de Inukjuak et de Kuujjuarapik dans le Nunavik. Ces interviews ont permis de compiler un important corpus d'information sur la taxonomie, la biogéographie, le comportement, l'alimentation, le cycle de vie, la reproduction et l'écologie d'hiver de l'Eider.

Des descriptions précises fournies par les chasseurs de Sanikiluaq indiquent que la femelle et les jeunes Eiders, *S.m. borealis*, pénètrent en été et à l'automne dans la partie sud-est de la baie d'Hudson qu'ils quittent avant l'arrivée de l'hiver. Dans les îles Belcher, certains des chasseurs divisent la population locale d'Eider de la baie d'Hudson en composantes nord et sud. On distingue l'Eider des polynies de ceux qui vivent en bordure de la banquise, ceci suivant un jeu complexe de caractéristiques portant notamment sur le comportement, l'alimentation et la grosseur du gésier.

Les données biogéographiques, consignées sur des cartes thématiques transparentes, montrent le modèle saisonnier des mouvements de l'Eider et sa distribution. En février et en mars, lorsque les glaces marines couvrent une superficie maximale, l'Eider de la baie d'Hudson se concentre en grands vols le long de la côte des îles Belcher, North Belcher et Sleeper et dans les polynies voisines, en particulier celles des environs d'Agiaraaluk, au sud-ouest de l'embouchure de la baie Robertson. En avril et au début mai, il quitte ces aires de concentrations hivernales et se dirigent vers les eaux libres de glaces à mesure que celles-ci apparaissent dans la banquise.

Lorsque les chenaux libres de glaces le permettent, l'Eider gagne les environs des îles où il nichera éventuellement. Les voies migratoires importantes comportent un mouvement vers l'est le long de la banquise, au nord du pont de glace des îles Salikuit, un autre vers le nord le long de la côte dans la région d'Inukjuak et enfin, un déplacement vers le nord le long de la côte à partir de l'embouchure de la baie James.

La nidification a lieu à la fin juin et en juillet. Les colonies d'Eiders sont largement distribuées dans toutes les îles au large du sud-est de la baie d'Hudson. Un plus grand nombre d'Eiders nichent dans des endroits éloignés des collectivités actuelles; on compte parmi les principales aires de nidification les îles Belcher, North Belcher et Sleeper, l'archipel Salikiut, les îles du nord de l'archipel Nastapoka ainsi que les îles côtières au nord de Inukjuak.

De la mi-été jusqu'à l'automne, la population d'Eiders est largement dispersée et dissimulée. Les adultes femelles et leur nichée quittent alors les aires de nidification et les mâles adultes migrent vers les îles les plus éloignées pour la mue. Ils retrouvent leur aptitude à voler en octobre et sont suivis par les femelles et les jeunes en novembre. Les oiseaux se rassemblent alors en grandes volées qui vont et viennent entre les îles et la terre ferme. Au moment de la migration automnale, ils longent la côte du Québec en direction du sud. À mesure que les glaces se forment le long de cette côte et dans les archipels côtiers et du large, l'Eider réduit ses mouvements à une aire de plus en plus restreinte; la mi-hiver venue, il concentre ses mouvements le long des chenaux les plus éloignés.

Les Inuits ont observé que les rigueurs de l'hiver entraînent la mortalité chez l'Eider de certains groupes d'âge. Souvent, les jeunes canards inexpérimentés sont pris au piège lors de la formation des glaces; par la suite, les chasseurs trouveront leurs carcasses gelées le long de la rive est de l'île Tukarak et des îles Bakers Dozens. Il est rare, toutefois, que les mâles adultes subissent un tel sort.

Les moules constituent l'élément principal de l'alimentation de l'Eider, mais l'espèce consomme aussi d'autres organismes, notamment divers types de mollusques, l'oursin, l'holothurie, les gastropodes, le chabot et le capelan.

En résumé, l'information recueillie auprès des Inuits pendant l'étude contribue substantiellement au progrès des connaissances scientifiques sur l'écologie de l'Eider du sud-est de la baie d'Hudson. Ces données, qui ne trouvent pas de contrepartie dans la documentation scientifique, fournissent une base de savoir environnemental nécessaire à la planification de l'action en cas de déversements de pétrole.

L'étude, cependant, comporte des implications allant au-delà de ces objectifs précis. Les techniques d'inventaires biologiques combinées à l'information livrée par les Inuits génèrent une base unique de données, qui présente une mine de détails qualitatifs sans pour autant perdre de sa précision sur le plan quantitatif. Les études intégrant ainsi le savoir des Inuits aux connaissances scientifiques sont fort prometteuses pour l'évaluation des répercussions environnementales et la gestion des ressources renouvelables.

## ᐳᕐᑐᓂᕐᓴᐃᑦ ᑐᑭᓯᒪᒋᐊᓕᖕᒋᑦ

ᖃᑦᓴᓐ ᐸᐃ ᒥᑎᑦᓴᔭᖓ ᒥᑎᑐᐃᓐᓇᐅᓯᓂ ᖃᐅᔨᒪᔭᐅᑦᓯᐊᖏᓐᓂᐸᐅᔭᖅ ᐃᓕᕆᔭᒥᓂᒃ. ᐅᓪᓗᒥ ᖃᐅᔨᓴᕐᓂᐅᑉ ᓯᕗᓂᐊᒍᑦ, ᑕᒪᒃᑯᐊ ᒥᑏᑦ ᕿᑐᕐᖏᐅᕈᓐᓇᑐᐃᑦ ᐅᓄᕐᓂᕆᔭᖏᑦ ᖃᐅᔨᒪᔭᐅᓂᖃᓚᐅᔭᙱᑐᑦ, ᑕᒪᒃᑯᐊ ᒥᑏᑦ ᐅᓪᓗᒥ ᐊᒥᓱᒻᒪᓇᐅᓂᖃᕐᑎᓗᒋᑦ ᑭᓯᑕᐅᓂᖃᓚᐅᕐᓯᒪᙱᒪᑕ. ᑕᒪᒃᑯᐊ ᐅᕐᓯᐊᓗᒻᒥᒃ ᕿᓂᕐᑐᐃᑦ ᖃᑦᓴᓐ ᐸᐃ ᕿᑎᖓᓂ ᑲᐸᐊᓇᕐᑎᓯᒍᓐᓇᓂᖏᑦ ᐱᑦᔭᑎᕆᑦᓯᕆᑦ, ᑕᒪᓐᓇ ᖃᐅᔨᓴᕐᓂᐅᔭᖅ ᐊᖅᑭᓯᕐᑕᐅᓯᒪᔭᖅ ᖃᐅᔨᓴᕐᑕᐅᔭᑦᓴᐅᑎᓐᓗᒋᑦ ᒥᑏᑦ ᐅᓄᕐᓂᕆᔪᓇᖏᑦ, ᕿᑐᕐᖏᐅᕈᓐᓇᓂᖏᓐᓗ ᐊᒻᒪᓗ ᐱᕈᕐᐱᕆᐸᑦᑕᖏᑦ ᑖᒪᓂ ᖃᑦᓴᓐ ᐸᐃ ᓯᑦᔭᖓᓂ. ᓄᓇᐱᐅᑉ ᓯᑦᔭᖓ ᖃᑦᓴᓐ ᐸᐃᒥ ᐃᓯᒫᓗᕆᔭᐅᓗᐊᒃᒍᐊᑐᖅ ᐊᓄᓈᑦ ᐅᐊᓐᓂᓗᐊᒃᒍᐊᐸᓪᓚᑕ ᑕᐃᒪᐃᖓᒥᒃ ᐅᕐᓯᐊᓗᒻᒧᑦ ᓱᒃᑯᑕᐅᒍᓇᐅᓂᕐᐸᐅᔭᑦ [Davidson ᑐᓴᕐᑎᓯᒍᑎᐱᓂᖏᑦ 1985-ᒥ]. ᑖᑦᓯᒪ ᖃᐅᔨᓴᕐᓂᐅᑉ ᓄᐃᓕᐅᕐᑕᖏᑦ ᑕᑯᑎᑦᓯᓕᐅᕐᑐᑦ ᒥᑏᑦ ᐅᓄᕐᓂᖏᓐᓂᒃ ᖃᐅᔨᓴᕈᑎᐅᒍᓐᓇᑐᓂᒃ ᐊᒻᒪᓗ ᐱᑕᖃᕐᑎᓯᓗᓂ ᒥᑏᑦ ᐱᕈᕐᐸᓕᐊᒍᑎᖏᑦᑕ ᖃᐅᔨᒪᐅᑎᕆᔭᖏᓐᓂᒃ ᐸᕐᓇᕈᑎᑦᓴᐅᐅᑎᓐᓗᒋᑦ ᐅᕐᓯᐊᓗᒻᒥᒃ ᑯᐱᔭᖃᑦᓴᐸᑦ ᐱᓇᓯᐊᕈᑎᑦᓴᓂᒃ.

### ᐃᒻᒥᒎᓕᖓᔭᐃᑦ 1: ᕿᑐᕐᖏᐅᕈᓐᓇᑐᐃᑦ ᐅᓄᕐᓂᖏᑦ ᐊᒻᒪᓗ ᕿᑐᕐᖏᐅᐸᓪᓕᐊᓂᖏᑦ

7-ᖑᔭᑦ ᓄᓇᐃᑦ ᓂᕈᐊᕐᑕᐅᓚᐅᕐᑐᑦ ᒥᑎᕐᓂᒃ ᖃᐅᔨᓴᕐᐱᓴᐅᑎᓐᓗᒋᑦ. ᑖᒃᑯᐊ ᓄᓇᐃᑦ ᐃᓕᖏᑦᑕ ᐱᖓᓱᐃᑦ ᕿᑭᕐᑕᐅᔭᑦ ᓄᓇᐅᑉ ᓴᓂᐋᓃᑦᓯᑎᒃ ᐅᑯᓇᓂ: Long Island Sound, ᓈᓐᑖᐳᑲ ᕿᑭᕐᑕᖏᑦ ᐊᒻᒪᓗ ᑰᑦᑕᖅ ᑰᖓᓂ. ᓯᑕᒪᐃᑦ ᕿᑭᕐᑕᐃ ᐊᓯᖏᑦ ᐃᒪᕐᐲᒥᑦᑐᑦ ᐅᑯᓇᓂ: Laddie-ᐅᑉ ᕿᑭᕐᑕᖓ , Split ᕿᑭᕐᑕᖓ ᐊᒻᒪᓗ Sleeper ᕿᑭᕐᑕᖏᓐᓂ. ᖃᐅᔨᓴᓚᐅᕐᑕᐳᑦ ᑕᑯᑦᓯᕆᑦ, ᐃᓯᒪᖃᕐᑐᒍᑦ ᑕᒪᒃᑯᐊ ᒥᑏᑦ ᕿᑐᕐᖏᐅᕈᓐᓇᑐᐃᑦ ᑖᒪᓂ ᖃᑦᓴᓐ ᐸᐃ ᓯᑦᔭᖓᓂ (ᐊᑯᓕᐱᐅᑉ ᒦᑦᓴᓂ ᐱᕆᐊᕐᓯᑎᒃ ᔭᐃᓪᓯ ᐸᐃᓘᑦ ᑎᑭᑦᑎᓗᒋᑦ) ᐅᓄᕐᓂᖃᓇᐊᖏᑦ 41,490-ᓂᒃ ᐊᐃᐸᐃᓈᑦᑎᑐᓂᒃ ᐲᕐᓗᒋᑦ ᐃᓕᕆᐊᕐᓗᒋᓐᓘᓃᑦ 15,060-ᓂᒃ ᐅᐸᓘᓐᓃᑦ 873,000-ᓂᒃ ᒥᑎᕐᓂᒃ. ᑖᒃᑯᐊ ᐃᓯᒪᕆᔭᐅᓯᒪᔭᐃᑦ ᐅᓄᕐᓂᕆᔭᐅᔭᑦ ᐊᐱᑦᑐᑕᐅᒍᓐᓇᒥᔭᑦ ᓇᓕᖏᑦ ᐃᒪᕐᐲᒻᒪᖔᑕ ᐊᒻᒪᓗ ᖃᑦᓯᑦ ᓄᓇᐅᑉ ᖃᓂᑦᑕᖓ ᓂᒻᒫᖔᑕ. ᑕᒪᒃᑯᐊ ᕿᑭᕐᑕᐃᑦ ᑯᐸᐃᒃ ᓄᓇᖔᓄᑦ ᖃᓂᑦᑐᐃᑦ ᐃᓯᒪᕆᔭᐅᓯᒪᔭᑦ ᒥᑎᕐᓂᒃ ᐊᐃᐸᐃᓈᑦᑎᑐᓂᒃ ᐅᓄᕐᓂᖃᓇᐊᖏᑦ 10,670-ᓂᒃ ᑖᑯᐊ ᐱᕐᓯᐱᕆᓗᒋᑦ ᐃᓕᕆᐊᕐᓗᒋᓐᓘᓃᑦ 3,350-ᓂᒃ. ᑖᒃᑯᐊ ᓄᓇᓗᑦ ᖃᓂᑦᑑᒥᑦᑐᑦ ᐅᓄᕐᓂᖏᑦᑕ ᐃᓯᒪᕆᔭᐅᒍᑎᖏᑦ ᐊᖅᑭᑕᐅᓯᒪᔪᑦ ᑖᒃᑯᐊ ᐊᑐᓂᑦ ᕿᑭᕐᑕᐃᑦ ᐅᓪᓗᖃᕐᑐᐱᓂᐅᑎᓐᓗᒋᑦ 3.5-ᒥᒃ ᑖᒃᑯᐊ ᕿᑭᕐᑕᐃᑦ ᖃᐅᔨᓴᕐᑕᐱᓂᐅᑎᓐᓗᒋ.

ᐃᒪᕐᐲᒥᑦᑐᑦ ᕿᑭᕐᑕᐃᑦ ᐃᓯᒪᕆᔭᐅᔭᑦ ᒥᑎᖃᕐᓂᓴᐅᕆᐊᖏᑦ ᕿᑐᕐᖏᐅᕈᓐᓇᑐᓂ ᐅᓄᕐᓂᖃᕈᓇᐅᑦᓯᑎᒃ 30,820-ᓂᒃ ᐊᐃᐸᐃᓈᑦᑎᑐᓂᒃ ᑖᒃᑯᐊ ᐲᕐᓯᐱᕆᓗᒋᑦ ᐃᓕᕆᐊᕐᓗᒋᓐᓘᓃᑦ 11,720-ᓂᒃ. ᑖᒃᑯᐊ ᕿᑭᕐᑕᐃᑦ ᐊᑐᓂᑦ ᐅᓪᓗᖃᖃᑦᑕᓚᐅᕐᑐᑦ 13.25 ᒦᑦᓵᓂᑦᑐᓂᒃ . ᑖᒃᑯᐊ ᕿᑭᕐᑕᐃᑦ ᒥᑎᖃᕐᓂᖏᑦᑕ ᐊᑦᓵᕆᖕᖏᑐᓂᒃ ᐊᖏᔭᒻᒪᕆᐅᓚᐅᕐᑐᑦ.

ᒥᑏᑦ ᖁᑐᕐᕆᐅᕈᓐᓇᑐᐃᑦ 83,000-ᓂᒃ ᐅᓄᕐᓂᖃᓇᐊᖏᑦ ᐃᓯᒪᒋᔭ-ᐅᓚᐅᖅᑐᑦ ᑖᒪᓂ ᖃᑦᓵ ᐸᐃ ᓯᑦᔭᕐᓚᓂ ᐅᓄᕐᓂᓴᐅᒋᕗᑦ 84 ᐳᓴᓄᑦ ᑖᒃᑯᐊ Abraham and Finney (1986) ᐃᓱᒪᒋᓯᒪᔪᖏᓐᓂ ᑖᒃᑯᓂᖓ ᒥᑎᓕᒫᑦᓯᐊᓂᒃ. ᑖᑯᐊ ᓄᑖᑦ ᐃᓱᒪᒋᔭᐅᓯᒪᔪᑦ ᐊᑐᕐᓯᒋᑦ, ᑖᑯᐊ Reed-Erskine-ᑯᑦ (1986) ᐊᑐᖅᑕᒋᑦ ᓯᐳᓂᖃᖅᑎᓯᔪᑦ ᑕᒪᒃᑯᐊ ᒥᑏᑦ 7.2 ᐳᓴᒧᑦ ᐅᓄᒃᓯᒋᐊᖃᑦᑕᕋᔭᖅᑎᓗᒋᑦ ᐊᒃᑲᔪᑖᒪᑦ ᑖᒃᑯᐊ Abraham and Finney-ᑯᑦ ᐃᓱᒪᖃᖅᓯᒪᒐᓗᐊᖅᑎᓗᒋᑦ 5 ᐳᓴᒧᑦ ᑕᒪᒃᑯᐊ ᒥᑏᑦ ᐃᑭᓕᕙᓪᓕᐊᕋᔭᖅᑎᓗᒋᑦ. ᑕᒪᒃᑯᓇᓂ ᕿᑭᖅᑕᓂ ᓄᓇᒧᑦ ᖃᓂᑦᑐᔪᓂ ᒥᑏᑦ ᐃᑭᓕᕙᓪᓕᐊᓂᖏᑦ ᐃᑉᐱᓇᖅᓯᒪᓕᕋᓗᐊᖅᑎᓗᒋᑦ, ᒥᑎᓕᒫᑦᓯᐊᑦ ᑖᒫᓂᑦᑐᑦ ᖃᑦᓵ ᐸᐃᒥ ᖃᓄᐃᑦᑐᔭᑦᔭᖏᑦᑐᑦ ᐊᒻᒪᓗ ᐃᑭᓕᕙᓪᓕᐊᕋᓗᑦᑐ-ᔭᑦᔭᒐᑎᒃ.

ᒥᑏᑦ ᒫᓂᓕᐅᖅᑐᑦ ᐅᓄᕐᓂᓴᓂᒃ ᒫᓂᓕᐅᕐᓂᓴᐅᖃᑦᑕᓚᐅᖅᑐᑦ ᕿᑭᖅᑕᓂ ᓄᓇᒧᑦ ᖃᓂᑦᑐᔪᓂ. ᐅᕙᓂ Long Island Sound-ᒥ ᐊᑐᓂᑦ ᐅᓪᓗᐃᑦ ᒫᓂᓕᐅᖅᐱᐅᖃᑦᑕᓚᐅᖅᑐᑦ ᐅᓄᖅᑐᓂᖃᓚᐅᖅᒥᔪᑦ ᐅᓄᕐᓂᖃᖅᓯᑎᒃ 5.58-ᓂᒃ ᐊᒻᒪᓗ ᑖᓐᓇ ᕿᑭᖅᑖᑐᑎᓪᓗᒍ ᕿᒥᒃᕈᔭᐅᓚᐅᖅᑐᖅ ᒫᓂᓂᒃ ᐱᒐᓯᔪᑐᓕᖃᖅ-ᑐᔪᓂᒃ. 5,666-ᓂᒃ ᐅᓪᓗᓂᒃ ᑭᓯᑕᐅᓚᐅᖅᑐᓂᒃ ᖃᑦᓵ ᐸᐃ ᓯᑦᔭᕐᓚᓂ ᐊᑐᓂᑦ ᒫᓂᓕᐅᓯᒪᓚᐅᖅᑐᑦ 4.24-ᓂᒃ. ᖁᓂᒍᐃᑦ ᐆᑦᑐᕋᐅᑎᐅᔭᐃᑦ ᓄᐊᑕᐅᑦᓯᑎᒃ 107-ᓂᒃ ᐅᓪᓗᓂᒃ ᓄᐃᑦᓯᒍᓐᓇᖃᑦᑕᓚᐅᖅᑐᑦ 12.44 Grams-ᓂᒃ ᐅᖁᒪᐃᓐᓂᐊᕈᖅᓂᒃ ᐊᑐᓂᑦ ᐅᓪᓗᐃᑦ. ᐃᒪᖅᐱᒦᑦᑐᑦ ᕿᑭᖅᑕᓂ ᐅᓪᓗᐃᑦ ᖁᓂᒍᖅᓂᒃ ᓄᐃᑦᓯᓂᖅᓴᐅᖃᑦᑕ-ᓚᐅᖅᒥᔪᑦ. ᑖᒃᑯᓇᖕᖓᑦ ᕿᑭᖅᑕᓂᑦ ᓄᓇᒧᑦ ᖃᓂᑦᑐᔪᓂᒃ.

ᓇᐅᔭᐃᑦ ᐊᑦᔨᒌᒃᖏᑐᐃᑦ ᐅᓄᕐᓂᓇᔭᖏᑦ ᐃᓯᒪᒋᔭᐅᓚᐅᖅᑐᑦ 4,302-ᖑᒋᐊᖏᑦ ᐊᐃᑉᐸᓈᖅᑎᓯᑎᒃ ᑖᒪᓂ ᖃᑦᓵ ᐸᐃ ᓯᑦᔭᓕᒫᖕᒐᓂ ᑖᒪᖕᖓᑦ ᔭᐃᒻᔅ ᐸᐃᒥᑦ ᐱᒋᐊᖅᓯᓂ ᐊᑯᓕᕕᒻᒧᑦ ᑎᑭᑦᓯᒍ. ᐃᒥᖅᑯᑕᐃᓚᐃᑦ ᐅᓄᕐᓂᖏᑦ ᐃᓯᒪᒋᔭᐅᓚᐅᖅᑐᑦ ᐅᓄᕐᓂᖃᓇᐊᖏᑦ 13,856-ᓂᒃ ᑖᒪᓂᑦᓴᐃᓇᖅ ᕿᑭᖅᑕᐅᔪᓂᒃ. ᐃᒥᖅᑯᑕᐃᓚᐃᑦ ᐅᓪᓗᖏᑦ ᓇᓂᔭᐅᓚᐅᖕᒋᑐᑦ ᓈᑦᑖ ᐳᑲᐅᑉ ᕿᑭᖅᑕᖏᓐᓂ.

**ᐃᒻᒥᒍᓕᖓᔭᐃᑦ 2: ᒥᑏᑦ ᐱᕈᖅᐸᓪᓕᐊᓂᓇᕙᑦᑕᖏᑦ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᖏᑎᒍᑦ**

ᖃᑦᓵ ᐸᐃ ᒥᑎᖏᑦᑕ ᐱᕈᖅᐸᓪᓕᐊᓂᓇᔭᖏᓐᓄᑦ ᖃᐅᔨᒪᒍᑎᑦᓴᐅᔭᐃᑦ ᓄᐊᑕᐅᓚᐅᖅᑐᑦ 134-ᓂᒃ ᑲᐃᕙᓪᓚᒍᓯᓂᒃ 41-ᖑᔪᑦ ᐃᓄᐃᑦ ᓴᓂᑭᓗᐊᕐᒥᐅᑦ, ᐃᓄᑦᔪᐊᒥᐅᑦ ᐊᒻᒪᓗ ᑰᑦᔪᐊᕌᐱᒻᒥᐅᑦ ᐊᐱᕆᔭᐅᑎᓗᒋᑦ. ᑕᒪᒃᑯᐊ ᓄᐊᑕᐅᓚ-ᐅᕆᐳᑦ ᒥᑏᑦ ᐃᒻᒥᒍᓕᖓᓂᓯᖏᑦ, ᐃᖏᕐᕋᓂᓇᕙᑦᑕᖏᓐᓂᓗ ᐊᒻᒪᓗ ᖃᓄᐃᓘᖅᓂᓇᓯᖏᓐᓂᒃ, ᓂᕿᒦᓯᖏᓐᓂᓗ ᐆᒪᓂᖏᑦᑕᓗ ᐊᑯᓃᕐᓂᖏᓐᓂᒃ ᐊᒻᒪᓗ ᐱᕈᖅᕕᒋᕙᑦᑕᖏᓐᓂᒃ ᐅᑭᐅᖅᑐᕕᒋᕙᑦᑕᖏᓐᓄ

ᓴᓂᑭᓗᐊᕐᒥᐅᑦ ᒪᖃᐃᑦᑎᖏᑦ ᐅᖃᖅᓯᒪᒻᒥᔪᑦ ᑕᒪᒃᑯᐊ ᐊᕐᓇᕕᐊᑦ ᐊᒻᒪᓗ ᒥᑎᐊᕈᐃᑦ ᖃᑦᓵ ᐸᐃ ᓯᑦᔭᖕᑕ ᓯᕿᓂᖕᒐᓄᑦ ᐅᐸᐃᓯᖑᒋᐊᖏᑦ ᐊᐅᔭᐅᑉ ᓈᓂᖓᓕᖅᑕᖕᒐᓂ ᐅᒻᒪᓗ ᐊᐅᓚᑦᓯᑎᒃ ᐅᑭᐅᓚᐅᖅᑎᓇᒍ. ᓴᓂᑭᓗᐊᑉ ᕿᑭᖅᑕᖏᓐᓂᓕ, ᒪᖃᐃᑏᑦ ᐃᓚᖏᑦ ᐊᕕᑦᑎᔨᔨᒪᕙᑦᑐᑦ ᖃᑦᓵ ᐸᐃ ᒥᑎᖏᓐᓂᒃ ᑕᒃᕋᒥᐅᖑᓂᕋᖅᓯᒋᑦ ᐊᒻᒪᓗ ᓯᕿᓂᕐᒥᐅᖑᓂᕋᖅᓯᒋᑦ. ᒥᑏᑦ ᐃᒪᖅᐱᒦᑦᑐᑦ ᓇᓗᓇᐃᖅᑕᐅᕙᑦᑐᑦ ᐊᑦᔨ-ᒋᔭᐅᖏᑦᑐᒋᐊᖏᑦ ᑖᒃᑯᓇᖕᖓᑦ ᓯᑯᐃᑦ ᑭᓪᓕᖓᓂ ᓯᓂᒃ, ᑕᒪᒃᑯᐊ ᑕᑯᑦᓴᐅᒍᑎᖏᓪᓗ ᐊᒻᒪᓗ ᐱᐅᓯᓇᔭᖏᑦ ᓂᕿᒦᓯᖏᓗ ᒪᓕᑦᓯᒋᑦ.

ᒥᑏᑦ ᐃᖏᕐᕋᐱᕆᓰᖏᓐᓄᑦ ᖃᐅᔨᒪᒍᑏᑦ, ᓄᐃᑕᐅᓚᐅᖅᑐᑦ ᓄᓇᙳᐊᒥ ᑎᑎᕐᑕᐅᑎᓐᓄᕆᑦ ᓄᐃᑕᑎᑦᓯᒥᔪᑦ ᒥᑏᑦ ᐅᓐᓄᖏᑦ ᒪᓕᑦᓯᕆᑦ ᐃᖏᕐᕋᐱᕆᐸᑦᑕᖏᓐᓂᒃ ᐊᒻᒪ ᕿᑐᖕᖏᐅᐱᕆᐸᑦᑕᖏᓐᓂᒃ. ᐱᕗᐊᓇᐅᑎᓐᓄᒍ ᐊᒻᒪ ᒫᑦᔭᐅᑎᓐᓄᒍ, ᐃᒪᕐᒥ ᓯᑯᑦᑕᖅᑑᔭᒥ. ᖃᑦᓴ ᐸᐃ ᒥᑎᖏᑦ ᐊᑕᐅᓯᐅᓕᖓᓕᕋᒥᒃ ᐅᓄᕐᑐᒪᓇᐊᖁᐸᑦᑐᑦ ᑖᒪᓂ ᓴᓂᑭᓄᐊᑉ ᕿᑭᑦᑕᖏᓐᓂ ᑕᕐᕋᖓᓂᓗ ᐊᒻᒪ Sleeper ᕿᑭᑦᑕᖏᓐᓂ ᐊᒻᒪᓗᑦᑕᐅᖅ ᑖᒪᓂ ᐊᕆᐊᕋᓗᑉ ᓴᓂᐊᓂ ᑖᑦᓯᒪ Robertson Bay ᐃᑎᐱᐊᖓᓂ. ᐊᐃᓇᓕᒥ ᐊᒻᒪ ᒪᐃ ᐱᕆᐊᕐᓂᖓᓂ ᑕᒪᒃᑯᐊ ᒥᑏᑦ ᐊᐅᓚᐸᑦᑐᑦ ᑕᒪᓐᖓᑦ ᐅᑭᐅᕐᑐᐱᒻᒥᓂᑦ ᓯᑯᖃᖕᖏᓂᕐᒧᑦ ᐃᒪᒧᑦ ᐊᐃᑦᓯᑎᒃ. ᐃᒪᖃᓕᕐᑐᐊᕐᒪᑦ, ᑕᒪᒃᑯᐊ ᐃᖏᕐᕋᐱᕆᔭᐅᓗᐊᖑᐊᐸᑦᑐᑦ ᐃᓚᖃᕐᑐᑦ ᑕᒪᒃᑯᐅ ᓯᑯᐃᑦ ᑭᓕᖏᑦᑎᒍᑦ ᑖᒃᑯᐊ ᓴᓕᑯᐃᑦ ᕿᑭᑦᑕᐃᑦ ᓴᓂᐊᒍᑦ ᑕᕐᕋᓘᕐᐸᓕᐊᑦᓯᑎᒃ ᐃᓄᑦᔭᐊᑉ ᓯᑦᔭᖑᒍᑦ, ᐊᒻᒪ ᑕᕐᕋᓗᑦ ᐃᖏᕐᕋᓂᖃᕐᐸᒥᔭᑦ ᑖᒪᖕᖓ ᔭᐃᒻᒃ ᐸᐃ ᓯᑦᔭᖓᓂᑦ.

ᒥᑏᑦ ᐅᓗᓕᐅᕐᐸᑦᑐᑦ ᐃᐸᔪᓂᐊᕐᓯᑎᒃ ᔮᓂᒥ ᐊᒻᒪ ᔭᓕᐃᒥ, ᐊᒥᓰᓂᕐᓴᐃᑦ ᒥᑏᑦ ᐅᓗᓕᐅᕐᐸᑦᑐᑦ ᕿᑭᑦᑕᓂ ᓄᓕᓕᓐᓂ ᐅᖓᔪᑦᑑᔭᓂᒃ ᐊᒻᒪ ᐅᓗᓕᐅᓗᐊᖑᐊᐸᑦᓯᑎᒃ ᕿᑭᑦᑕᒪᓇᐅᔭᓂ ᓴᓂᑭᓄᐊᑉ ᕿᑭᑦᑕᖏᑦᑕ ᓯᕿᓂᖓᓂᑦᑐᓂ ᑕᒪᒃᑯᓇᓂ ᓴᓂᑭᓄᐊᑉ ᕿᑭᑦᑕᖏᑦᑕ ᑕᕐᕋᖓᓂ ᐊᒻᒪ Sleeper ᕿᑭᑦᑕᖓᓂ, ᓴᓕᑯᐃᑦ ᕿᑭᑦᑕᖏᓐᓂᓗ ᓈᑦᑖᕗᑲᐅᑉ ᕿᑭᑦᑕᖏᓐᓂᓗ ᐊᒻᒪ ᓯᑦᔭᐅ ᕿᑭᑦᑕᖏᓐᓂ ᐃᓄᑦᔭᐊᑉ ᑕᕐᕋᖓᓃᑦᑐᓂᒃ.

ᐊᐅᔭᐅᑉ ᕿᑎᖓᓂ ᐱᕆᐊᕐᓯᒍ ᐅᑭᐊᑦᓴᒧᑦ ᑎᑭᑦᓯᒍ, ᒥᑏᑦ ᐃᕐᐸᖓᐲᖕ-ᖓᐸᑦᑐᑦ ᐊᒻᒪ ᖃᐅᔨᒪᔭᐅᓗᐊᕐᑕᐃᓕᑦᓯᑎᒃ. ᒥᑎᒻᒪᓈᑦ ᐊᕐᓇᐱᐊᑦ ᐊᒻᒪ ᕿᑐᕐᖓᓇᔭᖏᑦ ᐊᐱᑦᑑᓯᖑᕗᑦ ᑕᒪᓐᖓᑦ ᐅᓗᐱᓂᕐᒥᓂᑦ ᐊᒻᒪ ᐊᖑᑎᐱᐊᖏᑦ ᐃᖏᕐᕋᐸᑦᓯᑎᒃ ᕿᑭᑦᑕᓄᑦ ᐃᒪᕐᐱᒦᓐᓂᐸᐅᔭᓄᑦ ᐃᓴᕈᐱᓂᕐᒥᓂᒃ ᐱᔭᐃᕆᐊᕐᑐᓯᑎ. ᑕᒪᒃᑯᐊ ᒥᑏᑦ ᐊᖑᑎᐱᐊᑦ ᑎᑭᒍᓐᓇᓯᐸᑦᑐᑦ ᐅᑦᑑᐸᐅᑎᓐᓄᒍ, ᒪᓕᑦᑕᐅᓯᑦᓯᑎᒃ ᐊᕐᓇᐱᐊᓄᑦ ᐊᒻᒪ ᒥᑎᐊᕉᓕᕐᑐᓄᑦ ᓅᐱᒻᐱᓇᒥ. ᑕᒪᒃᑯᐊ ᐃᖏᕐᕋᒪᓇᓕᑐᐊᕋᒥᒃ ᐅᓄᕐᑐᒪᓇᐅᐸᑦᑐᑦ ᐅᑎᕐᑕᖅᑦᑕᓕᕐᓯᑎᒃ ᕿᑭᑦᑕᐃᑦ ᓯᑦᔭᖏᓐᓂ ᐊᒻᒪ ᓄᓇᐅᑉ ᓯᑦᔭᖏᓐᓂ. ᐅᑭᐊᒃᑯᑦ ᐃᖏᕐᕋᐱᐅᐸᑦᑐᑦ ᐊᖅᑯᑎᖃᕐᐸᑦᑐᑦ ᑯᓚᐃᑉ ᓄᓇᖓᑕ ᓯᑦᔭᖓᓂ. ᓄᓇᐅᑉ ᓯᑦᔭᖓ ᓯᑯᕈᕐᐸᓕᐊᓕᑐᐊᕐᒪᑦ ᐊᒻᒪ ᕿᑭᑦᑕᐃ ᓄᓇᐅᑉ ᓴᓂᐋᓂᑦᑐ ᐊᒻᒪ ᐃᒪᕐᐱᒦᑦᑐᐃᑦ ᓯᑯᓯᔭᐅᐸᓕᓕᐊᓕᑐᐊᕐᒪᑕ, ᒥᑏᑦ ᓇᓃᑦᐱᓴᖃᑦᓯᐊ-ᐸᖕᖏᑐᑦ ᐅᑭᐅᑉ ᕿᑎᖓᓂᐅᓕᕐᒪᑦ ᐊᔭᕋᕐᓂᐸᑦᓯᑎᒃ.

ᐃᓄᐃᑦ ᖃᐅᔨᒪᓂᖃᕐᑐᑦ ᑕᒪᒃᑯᐊ ᒥᑏᑦ ᐆᒪᓂᖏᑦᑕ ᐊᑯᓃᕐᓂᖏᑦ ᒪᓕᓂᖃᕐᐸᒪᑕ ᐅᑭᐅᕈᕐᑕᓂᓇᐸᓂᐅᔭᒧᑦ. ᐊᒥᓯᓂᒃ ᐊᕐᕌᒍᓂᒃ, ᒥᑎᐋᕌᐲᑦ ᖃᐅᔨᒪᓂᖃᑦᓯᐊᖏᑦᑐᑦ ᐅᖑᔭᐅᐸᑦᑐᑦ ᓯᑯᓄᑦ ᐊᒻᒪ ᑕᐃᒪᖕᖓᒐᓛᒃ ᒥᑎᐲᓂᑦ ᑕᑯᔭᐅᐸᑦᑐᑦ ᖁᐊᖑᑎᓐᓄᕆᑦ ᑖᒪᓂ ᑐᑲᕋᐅᑉ ᕿᑭᑦᑕᖏᓐᓂ ᐊᒻᒪ Bakers Dozen ᕿᑭᑦᑕᖏᓐᓂ. ᐊᖑᑎᐱᐊᑦ ᒥᑎᒻᒪᓈᑦ ᑕᐃᒪᐃᓗᐊᐸᖕᖏᑐᐃᓐᓇ.

ᑕᒪᒃᑯᐊ ᒥᑏᑦ ᓂᕿᒃᑲᓗᐊᖑᐊᐸᒃᑲᓗᐊᕐᑎᓗᕆᑦ ᐅᐱᓗᕐᓂᒃ ᑐᖑᔭᕐᑕᓂᒃ, ᐊᓯᖏᓐᓂᒃ ᓂᓇᐸᒻᒥᔭᑦ, ᑕᒪᒃᑯᐊ ᓂᓇᔭᐅᐸᑦᑐᑦ ᐃᓚᖃᕐᑐᑦ ᐊᒻᒨᒪᔭᓂᒃ ᑭᖑᕐᓂᓗ ᑲᓇᔭᕐᓂᓗ ᐊᒻᒪ ᐊᓯᖏᓐᓂ.

ᓇᐃᓪᓕᑎᕐᓯᒪᑎᓪᓗᒋᑦ ᐅᖃᕐᓗᒋᑦ ᑕᒪᒃᑯᐊ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔪᑎᑦᓴᐅᔭᓂᒃ ᓄᐊᑦᓯᕕᐅᓚᐅᕐᑐᐃᑦ ᑖᒃᑯᓂ ᖃᐅᔨᓴᕐᓂᐅᔭᒥ ᓱᑲᓯᒋᐊᕐᑎᓯᒪᓇᓚᐅᕐᑐᑦ ᒥ'ᑎᑦ ᐱᕈᕐᐸᓕᐊᓂᖏᑦᑕ ᖃᐅᔨᒪᔪᑎᒋᔭᐅᔭᓂᒃ ᑖᒪᓂ ᖄᑦᓴᖕ ᐸᐃᒥ. ᑕᒪᒃᑯᐊ ᖃᐅᔨᒪᔪᑎᑦᓴᐃᑦ ᐊᔾᖄᖏᑐᑦ ᑕᒪᑦᓯᒪᐅᑉ ᖃᐅᔨᓴᕐᑕᐅᓂᕈᓂᒃ ᐱᑕᖃᕐᑎᓯᓚᕈᔭᑦ ᓄᓇᓕᓐᖑᑎᑦᓴᐅᔭᓂᒃ ᐅᕐᓯᐊᓗᒻᒥᒃ ᑯᐱᔭᖃᑦᓴᐸᑦ ᐸᕐᓇᓯᒪᒍᑎᑦᓴᐅᔭᓄᑦ.

ᑕᒪᑦᓯᒪᐅᑉ ᖃᐅᔨᓴᕐᓂᐅᑉ ᖃᓄᐃᓕᓂᕆᔭᖓ, ᑭᓯᐊᓂ, ᖄᖏᐆᑎᑦᓯᓂᖃᕐᑐᑦ ᑕᒪᒃᑯᐊ ᓯᕗᓂᑦᓴᓇᔭᐅᓚᐅᕐᑐᐃᑦ ᐊᓪᓚᓯᒪᐅᑎᒋᔭᖏᓐᓂ. ᑕᒪᒃᑯᐊ ᐊᑕᐅᑦᓯᑯᑦᑕᐅᓯᑎᒃ ᖃᐅᔨᓴᕐᓂᐅᔪᐃᑦ ᑭᓯᑦᓯᓯᑎᒃ ᐅᓪᓗᓂᒃ ᐊᒻᒪᓗ ᐃᓄᓪᓂᒃ ᐊᐱᕆᑦᓯᑎᒃ ᓄᐃᑎᑦᓯᓯᒪᓕᕐᑐᑦ ᖃᐅᔨᒪᔪᑎᓂᒃ ᐊᔾᖄᖏᑐᓂᒃ ᓱᓕᑦᓯᐋᑐᑦᓯᑎᒃ ᐊᒻᒪᓗ ᐅᖃᑦᓯᐊᑐᒪᓇᐅᑦᓯᑎᒃ. ᑕᒪᒃᑯᐊ ᖃᐅᔨᓴᕐᓂᐅᔪᐃᑦ ᐊᑕᐅᑦᓯᑯᑦᑎᓯᑦᓯᑎᒃ ᐃᓄᐃᑦ ᖃᐅᔨᒪᓂᓇᔭᖏᓪᓂᒃ ᐊᒻᒪᓗ ᖃᐅᔨᓴᕐᓂᑐᐃᓪᓇᐅᑐᔭᓂᒃ ᐱᑕᖃᕐᑎᓯᑉᓯᐊᕈᓇᐅᔭᑦ ᓄ'ᓇᐅᑉ ᓯᕐᕿᑕᐅᓂᖏᑦᑕ ᐃᓂᓪᓚᑕᐅᓕᓯᐊᕐᓂᖓᓄᑦ ᐊᒻᒪᓗ ᓄᑕᐅᓯᓕᕈᓪᓇᑐᐃᑦ ᐱᕕᑦᓴᐅᔭᐃᑦ ᐊᐅᓚᑕᐅᒍᓪᓇᓂᖏᓪᓂ.

# 1.0 INTRODUCTION

This study was organized as a response to the concerns of eastern Hudson Bay communities about offshore exploratory drilling in Hudson Bay. By late 1984, Canadian Occidental Petroleum Ltd. and Inter City Gas had negotiated Exploration Agreements for Hudson Bay with the Canada Oil and Gas Lands Administration (COGLA). A third petroleum company, Canterra Energy Ltd. was contracted to drill two exploratory wells and had submitted to COGLA a drilling program for the summer of 1985.

Confronted with news of an oil exploration program within Hudson Bay, Inuit communities voiced concerns about the possibility of an oil spill and the threat it posed to their subsistence lifestyle. From a brief review of the Environmental Overview (EAG 1984) submitted by Canadian Occidental Petroleum, it was apparent that the environmental information required for appropriate oil spill response was lacking for Hudson Bay. Even the most fundamental baseline information on seasonal distribution and population size of major faunal species was scanty or completely absent. Certainly there was no comparison with the massive environmental databanks accumulated by the Beaufort Sea Project or the Eastern Arctic Marine Environmental Studies, both of which were government-sponsored reactions to oil exploration.

As an attempt to improve our knowledge of the Hudson Bay ecosystem, the present study of the Common Eider, *Somateria mollissima L.* was proposed. Several factors directed us to a study of the Common Eider. Seabirds, especially alcids and seaducks, are considered to be the most vulnerable of arctic and subarctic fauna to marine oil pollution (Blood 1977; Leighton et al. 1985; Percy and Wells 1984). Prior to the present research, no reliable population estimates for the Hudson Bay subspecies, *S. m. sedentaria*, of the Common Eider were available. A recent comprehensive evaluation of Common Eider populations in eastern North America stated that "nest surveys of Hudson Bay Eiders are badly-needed" (Reed and Erskine 1986: 161).

The Common Eider is also a subsistence resource of considerable importance, providing eastern Hudson Bay communities with an annual harvest of more than 15,000 kg of meat and eggs (JBNQHRC 1982; BRIA unpublished data; Donaldson 1983a, b). The down of the eider is used locally for winter parkas and pants and, at present, opportunities for its commercial exploitation are actively being pursued by the Inuit communities of Northern Québec and the Northwest Territories.

Finally, our own research experience from several years of studying Common Eiders in Ungava Bay, made it feasible to mount a field research effort of this scale in the relatively short period of time available.

One aspect of the present study is worthy of special mention. The research project provides a unique blend of the knowledge and expertise of both scientists and Inuit. Given the paucity of baseline data available on Common Eider it was immediately apparent that a census of nesting colonies would provide only a very limited preparation for appropriate oil spill response. While estimates of breeding population size are critical for a quantitative evaluation of oil spill impact, a nest survey is necessarily restricted to the nesting season. It is also restricted in area, focusing on selected archipelagos where eiders are known to nest.

Effective oil spill response is dependent upon the availability of comprehensive data on wildlife distribution and ecology. Such comprehensive data must cover all seasons and include information of year to year variation for the entire area possibly affected by oil spill.

The accumulation of a baseline data set of this nature by "traditional" scientific methods requires a massive investment of manpower, time and funds. The forementioned Beaufort Sea and EAMES projects are only two examples of such mega-endeavours. That even a scaled-down version of such studies should take place in Hudson Bay was neither feasible nor, from the point of view of the communities, desirable. The communities themselves, however, could provide an alternative: the collective ethno-ecological knowledge of their hunters. This data set is ideally suited for the task, providing detailed biogeographical and ecological information for all seasons over an extensive region. Inuit hunter knowledge of Common Eider ecology is a perfect complement for the quantitative data generated by the survey of eider nest colonies.

## 2.0 THE STUDY AREA

Hudson Bay is a shallow, closed sea, encircled by the Northwest Territories and the provinces of Quebec, Ontario and Manitoba (Fig. 1). It is 637,000 square kilometres in area with a maximum depth of 235 m. The only openings from the Bay are the narrow Fury and Hecla Strait to the Arctic Ocean, and the wider Hudson Strait to the Atlantic. The drainage basin of Hudson Bay is about 4 million square kilometres. The fresh water input from the rivers draining into the bay is immense, an average of 30,900 cubic metres per second. This fresh water input lends an estuarine character to the Hudson Bay environment. Warm and relatively fresh surface waters overlie deeper, cold and saline water whose temperatures range between -1 and -2 degrees Celsius (Marsh 1985).

The region surrounding the south and west coasts of Hudson Bay is of low relief. The shores of Ontario and Manitoba are an almost flat plain, extending inland for almost 300 kilometres. This region, which extends from the south end of James Bay to Churchill, Manitoba, is called the South Coast Lowland. From Churchill to Chesterfield Inlet is the West Coast Lowland, a similar but less extensive plain. The two regions differ in geology, vegetation and inhabitants (Robinson 1968).

The Northwest Hills region lies north of Chesterfield Inlet. Here the land is composed of rugged hills which exceed 300 metres. The northern islands of Southampton, Coats and Mansel, are situated at the mouth of Hudson Bay (Robinson 1968).

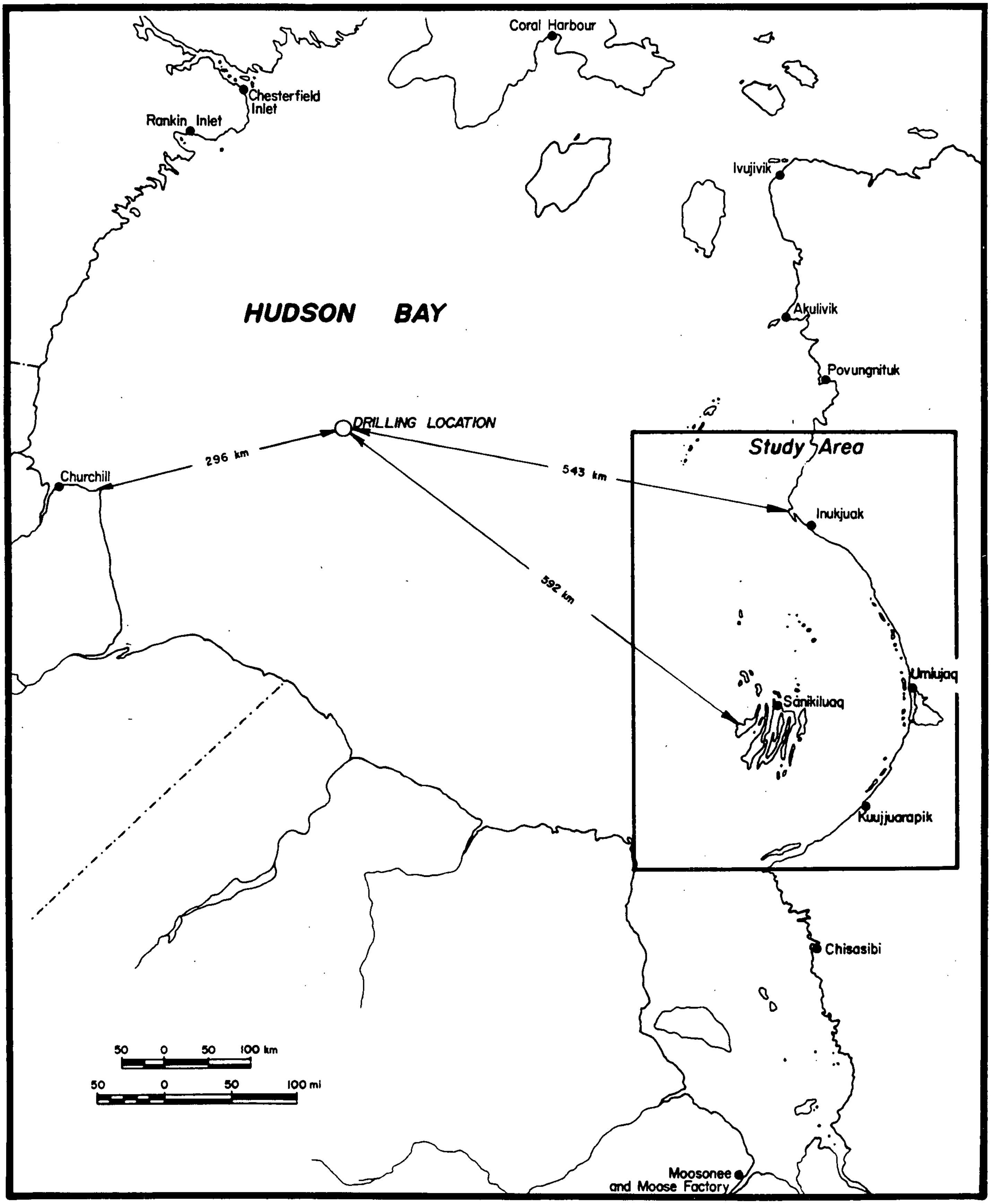



Figure 1. Locations of the drillsites and study area in Hudson Bay (after EAG 1985)

The east coast of Hudson Bay, sometimes called the Eastmain, has much more rugged relief than the west. The northern Ungava Peninsula meets the sea with 300 metre bluffs in the area of Cape Wolstenholme, the site of the community of Ivujivik. The Povungnituk Mountains run east-west across the peninsula, entering Hudson Bay at Cape Smith, where the community of Akulivik is located (Robinson 1968).

The most interesting geological feature of Hudson Bay is in the southeast, where the coast takes the form of a large semi-circle, sometimes referred to as the Hudson Bay Arc (Fig. 2). This arc, of possibly meteoric origin, is centred northwest of the Belcher Islands and has a radius of about 250 kilometres. Around the arc, the land angles into the sea. The coast is paralleled by several island chains; Long Island, the Manitounuk Islands, the Nastapoka Islands and the Hopewell Islands. These islands are characterized by their wedge shaped appearance, rising in steep bluffs or cliffs on the landward side, and sloping gently to the water on the seaward side (Beals 1968).

The main archipelago within Hudson Bay is the Belcher Islands, a complicated maze of low, long, north-south trending islands. They are mostly basaltic and poorly vegetated with moss and grasses. To the north are several other archipelagos; the Bakers Dozen Islands, the King George Islands, the Sleeper Islands, the Marcopeet Islands, and the Ottawa Islands (Robinson 1968).

In winter most of Hudson Bay is covered with shifting pack ice. There is a large polynya in Roes Welcome Sound (Larnder 1968). Elsewhere in the Bay, small polynyas are maintained, in all but the coldest weather, by strong tidal currents. Other areas are opened periodically by the wind.

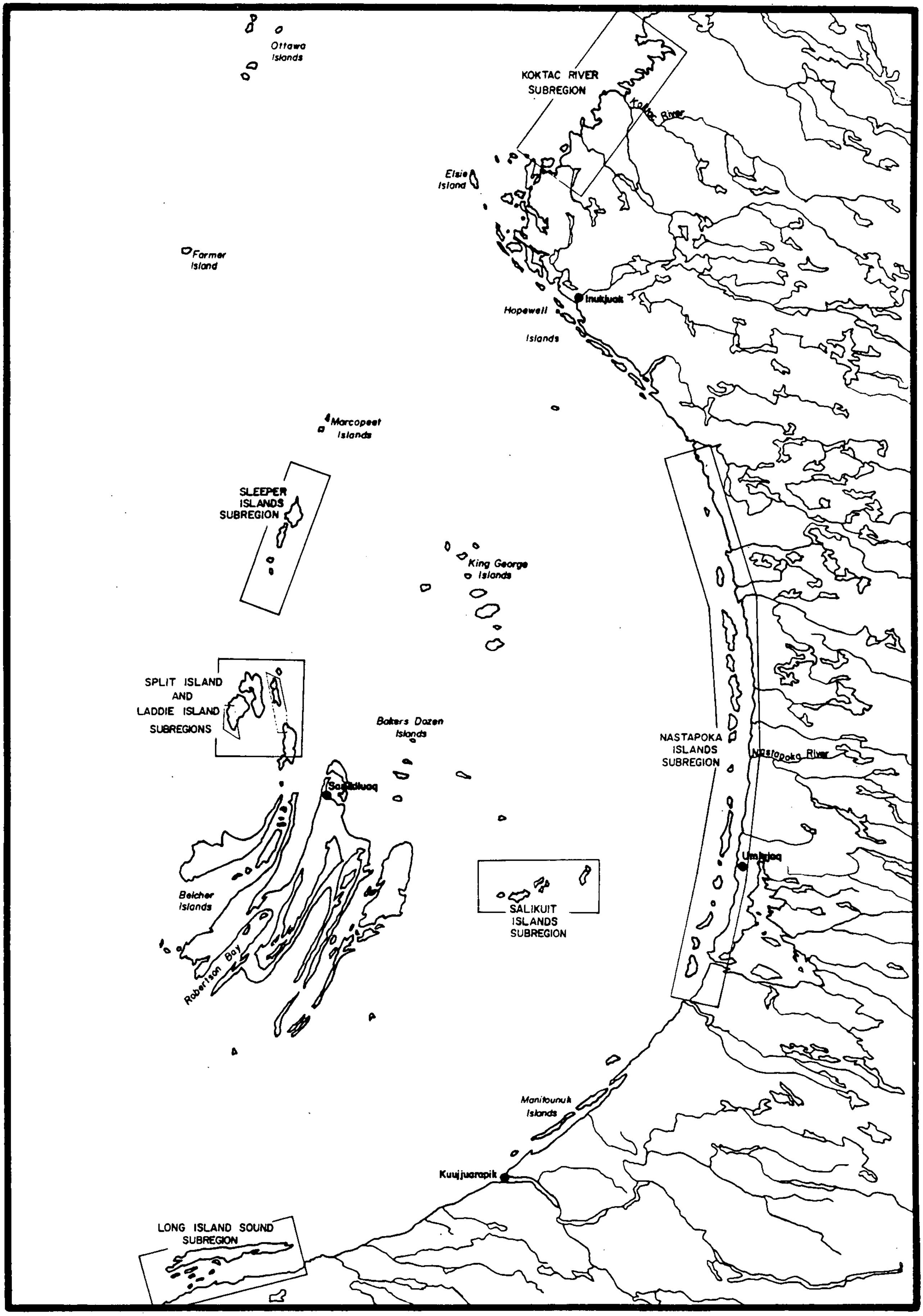



Figure 2. Locations of the surveyed subregions in eastern Hudson Bay

Open water often occurs downwind of islands. West of the Belcher Islands is an area of constantly moving ice, shifting leads and high pressure ridges. To the east of the Belcher Islands, a solid and dependable cover of ice extends to the mainland during the coldest months of the winter.

The first open water in spring occurs at the river mouths. As the spring thaw depends upon the run off of warm fresh water from the rivers, the ice deteriorates most rapidly in the south part of the bay. Predominant northwest winds force the ice pack south, and thus, the first open areas are usually in the northwest.

The general circulation of surface currents in Hudson Bay is in a counter-clockwise direction (Pelletier et al. 1968). Tides advance in a similar way around the bay. High tides reach Churchill hours before the Eastmain (Canadian Hydrographic Service 1983). These currents, and the rivers which drain into the bay greatly affect its productivity. Some of the most productive waters are in the zone of mixing currents north of James Bay.

## 3.0 REVIEW OF THE SCIENTIFIC LITERATURE ON THE HUDSON BAY EIDER

The Common Eider of Hudson and James Bays, also referred to as the Hudson Bay Eider, was first identified as a distinct subspecies by L.L. Snyder in 1941 (Todd 1963). Snyder christened the subspecies *sedentaria*, in reference to the non-migratory habit of this population. The northern limit of the breeding distribution of *S. m. sedentaria* is north Hudson Bay, where it overlaps the distribution of *S. m. borealis*, the northern subspecies of the Common Eider. The boundary between the two subspecies has not been clearly defined by biologists. It is generally accepted, however, that the breeding distributions of the two subspecies meet on the east side of Hudson Bay, somewhere between Cape Smith and Cape Wolstenholme and on the west side, in the Chesterfield Inlet - Cape Fullerton area (Godfrey 1966; Palmer 1976; Todd 1963). Mansel, Coats and Southampton Islands in north Hudson Bay are considered to be within the breeding range of *borealis*, while *sedentaria* nests on the Ottawa and Sleeper Islands (Godfrey 1966; Palmer 1976). Abraham and Finney (1986), however, speculate that *sedentaria* may nest on all of these islands. Recent surveys on Southampton Island by Abraham and Ankney (1986), confirm breeding by *borealis* and the presence of adult male *sedentaria*.

Reported nesting locations for the Hudson Bay Eider are summarized in part by Abraham and Finney (1986). For the eastern Hudson Bay region, accounts of the presence of nests or broods have been published for the following locations: Great Whale River (Eifrig 1906); several sites along Nastapoka and Hopewell Sounds (Murie in Todd 1963); Richmond Gulf (Macoun in Todd 1963); Robertson Bay, Kasegalik River, Eskimo Harbour (Freeman 1970), Gushie Point, Tukarak Island, Weetalltok Bay (Twomey in Todd 1963), and Kugong Island and adjacent islands (Manning 1976) all within the Belcher Islands; Sleeper and Marcopeet Islands (Manning 1976); King George Islands (Manning 1946); and Cape Anderson, Agnes Smith Point (Furneaux 1962), Magnet Point and near Smith Island (Todd 1963) in the Povungnituk/ Akulivik area. Several records of breeding eiders exist for James Bay and the south and west coasts of Hudson Bay (Abraham and Finney 1986).

Few systematic surveys of Common Eider colonies have been conducted in Hudson and James Bays. In the Belcher Islands, Freeman (1970) estimates an eider population density of 12.5 individuals per square mile in the vicinity of breeding sites southwest of the mouth of Robertson Bay. An aerial survey of the Quebec coastline of Hudson Bay conducted in 1978 by the Canadian Wildlife Service (Chapdelaine and Tremblay 1979) provides a count of 732 drakes between Point Louis XIV and Ivujivik. Based upon ground surveys in Ungava Bay in 1980, Chapdelaine et al. (1986) use a correction factor of 28.4 nests per drake observed from the air, to estimate the Quebec nearshore population of *sedentaria* as 41,600 breeding individuals. The authors emphasize the tentative nature of this estimate.

Abraham and Finney (1986), on the basis of local ground surveys including those of Freeman (1970) and Manning (1946), estimate that an additional 3,600 eiders nest in the Belcher Islands, James Bay and along the south and west coasts of Hudson Bay. They therefore offer a working figure of 45,200 breeding individuals as a first attempt at estimating the size of the Hudson Bay Eider population.

# PART I
# Breeding Population Size and Distribution

by D.J. Nakashima and D.J. Murray

## 4.0 METHODS

### 4.1 Community consultation and the selection of survey crews

Before beginning the field work, meetings were held with the local community councils and wildlife committees of the three participating communities: Kuujjuarapik, Sanikiluaq and Inukjuak. The purpose of these meetings was 1) to identify the areas the communities wanted to be surveyed, 2) to select the census crews and 3) to have hunters stratify nest islands according to their knowledge of eider nest distribution.

From these meetings it was agreed that the census crews from Kuujjuarapik would survey Long Island Sound, the Nastapoka Islands south of the Nastapoka River and the Salikuit Islands (Figure 2). Richmond Gulf was to be censused only if sufficient time remained. The Sanikiluaq crew was assigned to survey the Sleeper Islands, the North Belcher Islands and the islands southwest of the mouth of Robertson Bay. The north part of the Nastapoka Islands, the coastal regions north of Inukjuak and the King George islands were identified as important census areas for the Inukjuak crew.

The composition of the census crews is shown in Table 1. Each crew consisted of a coordinator, two or three senior hunters and three or four young Inuit. The coordinator was responsible for maintaining the quality and consistency of the data collected. Uniformity among the three census crews was ensured by consultation and planning before going into the field and, once in the field, by radio

Table 1 - Survey crews for the three census regions

| **Community** | **Kuujjuarapik** | **Sanikiluaq** | **Inukjuak** |
|---|---|---|---|
| **Coordinator** | David Murray | Douglas Nakashima | Peter Inukpuk |
| **Senior Hunters** | Moses Inukpuk<br>Willie Fleming<br>Mark Inukpuk | Allie Ippak Jr.<br>Marcussie Sala | Daniel O. Kasudluak<br>Samson Qingalik<br>Joanassie Umarualuk |
| **Survey Workers** | Gilbert Inukpuk[1]<br>Johnny Meeko[2]<br>Josie Nuktie[3]<br>Abelie Tukaluk<br>Gilbert Weetaltuk | Lucassie Arragutainaq Jr.<br>Joanassie Inuktaluk[4]<br>Charlie Ippak[5]<br>Sam Qavvik[4]<br>Allie Sala<br>Isaac Sala[5] | Marc Carrier<br>Samson Epoo<br>Tommy Weetaluktuk |

1. Long Island and Nastapoka Island survey only
2. Nastapoka Islands survey only
3. Nastapoka and Salikuit Islands survey only
4. Sleeper Islands survey only
5. North Belcher Islands survey only

communication. The senior hunters were responsible for the safety of the census crew, for navigation and for island identification. The young crew members recorded the census data and checked for data recording errors. In addition to these specific tasks, all crew members cooperated in the day-to-day work of surveying the Common Eider colonies.

### 4.2 The random selection of survey islands

The eastern Hudson Bay region is geographically extensive and comprised of thousands of offshore islands. In order to facilitate the survey, this complex area was divided into geographic sub-units. In most cases, these units represent natural archipelagos, separated from adjacent topographic features by expanses of open water or by the configuration of the coastline. For the purpose of population estimation, these subregions are the units to be sampled. The three participant communities decided which of these subregions were the most important to survey. Seven of these areas were sampled during the 1985 nest survey. The location and boundaries of these sampled subregions are depicted in Figure 2.

Within each of these subregions, islands were assigned identification numbers. Islands were enumerated on standard 1:50,000 scale topographic sheets available from the Canada Map Office. Islands with areas greater than 500 hectares (ha) were considered as mainland, and excluded from the set of islands to be sampled. In addition, islands were excluded if, on the 1:50,000 map sheets, they appear within the foreshore flats of the mainland or of islands with areas greater than 500 ha. The rationale behind these two exclusions is first, the high probability of fox frequenting the mainland and very large islands and second, the vulnerability of islands within foreshore flats to fox predation. Access by fox generally precludes colonial nesting by seabirds such as the Common Eider (Ahlen and Andersson 1970; Larson 1960). Although scattered nesting does occur, the number of eiders nesting in these areas is considered to be insignificant for the purposes of this survey.

Large-scale topographic sheets were not available for the Sleeper Islands nor for the Salikuit Islands. For the Sleeper Islands we were able to produce our own maps at a scale of 1:60,000 from airphotos available from the Canada Airphoto Library. Unfortunately, no airphotos of any kind are presently available for the Salikuit Islands. The enumeration of islands in this subregion was conducted on 1:250,000 scale topographic and nautical charts. For these two subregions, information is not available on the extent of foreshore flats. As a result, some islands in the data set may connect to islands with areas greater than 500 ha at low tide.

Having identified and enumerated eligible islands in each subregion, we then randomly selected 50% of these islands for surveying. The selection was made by taking numbers from a random number table until 50% of eligible islands were chosen.

### 4.3 Measurement of area and stratification on the basis of island size

Island areas were measured from 1:50,000 scale topographic sheets, or in the case of the Sleeper Islands from 1:60,000 airphotos. No areas were measured in the Salikuit Islands as the only available maps were considered to be at too small a scale for accurate measurement

(1:250,000). One of two methods of measurement was applied depending upon island size. For very small islands (2.5 ha and less) a dot grid system was used. The selected grid had a density of 117.5 dots per square centimetre. As 1 $cm^2$ at a scale of 1:50,000 represents 25 ha, the area of a single dot represents 0.2 ha. Island area for very small islands was assessed by overlaying the dot-grid and counting the number of dots within the island perimeter.

For islands larger than 2.5 ha a digital planimeter was used (Koizumi, Placom KP-90). The operator traced the perimeter of each island using the planimeter's crosshairs, and the planimeter calculated island area. To minimize errors in measurement, this process was repeated three times and the average of the three readings was used.

If nest density differs significantly between island size classes, then our population estimate can be improved by the stratification of our data on the basis of island size class. In order to investigate if such a relationship exists, islands were sorted into one of four size categories; 0 to less than 2 ha; 2 ha to less than 10 ha; 10 ha to less than 50 ha; and 50 to less than 500 ha.

### 4.4 Stratification of islands on the basis of hunter appraisal

Prior to the census, interviews were organized with experienced hunters to obtain their appraisals of the distribution of Common Eider nest colonies. If the nest densities of islands in different hunter appraisal classes are significantly different, then our estimates of population size will be improved by stratifying in accordance to these classes.

Hunters were asked to assess islands according to their knowledge of the distribution of Common Eider nest colonies. Some additional information was collected for other species, in particular for gulls and Arctic Terns, but a comprehensive assessment was made only for Common Eiders.

Using 1:50,000 scale topographic maps, hunters assigned each island to one of the following classes:

1. Excellent nest island
2. Good nest island
3. Indifferent
4. Island with no nests
5. Island unknown to hunters

Detailed hunter appraisals were obtained for the following subregions: Long Island Sound, the Nastapoka Islands and the south part of the Koktac River area.

### 4.5 Survey techniques

The survey techniques were developed in cooperation with Dr. Austin Reed of the Canadian Wildlife Service. A sampling intensity of 50% of eligible islands within a subregion was selected as the best a priori compromise between producing population estimates with reasonable confidence limits and sampling a diversity of breeding areas. Consequently, survey crews attempted to survey as many randomly pre-selected islands as possible, to a limit of 50%, before moving on to another subregion. The most commonly employed survey technique was the total ground count of an island. Depending upon island size, some or all of the survey crew would disembark on a selected island. A survey line would be organized with individuals evenly spaced along its length. Distance between surveyors would vary from a few meters on dense nest islands to 30 metres on large, sparsely-occupied islands. In the latter case, surveyors would zig-zag back and forth to investigate all areas that appeared to be suitable for nesting. The survey line would traverse back and forth across the island until the entire surface area would be inspected.

Very small, relatively flat islands with little vegetation were often surveyed by approaching as closely as possible in the canoes and slowly cruising along the shore. Careful scanning with the aid of binoculars was generally found to be sufficient to detect the presence of gull or eider nests. By speeding up the census, scanning permitted the survey of a greater number of islands. A ground count was conducted if scanning revealed; 1) the presence of an eider or an eider nest; 2) suitable substrate for eider nesting; or 3) that portions of the island surface were not easily inspected from the boat.

Partial counts were conducted on large, sparsely-nested islands. An estimate of the number of nests on each island was calculated on the basis of the proportion of suitable nesting habitat surveyed. Partial counts were conducted on 13 islands of less than 500 ha.

It was decided that very large islands of greater than 500 ha should be treated as mainland, and therefore not be surveyed. Nevertheless some of them were partially surveyed by slowly cruising the shore, spot-checking peninsulas and other potential nest habitat and by conducting long, exploratory traverses and coastal walks when bouts of bad weather precluded work elsewhere. These data serve as a verification of our assumption that very large islands harbour fox, and consequently are avoided by nesting eiders.

Survey data was recorded on standardized data sheets (Fig. 3). These data sheets were designed to facilitate data recording and subsequently, entry of the data into the computer. The following information was recorded for each island:

1. Region number
2. Island identification number
3. Survey date
4. Survey type (total count, scan, partial count)
5. Survey crew members
6. Transcriber
7. Description of island topography and substrata

For each nest encountered, the following information was recorded:

1. Species name
2. Species code
3. Number of eggs
4. Number of young
5. Nest status

Nest status was recorded as one of six options shown in Table 2. Eggs were inspected for evidence of hatching. As the egg membrane separates easily from the egg shell at the time of hatching, the presence of large pieces of membrane independent of shell fragments was judged to be good evidence for a successfully hatched nest. Once inspected, active nests were carefully covered with nest down, to hide the eggs from predators and insulate them against the cold.

# ᒥᑏᑦ ᑭᑎᑕᐅᓂᖏᑦ 1985 EIDER DUCK CENSUS

ᓇᓂᒻ ᒪᕐᑦ REGION : ___ ___

ᐅᑦᓗ DATE : 8 5 ___ ___ ___ ___ (ᑕᖅᑭ MONTH) (ᐅᑦᓗᖓ DAY)

PAGE ᓱᑯᑦ ᓴᐳᑉ ᑭᑎᓯᒍᑎᖓ

ᕿᑭᖅ ᑕᐅᑉ ᑭᑎᑦ ᐊᑎᖓ ISLAND No. ___ ___ ___

ᕿᑭᖅ ᑕᐅᑉ ᐊᖏᓂᖓ ISLAND AREA : ___ ___ ___ ___ ___ ___

ᖃᓄᐃᓘᖅ ᒪᕐᑕ ᑲᒪᒍᑎᖏᑦ COUNT TECHNIQUE : ᑲᑎᑦ ᓯᑎᒃ ᑭᑎᑕᐅᔪᑦ TOTAL COUNT ☐ ᐊᓯᖏᑦ OTHER : ____________________

ᑭᓇᒃ ᑯᒪᕐᑕ ᐱᓇᓱᑦ ᑐᑦ CREW MEMBERS : ____________________

ᕿᑭᖅ ᑕᐅᑉ ᕿᒥᕐᕚᐅᓂᖓ ISLAND DESCRIPTION : ____________________

| ᑎᒻ ᒥᐊᑦ ᖃᓄᐃᑦ ᑐᓂᖏᑦ SPECIES | ᓇᓗᓇᐃᒃ ᑯᑕᖓ CODE | ᒫᓂᑦ EGGS | ᑎᒻ ᒥᐊᓛᕆᑦ YOUNG | ᑎᒻ ᒥᐊᑦ ᐅᑦᓗᖏᑦ NEST STATUS | ᐊᓯᖏᑦ ᐅᖃᐅᓯᒃᓴᑦ COMMENTS |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Figure 3. Sample of data collection sheet used during the nest survey

Table 2
Nest Status Codes

| Nest status code | Condition | Description |
|---|---|---|
| 1 | Nest in laying phase or being incubated | Eggs present |
| 2 | Hatching nest | Warm eggs present of which at least one is starred, or duckling present |
| 3 | Hatched nest | Empty nest but large pieces of egg membrane indicate successful hatching |
| 4 | Destroyed/abandoned nest | Empty nest with evidence of eggs destroyed; much nest down and cold eggs settled into nest bottom |
| 5 | Nest of unknown fate | Empty nest with fresh down but insufficient evidence to determine if hatched, destroyed or abandoned |
| 9 | Active but contents unknown | Active nest observed or known to be present due to presence and behaviour of adults, but contents not inspected |

### 4.6 Down sampling technique

Down samples were collected from the following subregions; 1. Nastapoka Islands (n=17); 2. Salikuit Islands (n=18); 3. Laddie Island (n=14); 4. Split Island (n=16); 5. Sleeper Islands (n=29); and 6. Koktac River (n=13).

Only nests with unhatched eggs were sampled. Sampling technique differed slightly between survey crews. The Kuujjuarapik and Sanikiluaq crews set the eggs aside and then removed the loose down. The remaining down compacted in the nest bottom was fluffed up, the eggs restored to the nest, and, if necessary, additional down replaced to surround and cover the eggs. In general the Sanikiluaq crew tended to leave more down in the nest than did the Kuujjuarapik crew. In the north Nastapoka Islands and Koktac River subregions the eggs were not removed from the nest. The outer ring of down was collected and the eggs covered with the remainder.

In the Salikuit, Laddie, Split and Sleeper Islands subregions, sampling frequency, decided a priori, varied between every nest and every third nest encountered in a colony. When a nest was encountered which had down too dirty or in insufficient quantity to be collected, it was recorded as having 0 gm of down. In the Nastapoka Islands and Koktac River subregions, down collection was done less systematically, and it is possible that the sample was biased in favour of nests with more down.

In all subregions, the down collected from each nest was placed in individual bags with a label identifying the date of collection, the region and island number and the nest contents. Individual nest samples were air-dried in their mesh bags and weighed uncleaned. They were then hand-cleaned using the traditional loom cleaner. Finally the cleaned down samples were individually weighed to determine clean down available per nest.

### 4.7 Data processing and statistical analysis

For each island, the following data was entered into the computer:

1. subregion identification number
2. island identification number
3. survey date (if surveyed)
4. island area
5. count variable -
   - Y - counted island
   - P - partially-counted island (area less than 500 ha.)
   - L - partially-counted island (area equal to or greater than 500 ha.)
   - N - not-counted island
6. random variable -
   - Y - randomly-selected island
   - N - not-selected island
   - O - new island, not appearing on topographic map sheets
7. hunter rating (see section 4.4)
8. map variable (information from topographic sheets) -
   - A - island of less than 50 ha.

C - true island (50 to less than 500 ha)

L - true island (500 ha. or larger)

M - island within the foreshore flats of the mainland or of an island 500 ha. or larger

9. Field variable (information from field observation) -

   A - true island (appearing on topographic maps)

   B - new island (not known from topographic maps)

   X - not an island (despite its existence on topographic maps)

   M - island connected to the mainland

   J - island joined to another island

   U - unknown (not field verified)

A second computer file was opened for the nest data and the following data was entered for each nest:

1. subregion identification number
2. island identification number
3. species code
4. number of eggs
5. nest status (Table 2)

The island and nest data files were then combined to form a composite file of 11,360 records. This file was manipulated on the main-frame computer at McGill University using the SAS system.

Statistical treatment of the data was complicated because the number of nests per island had a skewed distribution and a high standard deviation. Most statistical tests require a normal distribution. Cochrane (1977) suggests that if $n > 25G_1^2$, for

$$G_1 = \frac{\sum (X - \overline{X})^3}{NS^3}$$

then it can be assumed that the data are "close enough" to normal to use statistical tests and to establish confidence limits. Statistical procedures were only applied if Cochrane's test was satisfied.

To determine the significance of the difference between mean nests per island and clutch size in each subregion, t-tests were used. If T is larger then the value obtained from the t - table, at the appropriate degrees of freedom and confidence level, then the means can be said to be significantly different.

$$T = \frac{(\overline{X}_1 - \overline{X}_2)}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

$$\text{degrees of freedom} = V = \frac{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)^2}{\frac{\left(\frac{S_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{S_2^2}{n_2}\right)^2}{n_2 - 1}}$$

(Walpole and Myers 1978, p.252)

To determine whether eiders nest in positive association with other species (i.e. gulls and terns), we employed the chi-square statistic ($X^2$). This statistic tests the significance of the frequency with which two species nest on the same island. Knowing how many islands were used by gulls and how many were used by eiders, we calculate how many islands we would expect to find occupied by both gulls and eiders. We then compare this to the observed number of islands with both species, and test with $X^2$ to see if the difference is significant. In the example below (Fig.4), '+' indicates the number of islands that were nested on, and '-' indicates islands that were not.

Figure 4. Use of the chi-square test of independence to describe the nesting association of Common Eiders and gulls in Long Island Sound.

OBSERVED

| eiders | gulls + | gulls - |
|---|---|---|
| + | 18 | 1 |
| - | 11 | 24 |

EXPECTED

| eiders | gulls + | gulls - |
|---|---|---|
| + | 10 | 9 |
| - | 19 | 16 |

$$X^2 = \sum \frac{(o-e)^2}{e} = 18.25$$

for o = number of islands observed
e = number of islands expected

If $X^2$ is larger than the value taken from the $X^2$ table, then the two species can be said to nest in positive association. At the 99% confidence level and 1 degree of freedom, the value on the table is 7.879. Thus our example in Figure 4 shows that gulls and eiders in the Long island Sound subregion nest in positive association.

# 5.0 RESULTS

## 5.1 The Long Island Sound subregion

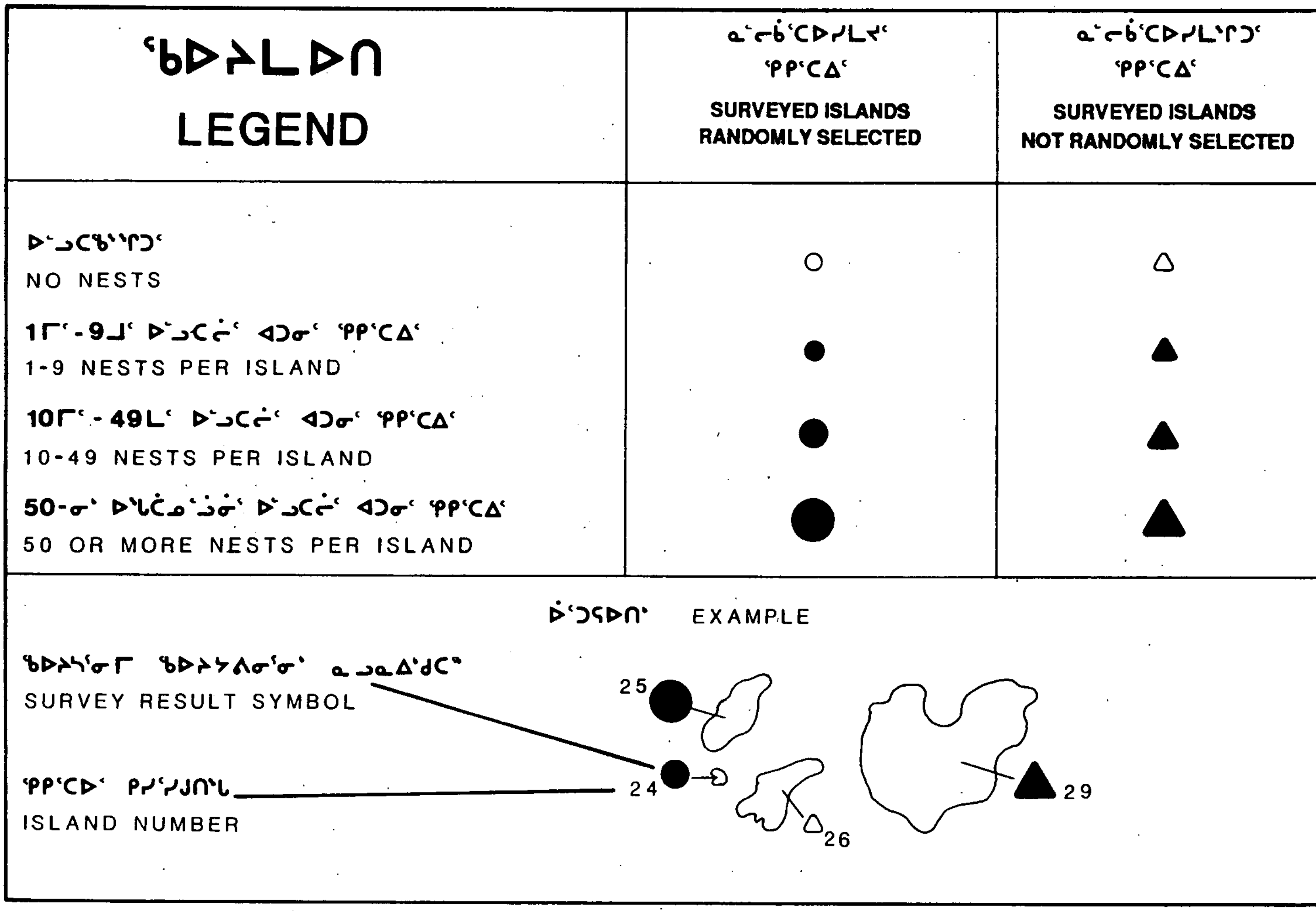
### 5.1.1 General description

Long Island Sound is immediately east of the meeting of Hudson and James Bays (Fig. 2). It is about 50 km long and 10 km wide. To the north its border is defined by Long Island and to the south by the Quebec mainland (Fig. 5).

Long Island Sound differs ecologically from the other subregions surveyed in the study, as it is the transition from a subarctic to an arctic ecological zones. The south coast of the Sound is heavily forested, and there are trees on Long Island. Species density is higher here than farther north in Hudson Bay, as both subarctic and arctic fauna inhabit the area. It is also an area used by Inuit and Cree from both Kuujjuarapik and Chisasibi for hunting and camping.

Long Island forms the north border of the area. Fifty kilometres (km) long and about 3 km wide for most of its length, it is the only island over 500 ha in the subregion. Sixteen islands have areas of 50 to 500 ha and 101 islands have areas up to 50 ha. In this latter group the 1:50,000 scale topographic maps show 32 islands connected to the mainland or Long Island by foreshore flats. Only the 69 islands separate from shore and less than 50 ha are considered in our estimates. The majority of the islands (90%) lie in the western half of the Sound.

A 1:50,000 scale map of the Long Island Sound subregion, showing island identification numbers, survey results and important landmarks is available upon request from the Makivik Research Department. Figure 5 is a reduced and simplified version of this map which has been included with the text for general reference.




Legend for figure 5.

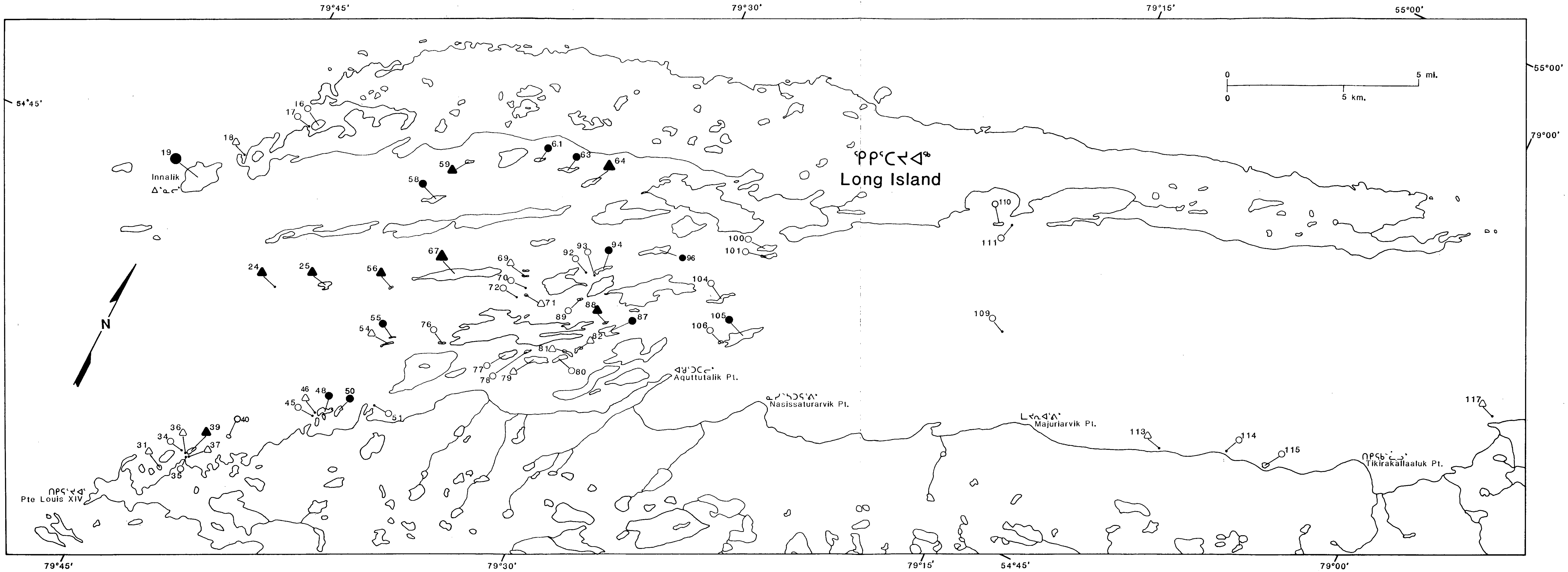



**Figure 5** - The Long Island Sound subregion. Island identification numbers and Common Eider survey results.

### 5.1.2 The nest survey

The Long Island Sound subregion was surveyed between 24 June and 1 July by a crew from Kuujjuarapik. A total of 57 islands were surveyed. Of the 69 islands outside the foreshore flats and with areas up to 50 ha, 26 islands were randomly selected and counted. This represents a sampling intensity of 37.7%. An additional 28 islands were counted (11 of which are in the foreshore flats) but as they had not been randomly selected their data do not contribute to the projection. Sixteen islands occur in the 50 to 500 ha size class. Only two of these larger islands were surveyed (islands #19 and #67) and due to their size the surveys covered only part of each island (Fig. 5).

Interviewed hunters in Kuujjuarapik indicated which islands were the best for nesting, and which islands were known to be unsuitable for nesting because of the presence of fox. The hunters marked 16 islands as good nesting, all of which were surveyed. Eleven islands were said to have fox. None of the 'fox' islands, all of which are over 50 ha, were surveyed.

The great amount of ice in the subregion during the survey period precluded travel to the north side of Long Island. Although none of the eleven islands on the north side of Long Island were surveyed, we nevertheless included them in our projection. The three westernmost islands in Long Island Sound were also inaccessible due to strong currents. Two of these were randomly selected, and none of them was said by hunters to be especially good for eiders, although one was said to have a lot of terns.

### 5.1.3 The number and distribution of Common Eider nests

The Long Island subregion had a relatively small population of nesting Common Eiders and a large population of gulls and Arctic Terns. Eiders nested on only 19 of the

54 surveyed islands. A total of 115 Common Eider nests were found (see Fig. 5). Three islands (#19, #64 and #67) accounted for 70 nests or 60.9% of the total nest count.

Twenty-six nests were found on the 26 randomly selected and counted islands of less than 50 ha. Using our average of 1.0 nests per island, we estimate a total of 69 nests ±41 (±59.4%) in the Long Island subregion, for the 69 islands less than 50 ha in area (Table 3). According to the guidelines suggested by Cochrane (1977), we are justified to use the normal approximation to generate confidence limits, as n $25G_1^2$. However, at $\alpha = 0.05$, the limits are so wide that the estimate is of limited use.

In the 50 to 500 ha size class, two islands (#19 and #67) were surveyed. Although only partially surveyed, these islands had the highest numbers of Common Eider nests of all islands censused in the subregion. Approximately two-thirds of island #19 was surveyed, and 19 eider nests were counted. The survey of island #67 covered roughly three-quarters of the suitable nesting habitat and 34 nests were discovered. We thus estimate the total nest number to be 29 and 44 for islands #19 and #67 respectively.

For the Long Island Sound subregion we suggest an estimate of 142 breeding pairs . This estimate includes 69 nests estimated for islands of up to 50 ha in area and 73 eider nests estimated for the two surveyed islands in the 50 and 500 ha size class. The latter value is conservative as it assumes that no eiders were nesting on any of the 14 other islands with areas of 50 to 500 ha. No confidence limits can be placed on this estimate of 142 Common Eider nests, but the fact that we located a total of 115 eider nests in the subregion in 1985, suggests that the estimate is conservative.

Table 3
Estimates of Common Eider breeding population size in seven subregions in eastern Hudson Bay

| Subregion | Total islands | Surveyed islands (%) | Number of nests counted | Nests per island | Standard deviation | Nest estimate and confidence limits at $\alpha = 0.05$ |
|---|---|---|---|---|---|---|
| 1. Long Island | 69 | 26 (37.7) | 26 | 1.0 | 2.0 | 69 ±41 (±59.4%) |
| 2. Nastapoka I. | 169 | 61 (36.1) | 289 | 4.7 | 22.3 | 801[t] |
| 3. Salikuit I. | 91 | 30 (33.0) | 295 | 9.8 | 20.5 | 895 ±546 (±61.0%) |
| 4. Laddie Island | 157 | 78 (49.7) | 821 | 10.5 | 30.1 | 1,653[t] |
| 5. Split Island | 113 | 56 (49.6) | 602 | 10.8 | 47.9 | 1,215[t] |
| 6. Sleeper Island | 372 | 175 (46.7) | 2,775 | 15.9 | 62.2 | 5,899 ±2,500 (±42.4%) |
| 7. Koktac River | 616 | 294 (47.7) | 1,017 | 3.5 | 8.6 | 2,131 ±438 (±20.6%) |
| ALL SUBREGIONS | 1,587 | 720 (45.3) | 5,825 | 8.1 | 36.5 | 12,839 ±3,123 (±24.3%) |

t - confidence limits cannot be calculated as departure from a normal distribution exceeds acceptable limits. i.e. $n < 25G_1^2$

### 5.1.4 The number and distribution of gull and Arctic Tern nests

Of all the subregions studied in eastern Hudson Bay, Long Island Sound had the largest populations of nesting gulls and Arctic Terns *(Sterna paradisea)*, on both a per island and per Common Eider nest basis. It was the only region which had more gulls per island and more Arctic Terns per island than eiders. Note that the term "gull" refers to both the Herring Gull *(Larus argentatus)* and the Glaucous Gull *(L. hyperboreus)*. One hundred and ten gull nests were counted on randomly-selected and counted islands under 50 ha. This is over four times the number of eider nests and this represents an average of 4.2 gull nests per island. The next highest density of gull nests was found in the Nastapoka and Salikuit Islands which each had an average of 2.0 gull nests per island (Table 4). The Long Island Sound gull population is estimated at 292 breeding pairs ±117 (±40.1%).

Similarly, there were 320 Arctic Tern nests counted in Long Island Sound, or 12.3 nests per island. Thus there were over 12 times as many terns as eiders. This was the only region with more terns than eiders. The Sleeper Island subregion had the next highest density of terns, 4.3 tern nests per island (Table 5). An estimated 849 Arctic Tern pairs ±407 (±47.9%) breed on islands of up to 50 ha in the Long Island Sound subregion.

In the Long Island Sound subregion Common Eiders nest in strong association with both gulls and Arctic Terns. The chi-square value for each of these associations refutes the hypothesis of independent nest site selection. For gulls and eiders, $X^2 = 18.25$ ($P < 0.01$, n=54). For Arctic Terns and eiders, $X^2 = 5.58$ ($P < 0.01$, n=54).

Table 4
Estimates of Herring and Glaucous Gull breeding population size in seven subregions in eastern Hudson Bay

| Subregion | Total islands | Surveyed islands (%) | Number of nests counted | Nests per island | Standard deviation | Nest estimate and confidence limits at $\alpha = 0.05$ |
|---|---|---|---|---|---|---|
| 1. Long Island | 69 | 26 (37.7) | 110 | 4.2 | 5.6 | 292 ±117 (±40.1%) |
| 2. Nastapoka I. | 169 | 61 (36.1) | 125 | 2.0 | 9.0 | 346[t] |
| 3. Salikuit I. | 91 | 30 (33.0) | 59 | 2.0 | 6.4 | 179[t] |
| 4. Laddie Island | 157 | 78 (49.7) | 54 | 0.7 | 1.3 | 109 ±33 (±30.3%) |
| 5. Split Island | 113 | 56 (49.6) | 37 | 0.7 | 2.3 | 75[t] |
| 6. Sleeper Island | 372 | 175 (46.7) | 133 | 0.8 | 2.9 | 284[t] |
| 7. Koktac River | 616 | 294 (47.7) | 76 | 0.26 | 0.6 | 159 ±40 (±18.9%) |
| ALL SUBREGIONS | 1,589 | 720 (45.3) | 594 | 0.8 | 3.6 | 1,311 ±310 (±23.6%) |

t - confidence limits cannot be calculated as departure from a normal distribution exceeds acceptable limits. i.e. $n < 25G_1^2$

Table 5
Estimates of Arctic Tern breeding population size in seven subregions in eastern Hudson Bay

| Subregion | Total islands | Surveyed islands (%) | Number of nests counted | Nests per island | Standard deviation | Nest estimate and confidence limits at $\alpha = 0.05$ |
|---|---|---|---|---|---|---|
| 1. Long Island | 69 | 26 (37.7) | 320 | 12.3 | 19.5 | 849 ±407 (±47.9%) |
| 2. Nastapoka I. | 169 | 61 (36.1) | 0 | 0 | 0 | 0 |
| 3. Salikuit I. | 91 | 30 (33.0) | 72 | 2.4 | 9.6 | $218^{t}$ |
| 4. Laddie Island | 157 | 78 (49.7) | 111 | 1.4 | 5.2 | $223^{t}$ |
| 5. Split Island | 113 | 56 (49.6) | 79 | 1.4 | 10.6 | $159^{t}$ |
| 6. Sleeper Island | 374 | 174 (46.5) | 752 | 4.3 | 26.0 | $1,607^{t}$ |
| 7. Koktac River | 616 | 294 (47.7) | 418 | 1.4 | 13.8 | $876^{t}$ |
| ALL SUBREGIONS | 1,589 | 719 (45.2) | 1,752 | 2.4 | 16.6 | 3,867 ±1,422 (±36.8%) |

t - confidence limits cannot be calculated as departure from a normal distribution exceeds acceptable limits. i.e. $n < 25G_1^2$

### 5.1.5 Stratification of the sample by island area

In the Long Island subregion, of the 26 surveyed islands that are less than 50 ha, 12 are less than two ha, nine are between two and 10 ha, and five fall between 10 and 50 ha (Table 6). There was an average of 0.2 nests per island on the less than two ha islands, with a standard deviation of 0.6. The islands less than 10 ha and greater than or equal to two ha averaged 1.1 nests per island, with a standard deviation of 2.0. The islands less than 50 and greater than or equal to 10 ha averaged 2.8 nests per island, with a standard deviation of 3.0.

Although there is a trend of increasing nests per island with island size the stratified survey data fail Cochrane's test. As departure from normal exceeds acceptable limits, we cannot test for significant differences between the means. Consequently we cannot refine the population projection by stratifying on the basis of area.

### 5.1.6 Stratification of the sample by hunter appraisal

We conducted two interviews with hunters from Kuujjuarapik to obtain their appraisal of the distribution of eider colonies in Long Island Sound. The main interview was conducted in June 1985 with a group of hunters who indicated islands that they knew to be good for eider nesting and others that were inhabited by fox and thus had no eider nests. Information was also gleaned from an interview held in 1978 with the late Charlie Tookalook, also of Kuujjuarapik.

Three islands were indicated as good nest islands in both the 1978 and the 1985 interviews. The mean number of nests on these islands was 8.33. Six other islands, selected as 'good' in 1985, had an average of 6.83 nests per

Table 6
Number of Common Eider nests per island for three categories of island size

| Subregion | 0 $\leq$ Island Area $<$ 2 ha | | | 2 ha $\leq$ Island Area $<$ 10 ha | | | 10 ha $\leq$ Island Area $<$ 50 ha | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of islands surveyed | Number of nests counted | Nests per island | Number of islands surveyed | Number of nests counted | Nests per island | Number of islands surveyed | Number of nests counted | Nests per island |
| Long Island | 12 | 2 | 0.2 | 9 | 10 | 1.1 | 5 | 14 | 2.8 |
| Nastapoka Island | 50 | 24 | 0.5 | 9 | 262 | 29.1 | 2 | 3 | 1.5 |
| Laddie Island | 63 | 164 | 2.6 | 12 | 420 | 35.0 | 3 | 237 | 79.0 |
| Split Island | 49 | 33 | 0.7 | 6 | 569 | 94.8 | 1 | 0 | 0 |
| Sleeper Island | 133 | 710 | 5.3 | 28 | 1,407 | 50.3 | 14 | 658 | 47.0 |
| Koktac River | 239 | 509 | 2.1 | 32 | 253 | 7.9 | 23 | 255 | 11.1 |
| All subregions* | 546 | 1,442 | 2.6 | 96 | 2,921 | 30.4 | 48 | 1,167 | 24.3 |

* except Salikuit Islands, as island areas are not available

island. Yet another seven islands selected by Charlie Tookalook as good nest islands in 1978, had an average of 3.57 nests per island in 1985.

No 'fox islands', all of which exceeded 50 ha, were surveyed. The 41 islands not indicated by hunters to be particularly good or bad for nesting, averaged 0.59 eider nests per island. Islands with no nests occurred in all categories and the highly variable data sets do not allow us to test for statistically significant differences between hunter appraisal categories.

### 5.1.7 Clutch initiation and clutch size

The Long Island survey was completed between June 24 and 30. All 113 active Common Eider nests that were discovered were being incubated. No hatching eider nests were observed (Table 7). In contrast, of seven Canada Goose nests observed, three had hatched and one was hatching. Hatching Arctic Tern nests were observed on June 24, 25 and 30, but these nests were exceptional as only five of 686 tern nests were recorded as hatching. The proportion of hatching tern nests is likely to be underestimated, as hatching eggs and hatched nests are easily overlooked.

The first hatching gull nests were observed on June 27. Two of 14 nests, three of 30 nests and seven of 103 gull nests were recorded as hatching on June 27, 28 and 30 respectively.

The mean clutch size for 113 Common Eider nests was 5.6 eggs per nest (Table 8). The largest clutch observed was seven eggs, and the most common clutch was 6 eggs (60 of 113 nests or 53.1% had 6 eggs). Long Island Sound was the only subregion with a mode of six eggs. Its mean clutch was significantly greater than that of any other subregion

Table 7
Daily percentage of Common Eider nests found to be hatching or hatched

| | JUNE | | | | | | JULY | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subregion | 25 | 26 | 27 | 28 | 29 | 30 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| Long Island | 0 / 13 | 0 / 27 | 0 / 19 | 0 / 48 | -- | 0 / 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Nastapoka I. | 0 / 5 | 0 / 333 | -- | -- | 0 / 324 | -- | 4.0 / 25 | -- | -- | 0 / 4 | -- | 0 / 8 | 4.7 / 107 | 0.9 / 116 | -- | -- | 25.0 / 8 | -- | -- | -- | -- | -- | -- | 50.0 / 2 | -- | -- | -- |
| Salikuit I. | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 45.0 / 40 | -- | -- | 38.5 / 234 | 48.9 / 184 | 62.5 / 104 | -- | -- |
| Laddie I. | -- | -- | -- | -- | -- | 0 / 116 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.6 / 313 | -- | 30.0 / 253 | -- | 46.3 / 121 |
| Split Island | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11.0 / 537 | -- | 23.5 / 17 | -- |
| Sleeper I. | -- | -- | -- | -- | -- | -- | 0 / 221 | 0 / 7 | 0.3 / 374 | 0 / 93 | 0 / 280 | -- | 0 / 873 | 0 / 53 | -- | -- | -- | -- | 0.3 / 679 | -- | -- | -- | -- | -- | -- | -- | -- |
| Koktac River | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0 / 56 | 0 / 3 | 0 / 15 | -- | 3.6 / 137 | 9.5 / 74 | 56.2 / 267 | 57.4 / 108 | 37.0 / 54 | 60.0 / 110 | -- | 49.5 / 111 | 38.0 / 50 | -- | -- |

| P | N |

P = percentage of active nests that were hatched or hatching
N = number of active nests
Destroyed/abandoned nests and nests of unknown fate (status 4 and 5) were not included in these figures

Table 8
Frequency of Common Eider clutch sizes

| Subregion | Clutch size | | | | | | | | | | | Number of nests | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | | | |
| Long Island | 1 | 1 | 1 | 9 | 29 | 60 | 12 | 0 | 0 | 0 | 0 | 113 | 5.58 | 0.98 |
| Nastapoka I. | 38 | 102 | 150 | 249 | 276 | 88 | 15 | 5 | 1 | 0 | 1 | 925 | 4.07 | 1.40 |
| Salikuit I. | 16 | 25 | 36 | 79 | 106 | 29 | 5 | 3 | 0 | 0 | 0 | 299 | 4.19 | 1.40 |
| Laddie Island | 26 | 45 | 107 | 243 | 184 | 39 | 5 | 0 | 0 | 0 | 0 | 649 | 4.00 | 1.18 |
| Split Island | 27 | 51 | 95 | 151 | 122 | 29 | 8 | 7 | 0 | 1 | 0 | 491 | 3.92 | 1.42 |
| Sleeper I. | 106 | 184 | 324 | 735 | 855 | 198 | 43 | 23 | 7 | 2 | 0 | 2,577 | 4.28 | 1.38 |
| Koktac River | 10 | 33 | 35 | 124 | 228 | 153 | 21 | 6 | 2 | 0 | 0 | 612 | 4.82 | 1.29 |
| ALL SUBREGIONS | 224 | 441 | 748 | 1,590 | 1,800 | 696 | 109 | 44 | 10 | 3 | 1 | 5,666 | 4.24 | 1.38 |

($T = 7.2$ to $15.3$, $P < 0.01$). Gull clutch size averaged 2.5 eggs per nest (n=224). Arctic Tern clutches averaged 1.8 eggs per nest (n=681). Seventy-nine Black Guillemot nests in incubation phase averaged 1.5 eggs per nest.

## 5.2 The Nastapoka Islands subregion

### 5.2.1 General description

The half-moon curve of the Nastapoka Arc, accentuated by the Nastapoka Islands which parallel much of its length, is one of the most striking geological formations of Hudson Bay. The Nastapoka Islands tilt towards the offshore, rising gradually from the seaward shore and dropping precipitously on the landward edge. Parallel ridges on the mainland coast repeat this pattern (Beals 1968). The Nastapoka Island chain consists of 14 large elongate islands of greater than 500 ha in size. These islands lie end to end, and parallel almost 200 km of the Quebec coastline. An additional 259 smaller islands are scattered along the length of this chain and along the adjacent Quebec shoreline. Seventy-one of these smaller islands are within the foreshore flats of the mainland or of islands larger than 500 ha. When the foreshore flat islands are removed, we are left with the 178 islands which were the focus of the nest survey.

People from Inukjuak and Kuujjuarapik use the Nastapoka islands extensively for hunting and camping. The Nastapoka River roughly divides their areas of use, although there is much overlap. The new community of Umiujaq is on Nastapoka Sound and the Nastapoka islands are the prime resource area for its inabitants.

Detailed 1:50,000 scale maps of the Nastapoka Island subregion are available upon request from the Makivik

Research Department. Figure 6 and 7 which appear in this volume are reductions of the forementioned maps for general use with the text. Note that the Nastapoka Island subregion is subdivided at the Nastapoka River into north and south. Island identification numbers are thus followed by an N or S to indicate in which section they occur.

### 5.2.2 The nest survey

The Inukjuak and Kuujjuarapik crews cooperated in the survey of the Nastapoka Islands subregion. The Inukjuak crew began its survey of the islands north of the Nastapoka River on June 25 and completed its work on July 1. The Kuujjuarapik crew began surveying south of the Nastapoka River on July 4 and continued until July 14, at which date they moved their camp to the Salikuit Islands. On July 19, they did one last day of surveying in the Nastapoka Islands subregion on their way back to Kuujjuarapik. This combined survey effort covered all areas of the Nastapoka chain. Of the 169 islands occurring in the less than 50 ha size class, data was collected on 61 randomly-selected islands, representing a sampling intensity of 36.1%. An additional 39 islands which were not part of the random sample were also surveyed. These islands had been selected by Inukjuak and Kuujjuarapik hunters during the pre-census evaluation. Two of nine islands in the 50 to 500 ha size class were surveyed.

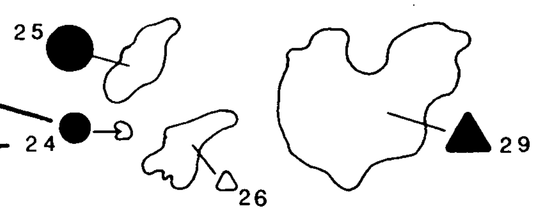
In order to confirm the assumption that very large islands (areas greater than 500 ha) were "like the mainland" and had few eider nests, some of the 'mainland' islands were examined. The objective was not to exhaustively census these very large islands, but to roughly assess their significance for eider nesting. Coastline cruises of Cotter (#24N) and Christie (#121N) Islands were carried out to search for Common Eiders showing signs of nesting. Extended

| ᖃᐅᔨᒪᐅᑎ<br>LEGEND | ᓇᓪᓕᖄᑦᑕᐅᓯᒪᔪᑦ<br>ᕿᑭᖅᑕᐃᑦ<br>**SURVEYED ISLANDS RANDOMLY SELECTED** | ᓇᓪᓕᖄᑦᑕᐅᓯᒪᖏᑦᑐᑦ<br>ᕿᑭᖅᑕᐃᑦ<br>**SURVEYED ISLANDS NOT RANDOMLY SELECTED** |
|---|---|---|
| **ᐅᒡᓗᑕᖃᖏᑦᑐᑦ**<br>NO NESTS | ○ | △ |
| **1ᒥᑦ-9ᒧᑦ ᐅᒡᓗᑖᑦ ᐊᑐᓂᑦ ᕿᑭᖅᑕᐃᑦ**<br>1-9 NESTS PER ISLAND | ● | ▲ |
| **10ᒥᑦ-49ᒪᑦ ᐅᒡᓗᑖᑦ ᐊᑐᓂᑦ ᕿᑭᖅᑕᐃᑦ**<br>10-49 NESTS PER ISLAND | ● | ▲ |
| **50-ᓂᑦ ᐅᖓᑖᓄᑦᓘᓃᑦ ᐅᒡᓗᑖᑦ ᐊᑐᓂᑦ ᕿᑭᖅᑕᐃᑦ**<br>50 OR MORE NESTS PER ISLAND | ● | ▲ |

ᐆᑦᑐᕋᐅᑎᑦ EXAMPLE

ᖃᐅᔨᓴᕐᓂᒥ ᖃᐅᔨᔭᐅᓂᕐᓂᑦ ᓇᓗᓇᐃᖅᑯᑕᖅ
SURVEY RESULT SYMBOL

ᕿᑭᖅᑕᐅᑉ ᑭᓯᑦᓯᒍᑎᖓ
ISLAND NUMBER




Legend for figures 6 and 7.

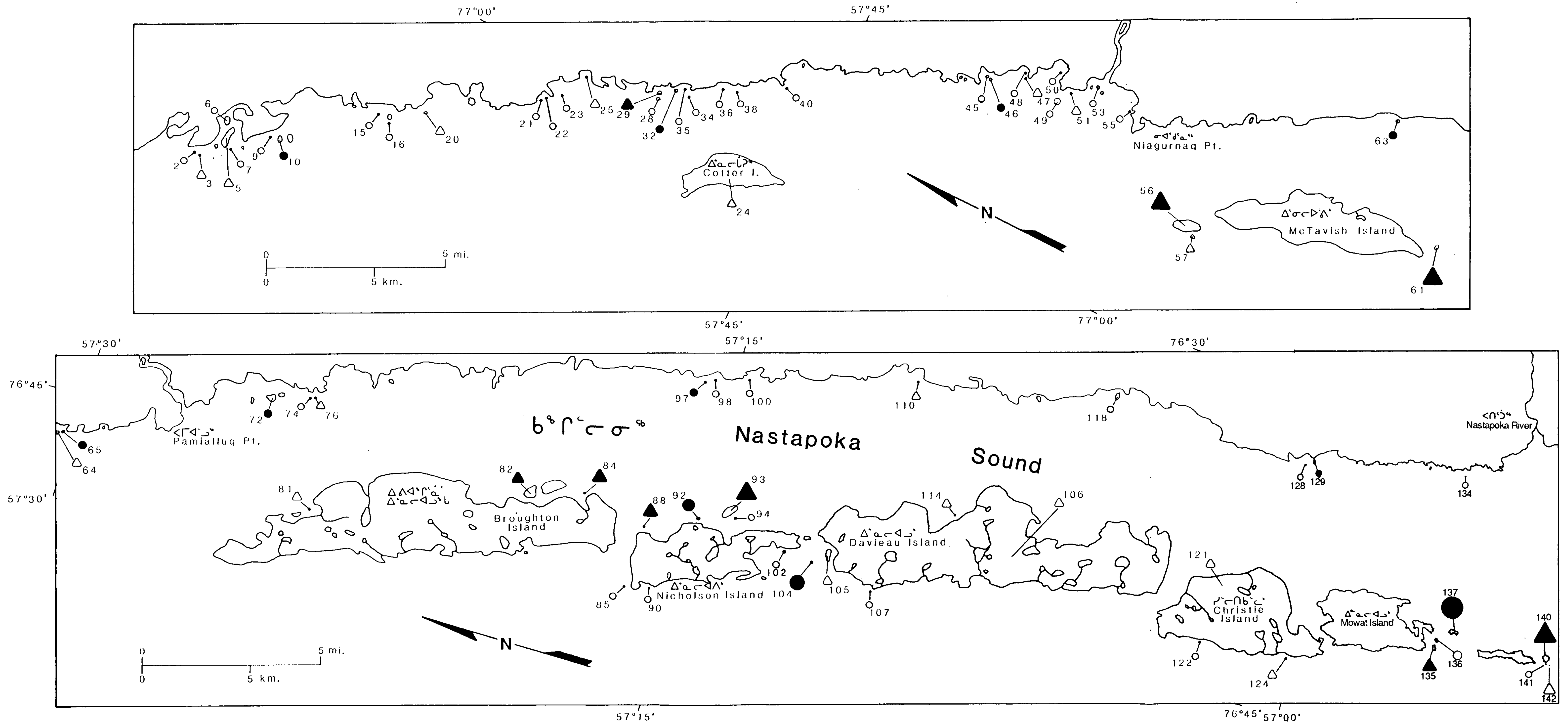



**Figure 6** - The Nastapoka Islands subregion - north section. Island identification numbers and Common Eider survey results.

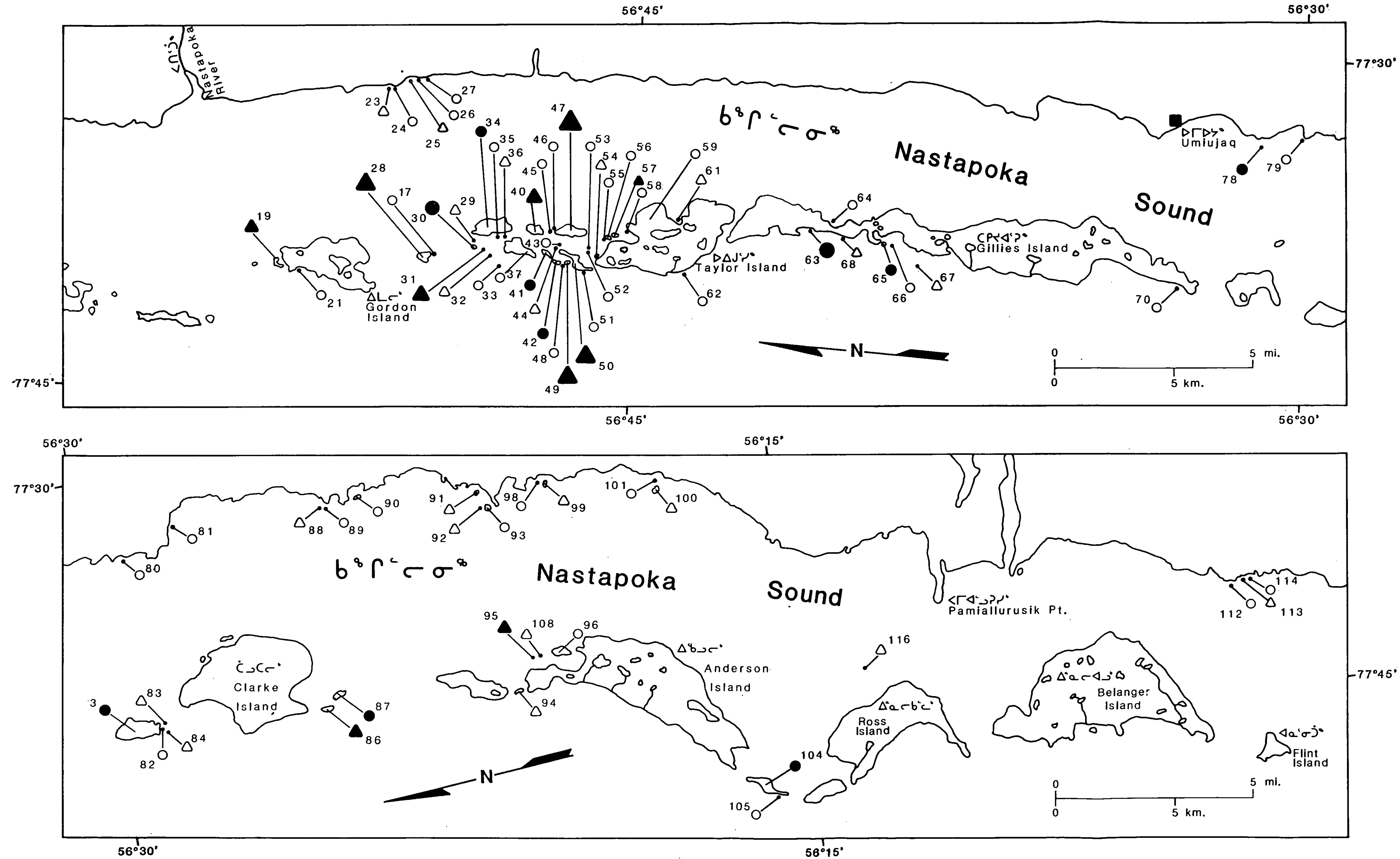



Figure 7 - The Nastapoka Islands subregion - south section. Island identification numbers and Common Eider survey results. (see fig. 6 for map legend)

walks were made on Davieau (#106N) in search of eider nests. Finally, spot checks were made of areas which the late Charlie Tookalook of Kuujjuarapik had identified in an interview in 1979 as good eider nesting sites. These sites include prominent peninsulas on islands #1S and 59S.

### 5.2.3 The number and distribution of Common Eider nests

In the Nastapoka Island subregion, 289 Common Eider nests were counted on 61 randomly-selected islands (see Fig. 6 and 7). The average number of nests per island was 4.7 and the range from 0 to 157 nests per island. The overall nest density for randomly-sampled islands was 3.07 nests per hectare. An examination of the data for randomly-selected islands reveals a strong tendency to nest in colonies. Two major Common Eider colonies account for over 80% of counted nests (island #137N with 157 nests; #104N with 77 nests). Forty-six of 61 selected and counted islands (75.4%) were without eider nests. The maximum nest density for the archipelago was recorded on island #84N, which was outside the random sample. This island of 0.4 ha had 36 Common Eider nests, a density of 90.0 nests per hectare.

All of the largest Common Eider colonies were located away from the mainland coast. Aside from a cluster of 10 islands with 216 Common Eider nests north of Taylor Island, the eider colonies were well-dispersed along the length of the Nastapoka Island chain from the north end of Gillies Island to Cotter Island.

Four islands between 50 and 500 ha in size were surveyed. The Kuujjuarapik crew was trapped on Armstrong Island (#3S) for three days due to bad weather. During this time, they were able to roughly survey all 126.3 ha of this island. Nine Common Eider and two gull nests were found. It is noteworthy that all of the nests were found at the southwest end of the island on a peninsula which at high tide becomes an island. All of island #104S (50.0 ha) was surveyed and two nests were found at the southwest end. The north and south ends of island #34S (85.0 ha) were surveyed and two Common Eider nests were found in each area. About half of the total surface area was surveyed. In the north Nastapoka Islands, the Inukjuak crew surveyed one island in the 50 to 500 ha range. A large colony of 121 Common Eider nests was found on island #56N (55.0 ha). The colony was located on the southwestern shore of the island on a peninsula which accounts for less than 10% of total surface area. Coastal surveys by boat and a partial ground survey along the middle of the main island and around the south cape revealed no other important nesting concentrations.

Partial surveys of "mainland" islands (areas greater than 500 ha) failed to locate any major Common Eider nest colonies. The coastlines of islands #24N (Cotter Island) and #121N were cruised slowly by boat, but no eiders showing signs of nesting were seen. On Cotter Island, the crew landed to survey the south tip and the perimeter of the large lake at the island's north end, but found no eider nests. Numerous and extensive walks covering much of the coastline and traversing the entire length of Davieau Island (#106N; 2,947.5 ha) resulted in observations of Canada Goose broods but found no Common Eider nests. Spot checks of peninsulas on the north and west coasts of Taylor Island (#59S) and Gillies Island (#1S) found no eider nests. Two eider nests were found on a peninsula at the south end of Gillies Island, but both had been destroyed by an unidentified predator.

On the basis of these survey results, we can attempt to estimate the number of Common Eider nests in the Nastapoka Island subregion. First, our results confirm that few or no eider nests occur on islands of greater than 500 ha.

Secondly, in the 50 to 500 ha size class, three of four surveyed islands had very few eider nests (less than 10 nests). The fourth island (#56N) had a large colony of 121 nests. Our data for this size class is too limited to make a projection over unsurveyed islands. Therefore, we will make the conservative assumption that the number of eider nests occurring on islands of this size class was the total of nests on the surveyed islands. This figure is 140 nests.

Finally, for the under 50 ha class, we can estimate total nest number by using the average number of nests found on randomly selected islands, and extrapolating across all eligible islands. The estimated nest number is 801 nests (Table 3). No confidence limits can be generated for this estimate as the data fail Cochrane's test (ie. $n < 25G_1^2$). Our total estimate for the Nastapoka Island subregion is therefore 941 nests (801 nests + 140 nests).

The Inukjuak and Kuujjuarapik crews did much surveying on islands other than those randomly selected. In particular, they surveyed islands which hunters knew to be excellent for eider nests. Consequently, the actual number of eider nests counted on all islands, randomly-selected and not, was 1,002 nests. These data illustrate the pitfalls of random sampling of a population with a highly clumped distribution. In this case, our random sample was too small. By chance, islands with few eider nests were over-represented and large colonies slipped through without being randomly selected. Consequently, our subregion estimate is lower than the actual number of nests counted.

As only 71.3% of total islands less than 500 ha were surveyed, there are certainly more than 1,002 eider nests in the Nastapoka Island subregion. However, there is no means to produce a corrected and unbiased estimate. Consequently, we will use the figure of 1,002 Common Eider nests as the minimum breeding population size for this subregion.

#### 5.2.4 The number and distribution of gull nests

Herring Gull and Glaucous Gull data are combined as no distinction between the nests of these species was made in the field. Great Black-backed Gulls *(L. marinus)* were also observed but nesting by this species was not confirmed. A total of 340 gull nests were counted on 150 islands. Only 125 of these gull nests occurred on the 61 randomly selected and counted islands with areas less than 50 ha. The mean number of gull nests per randomly selected island was 2.0. From these figures we estimate that 346 gull nests occurred on islands of up to 50 ha (Table 4).

The maximum number of nests found on a single island was 79 nests on island #61N. This island was outside of the random sample. Forty-four of the 61 randomly-selected islands had no gull nests (72.1%). Of the remaining 17 islands with one or more gull nests, ten had only a single nest.

Two gull colonies were found on the cliffs along the north-east and south-east shores of Cotter Island (#24N). These colonies were not surveyed but Dr. A. Reed who was accompanying the Inukjuak crew estimated that the south-east colony consisted of about 30 pairs of Glaucous Gull.

Similar to the Common Eider, all large gull colonies were situated away from the mainland and dispersed amongst small islands along the Nastapoka Island chain. The only observed exception to this pattern are the previously mentioned colonies on the cliffs of Cotter Island (506.3 ha). With the exception of Cotter Island, all islands with many gull nests had many Common Eider nests.

In the northern part of the Nastapoka Islands, gulls and Common Eiders exhibited a strong tendency to nest together ($X^2 = 12.35$, $P<0.01$, $n=72$). This positive nesting association was also observed in the southern part of the Nastapoka Islands subregion, but the tendency was less marked ($X^2 = 4.52$, $0.025<P<0.05$, $n=78$).

The Nastapoka Island subregion was the only surveyed area in which Arctic Terns did not nest. The reason(s) for the absence of nesting terns is not known. Possibly, the marine food resources in this more-sheltered, nearshore archipelago are not sufficient to support Arctic Terns colonies.

#### 5.2.5 Stratification of the sample by island area

In the Nastapoka Islands subregion, of the 61 randomly selected and counted islands of less than 50 ha, 50 islands had areas of less than 2 ha, nine had areas of 2 to less than 10 ha and two had areas of 10 to less than 50 ha (Table 6). The mean number of eider nests discovered on islands in each of these three size categories was 0.5, 29.1 and 1.5 respectively.

At a 95% level of confidence there is no significant difference between these mean nest per island values. Consequently there is no statistical justification for producing a stratified population estimate.

### 5.2.6 Stratification of the sample by hunter appraisal

Kuujjuarapik hunters appraised the south part of the Nastapoka Islands subregion (south of the Nastapoka River) and Inukjuak hunters appraised the north part. In the south section, Kuujjuarapik hunters indicated six islands which they believe to be important for eider nesting. The average number of eider nests per island on these islands was 28.2 nests. Nineteen other islands were selected by the late Charlie Tookalook, during an interview in 1978. These islands averaged 5.5 nests per island. The hunters were indifferent to the other 52 censused islands, and these islands averaged only 0.23 nests per island.

In the north sector Inukjuak hunters selected three islands as excellent for eider nesting. Average nest per island figures for these islands are 54.3 nests. Seven 'good' islands averaged 32.9 nests per island. Finally three 'fox' islands were confirmed to have no eider nests and 59 other islands which elicited no specific response from hunters, averaged 5.41 nests per island.

In all of the above cases departure from normalcy is too great to allow statistical testing of differences between the means. Consequently we cannot justify a stratification of our population estimate according to hunter appraisal.

### 5.2.7 Clutch initiation, clutch size and down production

The Nastapoka Islands subregion north of the Nastapoka River was surveyed between June 25 and July 1. The area south of the Nastapoka River was surveyed between July 4 and 19. A single hatching Common Eider nest was discovered in the northern sector on July 1, the last day of surveying in this area (Table 7). In the south sector the first evidence of hatching was found on July 7, when four hatching nests and one hatched nest were discovered on islands #28S and #30S, respectively. These five nests represent 4.7% of the 107 active eider nests found on that day. On July 8, one of 116 surveyed eider nests was hatching. Hatching and hatched nests were also found on July 11 and 19 but too few eider nests were surveyed to provide a reasonable indication of the progress of the hatch.

Hatching gull nests were recorded from the earliest to the last days of the Nastapoka Islands survey. The first hatching nest was discovered on June 25 on island #20N. On June 29, 9 of 68 gull nests on island #104N were reported to be hatching. By July 19, of eight gull nests surveyed, six were hatched and one was hatching.

The mean clutch size for 925 incubated Common Eider nests was 4.1 eggs per nest (Table 8). A single clutch of 11 eggs in the south Nastapoka Island subregion was the largest observed. The most commonly observed clutch size was five eggs (276 of 925 nests; 29.8%). Gull clutch size averaged 2.5 eggs per nest (n=282). Black Guillemot clutch size averaged 1.8 eggs per nest (n=64).

Eider down was collected from 17 nests in the north part of the Nastapoka Islands subregion. The mean weight of uncleaned down gathered from each nest was 21.8 gm (Std. dev. = 6.56) (Table 9). As a result of the cleaning process, the samples lost on average 56.7% of their weight to provide a final per nest yield of 9.43 gm (Std. dev. = 3.57).

Table 9
Weights of uncleaned and cleaned down samples

| Subregions * | Sample size | Uncleaned down | | Cleaned down | |
|---|---|---|---|---|---|
| | | mean weight per nest (gm) | Std. dev. | mean weight per nest (gm) | Std. dev. |
| Nastapoka I. | 17 | 21.76 | 6.56 | 9.43 | 3.57 |
| Salikuit I. | 18 | 53.12 | 15.51 | 17.02 | 4.78 |
| Laddie Island | 14 | 37.85 | 19.13 | 12.14 | 5.09 |
| Split Island | 16 | 35.00 | 13.80 | 11.59 | 4.89 |
| Sleeper Island | 29 | 30.90 | 16.29 | 13.12 | 5.87 |
| Koktac River | 13 | 31.31 | 10.20 | 9.88 | 4.39 |
| SUBREGIONS TOTAL | 107 | 34.76 | | 12.44 | |

* No data is available for Long Island Sound subregion

## 5.3 The Salikuit Islands subregion

### 5.3.1 General description

The Salikuit Islands are located between the Belcher Islands and the Nastapoka Islands (Fig. 2). They lie in the area that stretches from 77° to 78° 15' W and from 56° 15' to 56° 30' N. The most easterly island in the archipelago lies about 20 kilometers west of Anderson Island in the Nastapoka Island chain, or about 30 kilometres from the nearest point on the mainland.

There are 91 islands of less than 50 ha in the archipelago, and 12 between 50 and 500 ha. All the islands are of low relief and composed mostly of basaltic bedrock, with some cobble. Grass and moss are the dominant vegetation. Some islands had extensive cobble beaches, which in several cases connected islands at low tide, and in some cases permanently. The beaches of some islands were covered by a thick layer of cast-up seaweed, in which several eider nests were discovered.

The Salikuit Islands are seldom visited as access is difficult. In summer they provide harbours and camping places. In winter they act as an ice dam, causing the formation of a causeway which allows dogsled or snowmobile travel between January and April. Historically, they were part of the travel route between the Belcher Islands and posts of the Hudson's Bay Company on the Quebec coast. In recent years, with the establishment of scheduled air service, the Salikuit Island route has been largely abandoned. It is likely that the residents of the new community of Umiujaq, on Nastapoka Sound near Richmond Gulf (Fig. 2), will increase the use of the islands as a hunting and camping area.

A detailed 1:50,000 scale map of the Salikuit Islands subregion, showing island identification numbers and survey results is available upon request from the Makivik Research Department. For convenience we have included in this section a simplified version of this map (Fig. 8).

### 5.3.2 The nest survey

The Salikuit Islands were surveyed by the Kuujjuarapik crew. The survey ran from July 14 to July 19, and was interrupted several times by bad weather, particularly fog. Two complete days were lost, and there were several delays. The survey was stopped on July 19 as many hatched and hatching eider nests were encountered (63% of eider nests were hatching or hatched). Further surveying was thought to be unreliable and potentially harmful to the local eider population.

There is no aerial photography available for the area, and there are no maps at 1:50,000 scale published, therefore the planning and island numbering was done on 1:250,000 scale maps. Information was compiled from national topographic survey maps of 1:500,000 and 1:250,000 scales published by Energy, Mines and Resources and nautical charts at 1:250,000 scale published by the Hydrographic Service. These sources do not show foreshore flat areas, therefore the process of removing the foreshore flat islands from the sample was not done. All islands that appeared on the maps were numbered, and are included in our totals, even though some of these proved to be merely shoal areas, or connected to other islands.

In the subregion there are 91 islands under 50 ha, and 12 between 50 to 500 ha. Of the 91 islands under 50 ha, 46 were selected randomly. Thirty of the selected islands were surveyed, providing a sampling intensity of 33.0%.

In addition to the randomly-selected islands, 20 other islands were surveyed. Eight of these had no nests of any species, and were essentially just cobble bars or shoals which were surveyed easily from the boat. The others were surveyed because they were in close proximity to other surveyed islands.

The majority of the unsurveyed islands were in the western end of the archipelago. From our results, there is no clear suggestion that there might be more or less eiders in the west. Thus we do not know if this will introduce bias in our estimate.

### 5.3.3 The number and distribution of Common Eider nests

Of the 91 islands less than 50 ha in the Salikuit subregion, 30 randomly selected islands (33.0%) were censused. On these islands, a total of 295 Common Eider nests were counted, an average of 9.8 nests per island, with a standard deviation of 20.5. As can be deducted from the high value of the standard deviation, the distribution of nests was highly dampted. One island alone (#32) had 100 nests (33.9% of all nests), and six islands (20%) (#11, #13, #32, #51, #55 and #79) accounted for 84% (248) of all nests. Fifteen islands had no Common Eider nests at all (see Fig.8).

There are 12 islands greater than 50 ha, one of which (#21) was partly surveyed. No nests were seen on the partly surveyed large island, although 15 to 20 ducklings were seen with females on a pond on the island.

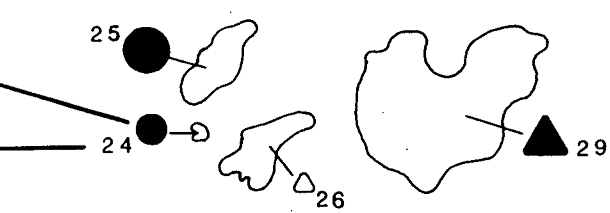
On the 20 islands surveyed which were not randomly selected, a total of 307 eider nests were counted, an average of 15.35 nests per island, with a standard deviation

| ᖃᐅᔨᒪᐅᑎ<br>LEGEND | ᓇᓪᓕᑳᑦᑕᐅᓯᒪᔪᑦ ᕿᑭᖅᑕᐃᑦ<br>SURVEYED ISLANDS RANDOMLY SELECTED | ᓇᓪᓕᑳᑦᑕᐅᓯᒪᙱᑦᑐᑦ ᕿᑭᖅᑕᐃᑦ<br>SURVEYED ISLANDS NOT RANDOMLY SELECTED |
|---|---|---|
| ᐅᒃᒍᑕᖃᙱᑦᑐᑦ<br>NO NESTS | ○ | △ |
| 1ᒥᑦ-9ᒧᑦ ᐅᒃᒍᑕᓖᑦ ᐊᑐᓂᑦ ᕿᑭᖅᑕᐃᑦ<br>1-9 NESTS PER ISLAND | ● | ▲ |
| 10ᒥᑦ-49ᒪᑦ ᐅᒃᒍᑕᓖᑦ ᐊᑐᓂᑦ ᕿᑭᖅᑕᐃᑦ<br>10-49 NESTS PER ISLAND | ● | ▲ |
| 50-ᓂᒃ ᐅᖓᑖᓄᒃᒎᓃᑦ ᐅᒃᒍᑕᓖᑦ ᐊᑐᓂᑦ ᕿᑭᖅᑕᐃᑦ<br>50 OR MORE NESTS PER ISLAND | ● | ▲ |

ᐆᑦᑐᕋᐅᑎᑦ EXAMPLE

ᖃᐅᔨᓴᕐᓂᒥ ᖃᐅᔨᔭᐱᓂᕐᓂᑦ ᓇᓗᓇᐃᖅᑯᑕ"
SURVEY RESULT SYMBOL

ᕿᑭᖅᑕᐅᑉ ᑭᓯᖅᓯᒍᑎᖓ
ISLAND NUMBER




Legend for figure 8.

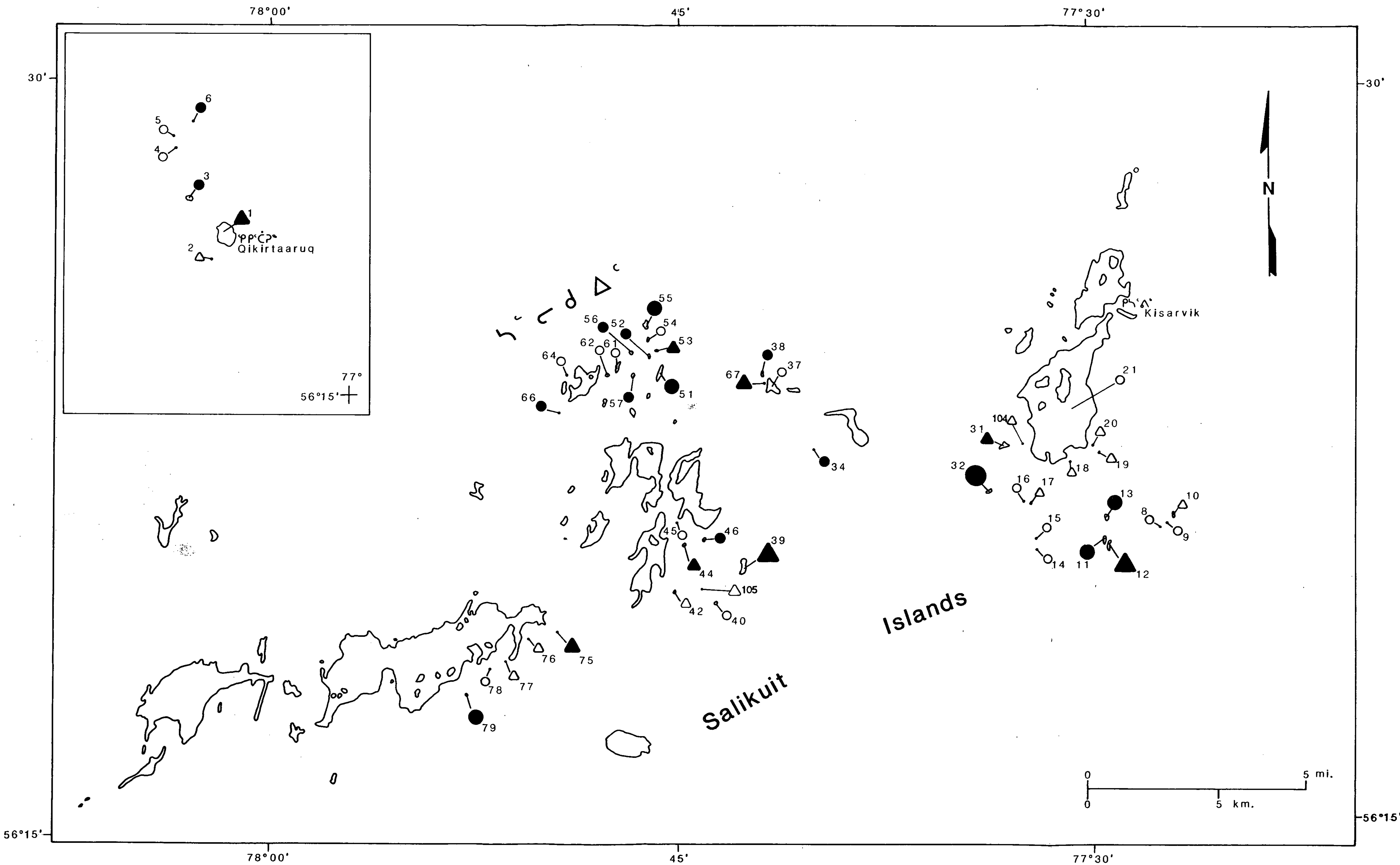



**Figure 8** - The Salikuit Islands subregion. Island identification numbers and Common Eider survey results.

of 32.47. The difference between the two means is not statistically significant (T=0.67).

From these data a population estimate can be generated for eiders nesting on islands with areas of less than 50 ha. Ninety-five percent confidence limits can be generated for this estimate as n (the number of randomly selected islands that were surveyed) is greater than 25 $G_1^2$ (Cochrane 1977). We estimate the Salikuit Island breeding population at 895 nesting pairs ±546 (61.0%) (Table 3).

### 5.3.4 The number and distribution of gull and Arctic Tern nests

In the field no distinction was made between Herring and Glaucous Gull nests. Consequently, in the following text 'gull' refers to both of these species. On the 30 counted and randomly-selected islands, 59 gull nests were counted, an average of 2.0 nests per island. Thirty-five of the gull nests (59.3% of total) were on one island (#32), while the remaining 24 were spread over many islands. The island with the 35 gull nests also had 100 Common Eider nests, or 33.8% of all eider nests. The Salikuit gull population is estimated to be 179 breeding pairs (Table 4). The data are too skewed to allow the use of the normal approximation to generate confidence limits.

Of the total of 50 surveyed islands, 16 had both gulls and Common Eiders nesting, three had only gulls, seven had only eiders, and the remaining 24 had neither. There is less than a 5% chance that this distribution of nests is the result of independent nesting of the two species ($X^2$=18.22; $P < 0.05$; n=50).

One hundred pairs of Arctic Terns nested on five of the 50 islands surveyed in the Salikuit subregion. These five islands also had Common Eider nests, which indicates with 95% confidence that eiders and terns did not nest independently ($X^2 = 6.52$; $P < 0.05$; n=50). On the 30 randomly-selected islands, 72 Arctic Tern nests were counted, for an average of 2.4 tern nests per island. The Salikuit tern population is estimated to be 218 breeding pairs (Table 5).

### 5.3.5 Stratification of the sample by island area

There were no maps or aerial photography at better than 1:250,000 scale, so we were unable to measure the size of the islands with any precision. Thus no stratification by island area was possible.

### 5.3.6 Stratification of the sample by hunter appraisal

For the Salikuit subregion, Kuujjuarapik hunters tented to indicate general areas which they believed to be good for eider nesting, rather than specific islands. Twenty islands were classified by hunters as good for eider nesting. On these islands, 278 nests were counted, an average of 13.9 nests per island. On the other 30 islands, 324 nests were counted, an average of 10.8 nests per island. These figures have standard deviations of 20.6 and 28.2 nests per island, respectively. There is no statistically significant difference between the two means.

### 5.3.7 Clutch initiation, clutch size and down production

In the Salikuit subregion, the nest survey took place late in the nesting period. Surveys were carried out on four days, July 14, 17, 18, and 19. The proportion of hatching and hatched nests was high throughout this period (Table 7). Two islands east of the main archipelago (islands #1 and #3), were surveyed on the first day and the hatched and hatching rate was 45%. The majority of the islands were censused in the last three days, during which time the percentage of eider nests either hatching or hatched steadily increased : 39% on the 17th, 49% on the 18th, and on the final day, 63%.

An examination of the percentage of hatched nests encountered reveals a straightforward progression with time. On the four survey days, the percentage of hatched nests was, in chronological order, 12.5% (n=40 nests), 26.9% (n=234 nests), 28.8% (n=184 nests) and 43.9% (n=104 nests).

The mean clutch size for eider nests which had not started to hatch was 4.19 (std. dev. = 1.40, n=299), while for the nests that had started to hatch, the mean clutch was 4.42 (std. dev. = 1.52). Three clutches of eight eggs were observed, which were the largest clutch sizes recorded. The most common clutch size was five eggs, observed 106 times, or in 35% of all incubating nests (Table 8).

For 34 incubating gull nests the average clutch was 1.7 eggs. The 96 incubating Arctic Tern nests had an average clutch of 1.9 eggs per nest.

Eighteen Common Eider nests were sampled to measure down production per nest (Table 9). On average, these nests provided 53.1 grams (std. dev. = 15.51) and 17.0 grams (std. dev. = 4.78) of uncleaned and cleaned down respectively. The Salikuit Islands provided the highest mean down production per nest of all the surveyed subregions in eastern Hudson Bay.

## 5.4 The North Belchers: Laddie Island and Split Island subregions

### 5.4.1 General description

The North Belcher Islands are comprised of Split Island, Johnson Island, Laddie Island, the Lukisee Islands and hundreds of small associated islands (Fig. 2). The first three islands exceed 1,000 ha in size and for the purposes of this study will be considered as "mainland". Although Split Island is depicted on the map as two separate islands, the eastern Hudson Bay region is one of rapid uplift. Hunters report that the islands are now permanently connected, and that Common Eiders continue to nest in large numbers in what has now become a large lake in the centre of the island. This inland nesting area was not surveyed.

Surrounding the three main islands of Split, Johnson and Laddie are almost 700 small islands roughly geographically segregated into three groups as follows : the Lukisee Islands north of Johnson; the islands off the east and south shores of Laddie; and the islands along the southwest, west and north shores of Split. The topography of these islands varies considerably from site to site. A typical island in the Lukisee Archipelago exhibits an accentuated hump-shaped cross-section, with steep sides of exposed bedrock. This archipelago is a dramatic maze of narrow passages between tall ridges. More than 90% of island surface area is bare, glaciated bedrock offering little purchase for vegetation. On small islands, grasses, moss and lichens manage to colonize small depressions or long, narrow faults. Larger islands are composed of ridges of bare, humped bedrock between which lie sheltered valleys, relatively richly vegetated with mosses, grasses, lichen and other low-lying vegetation.

The islands in the proximity of Laddie and Split Islands are typically less pronounced in contour and are frequently quite flat. Although exposed bedrock remains a prominent surface feature, extensive areas of cobble and gravel occur, at times mixed with a large proportion of mussel shells. The islands off the southwest tip of Split Island are unusual, as they are composed completely of cobble and boulders, piled high by ice action.

From at least the turn of the century to the 1940's, Split Island harboured the most important Inuit camp in the Belcher Islands. Most of the elderly members of present-day Sanikiluaq spent a significant part of their youth on Split Island's east shore. Walrus was the main motivation for the continued occupation of this site. One man, Inuktaluk, the main hunter of the camp, was renowned as a skilled and fearless walrus hunter. He predicted that upon his death, the walrus would leave the area. Today the elders of Sanikiluaq recount that the prediction was accurate, and that the walrus left the area after Inuktaluk's death. Subsequently, many families dispersed to other parts of the Belcher Islands. Today the North Belcher Islands continue to be an important camping and harvesting area for the Sanikiluaq people.

Figures 9 and 10 provide the survey data and island identification numbers respectively, for the Laddie Island subregion. Figures 11 and 12 provide similar data for the Split island subregion.

### 5.4.2 The nest survey

The North Belcher Islands were surveyed by the Sanikiluaq crews. The original objective was a 50% random sample of the entire North Belcher Islands. However, as time was limited, we decided to restrict the survey to two zones within the North Belcher Islands rather than disperse the survey effort over the entire area. The selected subregions were the islands associated with Laddie Island, and the islands along the southwest and west coasts of Split Island.

Early surveys on July 25 were conducted on Qutjutujuak and adjacent islands, north of Split Island. These islands are not in either subregion and the census data is not used in any calculations. The Laddie Island subregion was surveyed on June 30 and July 17, 19 and 21. The Split Island subregion was surveyed on July 18 and 20.

In the less than 50 ha size class in the Laddie Island subregion, there are 157 islands outside of the foreshore flats. Seventy-eight of these islands were randomly selected and counted. This represents a sampling intensity of 49.7%. Split Island has 113 eligible islands, 56 of which were selected and counted. The sampling intensity for this area was 49.6%.

In both Laddie and Split Island subregions, there were numerous small islands. In both regions, more than 80% of the randomly-selected islands had areas of less than two ha. Scanning of small, flat or slightly-humped islands was consequently an effective and efficient technique and was often used. However, islands with any indication of eider nesting were surveyed on foot.

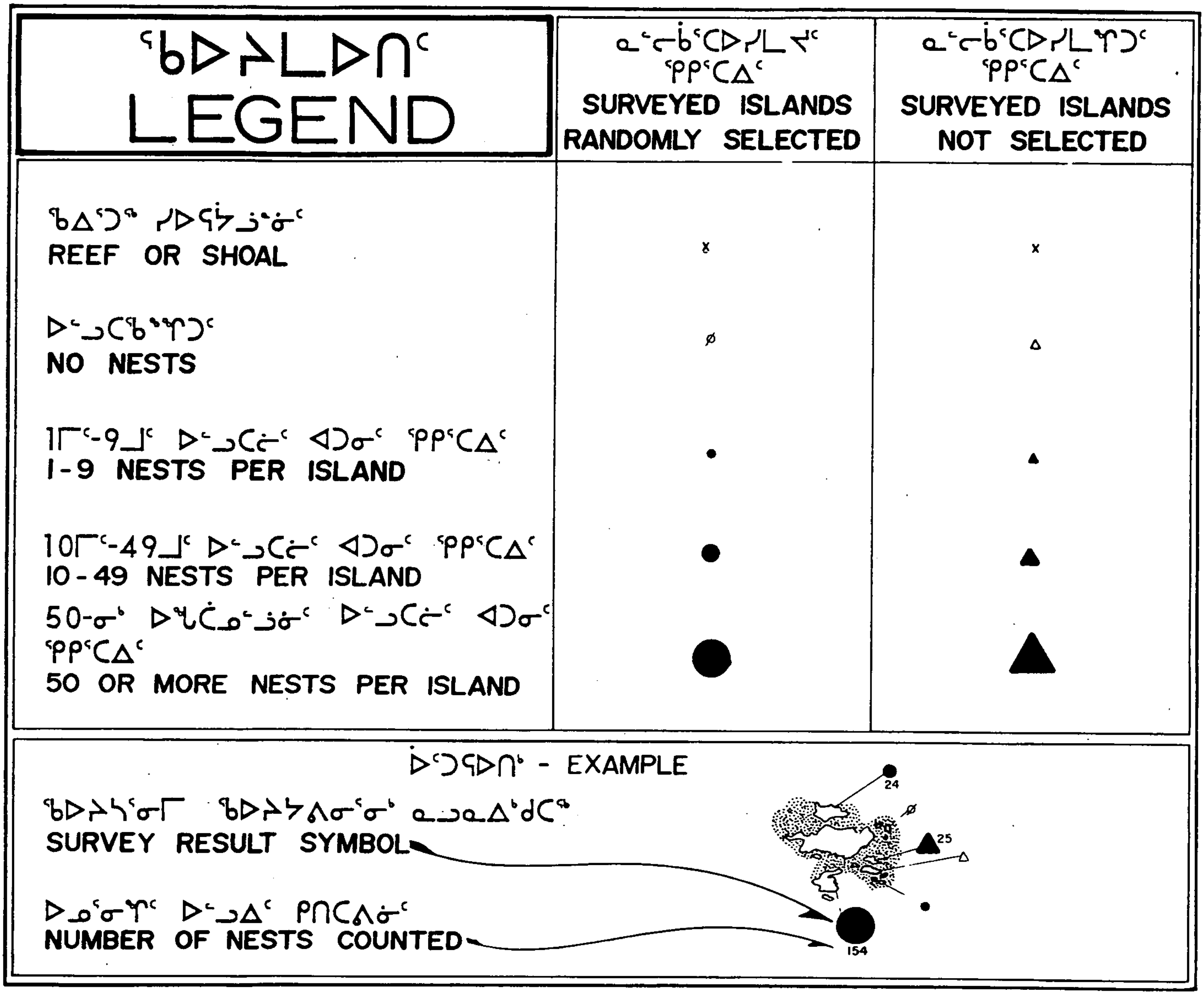
Two islands greater than 50 and less than 500 ha occur in the Laddie Island subregion (islands #123 and #226). Neither of these large islands was surveyed and we will assume that the number of eiders nesting on these islands is insignificant. No islands greater than 50 ha exist in the Split Island subregion. Islands greater than 500 ha were considered as mainland and were not surveyed.

Incidental to the survey of randomly-selected islands, a limited number of surveys of not-selected islands were made in both subregions. Data were collected on an additional 36 and 17 islands in the Laddie and Split Island subregions, respectively. These data are not included in the estimate of breeding population size as they over-represent small islands with few nests.

### 5.4.3 The number and distribution of Common Eider nests

In the Laddie Island subregion, 78 randomly-selected islands with areas less than 50 ha were counted. The Common Eider nests on these islands numbered 821. The average number of nests per island was 10.5 (see Fig. 9 and 10). In the Split Island subregion, 602 eider nests were found on 56 islands, resulting in an almost identical average of 10.8 nests per island (see Fig. 11 and 12).

The Common Eider nests in the Laddie Island area were not evenly distributed. The number of nests per island ranged between 0 and 197. More than 80% of the nests were on nine islands (11.5% of selected and counted islands). Forty-five of the 78 selected and counted islands (57.7%) had no eider nests. The nest density for the archipelago was 6.4 nests per ha with a peak single island density of 70.0 nests per ha on island #355 (28 nests on 0.4 ha).




Legend for figures 9 and 11.

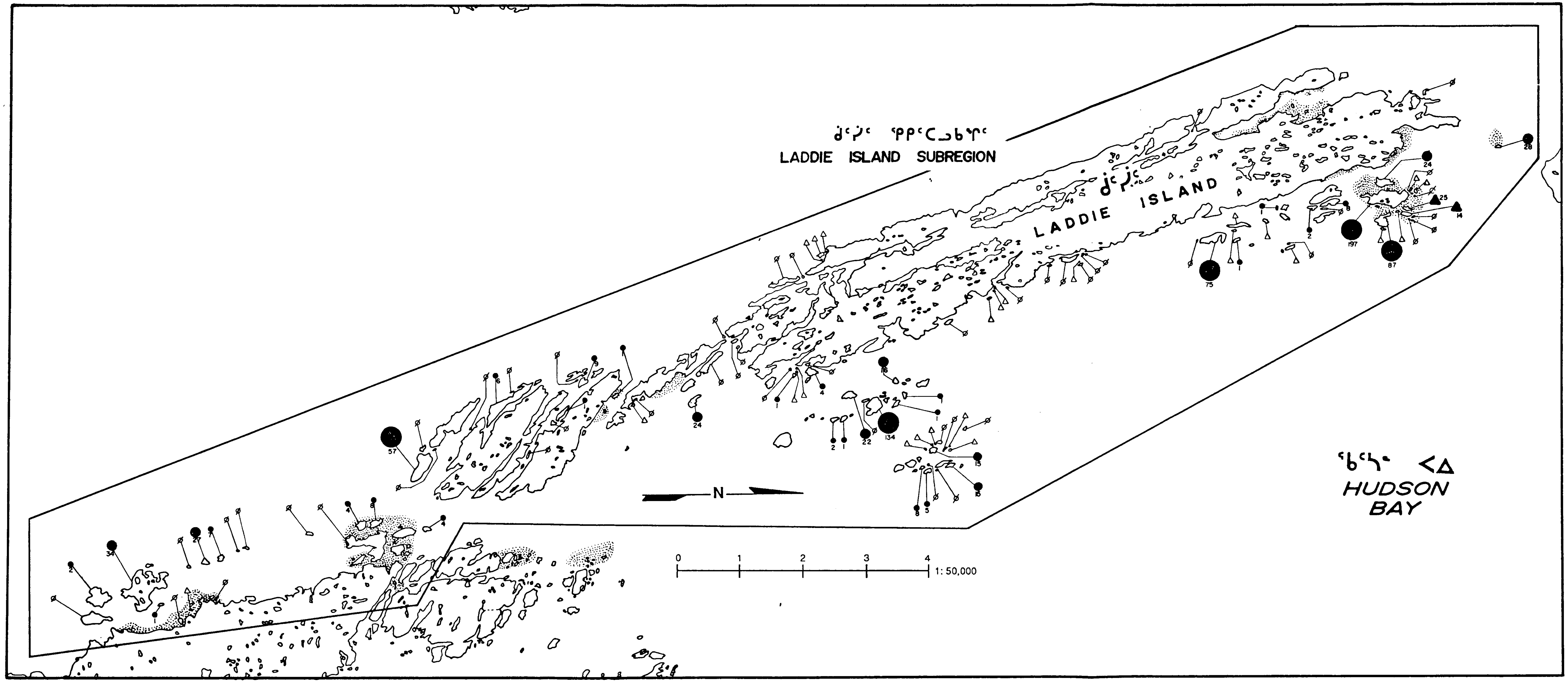



**Figure 9** - Laddie Island subregion. Common Eider survey results

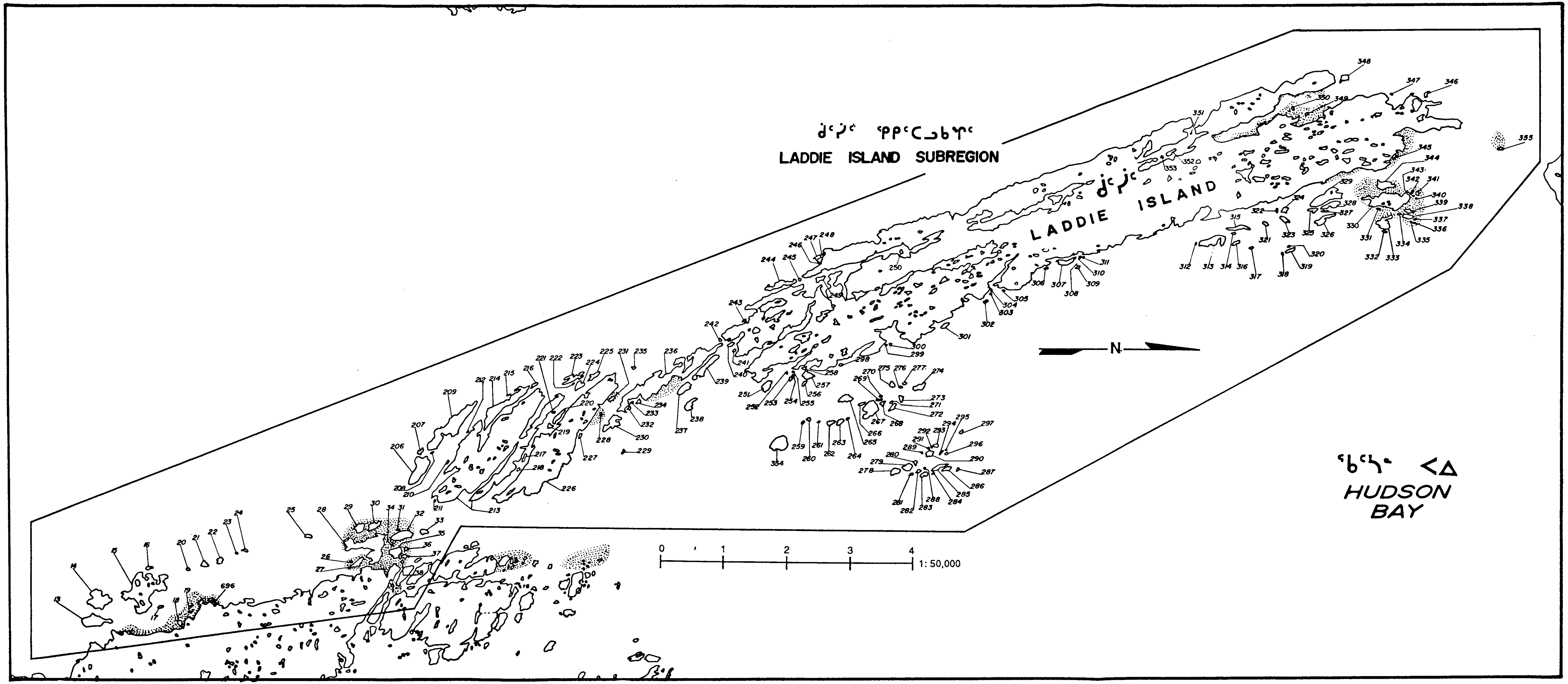



**Figure 10** - Laddie Island subregion. Island Identification numbers.

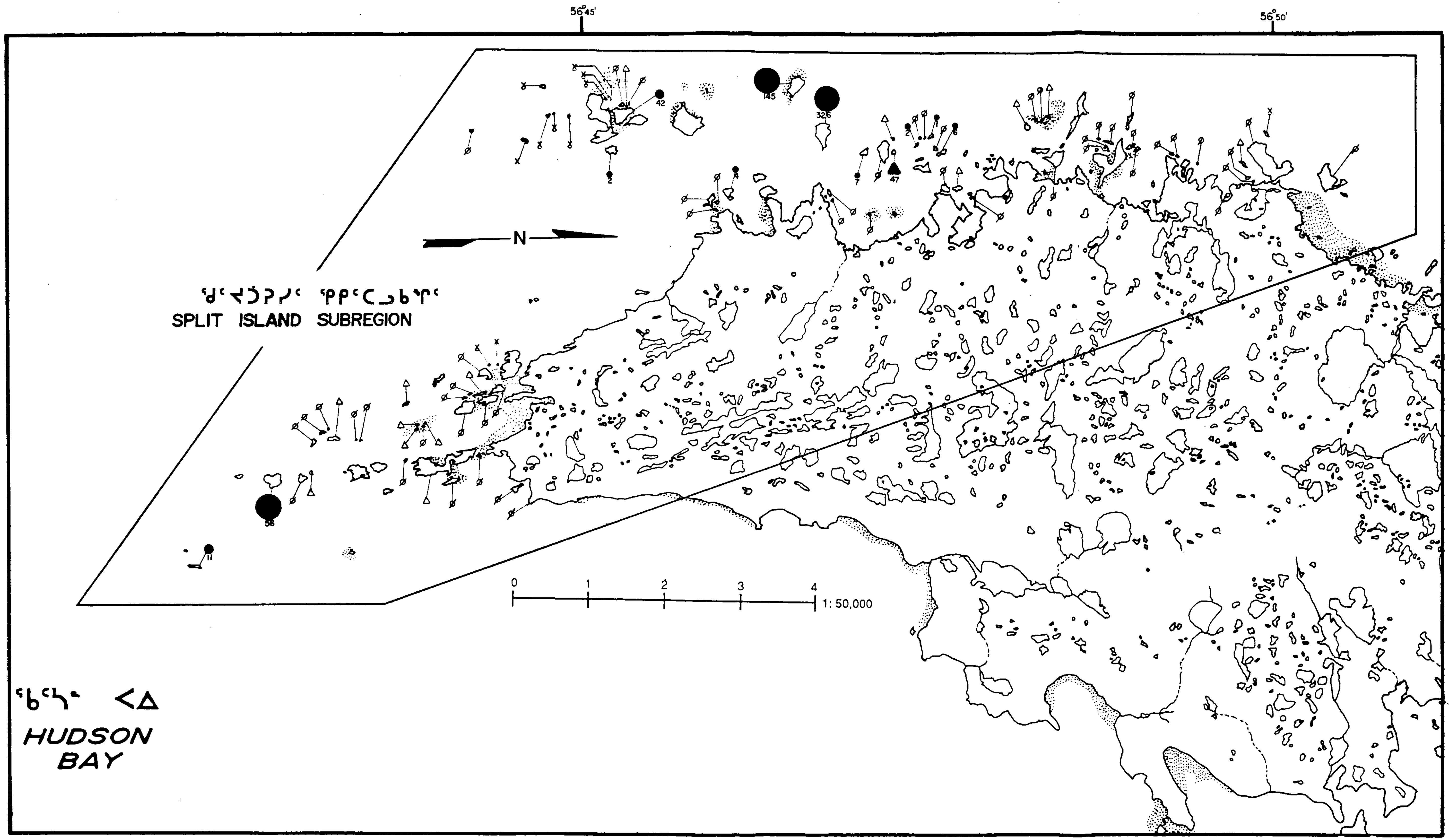



**Figure 11** - Split Island subregion. Common Eider survey results (see fig. 9 for map legend)

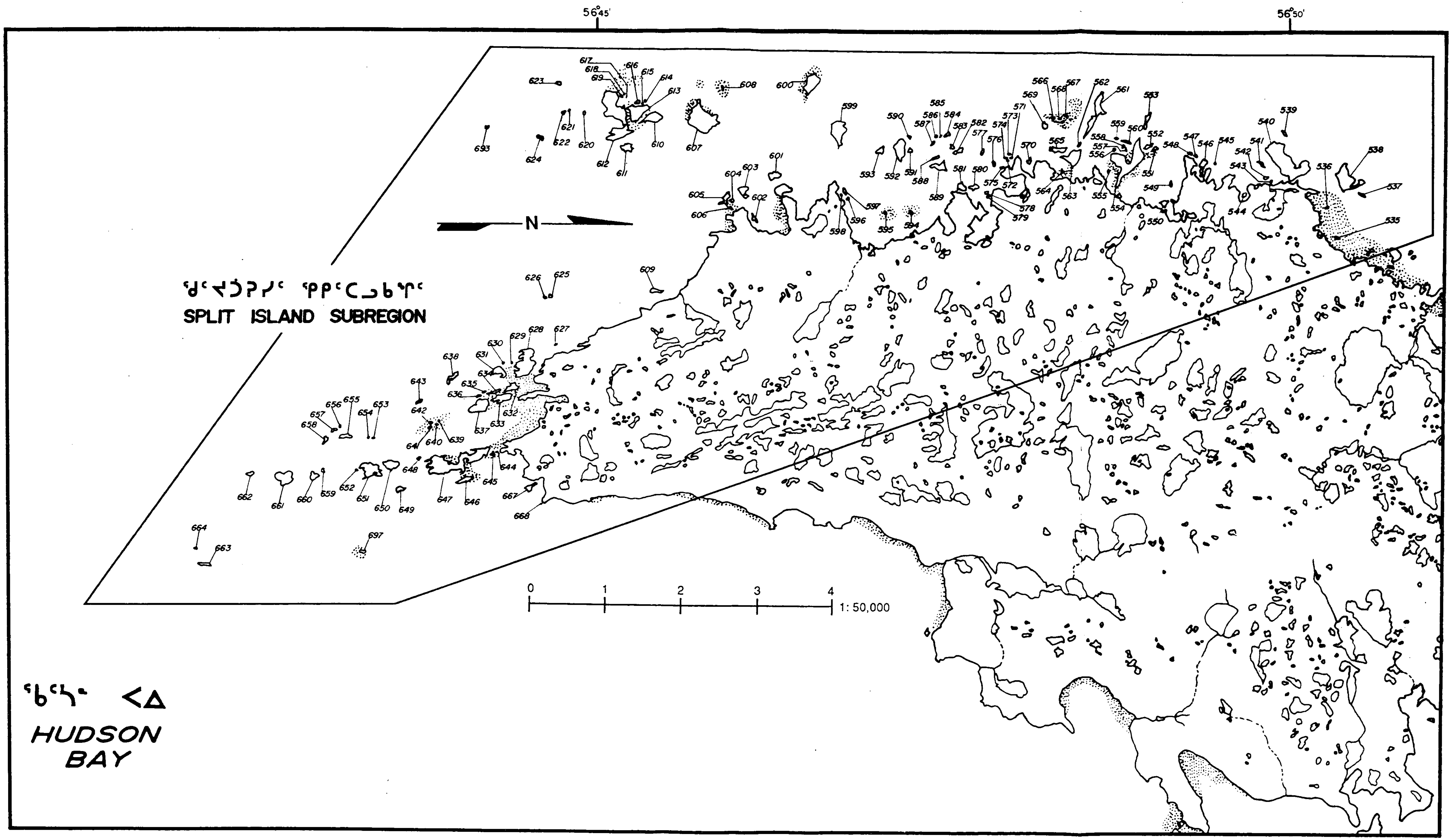



**Figure 12 -** Split Island subregion. Island Identification numbers.

The nests in Split Island were considerably more clustered. Nest number per island ranged from 0 to 326. In this subregion, three islands (5.4% of counted and selected islands) harboured 87.5% of the Common Eider nests (527 of 602 nests). Not surprisingly, a large number of islands had no eider nests: 45 of 56 islands or 80.3%. The overall nest density was 10.5 nests per ha. The maximum density for a single island was 65.2 nests per ha on island #599 (326 nests on 5 ha).

In the Laddie Island subregion, the islands with the greatest number of nests per island or the highest nest density (nests per ha) are scattered in different parts of the archipelago. They vary both in topography and size. Island #355, which had only 28 eider nests, had the highest nest density (70 nests per ha). It is a small isolated island (0.4 ha) situated in the middle of the broad passage between the north tip of Laddie Island and Radar Island (Fig. 9 and 10). The island is relatively flat in profile, with exposed bedrock comprising about 75% of its surface area. Between the outcrops of bedrock are flat areas of small stones, broken shells and sand, where the Common Eiders preferred to nest.

To the northeast of Laddie Island is a cluster of islands, many of which had Common Eider colonies. Islands #313 (75 nests), #330 (197 nests) and #333 (87 nests) are all relatively flat islands although the occasional low ridge of bedrock and boulders offers some nesting opportunities for Black Guillemot. Throughout these islands exposed bedrock is the predominant surface feature. However, areas of moss and short grass on islands #330 and #313 and sand and gravel on island #333 offer ample nest opportunities for Common Eiders. Several nests on island #330 were set in basins surrounded by man-made rings of stone. Some of these were evidently quite old as the rocks were overgrown with lichen and moss.

As we move southward, the islands have a higher relief and approach the distinctive humped profile of the Lukisee Islands. The cluster of islands east of the south end of Laddie Island had many Common Eider nests. Island #267 with 134 nests on five ha had a density of 26.8 nests per ha. Smaller islands (#265, #275, #286) had lower absolute numbers of nests (between 16 to 25 nests), but similar nest densities (18.3 to 26.6 nests per ha).

More than 75% of the surface area of island #206, located at the extreme south tip of the Laddie Island chain, is a ridge of exposed bedrock. The 57 pairs of Common Eider that had nests on this island nested in sheltered valleys adjacent to the bedrock ridge in areas of fine gravel and rocks or in tussocks of beach grass.

The largest nest colonies in the Split Island sub-region are on the outermost islands. The four major colonies which account for 94.5% of the subregion's counted nests, are #599 (326 nests), #600 (145 nests), #613 (42 nests) and #661 (56 nests) (Fig. 11 and 12).

Island #661 is amongst the islands at the extreme south tip of the archipelago. More than half of its surface area is flat, exposed bedrock. A large flat area of scattered rocks and fine gravel mixed with mussel shell fragments was used by Common Eiders for nesting. Nearby is island #651 (not surveyed) which appeared from a distance to have many nesting eiders, and which was described as exceptional during the hunter appraisal interview. Islands #663 (11 nests) and #697 (not surveyed), both with some eider nests, were unusual in being completely comprised of cobble and coarse gravel, which had the appearance of having been pushed up and gouged by ice movement.

Islands #599, #600 and #613, to the southwest of Split Island, are all exceptionally low in relief and more than 75% of the surface is small rocks, gravel and shell fragments. Vegetation is sparse, and the nest sites were as a rule very exposed. The eiders often selected sites beside pieces of driftwood which afforded some limited protection from the wind. Along the shore of island #599, nests were found nestled into stranded mats of dried kelp.

On the islands closer to the western shore of Split Island, eider nests were scarce. Many of the randomly selected and surveyed islands had no nests. Some of these islands appeared to be quite suitable nesting habitat. That the occasional eider colony does occur in this area is confirmed by our survey of island #591 which had 47 eider nests. These data were not included in the forementioned figures nor in the population estimation as the island was not part of the random sample.

Based upon the results of our survey, we can make an projection of breeding population size for the Laddie and Split Island subregions. Extrapolating our mean number of nests per island of 10.5 nests over the total island number in the Laddie Island subregion, we estimate a total of 1,653 nests (10.5 nests per island x 157 islands). For the Split Island subregion, we obtain a projection of 1,215 nests (10.8 nests per island x 113 islands) (Table 3). The large number of islands in our sample without nests results in a nest-per-island frequency distribution which is highly skewed. As a result, the Laddie and Split Island data do not fulfill the requirements set out by Cochrane (1977) ($25G_1^2 > n$) and therefore we cannot generate meaningful confidence limits for these population estimates.

### 5.4.4 The number and distribution of gull and Arctic Tern nests

Herring and Glaucous Gulls nest in the area. In the following discussion both species will be dealt with together as 'gulls'. Sixty-six gull nests were counted on 120 surveyed islands in the Laddie Island subregion. Seventy-eight of these 120 islands were randomly selected for sampling, and these islands accounted for 54 gull nests (Table 4). Unlike other subregions, the number of gull nests per island was limited. The maximum number of nests on a single island was six nests (islands #15 and #330). Twenty-one of the 78 randomly selected islands had only a single nest, while 49 islands (62.8%) had no gull nests at all. The Laddie Island subregion gull population is estimated to be 109 breeding pairs ±33 (±30.3%).

In the Split Island subregion, 41 gull nests were counted on 88 islands. Thirty-seven of these nests were on the 56 randomly-selected islands (Table 4). As in the Laddie Island subregion, the number of gull nets per island was limited. The largest colony was 13 nests on island #661. Eight of the 11 islands with at least one gull nest had only a single nest. The majority of surveyed islands, 45 of 56 islands (80.4%), had no gull nests. No confidence limits could be calculated for the Split Island breeding population estimate of 75 pairs of gulls.

In the Laddie and Split Island subregions, nesting Arctic Terns were more numerous than gulls but concentrated on fewer islands. Thus the 111 tern nests which were discovered on the 78 randomly-selected and surveyed islands of the Laddie Island subregion (Table 5), were distributed amongst nine islands (11.5% of surveyed islands). The largest concentrations of Arctic Tern nests were 31 and 26 nests on islands #333 and #330 respectively. In the Split

Island subregion, only a single Arctic Tern colony was discovered on 56 randomly selected islands. This colony of 79 nests was on island #600. Surveys of an additional 32 islands which were outside of the random sample, produced only a single tern nest on island #591. Population estimates of 223 and 159 pairs of Arctic Terns are calculated for the Laddie and Split Island subregions respectively. No confidence limits can be calculated due to the highly-skewed distribution of the data.

Arctic Tern nests were always found on islands where Common Eiders were nesting, often in large numbers. Ten of the 14 islands with tern nests had more than 10 Common Eider nests. Seven of these 14 islands had greated than 30 eider nests. The chi-square test for independence confirms that the nest distributions of Arctic Terns and Common Eiders are strongly positively associated ($X^2 = 22.7$; $P < 0.01$; n=120 for Laddie Island and $X^2 = 11.6$; $P < 0.01$; n=88 for Split Island). The same test confirms a strong positive association between Common Eider and gull nests ($X^2 = 56.80$; $P < 0.01$; n=120 for Laddie Island and $X^2 = 59.92$; $P < 0.01$; n=88 for Split Island).

### 5.4.5 Stratification of the sample by island area

In the Laddie Island subregion, the 78 randomly selected and counted islands can be stratified by area as follows; 63 islands with areas less than 2 ha; 12 islands between 2 and 10 ha; and 3 islands between 10 and 50 ha (Table 6). A mean of 2.6 eider nests was calculated for islands of less than 2 ha (std. dev. = 6.3). An average of 35.0 nests was determined for island of 2 to 10 ha (std. dev. = 43.7). Islands of 10 to 50 ha averaged 79.0 nests (std. dev. = 103.1).

In the Split Island subregion, 49 of the 56 randomly-selected and counted islands had areas of less than 2 ha, 6 had areas between 2 and 10 ha and one had an area between 10 and 50 ha. Within these three size classes the average number of nests per island was 0.7, 94.8 and 0 respectively.

In the Laddie Island subregion the data indicate a trend of increasing numbers of nests per island as area increases. However, in both subregions the nest per island values do not differ significantly from each others. Consequently there is no justification for stratifying the population estimates.

### 5.4.6 Clutch initiation, clutch size and down production

In the North Belcher Islands, two days of surveying were completed early in the Common Eider nesting season. On June 25 and 30, on Qutjutujuak and adjacent islands and in the north part of the Laddie Island subregion, none of the 389 active nests surveyed were hatching or hatched. The rest of the survey was completed between July 17 and 21 and on these dates an increasing proportion of hatching or hatched nests were found (Table 7). In the Laddie Island subregion 2.6% (n=313), 30% (n=223) and 46.3% (n=121) of active eider nests were recorded as hatched or hatching on July 17, 19 and 21 respectively. Similarly, in the Split Island subregion, 11% of 537 active nests were hatched or hatching on July 18 and 23.5% of 17 nests were hatched or hatching on July 20 (Table 7). These data suggest that most clutches were being completed during the last week of June.

Gulls nested earlier than eiders in the North Belcher Islands. Although no hatching nests were seen on June 30, 65.8% of the 76 active gull nests surveyed between July 17 and 21, were hatched or hatching. Of nine gull nests surveyed on July 17, six were still being incubated and showed no signs of hatching. By July 21, 12 of 19 nests were hatched and three others showed signs of hatching.

In contrast, no Arctic Tern nests were hatching in the Split Island subregion and only four of 123 nests (3.3%) were observed to be hatching in the Laddie Island subregion.

Average clutch sizes for incubated Common Eider nests were 4.0 and 3.9 eggs per nest in the Laddie and Split Island subregions respectively (Table 8). Five clutches of seven eggs per nest were the largest clutches observed in the Laddie Island subregion. Maximum clutch size in the Split island subregion was a single nest of 10 eggs. The most common clutch size in both subregions was four eggs per nest. Gull nests averaged 2.4 eggs (n=20) and 2.0 eggs (n=6) per incubated nest in the Laddie and Split Island subregions respectively. Arctic Tern clutch size was 1.6 eggs per nest (n=199) in both North Belcher Islands subregions. In the Laddie Island subregion, 47 Black Guillemot nests yielded an average of 1.8 eggs per nest. Only two guillemot nests were found in the Split Island subregion.

Down samples were collected from 14 and 16 nests in the Laddie and Split Island subregions respectively (Table 9). The uncleaned samples from the Laddie Island subregion averaged 37.9 gm (std. dev. = 19.13). After cleaning, they lost 67.9% of their weight, and the clean samples averaged 12.1 gm per nest (std. dev. = 5.09). The amount of clean down available per nest varied from 0 to 19 gm. For the Split Island subregion, the down samples averaged 35.0 gm before cleaning (std. dev. = 13.80) and 11.6 gm after hand cleaning (std. dev. = 4.89). Combining the data for both subregions, the clean down production for 30 sampled nests in the North Belcher Islands averaged 11.9 gm per nest (std. dev. = 4.90).

## 5.5 The Sleeper Islands subregion

### 5.5.1 General description

The Sleeper Islands or Qumiutuq, as they are known locally, are situated north of the Belcher Islands, some 112 km NNE of the community of Sanikiluaq and 150 km SW of the community of Inukjuak (Fig. 2). The surrounding expanses of open, and often rough water restrict access to this archipelago and it is infrequently visited by Inuit. Fall walrus hunting trips are an annual event for hunters from Sanikiluaq and Inukjuak, and most summers a few canoes or speedboats from Sanikiluaq will visit during the eider nesting period. The recent increase in the number of large community-owned boats in eastern Hudson Bay is expected to increase the frequency of trips to the Sleeper Islands.

Historically, the Sleeper Islands were occupied throughout the year, and older hunters from Inukjuak and Sanikiluaq recount stories of their experiences on the islands. During the 1985 survey, man-made stone rings surrounding active Common Eider nests or old nest basins were observed on several islands. Older hunters explain that in the past when bullets were scarce, they used to trap female eiders with leghold traps. The technique was to surround the active nest with rocks, leaving a single entranceway where the trap was set and through which the female eider would be obliged to pass when returning to her nest.

The Sleeper Islands archipelago, which extends roughly north-south, is about 49 km from end to end (Fig. 13). It consists of two main islands, each greater than 1,000 ha in area. The north island, Kidney Island, is the larger of the two. Its lakes are of sufficient size and depth to support an over-wintering population of Arctic Char (*Salvelinus alpinus*).

Scattered around these main islands are more than 360 smaller islands, and innumerable reefs and shoals. These are not evenly distributed. There is a concentration at the north tip, a second at the junction of the two main islands and a third which extends a considerable distance to the south. Along the eastern edge of the archipelago, the sea bottom drops away quickly and there are relatively few islands.

Many of the islands are very small. Only four of the 362 islands are in the 50 to 500 ha size class. Although each exhibits its own peculiarities, the following description would suit the great majority of islands with areas less than 2 ha; a simple hump-shaped contour from a low, almost flat, relief to about one fifth as high as wide; greater than 80% of the surface is exposed bedrock, polished smooth by glacial action; and little vegetation, that which occurs being limited to small depressions in the bedrock. Larger islands exhibit much more variation in topography and surface cover. Islands off the south and east coasts of Kidney Island are the most accentuated in contour, rising gradually (in one case to greater than 30 m) from the landward or inner shore and dropping sharply to the sea on the outer edge. Other large islands are almost completely flat. Although exposed bedrock continues to comprise a large proportion of the surface area of these islands, vegetation, cobble, gravel and, along the shoreline, washed-up mussel shells and kelp are also major elements.

The Common Eider survey results for the Sleeper Islands subregion are presented in Figure 13 and the island identification numbers are presented in Figure 14.

### 5.5.2 The nest survey

The Sleeper Islands subregion was surveyed by the Sanikiluaq crew. The survey began on July 1 and ended on July 13. Two of the 13 potential survey days were lost as a result of poor weather and rough water. Islands in all parts of the archipelago were censused. In the 0 to 50 ha size class, 175 randomly-selected islands were counted, representing a sampling intensity of 46.7% of the 375 islands present. Of these counted islands, 133 had surface areas of less than two ha, 28 islands had areas between two and 10 ha and 14 islands ranged from 10 to 50 ha.

Excepting the two main islands, only four of the Sleeper Islands exceed 50 ha in size. One of these four islands (#30) was partially surveyed by slowly cruising along the east coastline, and by widely-dispersed traverses of the southern peninsula (less than 10% of total surface area).

The large number of very small islands, most of which were relatively flat and had surfaces of bare bedrock, facilitated the use of scanning. Consequently, total ground counts were frequently supplemented with scan surveys. Scanning was limited to small, exposed islands which we could confidently pronounce to not be frequented by eiders upon careful examination from along the shore.

In addition to the surveying of randomly-selected islands, observations were made on non-selected islands whenever opportunities arose. These observations provide total count data for an additional 71 islands. These data, mostly collected by scanning, over-represent the number of small islands with no nests. Consequently, they were not used to generate the population estimate for the Sleeper Islands.

### 5.5.3 The number and distribution of Common Eider nests

The Common Eider is a colonially-nesting seabird. Its nest distribution in the Sleeper Islands clearly illustrates this aspect of its ecological character. On the 175 randomly-selected and surveyed islands with areas less than 50 ha, 2,775 Common Eider nests were found (see Fig. 13 and 14). The number of nests per island ranged from 0 to 484 with a mean of 15.9 nests per island (Table 3). Of the surveyed islands, 131 (74.9%) had no eider nests, while a few had very high numbers. Fourteen of the 176 counted islands (8%) had over 90% of the eider nests. Seven of these 14 had nest densities of greater than 50 nests per ha with an extreme value of 354.4 nests per ha on island #77 (379 nests on 0.9 ha). The nest density for the archipelago is 6.1 nests per ha.

When we examine the locations of these dense nest islands, it is interesting to note that they are situated along the perimeter of the archipelago. Island #0 (192 nests) is the most isolated, with 7 km of open water separating it from its nearest neighbour (Fig. 13). Islands #12 (118 nests), #20 (484 nests) and #77 (319 nests) are amongst the scattering of islands which extends south from the main islands. Other islands within this southern sector were not surveyed but our field observations suggest that they support colonies of a similar size (islands #43, #67, #68 and #72). Island #333 (222 nests) is isolated at the extreme northern tip of the Sleepers. Finally, islands #354 (209 nests), #359 (82 nests), #360 (260 nests), and #361 (387 nests) and two unsurveyed islands, upon which we observed large numbers of drakes and ducks (islands #90 and #92), are located along the outer edge of the archipelago, east and west of the north end of Kidney Island.

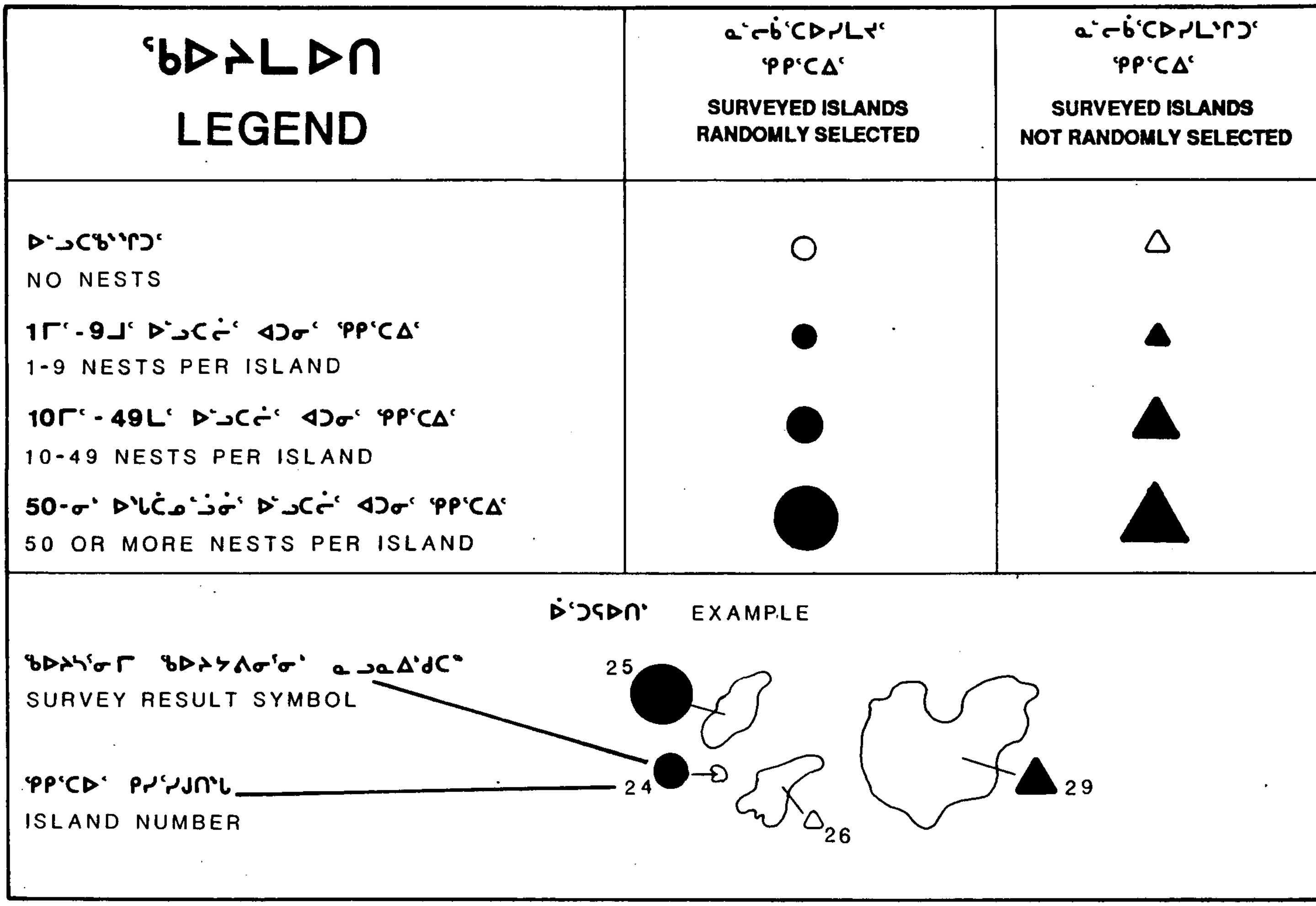
In spite of the large numbers of islands clustered between the two main islands and near their north and south tips, few eiders nested in these more sheltered inshore areas. This distribution is immediately obvious in the field. In sharp contrast with the outer edge of the archipelago, we saw few flying eiders when navigating the inner areas. It is likely that stronger currents to the perimeter of the archipelago are an important factor in speeding ice breakup in the spring and quickly restricting access by fox, conditions which are amenable to Common Eider nesting.

Topography and substrate also influenced the selection of nest islands by eiders. All of the largest colonies were on islands which offered large, relatively flat areas of vegetation or fine-grained material. Island #20 is a large 14.8 ha island, gently-humped at the north end and quite flat at the south end. Its surface is about one half short-cropped grass/moss and one half gravel and small stones, with scattered, exposed ridges of bedrock. The eider nests were dispersed over the entire surface area and selected substrates include grass/moss, clumps of searocket *(Sedum sp.)*, gravel and sand. Islands #354, #360 and #361 share a similar topography. Tiers of bedrock rise dramatically from the sea along the east side, but to the west, they descend gently in a series of shelves of lush, short-cropped moss/grass, to broad gravel/mussel shell beaches. This gentle west slope is peppered with nests from the beach to the crest of the island. From a distance, the hundreds of white drakes sitting along the ridges of bedrock which dissect the bright green moss/grass of the slopes present a pleasing spectacle.

Islands #12, #77 and #333, although in very different parts of the archipelago, resemble each other in that they are all quite flat and eiders nest in dense concentrations on a substrate of fine gravel and small stones. Island #0 is a flat, exposed bar of sand and small stones with eider nests dispersed along its length. Finally, island #154 (58 nests) is noteworthy because many of the Common Eiders on this island were nesting in thick mats of kelp which have been washed ashore along the island edge. Although kelp is used as a nest substrate throughout the archipelago, on island #154 it is particularly common. The nests away from the shoreline kelp are primarily nestled into clumps of searocket.

The Sleeper Islands subregion includes two main islands with areas greated than 500 ha and four large islands with areas beween 50 and 500 ha. No attempt was made to systematically census these islands. Our base camp was set at the north tip of the southern main island, beside the narrow east-west passage across the archipelago. From this campsite, individuals wandered inland to hunt geese or to explore the island. Similar exploratory walks were repeated at three locations on the north island and one other location on the south island. The only nest discovered during these wanderings was that of a Semipalmated Plover *(Charadrius semipalmatus)*. An Arctic fox was a frequent visitor at our base camp. Although the survey walks on these large islands were restricted in number and in the amount of area covered, our experiences on these main islands were in accordance with our decision to treat such large islands as if they had insignificant numbers of nests.

In the 50 to 500 ha size class, one island was partially counted. We cruised along the east shore of island #30 and surveyed about 10% of the island surface area with broad sweeps on the south peninsula. No eiders




Legend for figure 13.

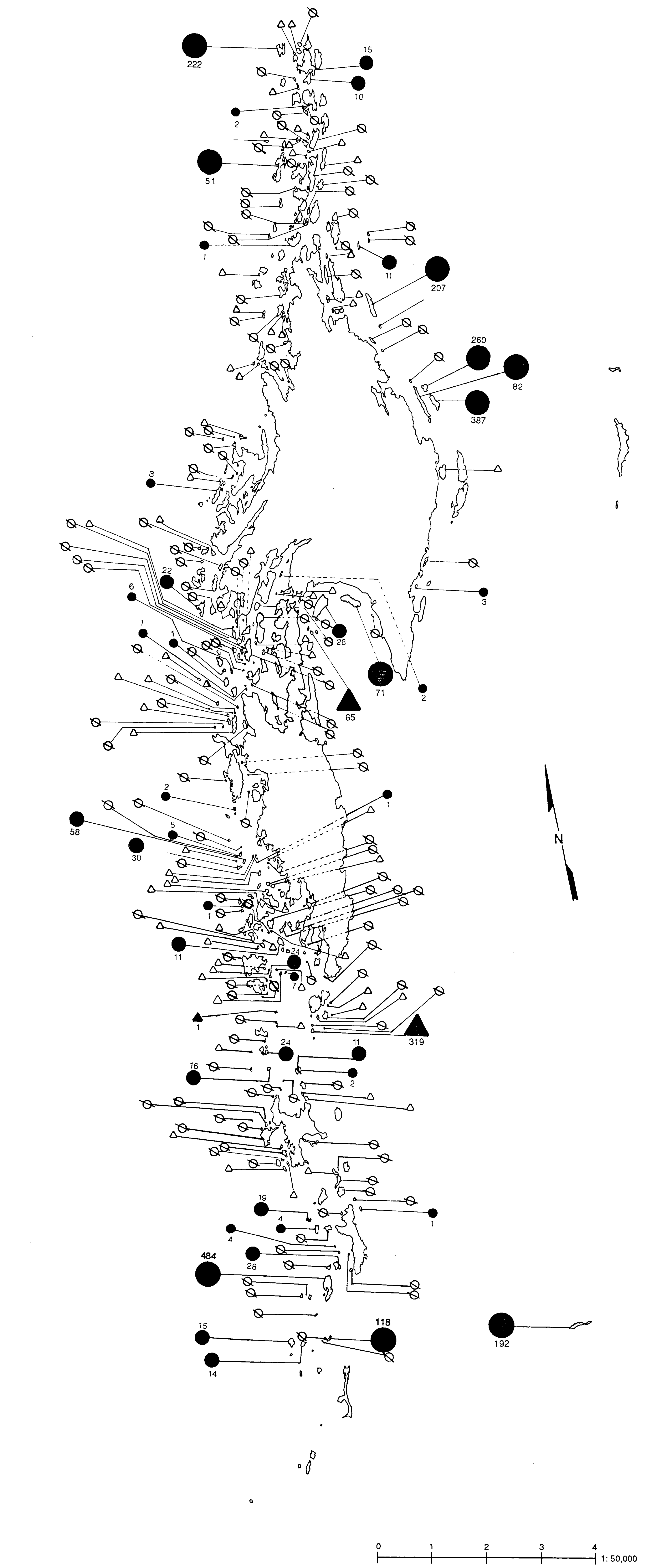



**Figure 13** - The Sleeper Islands subregion. Common Eider survey results.


**Figure 14** - The Sleeper Islands subregion. Island identification numbers.

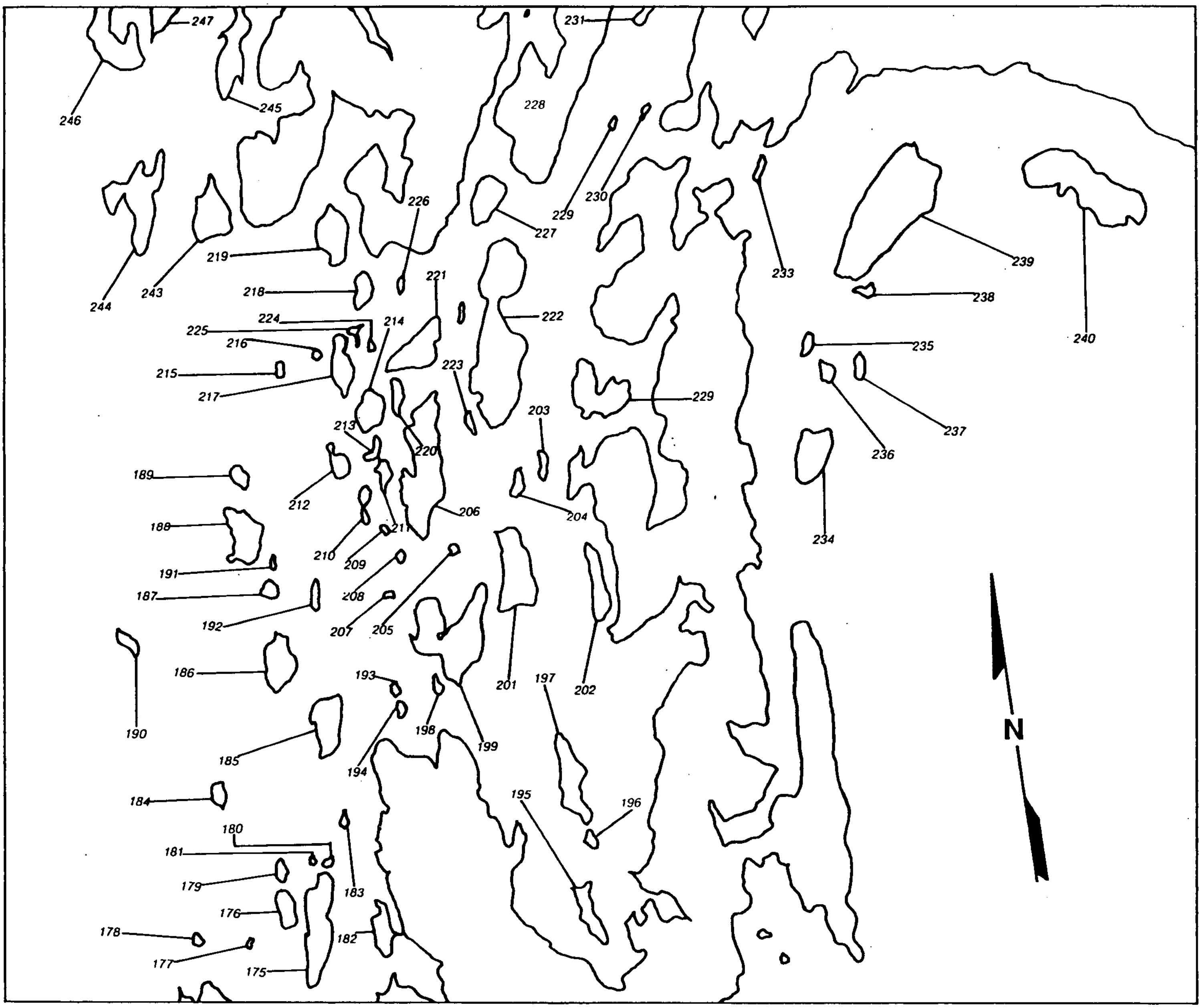



**Figure 14a** - The Sleeper Islands subregion. Island identification numbers (detail).

were seen during the cruise. Two Common Eider nests in incubation phase were found (three and four eggs) and two very old nest basins surrounded by stone rings were seen during the limited ground survey. A large complex of fox dens reinforced our overall impression that very few Common Eiders were nesting on this island.

Consequently, our estimate of the Common Eider breeding population for the Sleeper Islands is entirely based upon islands of less than 50 ha. From our survey of 175 randomly-selected islands in this size class, we obtain an average of 15.9 nests per island. Extrapolating over all islands less than 50 ha in area, we obtain our estimate of 5,899 nests ±2,500 (±42.4%) for the archipelago (15.9 nests per island multiplied by 372 island) (Table 3).

### 5.5.4 The number and distribution of gull and Arctic Tern nests

Herring Gulls, Glaucous Gulls and Arctic Terns nest in the Sleeper Islands archipelago. The data for both Herring and Glaucous Gulls will be presented together as no distinction between the nests of these species was made during the census. One hundred and thirty-three gull nests were counted on the 175 randomly-selected and surveyed islands with areas less than 50 ha. The number of gull nests per island ranged from 0 to 29, with a mean of 0.8 nests per island. Similar to the distribution of Common Eider nests, many islands had no gull nests (132 of 175 islands; 75.4%), while a few islands had many. The data indicate that many gulls nest alone. Thirty of the 43 islands with gull nests had only a single nest. From our census data we estimate a breeding population of 284 pairs of gulls (Table 4).

Arctic Terns in the Sleeper Islands exhibit an even stronger tendency to nest in colonies than do Common Eiders. Ninety percent of the 752 Arctic Tern nests were found on eight islands (only 4.6% of selected and counted islands). Over 90% of surveyed islands had no tern nests. Colony size ranged up to 283 nests (islands #244). An estimated 1,607 pairs of Arctic Terns nest in the Sleeper Islands subregion (Table 5).

The Arctic Tern data are subject to two sources of bias that arise because the survey focussed upon Common Eiders. First, scanned islands, which did not have Common Eider nests, would have been recorded as having no Arctic Tern nests when in fact some may have been present. Second, tern nests were not counted during the survey of island #20. The decision was taken to not census terns, when it was realized that survey time was limited and large numbers of nesting terns were probably present. Both of these procedures bias the Arctic Tern census data and result in an underrepresentation of the numbers of breeding pairs.

If we examine Common Eider nest distribution in relation to that of gulls and Arctic Terns, we discover a strong positive association between eiders and each of these species. The chi-square test for independence (Walpole and Myers 1978:268) confirms that Common Eider nest distribution is not independent of that of gulls ($X_2$ = 29.1; $P < 0.01$; n=236), nor of Arctic Terns ($X^2$ = 62.9; $P < 0.01$; n=236).

### 5.5.5 Stratification of the sample by island area

The 176 randomly-selected and counted islands in the Sleeper Islands subregion can be stratified by island area as follows : 133 islands of less than 2 ha; 28 islands of 2 to 10 ha; and 14 islands of 10 to 50 ha (Table 6). The survey results for islands in each of these three size categories give an average of 5.3 nests per island of less than 2 ha, 50.3 nests per island of 2 to 10 ha and 47 nests per island of 10 to 50 ha. The corresponding standard deviations are 30.1, 100.2 and 128.2, respectively.

T-tests indicate that none of these values differ significantly. Thus stratifying by island area will not improve the accuracy of our population estimate.

### 5.5.6 Clutch initiation, clutch size and down production

All but three of the 2,630 active Common Eider nests found in the Sleeper Islands, were being incubated and not yet hatching (Table 7). The earliest hatching nest was recorded on July 3, one of 318 nests on island #77. The other two hatching eider nests were observed on islands #12 and #20, on July 13, the last day of the Sleeper Islands survey.

The hatching nest on island #77 on July 3 is exceptionally early. On the same date and the same island other eggs were freshly laid or early in incubation phase, as evidenced by the examination of four eider eggs broken open by gulls. Ten days after the discovery of this first hatching nest, only 2 of 679 eider nests were hatching. A hatched gull nest with one young, found during the survey of island #77, was also an early event. No other hatching or hatched gull nests were discovered in the Sleeper Islands until July 13. Observations in other areas indicate that a disparity of two or three weeks between the earliest and mean dates of clutch initiation is normal (Palmer 1976; Schmutz 1981).

Using a 25-day incubation period (Palmer 1976) we calculate that these early clutches were initiated about June 8 and 18. As we left the Sleeper Islands when only three of 2,842 nests had hatched, we cannot determine the mean date of clutch initiation.

The mean clutch size of Common Eider nests in incubation phase was 4.3 eggs (n=2,577) (Table 8). The most commonly observed clutch was five eggs, recorded for 855 nests (33.2%). The maximum clutch size observed for the Sleeper Islands was 10 eggs. Gull clutch size averaged 2.5 eggs (n=103). Arctic Tern nests averaged 1.8 eggs (n=753).

Twenty-nine down samples were collected from Common Eider nests in the Sleeper Islands subregion (Table 9). Eighteen of these samples were collected on island #20 on July 13. The other 11 samples were collected on the same date from islands #12 and #13. The mean uncleaned weight per nest is 30.9 gm (std. dev. = 16.29). When hand-cleaned, the samples lost 57.5% of their weight. The average weight of the cleaned down samples was 13.12 gm per nest (std. dev. = 5.87).

## 5.6 The Koktac River subregion

### 5.6.1 General description

The Koktac River runs east to west, entering Hudson Bay just south of Kogaluk Bay at 59°15' N 78°00' W. This is at the center of the Koktac River subregion which covers some 70 km of the Quebec coastline between the communities of Inukjuak and Povungnituk. The mouth of the Koktac River is about 85 km due north of Inukjuak (Figure 2). The Koktac River is mislabeled on the topographic maps of the region. These maps give the name 'Koktac' to the river system to the south which should be labeled the Nauligakvik River.

The subregion's northern boundary is Pointe Bourjoli, which also defines the northern limit of Kogaluk Bay. The south perimeter includes but does not go beyond the large unnamed island at 58°55' N and 78°25' W. Scattered along the coastline between these two points are 768 islands. Two of these islands are greater than 500 ha in size and another 141 islands are within the foreshore flats. Of the remaining 622 islands, 616 have areas of less than 50 ha and six islands range in size between 50 and 500 ha.

Detailed 1:50,000 scale maps of the Koktac River subregion are available upon request from the Makivik Research Department. Figures 15 and 16 which are included with this text, are reductions of the former large-scale maps.

The numbering system for the islands of this subregion (Fig. 15 and 16) are divided into northern and southern components at the mouth of the Koktac River. When we refer to island numbers in the text, they will be followed by an N or S to designate whether they are in the section north or south of Koktac River, respectively.

### 5.6.2 The nest survey

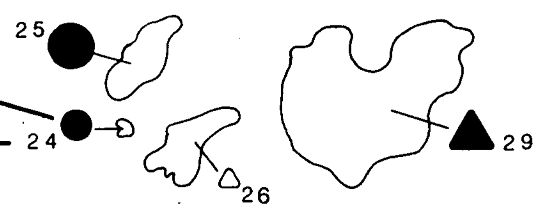
The Koktac River subregion was censused by the Inukjuak survey crew. The survey began on July 7 and was completed on July 19. Islands throughout the subregion were surveyed. Of the 616 eligible islands within the less than 50 ha size category, 294 randomly-selected islands were counted. This represents a sampling intensity of 47.7% of the islands in the subregion. Of the 294 censused islands, 239 had areas between 0 and 2 ha, 32 islands had areas from 2 to 10 ha and 23 islands were between 10 and 50 ha. No surveys of islands greater than 50 ha were done. We make the assumption that no eiders nested on the six islands

| ᖃᐅᔨᒪᐅᑎ<br>LEGEND | ᓇᓪᓕᑳᕐᑕᐅᓯᒪᔪᑦ<br>ᕿᑭᖅᑕᐃᑦ<br>SURVEYED ISLANDS<br>RANDOMLY SELECTED | ᓇᓪᓕᑳᕐᑕᐅᓯᒪᖏᑦᑐᑦ<br>ᕿᑭᖅᑕᐃᑦ<br>SURVEYED ISLANDS<br>NOT RANDOMLY SELECTED |
|---|---|---|
| ᐅᓪᓗᑕᖃᙱᑦᑐᑦ<br>NO NESTS | ○ | △ |
| 1ᒥᑦ-9ᒧᑦ ᐅᓪᓗᑖᑦ ᐊᑐᓂᑦ ᕿᑭᖅᑕᐃᑦ<br>1-9 NESTS PER ISLAND | ● | ▲ |
| 10ᒥᑦ-49ᒪᑦ ᐅᓪᓗᑖᑦ ᐊᑐᓂᑦ ᕿᑭᖅᑕᐃᑦ<br>10-49 NESTS PER ISLAND | ● | ▲ |
| 50-ᓂᑦ ᐅᑲᓪᓚᓐᓂᑦ ᐅᓪᓗᑖᑦ ᐊᑐᓂᑦ ᕿᑭᖅᑕᐃᑦ<br>50 OR MORE NESTS PER ISLAND | ● | ▲ |

ᐆᑦᑐᕋᐅᑎ EXAMPLE

ᖃᐅᔨᓴᕐᓂᒥ ᖃᐅᔨᔭᐅᓂᕐᓂᑦ ᓇᓗᓇᐃᖅᑯᑕᖅ
SURVEY RESULT SYMBOL

ᕿᑭᖅᑕᐅᑉ ᑭᓯᐊᓂᖓ
ISLAND NUMBER




Legend for figures 15 and 16.

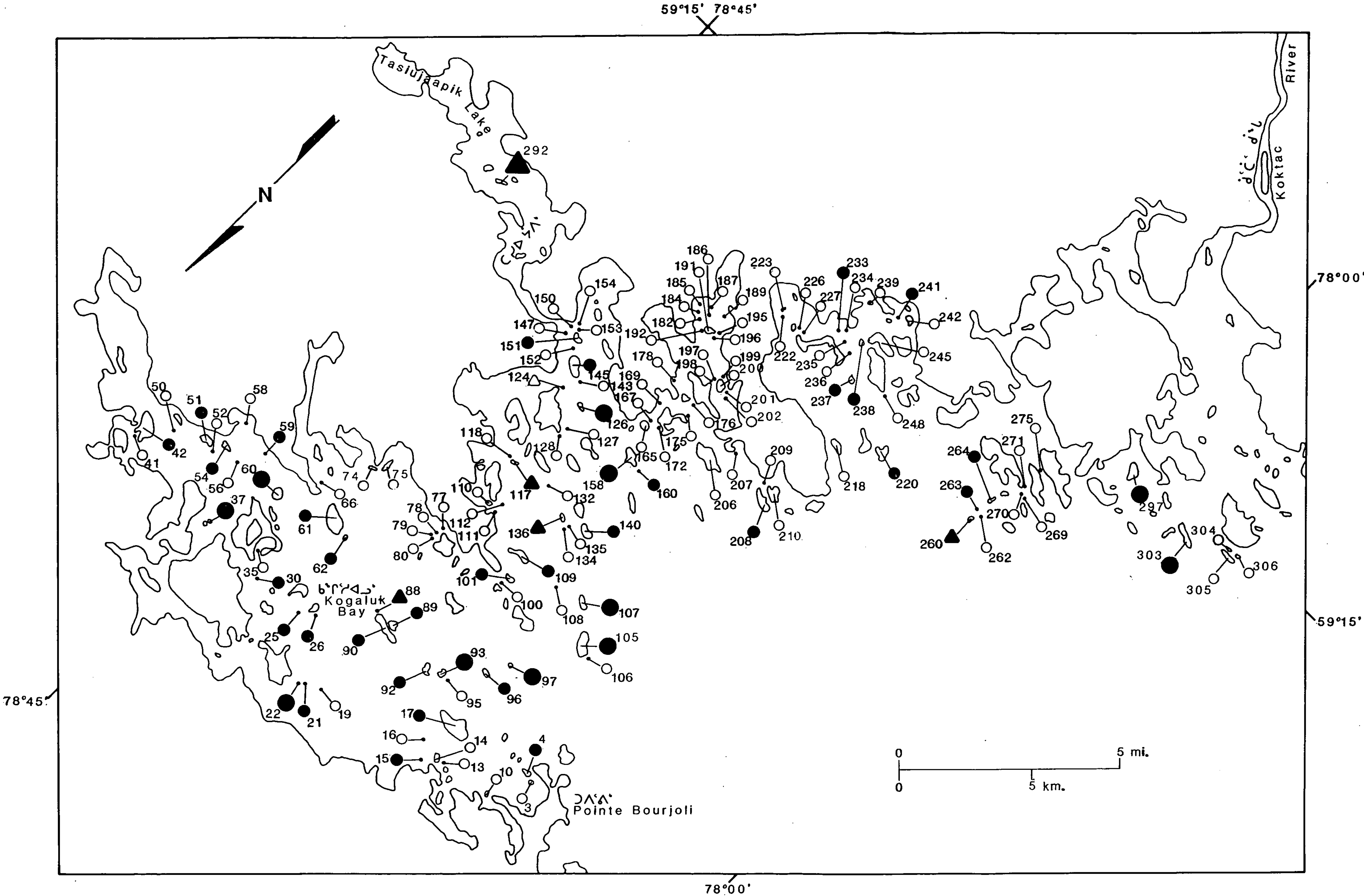



Figure 15 - The Koktac River subregion - north section. Island identification numbers and Common Eider survey results.

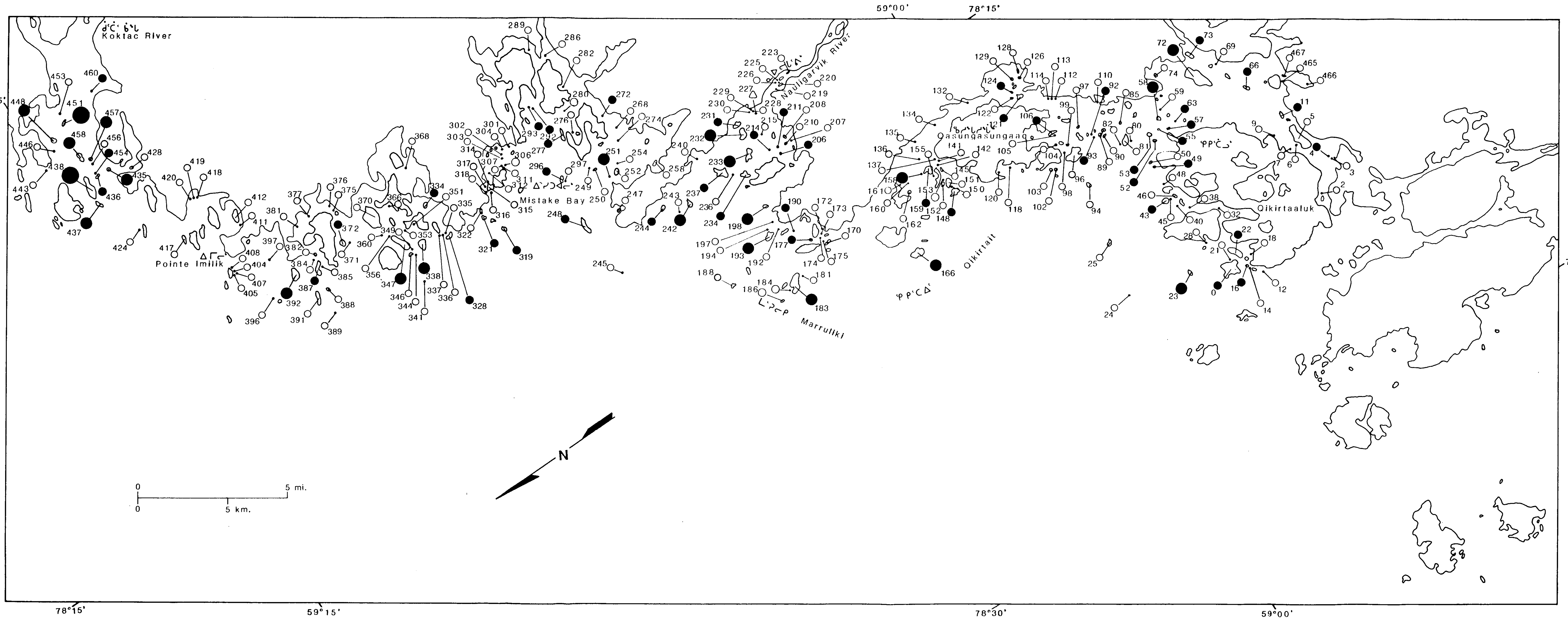



**Figure 16** - The Koktac River subregion - south section. Island identification numbers and Common Eider survey results. (see fig. 15 for map legend)

between 50 and 500 ha, and the two islands greater than 500 ha.

Ground counting was the most frequently employed survey technique in this subregion. On small islands, scanning was an acceptable means of verifying the absence of Common Eider nesting. Partial counts were done on 6 medium size islands (islands #0, #72, #248, #370, #382, #417 in Koktac South) with areas between 5 and 34 ha. An estimate was made of the percentage of suitable nesting habitat surveyed, and the total number of nests on the island was extrapolated by a simple rule of thumb. Three of the six islands had no nests. On islands #0, #72 and #248, about half of the surface area was censused. Total estimates for these islands were made by doubling their original count totals of 7, 11 and 5 nests, respectively.

### 5.6.3 The number and distribution of Common Eider nests

In the Koktac River subregion, 1,017 Common Eider nests were counted on 294 randomly-selected islands (see Fig. 15 and 16). The number of nests per island ranged from 0 to 77 and the average was 3.5 nests. Of the 294 censused islands, 186 had no Common Eider nests (63.3%). More than 80% of the nests were concentrated on 15% (44 islands) of randomly selected islands. The six islands with the highest nest densities (ranging from 50.7 to 64 nests per ha) were all small, having areas less than 1.5 ha. The overall nest density for the subregion is 1.82 nests per ha.

The islands with the largest numbers of Common Eider nests were distributed throughout the archipelago. Colonies tended to be on islands remote from the mainland. Nevertheless, 90 Common Eider nests were found on islands within the foreshore flats. In accordance with the assumption set out in our methodology, islands within the foreshore flats, and any nests found on them, are to be excluded from consideration. The assumption is that islands on the tidal flats are accessible to fox and therefore nest density is expected to be similar to those on the mainland proper, which in turn is assumed to be very low. However, in the Koktac River subregion, we find that 90 of 1,017 eider nests are within the foreshore flats (9%). This is a small but significant figure. In fact, nine of 67 islands censused within the foreshore flats (13.4%) had at least one Common Eider nest. Ninety nests on 67 randomly selected islands within the foreshore flats provides an average of 1.3 nests per island.

The Inukjuak crew also surveyed within Lac Tasiujaapik in the north part of the Koktac River subregion. Tasiujaapik is a large estuarine 'lake' which maintains its salinity by means of a narrow channel to the sea. The current in the channel changes direction with the tides. The brief survey within Tasiujaapik suggests that the inland nesting situation is quite unlike that on the offshore, and that the two data sets should be treated separately. Fifteen islands, free of the tidal flats, occur within Tasiujaapik. A count of about half of island #292N found 83 Common Eider nests, 18 gull nests, one King Eider *(S. spectabilis)* nest and one Red-throated Loon *(Gavia stellata)* nest. The survey was left incomplete because some of the Common Eider nests had hatched and gull predation on ducklings was a problem. The survey indicates that many Common Eiders nest in this inland area. Although island #292N was only partially counted, the number of eider nests recorded was greater than the number reported for any island surveyed on the offshore. Hunters report that Common Eiders nest in similar concentration on at least one other island within Tasiujaapik.

For the Koktac River subregion, we can estimate Common Eider breeding population size for islands of less than 50 ha that are free of the foreshore flats (Table 3). Using the average of 3.5 nests per island and extrapolating over the 616 islands in the archipelago, we obtain an estimate of 2,131 nests ±438 (±20.6%). As the data passes Cochrane's test the 95% confidence limits are presented. For this subregion it is assumed that insignificant numbers of eiders nest on islands greater than 50 ha.

As Common Eiders appear to be nesting at low but significant frequencies on islands designated as within the foreshore flats, we need to include an additional 183 nests (1.3 nests per island X 141 islands). Finally, we must remember that this total does not include Common Eiders nesting within Lac Tasiujaapik as it is not possible to provide an estimate of their numbers.

### 5.6.4 The number and distribution of gull and Arctic Terns nests

Seventy-six Herring and Glaucous Gull nests were found on the 289 randomly-selected and surveyed islands in the Koktac River subregion. In this subregion, gulls were not found nesting together in large numbers. The largest number of gull nests on a single island was five. Fifty-five of the 76 gull nests (72.4%) were solitary. Although gull nests were distributed amongst many islands, they were relatively few in number and were only found on 63 of the 294 surveyed islands (21.4%). The Koktac River subregion is estimated to have supported 159 ±30 (±18.9%) breeding pairs of gulls (Table 4).

On the 294 randomly selected and surveyed islands, 418 pairs of Arctic Tern nested (Table 5). One hundred and three of these tern nests were found on island #248S, which was only about one half surveyed. Therefore, the subregion total of 418 tern nests underrepresents the actual number of tern nests on surveyed islands. The largest number of tern nests on a single island was 211 nests on island #392S. In the Koktac Piver subregion, as elsewhere in eastern Hudson Bay, Arctic Terns reveal a strong tendency to nest colonially. Four of the 294 surveyed islands (1.4%) account for over 85% of the subregion's tern nests (367 of 418 nests), and 25 islands (8.7%) account for all tern nests. The Arctic Tern breeding population in the Koktac River subregion is estimated to have been 876 pairs. Our data departs too far from normal to allow the calculation of confidence limits.

In the Koktac River subregion, gulls and Arctic Tern nests are found with Common Eider nests significantly more often than would be expected at random. The chi-square test for independence demonstrates that gull nest distribution is dependent upon Common Eider nest distribution ($X^2$=36.6, $P < 0.01$; n=368). Arctic Tern nest distribution is also not independent of eider nest distribution ($X^2$=52.36; $P < 0.01$; n=368). Common Eider nests occurred on 23 of the 25 islands where Arctic Tern nests were found.

### 5.6.5 Stratification of the sample by island area

In the Koktac River subregion, 239 islands of less than 2 ha were randomly-selected and censused. Thirty-two islands of 2 to 10 ha were surveyed. Twenty-three surveyed islands had an area of 10 to 50 ha (Table 6). An average of 2.13 eider nests were found on each surveyed island of less than 2 ha. The average for islands of 2 to 10 ha was 7.9 nests per island. Finally for islands of 10 to 50 ha, 11.1 nest per island were found on average.

Although the data reveal a trend of increasing number of nests per island with increasing island size, t-tests indicate that no significant differences exist between the nest per island values. Consequently we make no attempt to stratify our population estimate according to island area.

### 5.6.6 Stratification of the sample by hunter appraisal

Inukjuak hunters appraised the islands occurring south of the mouth of the Koktac River in the Koktac River subregion. None of the interviewed hunters felt they knew the north region well enough to provide an island-by-island assessment. The one exception were the islands within Tasiujaapik which were recognized by several persons as excellent for eider nesting.

Within the south part of the Koktac River subregion, hunters assigned islands to one of five categories: excellent, good, fox (i.e. no eider nests), unknown or indifferent. The latter category includes all islands which received no specific categorization. Two hundred and thirty-one islands were surveyed in the south part of the subregion. The mean nest number per island was 15.89 in the excellent, and 3.42 in the good category. Fox islands averaged only 1.07 eider nests per island. Islands to which hunters were indifferent averaged 0.69 nests per island, and no nests were found on the 6 islands hunters identified as unknown to them.

In spite of the apparent accuracy of the hunter appraisals we could not justify stratifying our population estimate on this basis, as we cannot test whether or not the observed differences are statistically significant. Once again the samples are too small and too skewed..

### 5.6.7 Clutch initiation, clutch size and down production

The Kcktac River subregion was surveyed between July 7 and 19. On the first day of the survey, 19 islands were censused in the southern sector, at the mouth of the Nauligakvik River (mistakently labeled 'Koktac River' on topographic maps). At this early date, none of the 56 active Common Eider nests surveyed were hatching or hatched (Table 7). On the following days (July 8, 9) the Inukjuak crew censused 65 islands in the north sector near the outlet of Lake Tasiujaapik. None of the 18 active nests found on these days showed any evidence of hatching. Hatching on the offshore islands was first detected on July 11, when surveys in Kogaluk Bay showed 4% of the 137 active Common Eider nests were hatching or hatched. In the same area on July 12, 9% of 74 active nests were hatching or hatched.

From this date, the survey moved southwards along the coast and high percentages of hatching/hatched nests were encountered daily. Hatching/hatched rates of between 37 and 60% were recorded on each of the six remaining survey days. Given a 25-day incubation period (Palmer 1976), we could expect that most of the clutches were initiated during the last two weeks of June.

A July 8 survey in Lake Tasiujaapik suggests that nesting occurred significantly earlier at this inland site. Twenty percent of 83 active Common Eider nests were found to be hatching or hatched. On the offshore islands, comparable hatch rates were not observed until July 13.

Average clutch size for incubating Common Eider nests was 4.8 eggs per nest (Table 8). The largest clutch size observed were two nests with 9 eggs each. The mode was five eggs per nest. Gull nests averaged 2.3 eggs per nest (n=37) and Arctic Tern, 2.0 eggs per nest (n=386).

Down was sampled from thirteen Common Eider nests in the Koktac River subregion. Each nest provided an average of 31.3 gm (std. dev. = 10.2) of uncleaned down (Table 9). Cleaning reduced this average to 9.9 gm per nest (std. dev. = 4.4). For the thirteen sampled nests, clean down production per nest ranged between 4.9 and 20.4 grams.

# 6.0 DISCUSSION

## 6.1 Common Eider survey results

### 6.1.1 Nest number and distribution

In total, seven subregions were surveyed in the eastern Hudson Bay study area (Fig. 2). These subregions include the nearshore island groups of Long Island Sound, the Nastapoka Islands and Koktac River, as well as the offshore archipelagos of the Salikuit Islands, Laddie Island, Split Island and the Sleeper Islands. The mainland, islands with areas greater than 500 ha and islands within the foreshore flats of either of the forementioned were excluded from the survey. These areas are considered by Inuit (Nakashima 1986) and biologists (Larson 1960) to be little utilized by nesting eiders due to fox predation. Spot checks of these areas during the census largely confirmed this view, although a few islands within the foreshore flats in the Koktac River subregion accounted for a number of nests (see Section 5.6.3).

Islands outside of the tidal flats and with areas less than 500 ha were the target of the survey. In the seven subregions 1,589 target islands had areas of less than 50 ha and 45 islands had areas from 50 to 500 ha. In the 0 to 50 ha class, 720 islands (45.3%) of the 1,589 islands were randomly selected and surveyed. Five islands were surveyed in the 50 to 500 size class (11.1%), of which three had been randomly-selected. The survey found that Common Eiders nested in all subregions in eastern Hudson Bay. The size of the breeding population in each subregion, however, varied considerably. The largest estimated numbers of nests were in the Sleeper Islands and the Koktac River subregions.

These areas harboured an estimated 5,899 (±2,500) and 2,131 eider nests (±438), respectively, during the 1985 breeding season (Table 3). Relatively few eiders nested in the Long Island subregion. We counted 115 nests in this area and estimate the 1985 breeding population as 142 pairs.

Cochrane's $G_1$-test was used to determine whether the distribution of our data is close enough to normal to allow us to use statistical procedures such as t-tests and the computation of confidence limits. The Nastapoka Islands, Laddie Island and Split Island subregions had the most skewed nest per island distributions, and failed the $G_1$-test. In each of the remaining four subregions, the number of islands censused (n) was greater than $25G_1^2$ and therefore statistical tests could be applied. T-tests between these subregions gave the following results. The Long Island Sound subregion had significantly fewer eider nests per island than all three other subregions; Salikuit islands ($T=2.35$; $P < 0.05$); Sleeper Islands ($T=3.14$; $P < 0.01$); and Koktac River ($T=3.89$; $P < 0.01$). The Koktac River subregion had significantly fewer nests per island than the Sleeper Islands ($T=2.62$; $P < 0.01$). No significant difference existed between the Salikuit Islands subregion and either the Sleeper Islands or Koktac River subregions.

An interesting and alternative way to present the survey data is to combine the information from nearshore subregions and contrast it with that for offshore subregions. In this format both nearshore and offshore data sets satisfy the $G_1$-test and allow the use of the normal approximation. The Common Eider breeding population estimate for nearshore subregions (Long Island Sound, Nastapoka Islands and Koktac River) is 2,986 breeding pairs ±1,001 (33.5%). The mean number of nests per island in the nearshore subregions is 3.5. For the offshore subregions (Salikuit Islands, Laddie Island, Split Island and Sleeper Islands), we estimate 9,715 breeding pairs ±3,996 (41.1%) with an average of 13.25 nests per island. The difference between the mean nests per island in combined nearshore and offshore subregions is highly significant ($T=3.43$; $P < 0.01$). Many factors influence the distribution of Common Eider colonies. The available data, however, do not allow us to do anything more than suggest that certain elements may be more or less influential. Our field observations indicate that nest habitat is not limiting in any of the surveyed subregions. Gull predation may influence eider breeding distribution as the subregions with the highest gull to eider ratios have the lowest estimated number of eider nests. There is no evidence however, to suggest that this relationship is causative.

Harvesting and disturbance by local hunters seem to play an important role. The subregions with the largest breeding populations, Sleeper Islands and Koktac River, are distant from the communities and infrequently visited. The subregions with the lowest numbers of Common Eiders, Long Island Sound and the south part of the Nastapoka Islands, are amongst the most intensively exploited. Furthermore, Inuit point out that the more intensively used areas such as Long Island Sound, the south part of the Nastapoka Islands, and the Hopewell Islands, have fewer nesting eiders than in the past. In contrast, the north Nastapoka Islands have more eiders today than in the recent past because camps along the coast north of Cotter Island are less intensively used in spring. Hunters also described shifts in nesting distribution in the Elsie-Cox Island area north of Inukjuak. They believe that Common Eiders are responding to increased harvesting pressures by abandoning nearshore island colonies in favour of nest sites on islands on lakes along the coast. Ungava Bay Inuit have made similar observations (Nakashima 1986).

#### 6.1.2 Colony size and density

The largest Common Eider colonies surveyed were in the Sleeper Islands subregion. In this area, six islands had between 200 and 500 eider nests. One island in the Split Island subregion had 326 nests and an island in the Laddie island subregion had 197 nests. The highest nest density is also encountered in the Sleeper Islands subregion. Island #77 had 354.4 eider nests per ha. In the other subregions, the highest nest density encountered is less than one third of the Sleeper Island maximum. Island #84N in the Nastapoka Island subregion had 90 nests per ha.

The average number of nests per island (excluding islands with no eider nests) gives some indication of the dispersion of Common Eider nests within each subregion. In the Sleeper Islands for example, the 2,775 counted nests were distributed over 44 islands, giving a high value of 63.1 nests per island. In the Koktac River subregion, the area with the second largest number of eider nests, 1,017 nests were counted on 101 islands. Thus in this area, eider nests tended to be more dispersed, averaging only 10.4 nests per island. Only Long Island had a lower average number of nests per island (3.4 nests per island). Offshore island subregions (Sleeper, Split, Salikuit and Laddie Islands) had consistently higher average numbers of nests per island than nearshore subregions (Nastapoka Islands, Koktac River and Long Island).

The largest number of nests encountered on a single island in Ungava Bay, during the 1980 *S. m. borealis* survey, was 158 nests (Chapdelaine et al. 1986). Several islands in the Sleeper and North Belcher Islands exceed this number of nests. Cooch (1965) recorded up to 667 nests per island in the Cape Dorset area, N.W.T.

### 6.1.3 Clutch initiation dates, clutch size and down production

As census crews spent relatively short periods of time within any one subregion, our information on the progress of the hatch is sketchy (Table 7). Nevertheless, the data appears to fit a general pattern of earlier clutch initiation in the south and nearshore and later laying dates as one moves north and offshore. Aside from very early, solitary hatching nests in the north Nastapoka Islands (July 1) and Sleeper Islands (July 3) the first consistent observations of hatching are from the south Nastapoka Islands (July 7, 8, 11). This suggests egg-laying began before mid-June. The only subregion south of the Nastapoka Islands is Long Island Sound, where surveying was completed by June 30, before any nests were observed to have hatched.

Clutches were probably initiated in the Koktac River subregion just after the middle of June, and the peak of laying would have been at the end of the third week. In the Salikuit Islands the peak of laying was likely three or four days later than in the Koktac River subregion. The North Belcher Islands (Laddie and Split Island subregions) appear to be another three or four days behind the Salikuit Islands, with most females laying at the end of the fourth week of June. The Sanikiluaq crew did not remain long enough in the Sleeper Islands to establish the peak hatching dates, but on the last day of surveying in that subregion (July 13) only two of 679 eider nests were hatching. On the same date in the Koktac River subregion 65.2% of 267 nests were hatching or hatched.

Clutch size data were collected on 5,666 nests. No attempt was made to correct for incomplete or partially predated clutches. The overall mean clutch size was 4.24 eggs (Table 8). Clutch size varied significantly between subregions. The largest average clutch size was 5.58 eggs in the Long Island Sound subregion. This subregion was the only one with a mode of six eggs per nest rather than four or five. The difference between the average clutch size in Long Island Sound and that of all other subregions was highly significant ($T=7.24$ to $15.33$; $P<0.01$). Koktac River subregion had the next largest mean clutch size at 4.82 eggs per nest. It was also highly significantly different from all other subregions ($T=5.99$ to $16.21$; $P<0.01$). We also tested for clutch size difference between the north and south sectors of the Koktac River subregion, but no significant difference was found ($T=0.99$).

While the largest clutch sizes were recorded in two nearshore subregions, the smallest average clutch size was observed on the offshore. Laddie and Split Island subregions averaged 4.00 and 3.92 eggs per nest respectively. These two subregions also shared the lowest mode (four eggs). The difference in their average clutch sizes was not significant ($T=1.06$; n.s.). The mean clutch size of nearshore islands (4.44) was significantly greater than that of offshore islands (4.16) ($T=7.00$; $P<0.01$).

The overall mean clutch size of 4.24 eggs in similar to clutch sizes recorded for *sedentaria* by other studies. Freeman (1970) observed a mean of 4.6 eggs for 110 nests in the Belcher Islands southwest of the mouth of Robertson Bay. Manning (1976) recorded a mean of 4.37 eggs for 27 nests in Churchill Sound in the Belcher Islands. The mean clutch size at La Perouse Bay, Manitoba, was 4.41 eggs

(Schmutz 1981). These values are uniformly greater than clutch sizes reported for *S. m. borealis* from Ungava Bay (3.57 eggs) (Chapdelaine et al. 1986), south Baffin Island (3.44 eggs) (Cooch 1986), and the high Arctic Islands (3.30 eggs) (Prach et al 1986).

One hundred and seven nests in six subregions were sampled to measure the amount of uncleaned and cleaned down available per nest (Table 9). The raw down samples averaged 34.76 gm per sampled nest. After cleaning, an average of 12.44 gm of clean down per nest was available. The four offshore subregions exhibited average down weights which were consistently higher than the two inshore island subregions. Average clean down weights for the offshore varied between 11.59 and 17.02 gm per nest. The two nearshore subregions, Nastapoka Islands and Koktac River, averaged 9.43 and 9.88 gm per nest respectively. The highest per nest average for cleaned down was realized in the Salikuit Islands subregion. The mean down available per nest was 17.02 gm (std. dev. = 4.78), which was significantly greater than that of any other sampled subregion ($T=2.48$ to $5.34$; $P < 0.01$). The Sleeper Islands subregion averaged significantly more clean down per nest than either the Nastapoka Islands subregion ($T=2.65$; $P < 0.05$) or the Koktac River subregion ($T=2.08$; $P < 0.05$). All other comparisons between subregions were not significant.

### 6.1.4 Breeding population estimate for eastern Hudson Bay

From our survey results we have been able to generate breeding population estimates for Common Eiders in each of the seven sampled subregions (Table 3). We have also generated population estimates for surveyed nearshore and offshore subregions and have determined that their nest per island distributions were highly significantly different (Section 6.1.1). By using these data to extrapolate over unsurveyed areas we can generate a breeding population estimate for *S. m. sedentaria* in eastern Hudson Bay.

If we pool all of our data we obtain an average of 8.1 nests per randomly selected and surveyed island. However, as a significant difference exists between the mean nests per island for nearshore and offshore subregions ($T = 3.43$; $P < 0.01$), it is more appropriate to stratify our data. Average nest per island values are 3.5 and 13.25 for pooled nearshore and offshore subregions respectively. These data apply only to islands of less than 50 ha which are not connected by tidal flats to either the mainland or islands larger than 500 ha. Islands of 50 to 500 ha had Common Eider nests but were not sampled with sufficient intensity nor consistency to justify inclusion of the data. This size class of islands will be excluded from the extrapolation, lending a conservative element to the breeding population estimate.

The numbers of eligible islands in surveyed and unsurveyed nearshore and offshore regions of eastern Hudson Bay are presented in Tables 10 and 11 respectively. In the nearshore zone, 854 islands occur within the surveyed subregions (Long Island Sound, Nastapoka Islands and Koktac River) and 2,199 islands occur in unsurveyed areas. The total number of nearshore islands within the *sedentaria* breeding range of eastern Hudson Bay is 3,053. Using the factor of 3.5 nests per island, we project a nearshore Common Eider breeding population of 10,670 breeding pairs ±3,349 (31.3%) (Table 12).

Table 10
The number of nearshore islands in eastern Hudson Bay

| | |
|---|---|
| Nearshore Islands: surveyed subregions | |
| Long Island Sound | 69 |
| Nastapoka Island | 169 |
| Koktac River | 616 |
| Total islands in surveyed subregions | 854 |
| Nearshore Islands: unsurveyed subregions | |
| Manitounuk Islands | 92 |
| Hopewell Islands | 241 |
| Elsie and Cox Island area | 413 |
| Povungnituk area | 1,208 |
| Akulivik area | 245 |
| Total islands in unsurveyed subregions | 2,199 |
| **Eastern Hudson Bay, Total Nearshore Islands** | **3,053** |

Table 11
The number of offshore islands in eastern Hudson Bay

| | |
|---|---|
| Offshore Islands: surveyed subregions | |
| Salikuit Islands | 91 |
| Laddie Island | 157 |
| Split Island | 113 |
| Sleeper Islands | 372 |
| Total islands in surveyed subregions | 733 |
| Offshore Islands: unsurveyed subregions | |
| South Belcher Islands | 116 |
| Belcher Islands proper | |
| Churchill Sound | 395 |
| Robertson Bay | 370 |
| East Belchers | 231 |
| Coats Bay | 19 |
| North Belcher Islands (excluding Laddie and Split Islands subregions) | 341 |
| King George and Bakers Dozen Islands | 23 |
| Marcopeet, Ottawa and Farmers Islands | 97 |
| Total islands in unsurveyed subregions | 1,592 |
| **Eastern Hudson Bay, Total Offshore Islands** | **2,325** |

Table 12
Breeding population estimates for Common Eiders, gulls and Arctic Terns in eastern Hudson Bay

| | COMMON EIDER nearshore | COMMON EIDER offshore | GULL | TERN |
|---|---|---|---|---|
| Surveyed Islands | 381 | 339 | 720 | 658 |
| Number of nests counted | 1,332 | 4,493 | 594 | 1,752 |
| Nests per surveyed island | 3.5 | 13.3 | 0.8 | 2.7 |
| Total islands | 3,053 | 2,325 | 5,378 | 5,209 |
| Estimated number of nests | 10,673 | 30,815 | 4,437 | 13,870 |
| Estimated number of breeding individuals | 82,976 | | 8,874 | 27,740 |

Offshore islands in the surveyed subregions total 733 and in the unsurveyed areas total 1,592 (Table 11). The total numbers of offshore islands in eastern Hudson Bay is 2,325. With 13.3 nests per island, we estimate the offshore eider breeding population as 30,820 pairs ±11,715 (38.0%) (Table 12).

The total *S. m. sedentaria* breeding population for eastern Hudson Bay is therefore estimated at 41 490 breeding pairs ±15,064 (36.3%). At 95% confidence limits this represents between 52,850 and 113,110 breeding individuals ($\overline{X}$ = 82,980).

This new population estimate for east Hudson Bay greatly exceeds the estimate of 45,165 breeding eiders recently suggested for the entire *sedentaria* population by Abraham and Finney (1986). By examining nearshore and offshore components, we can see where disparities exist between these two estimates. For the islands near the Quebec coastline, Chapdelaine et al. (1986), based upon aerial survey work in 1978, estimate an eider breeding population of 41 600 individuals. Comparisons with aerial census results obtained by Cooch (1954) in 1954 led Chapdelaine and Tremblay (1979) to suggest that a 47.2% population decline had occurred in the Quebec nearshore area. If the 1978 population figure proposed by Chapdelaine et al. is correct, then the 1985 census data suggest that a further substantial decline has occurred in this region. However, our estimate of 61,612 breeding eiders for the offshore islands of eastern Hudson Bay, greatly surpasses Abraham and Finney's (1986) estimate of 3,600 breeders which was for not only the Belcher Islands, but also James Bay and the south and west coasts of Hudson Bay.

Reed and Erskine (1986) use a population model to assess the status of Common Eider populations and, with a figure of 45,165 breeding eiders, they calculate a 5% annual decline in the Hudson Bay stock. As they explain, the "decline" could result from an underestimation of breeding numbers. When we replace Abraham and Finney's population figure of 45,165 eiders with the figure derived from the 1985 census results (82,984 eiders) the Reed-Erskine population model yields an annual 7.3% increase. This figure would be higher if we were to include an estimate for eiders breeding in James Bay and south and west Hudson Bay.

Although only a rough approximation, these results suggest that, as a whole, the *sedentaria* population is in a healthy and more or less stable condition. As reported by Inuit, and suggested by the results of aerial surveys in 1959 and 1978, and the present ground survey, local declines and changes in population distribution are probably occurring. Nevertheless 'refuge' areas exist within the nearshore and offshore regions, where disturbance is low and nesting numbers are high.

## 6.2 Herring and Glaucous Gull survey results

### 6.2.1 Nest number and distribution

A total of 1,027 Herring and Glaucous Gull nests were counted in the seven subregions surveyed in eastern Hudson Bay. No attempt was made to distinguish between Herring and Glaucous Gull nests in the field, and the data for both species are presented together. The Nastapoka Islands subregion accounts for the largest proportion of the observed nests, 340 nests or 33.1%. Long Island Sound, which also had many gull nests (238 nests or 23.2%), had the highest number of nests per island counted (3.8 nests per island for all counted islands).

The survey results for randomly-selected islands provide the least biased perspective on the distribution of breeding gulls (Table 4). The data reveal a trend of decreasing numbers of gull nests per island from south to north. Long Island Sound has the highest ratio at 4.2 nests per island. The Nastapoka and Salikuit Islands are the next most dense at 2.0 nests per island, followed by the North Belcher and Sleeper Islands with 0.7 and 0.8 gull nests per island respectively. The lowest gull to island ratio is 0.26 for Koktac River, the northernmost subregion.

Breeding population estimates, calculated for each of the seven subregions, do not follow this same pattern. The largest estimated gull population is in the Nastapoka Islands where an estimated 346 pairs nest (Table 4). Our sample of randomly-selected and counted islands, however, was too small to allow the use of the normal approximation and the calculation of confidence limits. In fact, we know that this population estimate is low, as 370 gull nests were actually counted during the 1985 survey. Long Island Sound and Sleeper Islands have resident gull populations of 292 and 289 pairs respectively. The smallest breeding population is that of the Split Island subregion with only an estimated 75 breeding pairs.

### 6.2.2 Breeding population estimate for eastern Hudson Bay

For the seven surveyed subregions, we estimate a gull population of 1,311 breeding pairs ±310 (±23.6%). This figure is based on an average of 0.8 nests per surveyed island. If we apply this ratio to the total number of islands of up to 50 ha in area, occurring in eastern Hudson Bay, we can estimate the regional gull population nesting on islands of this size category.

From Tables 10 and 11 we obtain nearshore and offshore island counts of 3,053 and 2,325 islands. From this total of 5,378 islands, we extrapolate that the east Hudson Bay region, from the Akulivik area to James Bay, harbours an estimated 4,440 breeding pairs of gulls (Table 12).

## 6.3 Arctic Tern survey results

### 6.3.1 Nest number and distribution

A total of 2,168 Arctic Tern nests were counted during the 1985 nest survey. This number is conservative, for unlike other species such as Common Eiders and gulls, the nests are simple scrapes which are not tabulated if the eggs are not present. Furthermore, the small size of tern nests make them more easy to overlook.

On randomly-selected islands 1,752 Arctic Tern nests were discovered. In terms of breeding numbers per island, the Long Island Sound subregion had the highest tern nest to island ratio at 12.3. Sleeper Islands had the next highest value at 4.3 nests per island counted. The North Belcher Islands and the Koktac River subregion had the lowest tern nest to island ratio, equal to 1.4. It is interesting that no Arctic Tern nests were discoverd in the Nastapoka Island chain. The reason for their apparent absence from this area is unknown.

Only the Long Island Sound data set was "close enough" to normal to allow the use of the normal approximation and the calculation of confidence limits. Confidence limits were also calculable for the combined nest estimate for terns in all seven subregions, 3,867 tern nests ±1,422 (±36.8%).

Considering each subregion individually, the largest estimated breeding populations of Arctic Terns are found in the Sleeper Islands (1,607 pairs), the Koktac River subregion (876 pairs) and Long Island Sound (849 pairs).

### 6.3.2 Breeding population estimate for eastern Hudson Bay

The overall mean number of Arctic Tern nests found per surveyed island under 50 ha, was 2.4. If we leave the Nastapoka Islands subregion out of this calculation, assuming no terns nest there, the average rises to 2.7 nests per island. Adding the total number of offshore islands, 2,325, to the nearshore islands less the Nastapoka Islands, 3,053 - 169 = 2,884 gives us a total of 5,209 islands. Our estimate therefore is 2.663 nests/island multiplied by 5,209 islands = 13,870 breeding pairs of Arctic Terns between Akulivik and southern Long Island Sound (Table 12).

# PART II
# Eider Ecology from Inuit Hunters

by D.J. Nakashima

## 7.0 METHODS

The data on Hudson Bay Eider ecology were collected by means of semi-directive interviews with Inuit from the communities of Inukjuak and Kuujjuarapik, Northern Québec and Sanikiluaq, Northwest Territories. By 'semi-directive', we emphasize that our objective was to restrict our interference of the hunter's discourse, allowing them to lead the discussion and to identify topics of interest or importance. Our only guiding principle was to ensure that eiders and their ecology remained the focus of discussion and that a variety of ecological topics were considered. The actual nature of individual interviews varied considerably in accordance with the dynamic of interaction between interviewee(s), interpreters and interviewer(s).

Most interviewed hunters only spoke Inuttitut and in almost all interviews, an interpreter was essential. Tape recordings were made of all interviews. After the interview Inuttitut segments of the tape were translated and the entire interview was transcribed in English. This process provided us with a text which including the original English discussion between interviewer and interpreter and the translated discussion between interpreter and hunter. Although this 'double translation' was tedious, it was useful to compare the interpreter's and the translator's versions of hunter testimonies.

Biogeographic information was recorded with coloured markers on transparent acetate sheets overlaid on 1:250,000 topographic maps. These data were then coded and entered into a computer using a digitizer. Once computerized, the biogeographic data were sorted according to ecological or other parameters and plotted on basemaps.

A total of 37 interviews were conducted with 41 different individuals for a total of 131 person-hours of interview time. This includes 76.5 person-hours in Sanikiluaq, 38 person-hours in Inukjuak and 16.5 person-hours in Kuujjuarapik. The interviews were conducted during two visits to the communities: from November 12 to December 12, 1985 and March 19 to April 11, 1986.

## 8.0 MITIQ IN INUIT NOMENCLATURE

In the eastern Hudson Bay region, the inuttitut name mitiq (pl. mitiit) is applied or inferred to be applicable to four different levels of Inuit classification. In the context of a general classification of all umajuit (roughly equivalent to our term "animals"), mitiq encompasses "eiders and eider-like ducks". In the more limited context of a response to being asked "What types of mitiit do you know?", the term is used in a manner roughly equivalent to our term "eiders". In a more specific usage mitiq is the Hudson Bay Eider *(S. m. sedentaria)*, the representative or type "species" for the forementioned groups. Finally at its most restrictive, mitiq is the female Hudson Bay Eider, the eider duck as opposed to the drake. The context in which the term is used determines its precise meaning.

### 8.1 Mitiq as "eiders and eider-like ducks"

The Sanikiluaq system of classifying umajuit was described by three Sanikiluaq elders, Noah Arragutainaq, Joe Emikotailuk and Davidee Kavik. General classification systems were not investigated elsewhere, and the correspondence between this system and those of Inukjuak and Kuujjuarapik is not known.

The Inuit classification of umajuit includes two groups which correspond to the scientific class Aves. Timmiaq includes large birds : loons, anatids, raptors, ptarmigan, jaegers, larids, alcids and the Common Raven *(Corvus corax)*. Qupanuaq includes small birds : plovers, sandpipers and passerines.

Timmiaq is further subdivided into imatsiut, "water-seekers" and nunatsiut, "land-seekers". Loons, diving-ducks, mergansers and alcids are considered to be imatsiut. Swans, geese, raptors, ptarmigan, jaegers and the Raven are nunatsiut. Noah Arragutainaq included gulls, the Arctic tern *(Sterna paradisaea)* and dabbling ducks as imatsiut, while Joe Emikotailuk and Davidee Kavik classed them as nunatsiut.

Within the imatsiut group of timmiaq, Noah defined a set of three related "species" encompassed by the generic term mitiq : 1. mitiq, the Hudson Bay Eider; 2. mitiqluk, the King Eider *(S. spectabilis)*; and 3. a'iakanak, the Oldsquaw *(Clangula hyemalis)*. Oldsquaw was grouped with the Hudson Bay Eider because they nest together and feed upon similar things.

Joe and Davidee included four "species" under the generic term mitiq : 1. mitiq, the Hudson Bay Eider; 2. mitiqluk, the King Eider; 3. mitiqluk mikiniqsaq, a smaller type of mitiqluk (see discussion in Section 8.2); and 4. aningasik, the White-winged Scoter *(Melanitta deglandi)*. They referred to the King Eider as the "younger brother" (nukaq) of the Hudson Bay Eider.

## 8.2 Mitiq as "eiders"

In the context of interviews focusing on the Hudson Bay Eider, Inuit were asked "How many types of mitiit do you know?". In all interviews, two "species" were always included, mitiq, the Hudson Bay Eider and mitiqluk, the King Eider. Several individuals from Sanikiluaq and one from Kuujjuarapik, however, added a third and even a fourth type of mitiq.

Johnny Meeko Sr. of Sanikiluaq, spoke of a third type of mitiq which he knew as mitiqluujak. Mitiqluujak much ressembles the Hudson Bay Eider in appearance, and although not as small as the King Eider, it is slightly but nonetheless noticeably smaller than the Hudson Bay Eider. In comparison with the Hudson Bay Eider, mitiqluujak appears to maintain its head in a more erect position and its neck is thinner. Its plumage is browner in colour. Johnny has never seen a male of this "species". He has only seen females and mitiaraviniq, eider fledglings. As they only appear in the Belcher Islands region after eider eggs have hatched and when the juveniles can fly, and as they disappear before the ice freezes, Johnny believes that the mitiqluujak does not "live" in the Belcher Islands. His suggestion is that they come from the north, possibly from Inukjuak, as he has heard that the eiders near Inukjuak are smaller.

Johnny Meeko's very precise observations and his own reflections, strongly suggest that his mitiqluujak is what biologists refer to as the Northern Eider, the *S. m. borealis* subspecies of the Common Eider. Biologists usually designate the southern limit of the breeding range of the Northern Eider as northern Hudson Bay, including Chesterfield Inlet and Mansel, Coates and Southampton Islands (Abraham and Finney, 1986; Palmer, 1976). The actual range limits, however, remain unconfirmed (Abraham and Ankney 1986). Johnny Meeko's observations suggest that female and young *borealis* stray into southern Hudson Bay in late summer and fall, and leave again before freeze-up.

Other hunters' descriptions of a third eider type correspond with Johnny Meeko's description of mitiqluujak. Johnny Fleming of Kuujjuarapik described a third type of mitiq which he calls mitikallak (pl. mitikallait), the "small, plump(?) mitiq".

Again, this mitiq is intermediate in size between the Hudson Bay Eider and the King Eider. In appearance it closely ressembles the former, but has a shorter neck and darker coloration. Although mitikallait mix with the Hudson Bay Eider, they do not mate with the latter. They are few in numbers and are seen in the fall.

Allie Appaqaq, Sr. of Sanikiluaq referred to a third eider type which he called mitiqluapik. These eiders are very small, smaller then the King Eider and the least numerous of all the eider types. Allie is only familiar with the female of mitiqluapik.

Moses Appaqaq, Sr. of Sanikiluaq, described three types of mitiit: the Hudson Bay Eider; the King Eider and a third type for which he had no name. This third type was small and dark-colored. He grouped these mitiit together because the flesh of all three was eaten raw.

In a joint interview, Noah Arragutainaq and Davidee Kavik described a third type of mitiq which closely ressembled the Hudson Bay Eider except that it was smaller in size. They knew no special name for this eider type, referring to it simply as mitiq. Its smaller size was evident in flight, as well as in the hand. It was generally the females that were seen, although Noah had on rare occasion seen small adult males. Noah was not very sure of how to explain this third type of mitiq and speculated that perhaps they were in fact just particularly small and young Hudson Bay Eider females.

Noah and Davidee also added a fourth type of mitiq which was exceptionally large. These mitiq are only seen in the winter at a polynya in the north part of Kipalu Inlet in the Belcher Islands. Noah speculated that they might nest in Qasigialik Lake and Davidee suggested they might be fish-eaters.

Finally, Joe Emikotailuk also added a third type of mitiq to the core group of the Hudson Bay and King Eiders. This eider was simply referred to as mitiq, but could be called mitiq mikiniqsaq, the "smaller mitiq"[1]. Joe Emikotailuk's mitiq mikiniqsaq, differs from Johnny Meeko's mitiqluujak. Unlike mitiqluujak, Joe's mitiq mikiniqsaq is resident within the Belcher Islands. It frequents the north part of the archipelago while the ordinary and larger mitiq frequents the south part. Joe explains the discovery of this size difference as follows:

> The people here (in the south) had the same parkas but they were bigger than the ones here (in the north). They each had the same amount of skins but their's were bigger than ours ... and since the parkas were bigger they started to realize that the mitiq were bigger.

Joe Emikotailuk's differentiation between northern mitiq mikiniqsaq and southern mitiq, appears to correspond with Johnny Kavik's north-south subdivision of the Belcher Islands population of the Hudson Bay Eider (see Section 8.3).

---

1. We have yet to clarify the relationship between mitiq mikiniqsaq and mitiqluk mikiniqsaq (Section 8.1), both referred to by Joe Emikotailuk.

### 8.3 **Mitimmarik, the "true mitiq", the Hudson Bay Eider**

While mitiq refers to assemblages of "eiders" and "eider-like species" it also is applied specifically to the Hudson Bay Eider, *S. m. sedentaria*. In order to make clear reference to the Hudson Bay Eider in a situation where confusion might arise, the Inuit of southeastern Hudson Bay use one of the following names : 1. mitimmarik, the true or complete mitiq; 2. mitituinnaq, the common or real mitiq; and 3. mitivik, the big mitiq.

On the basis of variation in distribution, habitat, behaviour and/or physiology, some Sanikiluaq hunters distinguish between different forms of mitimmarik. Johnny Kavik recognizes northern and southern wintering "populations" of the Belcher Island mitimmarik. His differentiation between the two groups is based upon observations of eider movements along the floe edges of the Belcher Islands archipelago. The northern group frequents the northern ice edge and the western edge north of the southwest end of Kugong Island. The southern group ranges along the southern and western ice edges, northwards to the area southwest of Flaherty Island. During the winter, the eiders of each group move back and forth along their respective stretches of ice edge or to and from the edge and polynyas in the landfast ice. Their ranges do not overlap.

Johnny speculates that the numbers of northern and southern eiders are more or less equal, the southern ones being perhaps somewhat fatter. From his experience the northern eiders are more "floe-edgers", spending more time out at the sea-ice edge and making less use of areas of open water within the landfast ice.

In Section 8.2, we discussed Joe Emikotailuk's differentiation between northern and southern eiders. Joe also distinguished between two forms of Hudson Bay Eider on the basis of winter habitat, behaviour and physiology. His "traveller eiders" are incessantly moving. They frequent the floe edge in winter. These "travellers" feed in deep waters and are therefore obliged to consume 'seal food', quliligaq (probably capelin, *Mallotus villosus)* As a direct consequence of their diet, the "traveller" eiders have small, soft gizzards.

The non-travellers or sedentary ducks frequent permanent areas of open water in the landfast ice. Here they dive and feed on benthic fauna such as mussels *(Mytilus edulis)*, sea urchins (probably *Strongylocentrotus droebachiensis)* and sea cucumbers (unidentified species). Due to their diet of hard-shelled or tough foods, they have large gizzards. The traveller eiders are many times more numerous than the sedentary ones.

### 8.4 Mitiq as "female eider" : gender and stages of development

The term mitiq can also be applied specifically to the female Hudson Bay Eider. It contrasts with amaulik (pl. amauliit), which refers to the drake. It is more common, however, to employ the terms arnaviaq (root arnaq = woman) for the female eider, and amaulik to designate the male. Arnaviaq and angutiviaq (root angut = man) designate the female and male for birds in general.

Gender differentiation begins with the egg of the Hudson Bay Eider. Elongate eggs are called amaulitsaq or more rarely angutiviatsaq, literally "future male", to indicate that they will produce male ducklings. More rounded eggs are referred to as arnaviatsaq, literally "future female", indicating that the ducklings will be female. This is an old tradition. Present-day elders explain that this is what their elders used to say.

Gender differentiation of ducklings is not possible at the time of hatching, but is possible by the fall. The plumage of male mitiraviniq (juvenile) is darker and the bill longer than those of the female mitiraviniq. Joe Emikotailuk stated that the earliest stage at which gender distinction was possible was the unirutik stage, when the young eiders were growing feathers under their wings (see Table 14). In the young male the under wing feathers are darker. At the next stage, when the young are isaqiliqtuk (see Table 14) the drake is evident because the feathers on the upper part of the head are darker then the females' brown coloration.

Nomenclatures for the development stages of eiders and their eggs varied from the relatively simple to greatly detailed. Tables 13 and 14 present Joe Emikotailuk's detailed nomenclatures for stages of egg and eider development respectively. Some of the terms are shared by hunters from all three communities, others are unique to Sanikiluaq and still others were only collected from Joe himself.

Table 13. Nomenclature of egg development stages from Joe Emikotailuk, Sanikiluaq, NWT

General terms:

1. mannik - egg
2. kauk - egg white (said to become the bird's feathers)
3. itsik - yolk; also tingutsaq - (said to become the bird's liver)
4. arnaviatsaq - eggs that are roundish (said to be female)
5. angutiviatsaq or amaulitsaq - eggs that are elongate (said to be male)

Stages of egg development:

1. mannitsaq - egg while still in the female's body
2. inutsurituk - newly-laid egg
3. imigatuk - as egg just starts to develop - "it has something like water", referring to watery condition of the egg white
4. inulik - embryo is visible
5. inulialuk - embryo is large and developing feathers
6. tukkariavituk - when the shell has a small hole-pipped
7. tukkaatuk - shell well-cracked and duckling emerging

Table 14. Nomenclature for stages of development of the Hudson Bay Eider from Joe Emikotailuk, Sanikiluaq, NWT.

Eider development stages:

1. *tukkagamik* - duckling just after hatching, still having difficulty standing

2. *mitiraq* - eider duckling

3. *sulutsataktuk* - when developing the flight feathers, *suluk*

4. *miqusaqaliqtuk* or *miqusataktuk* - when developing contour feathers, *miquk*, on its back

5. *unirutik* - developing feathers under the wing

6. *isaqiliqtuk* - all flight feathers present but still cannot fly, begins to practice flying

7. *mitiraviniq* - lit. "former ducklings" - a general term for young fledged eiders of either sex

Terms only used for female eiders:

8. *qinnaluk* - applied to female in summer, showing notched tail feathers (an immature female)

9. *arnaviatsaq* - lit. "future female" - young female without notched tail feathers and who will breed next year

10. *arnaviak* - female adult

Terms only used for male eiders:

11. *amaulitsaq* - lit. "future male". A general term that is applied from the moment a young eider is distinguishable as a male, until it is an adult

a) *tuullisaujaq* - male with dark head and neck with some white feathers appearing around base of neck; "they look like loons (*tuulliq* = Common Loon, *Gavia immer*) in the face, they remind us about loons with their black heads"

b) *angutiguluk* - male with white feathers appearing on back

c) *amaulitsaq* - like an adult male except the tips of elongate tertials are black, back of head brownish

12. *amaulik* - male adult

## 9.0 SPRING MIGRATION AND PRE-NESTING PHASE : APRIL TO JUNE

### 9.1 Dispersal from the wintering grounds - the offshore islands

In southeastern Hudson Bay, the major wintering areas of the Hudson Bay Eider are along the western fast ice edge of the Belcher and Sleeper Islands. With the approach of spring, Sanikiluaq hunters notice a change in the behaviour and physical condition of the eiders frequenting the ice edge.

> ... since the ice isn't going to freeze more and the edge will be mainly in the same area, the mitiit will be staying at the same place more and will be getting fatter now (early April).
>
> Johnny Kavik, Sanikiluaq

When the snow and ice begins to melt the eiders fly in all directions over the still frozen land. Johnassie Mannuk remarked that in summer the eiders never fly over stretches of mainland, yet this is a common sight in the spring. To the hunters, the eiders appear to actively seek out the first areas of open water, for even before new holes appear in the landfast ice, they are seen flying everywhere.

Very few sites within the Belcher Islands archipelago remain ice-free all winter. As the weather becomes milder, however, new open water areas appear. The first holes are in those areas of current which were the last to freeze the previous winter (Fig.17). Eiders quickly occupy these new sites.

One of these areas of early open water is between Kugong and Johnson Islands, west of the present day community of Sanikiluaq. Open waters appear off the north tip of Howard Point and in the numerous passages between Johnson Island and Lillico Point. Eiders arrive at these sites as soon as they are open. They are important spring hunting sites for Inuit seeking Hudson Bay Eider and Canada Goose, *Branta canadensis*. Soon after, several areas of open water appear among the islands at the north end of Churchill Sound (Fig.17). Eiders quickly shift from the former sites to these newly available ones.

As the melt continues, areas of open water are created along the shorelines as a result of spring run-off or the rising tide. Eiders also take advantage of these sites.

> It usually looks as if they know where to go when it's melting. When the river is running on the shore they usually stay there or even when there's water on the shore from the high tide, they seem to know about it. This can be seen when you hunt when the snow is melting.
>
> Johnassie Mannuk, Sanikiluaq

During this time, the eiders continue to frequent the areas in the landfast ice which were open all winter. Agiaraaluk, the most important over-wintering polynya in the Belcher Islands, is a major spring hunting area for Hudson Bay Eiders and Canada Geese. Large numbers of eiders also continue to frequent the edge of the landfast ice, following it shorewards as it gradually erodes during the lengthening days of spring.

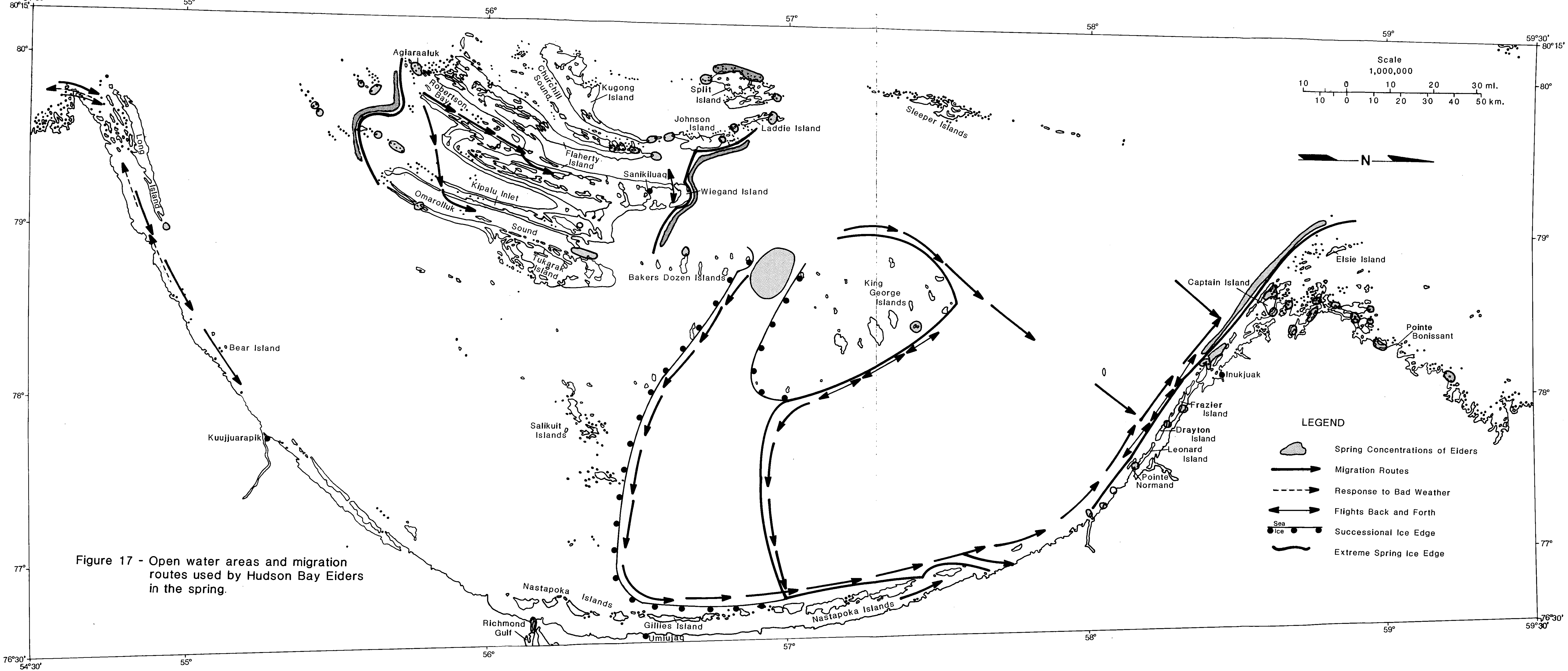



Figure 17 - Open water areas and migration routes used by Hudson Bay Eiders in the spring.

By mid-May, in a typical year, the ice edge to the north, west and south of the Belcher Islands closely follows the outer contour of the archipelago (Fig.17). Within the archipelago, however, the long bays remain locked in ice. Eiders occur in large numbers along the southern and northern ice edges, off the west side of Split Island and in an extensive area of open water at the mouth of Omarolluk Sound.

By early June there is still much ice in and around the archipelago, but it has been broken up and its movements are subject to the whims of wind and tide. At this time, Sanikiluaq Inuit encounter eiders almost everywhere along the coasts with a noteworthy accumulation around their future nest islands.

### 9.2 <u>Migration to the Québec nearshore area</u>

In the spring, Moses Appaqaq Sr. of Sanikiluaq has observed a northward movement of Hudson Bay Eiders within the Belcher Islands. He plotted two specific routes : first, northward up the length of Qasigialuk Lake; and second, through Ridge Passage and northward up Omarolluk Sound. He insisted, however, that these routes were only two examples of many. While Moses identified a northward trend, most Sanikiluaq hunters insisted on the eiders' tendency to fly everywhere and in all directions in the spring. In sharp contrast, hunters of the Québec nearshore area observe strongly directional spring movements along defined routes.

In March, the month of maximum extent of sea ice, the eastern Hudson Bay area is locked in ice from the coast to the outermost offshore islands. In April, however, the ice begins to break up north and east of the King George Islands. It shifts back and forth parallel to the coast according to the tide, and inshore and offshore according to the winds. At this time an ice edge may extend from the King George Islands, eastward to the Québec mainland. This edge is soon eroded southwards to the north edge of the Salikuit Islands (Fig.17).

When the ice first breaks between the Hopewell and the King George Islands, the shifting areas of open water created offshore are almost immediately occupied by Hudson Bay Eiders. They may arrive as early as late March, but in most years, the first arrivals are in April. Only at the end of April does the eider migration begin in earnest.

Incoming flocks of Hudson Bay Eiders follow the ice edge eastwards along the north edge of the Bakers Dozen and Salikuit archipelagos and then northwards along the outer edge of the Nastapoka and Hopewell Islands. Other flocks of eiders are believed to migrate directly from the far offshore islands to the Hopewell Islands. Many are believed to arrive from the Sleeper Islands. Others follow the west edge of the ice which remains fast to the King George Islands and then fly northwards to the Hopewell Islands.

In the Inukjuak region in April the edge of the land-fast ice runs outside of the Hopewell and Elsie Islands. Upon arriving, eiders fly back and forth along this edge, waiting for areas of open water to appear further inshore. Daniel Oweetaluktuk described three areas along the coast south of the Hopewell Islands which usually opened up before the end of April (Fig.17). Many early spring migrants are attracted to these areas. Along the Hopewell Island chain first areas opened by the currents are : 1. between the highest point of Frazer Island and the mainland; 2. between Frazer and Drayton Islands; and 3. between Bartlett Island and Pointe Normand. Depending upon the severity of the winter the first of these may remain open all winter and the latter two are open by early May.

Similarly, along the coast east of Elsie Island, numerous areas among the nearshore islands are known to be open by early May (Fig.17). As soon as these holes appear in the landfast ice, they are occupied by eiders.

Eiders continue to frequent the Hopewell Island chain throughout the month of May, waiting for the ice to break up among the nest islands further to the north. Soon after the beginning of June, they abandon the Hopewell Island area and move northwards to begin nesting in the vicinity of Commodore Island and beyond.

Inuit from Kuujjuarapik explained that the Salikuit Island chain impedes ice break up and allows a broad ice bridge to persist late into the spring between the Belcher Islands and the Manitounuk and south Nastapoka Islands. As a result, eiders are not immediately accessible near Kuujjuarapik in the spring. Hunters wishing to harvest eiders must go either north of Richmond Gulf or south to Long Island. As the ice between Kuujjuarapik and the Belchers eventually erodes away and as shore leads open up, Kuujjuarapik people observe an influx of eiders from both the north and the south.

Johnny Fleming of Kuujjuarapik spoke in detail about the spring movements of eiders south of Kuujjuarapik. Eiders fly northwards along this section of coastline in the spring. At Pointe Louis XIV, eiders short-cut across a narrow neck of land from George Bay to the southwest end of Long Island Sound. They occupy holes opened by tidal currents between the islands within the Sound. Eiders will fly northwards along the coast as shore leads open up, although winds which push the drifting pack ice against the shore, and bad weather, can force them to return southwards.

At these times, Johnny has seen eiders sheltering in areas of open water on the leeward side of nearshore islands or retreating southwards past Pointe Louis XIV. Even before conditions improve, however, the eiders press northwards again. It is said that they can foresee when the weather will clear and the shore leads will reopen.

## 9.3 Pairing and spring flock composition

> They just go with the weather, that's how they start to pair up. They don't bother each other during winter although they can be mixed together when they're flying. I don't think they even look at each other until the weather gets warm.
> Joe Emikotailuk, Sanikiluaq

The Hudson Bay Eiders fatten up before they begin pairing. Courtship, however, soon burns away the drakes' reserves.

> The only time they pair up is after they're fat, they stay in the open waters first (off the ice edge).
> Lucassie Ohaytook, Sanikiluaq

> The arnaviaat (females) are usually fat and the amauliit (drakes) are fat, too, but they grow thin from chasing the females.
> Noah Arragutainaq, Sanikiluaq

By the time the eiders begin prospecting for early holes in the landfast ice of the Belcher Islands, or migrating along the Québec coastline, the adults are flying in pairs.

In the Belcher Islands region, young non-breeding eiders accompany the paired adults on their early reconnaissance flights over the still frozen sea ice. They can also be seen with the adults on the first areas of water that become accessible within the landfast ice. The young tend to remain in these larger areas of open water, however, seldom following the adults to small open water sites such as those created by freshwater run off or the rising tide.

Along the Québec coast, Inukjuak and Kuujjuarapik Inuit provide similar observations. Young non-breeding eiders arrive with or very soon after the paired adults.

## 10.0 THE NESTING PERIOD : JUNE AND JULY

### 10.1 Factors influencing nest initiation and location

As the landfast ice continues to melt, the breeding pairs make an effort to establish themselves on open water as close as possible to the islands where they intend to nest. They do not nest immediately but await the further break up of the ice.

> I think they nest only when there's no ice near the shore... The ones on the south (Belchers) nest before the mitiit in the northern part (of the Belchers). The south melts faster. That's the way is is, they wait for it to melt to nest...
>
> Johnassie Mannuk, Sanikiluaq

> The south Belchers used to melt first... (the north) used to be behind and we used to hear that there were ducklings here (in the south) but here (in the north) they were just starting to lay eggs.
>
> Joe Emikotailuk, Sanikiluaq

The break up of ice around individual nest islands is an important determinant of nest initiation dates. Hunters explained that the ice provides a bridge from the mainland or adjacent large islands which allows Arctic fox *(Alopex lagopus)* and Red fox *(Vulpes fulva)* access to eider nests. For this reason, eiders do not lay eggs until the island shores are free of ice.

> It's because they're smart. If they have eggs when there's still ice the fox is going to get the eggs. That's the way they (the people) used to say it. They (the eiders) have to wait for the ice to melt before they can lay eggs.
>
> Joe Emikotailuk, Sanikiluaq

Ice break up not only influences the local date of nest initiation, it also affects the density of local nest colonies.

> They usually looked like they keep an eye on the first place that melts so that they can lay their eggs there... There used to be the most eggs on the island which melted first. I know that, since that was the way it was when I used to go out hunting.
>
> Joe Emikotailuk, Sanikiluaq

While islands that are ice-free early in the season attract eiders, islands that remain bound in ice are avoided. Noah Arragutainaq of Sanikiluaq explained that, even in the absence of fox, a normally good nest island would have few nests if the ice around its shores broke up late.

The actual presence or absence of fox has a direct influence on the location of eider nest colonies. Willia Weetaluktuk of Inukjuak illustrated this relationship in speaking about Qikirtaaruq, an isolated island with two small adjacent islets, about 35 km offshore and south of Inukjuak. Qikirtaaruq is a fairly large island (approx. 150 ha). When there are no fox it is covered with nesting eiders. He described the drakes when onshore as looking like snow. When fox are on Qikirtaaruq, however, few eiders nest there. Instead, breeding pairs crowd onto the two adjacent islets, placing their nests so close together that often the down rim of one nest touches its neighbour.

Throughout southeastern Hudson Bay, Inuit identified fox as an important influence on the local distribution of Hudson Bay Eider nest colonies. Their influence is not only restricted to the current nest season but could also affect nest island selection in the following year or years.

> Some foxes get trapped on an island where ducks lay their eggs. If that was to happen, then the foxes eat the ducks' eggs. So the eiders know that there was a fox that ate their eggs. So they don't go back to that island the following year because they didn't get any of their young...
> Paulusie Ekidlak, Sanikiluaq

Subsistence harvesting (hunting and egg and down collection) and human-caused disturbance (outboard motor traffic) significantly influence eider colony location. Changes in patterns of land use were often used to explain changes in eider colony density or location. The establishment of permanent central settlements in lieu of scattered seasonal camps has had a significant influence. In the Hopewell Island chain, for example, Samwillie Niviaxie used to go eider egg collecting by kayak on Bartlett Island and on the numerous small islands south of Leonard Island. Today, only a few scattered eider nests can be found in the Hopewell Islands due to their proximity to the community of Inukjuak and the resultant intensified harvesting and canoe traffic.

In contrast, in the northern Nastapoka Islands, Hudson Bay Eider colonies are said to have increased in size in recent times, again because of the establishment of Inukjuak. The north Nastapoka Islands region used to be an important spring sealing area. Numerous spring camps were located on the adjacent mainland. With the establishment of Inukjuak, spring use of the area around these camps has substantially declined. The decrease in the intensity of the area's use is believed to have allowed the increase in eider colony size.

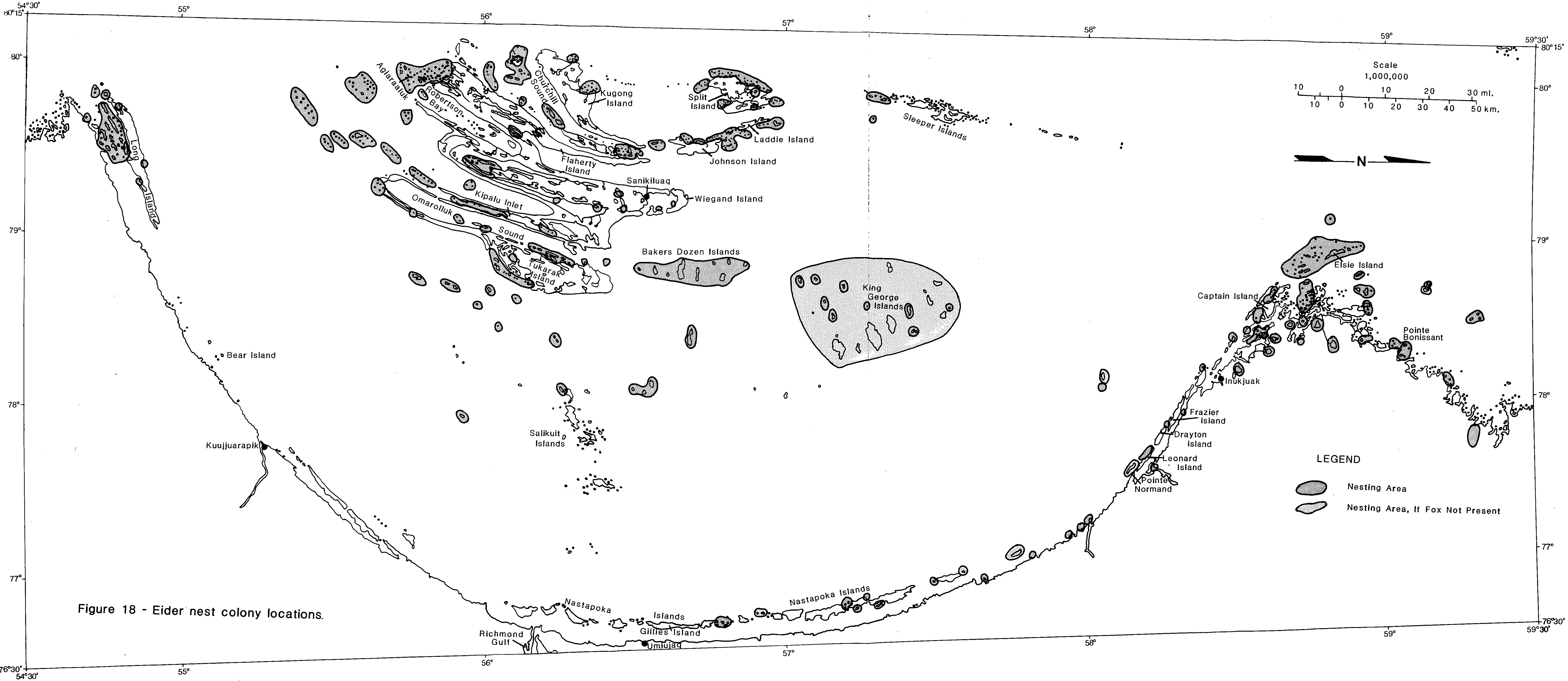



Figure 18 - Eider nest colony locations.

Sanikiluaq hunters have similar observations. The nest islands at the north end of Churchill Sound and those between Kugong and Johnson Islands are said to have fewer and smaller eider colonies than when the informants were young. The proximity of the community of Sanikiluaq is the reason given. In the south Belcher Islands, in contrast, the number of nesting eiders is believed to have increased since the closing of the community of South Camp.

### 10.2 Nest colony distribution

Eider nesting areas which hunters identified as important are shown on Figure 18. The criteria of assessment varied from community to community and from hunter to hunter. No effort was made to evaluate these criteria. The unifying factor was that hunters selected islands that they themselves considered to be important for nesting eiders, a valuable criteria given the objectives of the present study.

## 11.0 THE BROOD-REARING PERIOD : JULY TO NOVEMBER

> The female lays on them (the ducklings) until they're dry... and when they're dry and if they can handle themselves, then the mother takes them to the water... and they look for food right away even though they're still quite small.
>
> Noah Arragutainaq, Sanikiluaq

Initially the broods remain near the nest islands.

> When they're still quite small they just stay along the shore of their nesting place. They look for kinguk (gastropods) near their nesting place when they're small.
>
> Johnassie Mannuk, Sanikiluaq

Davidee Kavik of Sanikiluaq explained that as the ducklings grow, the broods move from the nest islands to the coasts of the main islands presumably to seek more sheltered areas. When the ducklings grow further, the broods move again.

> They take them (the ducklings) to a current to practice, where there are lots of waves. Even though some stay on the islands, those in large groups are taken to a place where there's current and waves.
>
> Noah Arragutainaq, Sanikiluaq

> ... these areas are where the strong currents are and I think the mother takes them there to practice, so I know that there are usually more in the current areas than the smoother ones.
>
> Lucassie Inuktaluk, Sanikiluaq

Several broods will group to form a single flock of mothers and ducklings. The families, however, maintain their integrity and the ducklings follow their own mothers.

> They're in a group so I think that they join those that they see since there's usually so many of them... There's usually so many of them even though they have their own mother.
> Johnassie Mannuk, Sanikiluaq

As a result of their wanderings the groups of ducklings and mothers become widely-dispersed (Fig.19). The complex archipelago southwest of Flaherty Island in the Belcher Islands and the area near Inukjuak, inshore from Elsie Island and north of Commodore Island, were identified as harbouring particularly large numbers of broods. Although densities might be somewhat greater in these areas, eider broods can be encountered anywhere among the nearshore and offshore islands.

While the young of the year are developing, the adult females moult their flight feathers and are flightless for several weeks. The mothers fly again at the same time or slightly before their young fledge.

## 12.0 THE DRAKE MOULT : JULY TO OCTOBER

Soon after the eggs are laid and the female eider begins incubation, hunters note that the drake becomes less attentive of the female.

> When the female is nesting, the males just sit by their side, go away when they feel like it, just go travel anywhere, anywhere they wish. They do whatever they want...
>
> Simiunie Uppik, Sanikiluaq

Silasi Tukai and Jusipi Nalukturak of Inukjuak link the drake's departure to the behaviour of the female. The drake remains with the female as long as she does not stay in one place. Once the female settles down on the nest, the drake leaves. The pre-moulting drakes remain in the vicinity of the nest islands for a period of time before their final departure to the areas where they will moult their flight feathers.

> They feed and stay on the shore and usually join the other <u>amauliit</u> (drakes) when they're about to moult.
>
> Noah Arragutainaq, Sanikiluaq

Immature eiders would join the flocks of <u>amauliit</u>, adult males. This was advantageous to hunters who were trying to shoot <u>amauliit</u> in this season.

> ... from my experience those <u>amaulitsaq</u> (sub-adult drakes) and <u>mitiaraviniit</u> (one year old eiders), when the females are laying they're usually in a group with <u>amauliit</u>. Since the <u>mitiaraviniit</u> aren't scared of people, the <u>amauliit</u> used to follow the <u>mitiaraviniit</u> right next to us. That was the only thing that made me happy about <u>mitiaraviniit</u>, because the <u>amauliit</u> just follow them.
>
> Davidee Kavik, Sanikiluaq

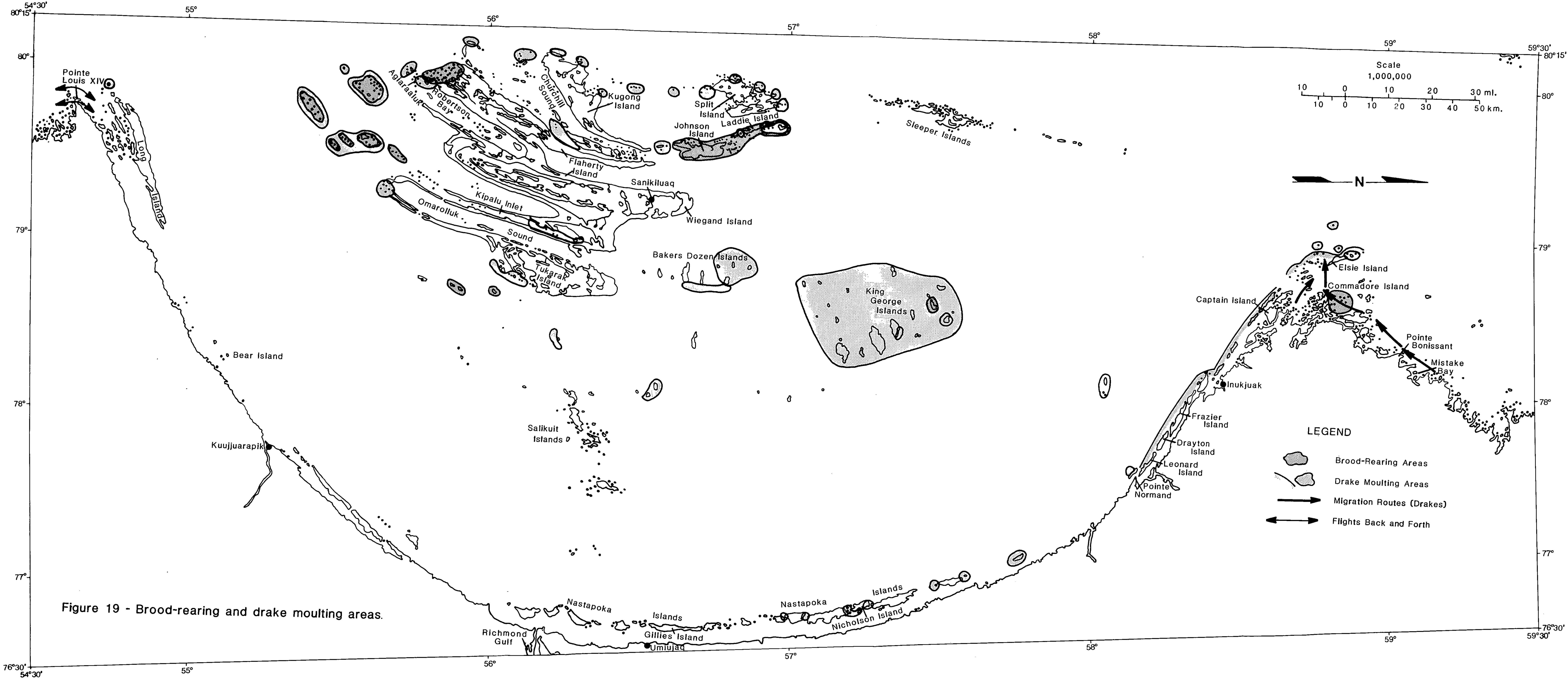



Figure 19 - Brood-rearing and drake moulting areas.

As Noah Arragutainaq added,

> ... and the ones that he's happy about (the mitiaraviniit) won't be bothered, even though they're the ones that made them (the flock) come. He would only get the older ones (the amauliit).

The drake departure from the nest islands is neither conspicious nor synchronous. In most hunters' experience the majority of drakes leave during the latter part of the incubation period, although some linger behind until the eggs begin to hatch. Hunters' comments suggest that the drakes in the more southerly part of Hudson Bay leave before mid-July, while in the Inukjuak area they leave close to the end of July.

For most of the southeastern Hudson Bay region a conspicious moult migration is not observed. Johnny Fleming of Kuujjuarapik has seen groups of pre-moulting males flying southwards past Pointe Louis XIV. Daniel Oweetaluktuk of Inukjuak has witnessed large numbers of drakes, conspicious due to their white plumage, migrating from the area of Mistake Bay southwards along the coast. At Commodore Island the drakes fly westwards to their moulting areas along the west edge of Elsie Island and the islands immediately to the south. No other pronounced drake movements were reported, neither departing from nest areas, nor arriving to moulting areas.

As for the timing of the flightless period, Moses Echalook of Inukjuak specified that drakes arrive at the Elsie and Peckham Islands moulting area towards the end of July. By mid-August the moult begins, and soon after none of the drakes present can fly. For the Belcher Islands region, Johnny Kavik observed that the drakes are usually flightless when the ducklings are in the sea (about the end of July).

For the flightless period, the drakes seem to seek out areas where they will not be disturbed by hunters. They tend to move to islands which are further offshore and show a preference for the more exposed outer shorelines.

> ...They go to the furthest islands to moult... on the outside of the islands where the water's rough, that's where they go to moult after leaving the females.
>
> Simiunie Uppik, Sanikiluaq

> They go where there are no people and lots of waves.
>
> Davidee Kavik, Sanikiluaq

> They're almost all over (the King George Islands area). There are lots of moulting eiders since there are no people down there... and there are ocean currents there. I wonder why they want to be where the sea's rough when they're moulting?
>
> Johnassie Mannuk, Sanikiluaq

According to the hunters I spoke to from Kuujjuarapik, drakes do not moult in the Kuujjuarapik region. Aside from the observation of a few scattered individuals in the Salikuit Islands by Joseph Sala, it is clear that the breeding drakes of the southern Nastapoka Islands, the Manitounuk Islands and those nesting near Long island, migrate elsewhere to moult.

In the Inukjuak region, many moulting drakes are seen off the west edge of Elsie Island and west of the numerous small islands south of Elsie Island (Fig.19). The south-eastern coast of Nicholson Island and the various straits between northern Nastapoka Islands are considered to be important drake moulting sites.

For the Belcher Islands, virtually all of the farther offshore islands, especially their outer edges, were identified as moulting sites (Fig.19). The west edge of Split Island and the southwest coast of Flaherty Island are also important moulting sites. Although the majority of drakes go to the far offshore islands for the moult, some remain among the main islands. Flightless drakes have been observed in Kipalu Inlet, Churchill Sound and Fairweather Harbour.

When flightless the drakes become very secretive, evasive and difficult to hunt.

> ... those amauliit (drakes) go to the place where there's no people. They don't want to see people when they're moulting.
>
> Johnassie Mannuk, Sanikiluaq

> The amauliit seem to be the hardest to get when they're moulting. They're the hardest to get. I've worked on them... when they are alert only their head is on the surface when the water is calm. And they leave even before you can see them.
>
> Lucassie Ohaytook, Sanikiluaq

> When moulting, the amauliit are more clever than seals. You can't have enough time to shoot at a moulting amaulik.
>
> Willia Weetaluktuk, Inukjuak

During September and at least part of October, the moult continues. Some hunters speculated that the drakes were flightless for about two months. Davidee Kavik of Sanikiluaq explained that "when the snow geese are flying a little, then the mitiqs fly a little, too." When they regain their ability to fly they return to the mainland coast or, in the case of the Belcher Islands, the coasts of the main islands.

> When they're moulting they are where there are lots of waves and in the fall they come to the 'mainland' where there's more shelter.
>
> Simiunie Uppik, Sanikiluaq

Or, as Johnassie Mannuk of Sanikiluaq expressed it, "they come to us to be eaten".

## 13.0 FALL

### 13.1 Flock formation and distribution

The adult drakes regain the ability to fly about October, at the same time or slightly before the immatures. The breeding females and young of the year seem to fly somewhat later, about the time of the first snowfalls which occur in late November or early December. Hunters comment that in the fall eiders can be seen everywhere, following the coastlines and flying with the wind.

> "... so at this time they can be seen everywhere in the Belchers. Since they're flying they can be seen all over. You'll be able to eat anywhere the wind is blowing."
>
> Lucassie Kattuk, Sanikiluaq

When the females and young begin to fly they join the other eiders to form mixed flocks.

> "At this time (early December) all the mitiit are mixed and it's only in spring that they will split up."
>
> Lucassie Ohaytook, Sanikiluaq

Lucassie Ohaytook explains that the development of fall flocks is a passive response to the wind.

> "Animals don't fly against the wind. So the mitiit get into larger numbers that way."

Although flocks are usually mixed, adults may separate from young near hunting areas.

> (near Kuujjuarapik)...The adults are usually further down (offshore) since they're more alert than the younger ones. They're further down although some are near the shore... In Sanikiluaq where the water's salty... the adults are nearer to the shore if they don't see people... they're mixed with the others if people aren't near...
>
> Joshua Sala, Kuujjuarapik

> The adults don't go as near to the hunting areas as the younger ones. I think the amauliit (drakes) know which are the hunting areas.
>
> Charlie Qittosuk, Sanikiluaq

Figure 20 indicates a few of the favoured fall hunting sites for Hudson Bay Eiders. They do not represent distribution limits but do indicate areas of particular importance for subsistence. Most hunters did not indicate particular areas for eiders, insisting that in the fall they could be seen along any coastline.

## 13.2 Fall migration along the Québec coastline

Along the Québec coastline, eiders begin to follow the coast southwards about November. Flocks of drakes may be the very first to leave, but most of the migrants are in mixed flocks of eiders of all ages and both sexes. Figure 20 shows the path of fall migration indicated by the hunters of Inukjuak and Kuujjuarapik.

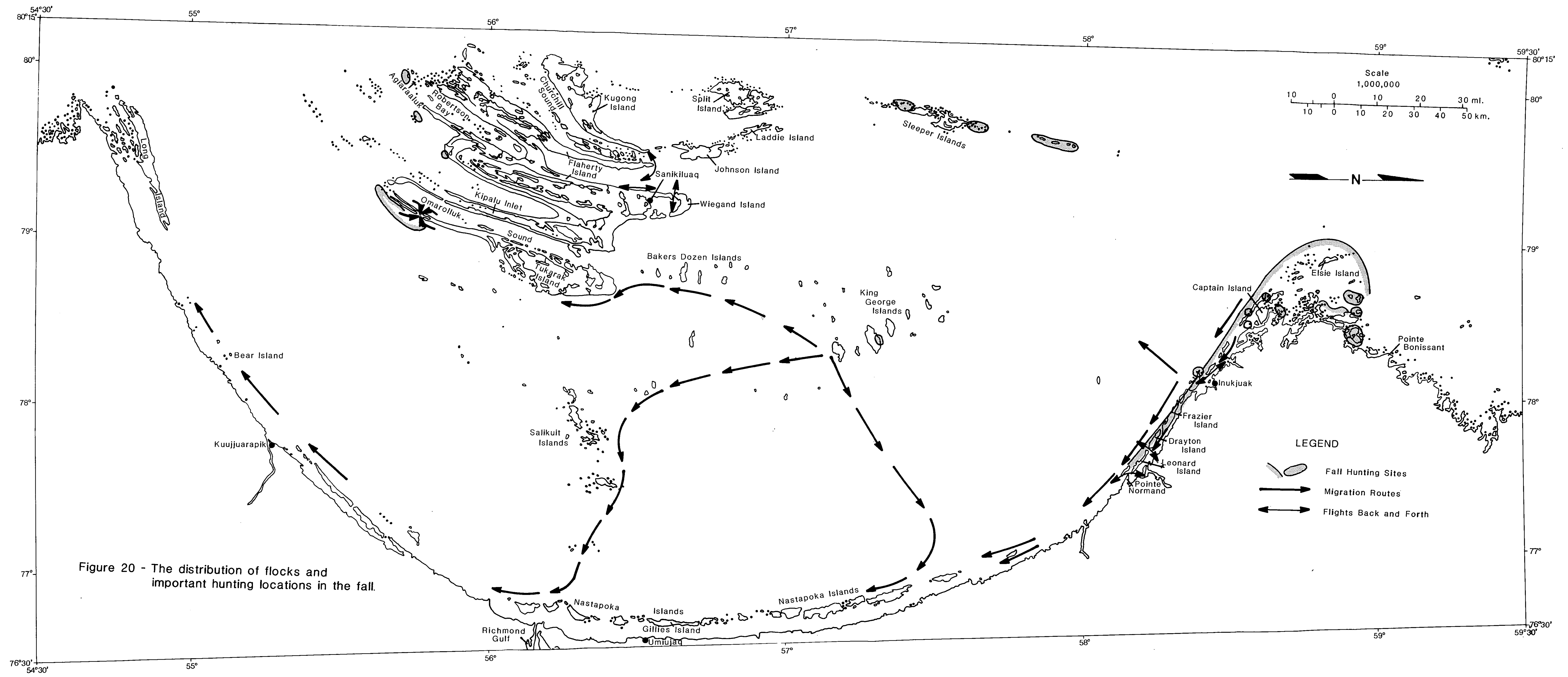



Figure 20 - The distribution of flocks and important hunting locations in the fall.

Although the migration commences before coastal ice formation, the final departure of eiders from the Québec nearshore is linked to the disappearance of open water.

> It's easy to tell when the water is freezing up because they are flying all over... looking for open water.
> ... They follow the water and that's how they usually disappear. In the fall they're all around here, but as the water freezes they just follow it.
> Joshua Sala, Kuujjuarapik

## 14.0 WINTER ECOLOGY

### 14.1 Eiders along the edge of the landfast ice

By January, sea ice development excludes Hudson Bay Eiders from the Québec nearshore areas and those offshore archipelagos which are located well within the Hudson Bay Arc : the Salikuit Islands, King George Islands and the Bakers Dozen Islands. It is usually in January that the sea freezes from the east shore of the Belcher Islands eastwards to the Québec mainland. The stable ice bridge that is formed incorporates the Salikuit Islands. This ice mass, once established, will exclude eiders from this area until the following spring.

The sea ice that forms in the northern half of the Hudson Bay Arc is considerably less stable due to the strength of local tidal currents. In very harsh winters the entire area may freeze as a single ice sheet extending from the Belcher Islands northwards and northeastwards to the Québec mainland and incorporating the Sleeper and King George Islands. This is an uncommon event. When it occurs, the ice sheet endures no more than a month. The more usual mid-winter ice configuration comprises masses of pack ice shifting back and forth between the landfast ice of the mainland coast and of the major archipelagos.

Although transient leads occur throughout the area it is not very hospitable to eiders and few remain all winter. Hunters who have over-wintered on the King George Islands report seeing a few eiders along the east edge of the fast ice in winter, but these disappeared during the coldest weeks. Willia Weetaluktuk of Inukjuak and Charlie Qittosuk of Sanikiluaq never saw any eiders during their winter sojourns on the King George Islands.

In the Belcher Islands, the intricate series of long bays and inlets are frozen by the end of December (Fig.21). The ice edge skirts the outer perimeter of the archipelago, joining Flaherty, Tukarak, Kugong, Johnson, Laddie and Split Islands. The eiders are forced to leave the inner part of the islands and move to the outer edge of the landfast ice. At this time of the year, eiders are particularly numerous off the southeast edge of the Belchers. Their presence is said to be largely a function of the prevailing northwest winds. When the winds temporarily shift to the south or southeast, the eiders fly downwind directly across the islands to the leeward ice edge on the northwest side. When the winds shift back to the northwest, the eiders return to the southeastern edge.

In January the Belcher Islands ice edge extends northwards to incorporate the Baker's Dozen Islands eastwards to the Québec mainland and southwards to incorporate all of the small islands to the south of the main archipelago. The formation of ice along the east side of the Belchers displaces the eiders once more. Moses Appaqaq Sr. of Sanikiluaq has observed flocks of eiders moving southwards along the eastern perimeter of the Belcher Islands. He interpreted their movement as a migration to the main wintering areas off the western edge of Robertson Bay.

When the ice freezes between the Belchers and the Québec mainland, an ice edge is created between the south Belchers and Long Island. Davidee Kavik of Sanikiluaq defined a triangular area with Bear Island near the Québec mainland at the apex and a line between the north shore of Long Island and the southernmost islands of the Belcher archipelago forming the base (Fig.21). The ice edge always occurs within this triangle but shifts its position depending upon the strength of wind and tide and the harshness of the winter. In a cold winter the extreme ice edge extends north from the west end of Long Island and in a mild winter it extends north from the east end of Long Island. The frozen area within the zone is always rough due to the continual breaking and refreezing of the ice. While polar bear hunting, Joshua Sala of Kuujjuarapik has seen many eiders along this ice edge, in particular along the edge closest to the Belcher Islands.

Open water will persist off the ice edge northeast of the Belcher Islands during a mild winter. Eiders will be present in these years. It is not unusual, however, for this ice edge to close for a period of at least several weeks. When this occurs eiders are forced to move elsewhere. Not all of the eiders leave, however, and those that remain occupy temporary areas of open water which occur northeast of Tukarak Island, northeast of Wiegand Island and east of each of the Bakers Dozen Islands (Fig.21). These stragglers are mostly juveniles who die when these areas eventually freeze.

The north ice edge between the Belcher Islands and the Sleeper and King George Islands only closes in the harshest of winters, and even then only for about a month. Thus in most years, eiders can remain along this edge all winter. They are particularly abundant northeast of Radar Island.

In a very cold year the only reliable ice edge for eiders seeking open water, is the outermost edge. It begins west of Long Island and extends northwards skirting the western perimeter of the Belcher and Sleeper Islands (Fig.21). The majority of Hudson Bay Eiders wintering in the region frequent this edge.

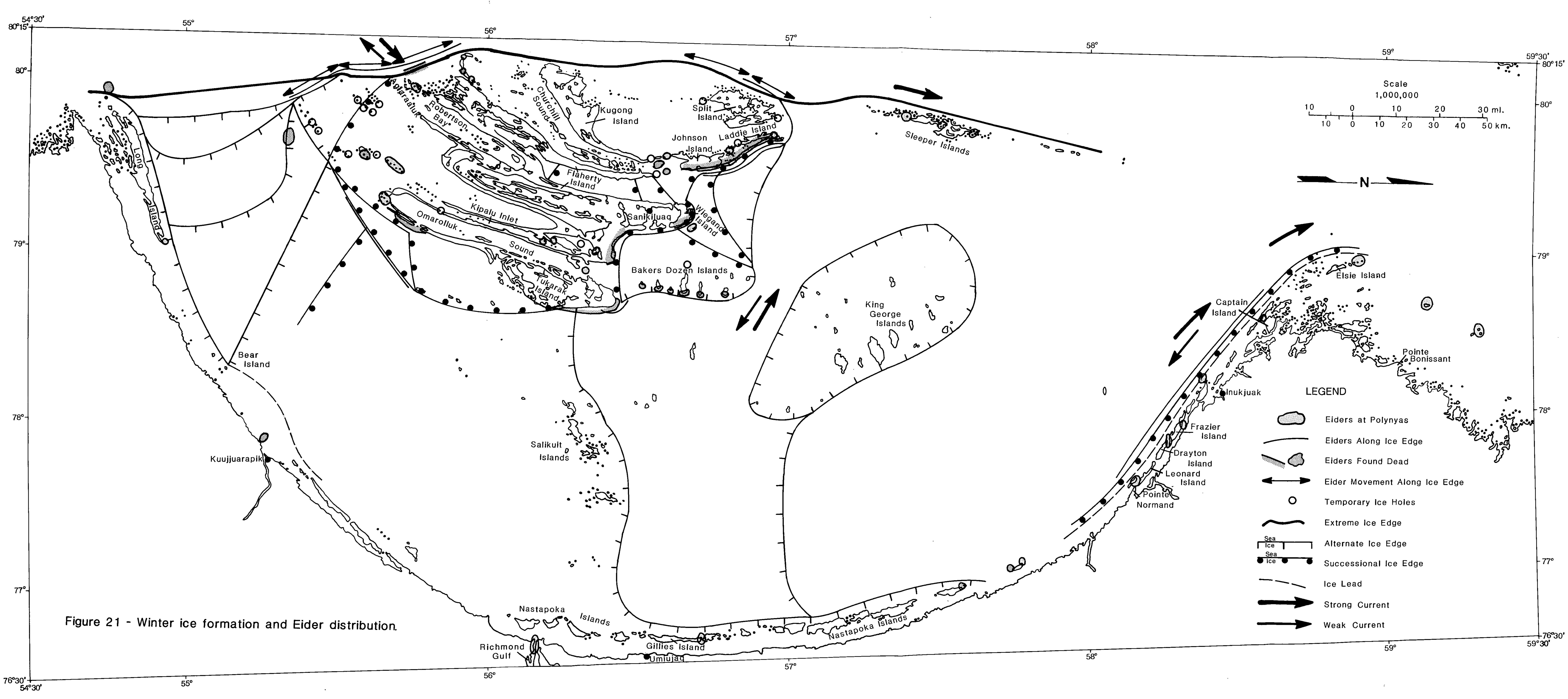



Figure 21 - Winter ice formation and Eider distribution.

> At this time of the year, there are a lot of ducks along the edge, say, west of Split Island. They're like a cloud of mosquitos, they are so many. They are not always in one area. They are always moving around... They travel looking for water, open water.
>
> Paulusie Ekidlak, Sanikiluaq

The eiders are said to occur anywhere along the edge so long as the water is not too deep.

> Every edge that can be reached usually has mitiit...
> I've never seen empty open water because at least one or two (eiders) are always there. As long as the land is near there's always ducks. But the areas far from land don't have any.
>
> Johnny Kavik, Sanikiluaq

> (They're) near the land and fewer on the main open water. Maybe they're usually trying to be where the water's not too deep.
>
> Lucassie Kattuk, Sanikiluaq

Moses POV and Jusipi Nalukturuk of Inukjuak have wintered in the Sleeper Islands. They saw impressive numbers of Hudson Bay Eiders in these islands in winter.

> I wasn't thinking of eiders in the morning. I got out of my snowhouse and got ready to trap for fox. It was snowing, foggy and cloudy. I was thinking that a cloud was touching the ground, but they were eider ducks. Lots of them.
>
> Moses POV, Inukjuak

Along the ice edge, the eiders frequently fly back and forth following the areas of open water which appear and disappear in response to shifting wind and tide.

> ... the same group doesn't stay in one area all the time because they go where there's water...
> ... even though you can't reach the open water you can usually see it from here and you can usually see them (the eiders) flying away when (the lead) is closing.
>
> Johnny Kavik, Sanikiluaq

In the evening the eiders gather along the edge of the landfast ice to spend the night. During the day, Sanikiluaq hunters would observe the gulls to try and locate the eiders along the edge and then try to locate the stretch of ice edge where eiders were spending the night.

> ... We used to walk here to the edge. We couldn't go by dog team because the ice was too rough. Since we were able to see gulls and gulls are usually seen where the ducks are, we used to try to go to them. And we used to see a lot of ducks on the moving ice...
>
> Davidee Kavik, Sanikiluaq

> There's big water here and we used to come here... when it's getting darker. We'd check the edge and notice that they (the eiders) have been there ... If the edge is hard all over that means that they have been there and so we just waited for them.
>
> Joe Emikotailuk, Sanikiluaq

Joe described in detail the ordered evening arrival of the eiders at the site where they would spend the night : first the juveniles; second, the adult females; and finally the adult males. Each group arriving at the open water along the edge, displaced the previous group up onto the ice edge.

> We went to the edge during the evening and there was lots of water and it was low tide. Pieces of ice came when there was still daylight and the mitiit came shortly after. But those that came were all young ones from last summer... and the females usually say "qauq" and when they did the young ones started landing on top of the ice so that the females could land here... When the females said "qauq, qauq" the younger ones started flying and splashing alot ... and those younger ones were on the way to the ice ... and so the amauliits (drakes) were heard and the females did the same thing and went on top of the ice because they didn't want to be in the way.

## 14.2 Eiders on polynyas within the landfast ice

Although the majority of Hudson Bay Eiders winter along the sea ice edge, small groups reside permanently at polynyas within the landfast ice. In the Kuujjuarapik region few polynyas exist. One area of open water occurs east of the easternmost tip of Long Island. This hole does not remain open in extremely cold winters. When it is open it is occupied by Hudson Bay and King Eiders. The majority of these are juveniles, although a few adult males and females may also be present. The eiders alternate between occupying the ice hole and an adjacent lead to the north which opens and closes according to wind direction.

The mouth of Richmond Gulf remains open all winter. The number of eiders overwintering at the mouth in any one year varies from many to none. In the south Nastapoka Islands, adult female and young eiders were seen at an open water area between Taylor and Gillies Island. Hunters did not specify whether or not this site remains open most winters.

Strong currents in the Inukjuak area maintain a few open water sites for part or all of the winter. In the Hopewell Islands, the most persistent areas of open water are located between Frazer and Drayton Islands, between the mainland and Frazer Island, between Leonard Island and Pointe Normand and south of Captain Island (Fig.21).

Other open areas occur north of Elsie Island and north of the two far offshore islands west of Pointe Bonissant (Fig.21). These areas are occupied by adult females and young. During harsh winters all of these sites will freeze and the eiders will die unless they can find open leads offshore.

Only in the Belcher Islands do we find true polynyas, areas which remain ice-free throughout the harshest winter. Johnny Kavik of Sanikiluaq distinguished between two types of holes within the landfast ice: first, those which are dependably open all winter and whose location is consistent from year to year; and second, holes which close during the coldest part of the winter and whose locations vary somewhat from year to year. These sites are indicated on Figure 21.

In the east part of the Belchers, polynyas occur in Rock Passage and in and near Narrows Passage at the head of Omarolluk Sound. Other polynyas occur off Tragedy Point at the mouth of Omarolluk Sound and south of Ney Island in Kipalu Inlet. In the north part of the archipelago, polynyas are found just south of Johnson Island and in the strait dividing Johnson from Laddie Island (Fig.21).

The most important polynyas for Hudson Bay Eiders are in the south Belchers near Agiaraaluk Island, along the west side of the mouth of Robertson Bay. One large open water area and 4 or 5 smaller ones occur in this area. Three other polynyas of lesser importance are located between the islands at the south edge of the mouth of Churchill Sound.

Sanikiluaq Inuit distinguish between Hudson Bay Eiders that are all-winter residents of these open water areas and those which frequent the ice edge. Residents are usually thinner and the majority tend to be young rather than adults.

> I would say the one that's already there (on the polynya), I think they stay there all the time. But most of the time they will be a lot poorer than the ... one coming from down there (the ice edge). You know, the one that's coming from down there, they'll be a lot fatter than those who stay around here.
> Zach Novalinga, Sanikiluaq

> They (the polynyas) always have mitiit but not that many and always the same group ... In mid-winter these open waters are used only by the younger ones. The adults don't stay in them.
> Johnny Kavik, Sanikiluaq

> I think there are a lot more young ones than adults. I think the adults are mostly staying where they are really safe, I guess.
> Zach Novalinga, Sanikiluaq

Joe Emikotailuk of Sanikiluaq explained that the eiders that frequent the ice edge differ in diet from those resident on polynyas.

> The only place where they (the ice-edge eiders) think there's water is where the open water is big and where there are quliligaq (probably capelin). Those that stay in small open waters (polynyas) eat those that are on the

> bottom of the sea, like uviluit (mussels) and miqulit (sea urchins). Those here usually have bigger stomachs since they eat something harder. Those that stay on the big open waters have a different size stomach (gizzard), theirs are smaller. Those qulíliqaq are soft, so those ducks have stomachs like seagulls which are soft all over.
>
> Joe Emikotailuk, Sanikiluaq

## 14.3 When pack ice closes the outer lead

When the pack ice moves in and closes the lead along the outermost edge of the landfast ice, large flocks of Hudson Bay Eiders leave the floe edge.

> Since the people know the ducks, they know that there's no open water anymore because they can see ducks everywhere and they usually see frozen dead ducks.
>
> Noah Arragutainaq, Sanikiluaq

Wind and tidal current direction influence pack ice movement and thus the opening and closing of the outer lead. Hunters identified the wind as a critical factor. As the best time to hunt eiders at the Agiaraaluk polynya was when the lead was jammed with pack ice, hunters would only go to Agiaraaluk if the winds were south or southwest.

> If the wind isn't blowing from the south, but from the north or the east, the ice is quite far from the land. The only time it would come is if it's from the south and then we used to go to these islands (Agiaraaluk).
>
> Simiunie Uppik, Sanikiluaq

> If the wind was coming from the south or southwest, they'd go hunting here. But if the wind was coming from the north or directly from the east, don't bother going ... even if they (the eiders) are already in these (the Agiaraaluk polynyas), as soon as you reached the area here, they'll fly away and they are not coming back.
>
> But if the wind was coming from here (south or southwest) you could hear them turning ... back and forth and then they'd suddenly come back.
>
> Zach Novalinga, Sanikiluaq

Tidal amplitude and current direction also influence pack ice movement. Tidal currents west of the Belcher Islands flow northeast-southwest. The current to the northeast is strong while that to the southwest is weak. The strong northeast current brings the pack ice against the landfast edge. Hunters disagreed as to whether the wind or the tide was the more important factor in opening or closing the lead along the edge of the landfast ice.

When the outer lead is closed eiders are seen inland, far from the ice edge.

> We don't even want to be asked where (the eiders were) because we used to go shopping (trading to Kuujjuarapik) and we used to see a lot of ducks in Tasitjuit (lakes) and all over when the big ice floe is here.
>
> Davidee Kavik, Sanikiluaq

The eiders fly everywhere, seeking open water.

> When it is mid-winter, they're not afraid and they used to land right next to the dogs, thinking that they're open water. Our dogs used to eat the ducks that landed next to them.
> Davidee Kavik, Sanikiluaq

Even though the outer lead was jammed with pack ice, eiders would spend the daylight hours along the edge of the landfast ice. They could always locate small cracks and holes by which they could gain access to the sea. But at sunset in a dramatic display of their numbers, huge flocks would wing back to the Agiaraaluk polynya to spend the night. Simiunie Uppik of Sanikiluaq explained that the eiders are afraid to spend the night along the ice edge for they fear that the ice cracks will close upon them. Joseph Niviaxie of Kuujjuarapik provided a similar explanation.

> They go anywhere that there's open water to spend the night even when they spend the day here (at the fast ice edge). Maybe it's because they try to think about the ice when they have to spend the night. They used to sound like thunder when they went to the place where they'll spend the night.
> Joseph Niviaxie, Kuujjuarapik

> We used to say that they want to sleep without something to bother them, like where nothing's moving. It's really good when they go here (to the Agiaraaluk polynya) to spend the night...
> Joe Emikotailuk, Sanikiluaq

The evening arrival of these huge flocks of Hudson Bay Eiders was an impressive, almost eerie event.

> When there's some kind of "smoke" over the water we used to listen because the only time it can do that is when the mitiit are starting to fly. When that happens you can hear the rumbling noise and then you can hear the noise they make even before you can see them.
>
> The mitiit used to come here when the ice comes in and we used to see lots. Even if the sun is still high, they could block it and it can't be seen for quite a while...
>
> Joe Emikotailuk, Sanikiluaq

> I used to wait here at this open water (the Agiaraaluk polynya), waiting for the current to switch since there are no ducks when it's going that way... When the currents are coming this way, the area was blocked by ice... Even when the weather's really cold, we never used to bother using mittens when the ducks are coming ... I said that the sky was red. It used to be red because there were so many of them. I'm telling the truth.
>
> And they were coming. And when the sky's clear you could see red sky, but still can't hear them... And when they reach quatjuit (the south edge of the mouth of Churchill Sound), then the world seems unusual from the noise they make.
>
> ... Then you just lay flat on your stomach, when they were coming in.
>
> Davidee Kavik, Sanikiluaq

When the eiders arrive at Agiaraaluk they are so numerous that they are said to cover all of the open water. Some eiders must move onto the adjacent ice edge for lack of space on the polynya's surface. Early in the morning the eiders leave the polynyas to go back out to the edge of the landfast ice, leaving the resident eiders behind. If the ice edge remains closed, and if the eiders are not disturbed by hunters, then the ice-edge eiders may stay at Agiaraaluk for a period of a few days.

Not all eiders spend the night at polynyas when the outer leads are blocked with pack ice. Some hunters believe that in spite of the impressive numbers which over-night at Agiaraaluk, many times more remain along the landfast ice edge.

Johnny Kavik of Sanikiluaq recognizes that, in the winter, distinct northern and southern "populations" of Hudson Bay Eiders frequent the western ice edge. These groups are roughly equivalent in size. The northern group frequents the ice edge as far south as the southwest end of Kugong Island. The southern group uses the ice edge south from approximately the middle of the mouth of Churchill Sound. The majority of the northern group remains at the ice edge whether or not the lead is open. When pack ice crowds the northern ice edge, closing the lead, some eiders move to the polynya in the strait between Laddie Island and northwest Johnson Island. This group is considerably smaller than that at Agiaraaluk.

Joe Emikotailuk of Sanikiluaq explains that "traveller" eiders live along the ice edge at all times. "Sedentary" eiders are resident at the polynyas. In mid-winter an evening mass flight of "travellers" leaves the edge of the landfast ice, passes over the Agiaraaluk polynya and then returns to the ice edge for the night. The mass of eiders follows a very specific route to and from the polynyas. According to Joe, the eiders that spend the night at Agiaraaluk are mostly younger ones. The adults return to the ice edge. In addition to those eiders that occupy the polynyas when the outer lead is closed, large numbers of eiders simply spend the night on the landfast ice, remote from any open water.

> Even when there's no water they spend the night on the ice.
> Noah Arragutainaq, Sanikiluaq

> There used to be lots of ducks (settled on the ice) and they used to be okay when they saw people and would fly away.
> Davidee Kavik, Sanikiluaq

After a night on the ice, not all of these eiders flew away the next morning. In cold weather, several hundred ducks would cluster together into living mounds in order to keep warm. Those individuals that landed first and formed the bottom of the pile, often were suffocated and crushed. When the flock flew away in the morning, hunters would find these dead individuals with their belly or breast feathers frozen into the ice. This death was not reserved for the younger or inexperienced. Hunters would find dead adult drakes and females as well as young.

# 15.0 INTERSPECIFIC RELATIONSHIPS

## 15.1 Mitiq as predator

Uviluk, the blue mussel *(Mytilus edulis)* was universally identified as the key element in the diet of the Hudson Bay Eider. In the experience of some Inukjuak hunters, it was the only food eaten. Other hunters had observed eiders eating other prey.

> I used to think they were only eating mussels. (But then I found that) those kanajuit (sculpins), their tails used to be eaten by eider ducks... The only thing they didn't eat was the head of the sculpin... I never knew how they cut them because the eiders don't have teeth.
>
> Moses POV, Inukjuak

For Moses, mussels were the eider's summer food and sculpin were only eaten in winter at ice holes where the mussel supply was depleted.

Willia Weetaluktuk of Inukjuak was also of the impression that eiders were only eating mussels. Only recently, he observed eiders eating sea urchin (probably *Strongylocentrotus droebachiensis)* at the edge of the landfast ice, far offshore from the Hopewell Islands. He speculated that, although mussels were the preferred diet of eiders, they would resort to sea urchins when necessary, such as in deep water.

Samwillie Niviaxie of Inukjuak has found the remains of mussels and sea urchins in the gizzards of the eiders he has killed. In the spring, he noted that eiders seem to only defecate mussel shell fragments. In his experience, eiders primarily eat mussels in the spring and mainly sea urchins in the fall.

Sea cucumbers were mentioned as an important element of eider diet by both Sanikiluaq and Kuujjuarapik hunters. Mussels, urchins and sea cucumbers were the prey items most often mentioned for the Belcher Islands. Other food items include: ipitsaunik (unidentified clam), kukiujaq (unidentified cockle), kinguk (gastropods), kanajuk (unidentified sculpin), kanajuapik (unidentified sculpin), quliligaq (probably capelin, *Mallotus villosus*), ammajak (probably sand launce, *Ammodytes sp.*) and qiquak (a type of seaweed). The last was said to be eaten only if the eiders were very hungry.

Johnassie Mannuk considered an eider's summer diet to be primarily composed of mussels, sea cucumbers and gastropods. In summer, the eiders have access to many different prey items and although they eat a variety of foods, they restrict their diet through preference.

> I don't think they bother anything but uviluk (mussels) in summer, but I think they'd eat anything that's available when the place that they're at doesn't have uviluk at hand ... they can eat anything in winter, but in summer they have a special diet.
>
> Joe Emikotailuk, Sanikiluaq

Johnassie Mannuk explains further that access to food in winter is restricted by the presence of the landfast ice. In this season, the prime food items are capelin and sculpins (kanajuk and kanajuapik).

> When they are staying out on the edge, in deep water, they can't go to the bottom because it's too deep. So they eat what the seals eat, the little fish quliliqaq (capelin).
>
> Paulusie Ekidlak, Sanikiluaq

> ... When they have been feeding on the big open water their stomachs are really small. those "travellers" (ice-edge eiders) seem to only eat seal food...
>
> Joe Emikotailuk, Sanikiluaq

In contrast, on the edges of the polynyas within the landfast ice, hunters find the remains of sea urchins and sea cucumbers which eiders have brought to the surface.

## 15.2 Mitiq as prey

Arctic and red foxes, raven, gulls *(Larus spp.)* and jaegers *(Stercorarius spp.)* prey upon eider eggs and ducklings. The significant influence of fox upon nest initiation and location has been discussed (section 10.1).

> It used to be really upsetting when the island you're trying to gather eggs from had a fox in it. And the ravens are even worse, because they can hop around and try to remove the mitiq. When she does move he'll take an egg for sure.
>
> Joe Emikotailuk, Sanikiluaq

> Gulls and ravens are the ones that eat the most (eggs)... I know the ravens. Once the female is in a nest, the raven will jump up and down in front (of her) trying to scare the mitiq. When she flies then the raven will eat.
>
> Davidee Kavik, Sanikiluaq

> The ravens go to every island to look for eggs. ... (they) get the eggs for their young. They put it in their throat and when they reach the nest they vomit it to their young.
>
> Moses Echalook, Inukjuak

> Lots of ducklings are eaten by gulls in the summer and I have seen more than

> once they just wait for the mitiaraks (ducklings) to go back to the surface before they snatch them.
> Lucassie Inuktaluk, Sanikiluaq

Snowy Owls *(Nyctea scandiaca)*, Gyrfalcons *(Falco rusticolus)*, polar bears *(Ursus maritimus)* and fox prey upon adult and immature Hudson Bay Eiders. Paulusie Ekidlak of Sanikiluaq explained that the Snowy Owl only feeds on eiders when other prey, such as rodents, are not available. But when an owl is hungry it has no difficulty capturing an eider.

> The owl usually follows the mitiq along the (ice) edge... the way the owl gets the mitiq is that the owl is just sitting there, just waiting. When he is hungry and knows the mitiq is going his way, he goes way up in the air and just dives right down to the mitiit and gets one of them, hits it with his breast, because the breast of the owl is very hard. So they hit the mitiq while it's flying... and when it falls to the ice they just grab it and kill it that way.
> Paulusie Ekidluk, Sanikiluaq

Foxes take their share of eiders from along the ice edge at night.

> When ducks go to sleep during the night, they bundle up together and they sit there (along the ice edge) and there are thousands of them... So the fox goes, creeps up on the whole bunch and just bites them during the night... In winter when there are a lot of ducks, you can see the tracks of foxes. There are a lot of tracks on the ice.
> Paulusie Ekidlak, Sanikiluaq

> (the fox) are always near the edge because of the mitiit. I've noticed that there aren't too many foxes in the

> mainland in midwinter. They're just on the floe edge because of the mitiit and eating the polar bear's leftovers. In the spring they move back to the mainland.
>
> Johnny Kavik, Sanikiluaq

In Johnny Kavik's experience, the "weaker" eiders are more likely to become the victims.

> Since the animals are like people ... some can be poor. Those poor ones are the ones that are usually caught by the other animals.
>
> Johnny Kavik, Sanikiluaq

But referring specifically to the Snowy Owl, Paulusie Ekidlak believed that owls will take any eider that ventures near enough, whether it be an adult or young, male or female.

## 15.3 Eider-gull association in winter

> The ducks are their mothers, they (the gulls) can only survive through them. If they spend the winter alone, they wouldn't survive. They usually take the food the ducks are eating.
>
> Davidee Kavik, Sanikiluaq

In winter, when hunters were trying to locate Hudson Bay Eiders along the sea ice edge, they would look for gulls.

> Since we were able to see gulls, and gulls are usually seen where the ducks are, we used to try to go to them. And we used to see a lot of ducks on the moving ice.
>
> Davidee Kavik, Sanikiluaq

The gulls would remain with the eiders in order to feed on prey that eiders brought-up from below the ice.

> The mitiit usually put the food on top of the ice and the gulls usually eat with the mitiit.
>
> Johnny Kavik, Sanikiluaq

This association between gulls and eiders was variously interpreted as the gulls stealing from eiders, gulls eating food rejected by eiders or gulls helping the eiders.

> Even if they (the gulls) don't take the food the duck are trying to eat, they (the ducks) usually put the food aside if it's too big.
>
> Noah Arragutainaq, Sanikiluaq

> ... the gulls help the mitiq. If the mitiq happens to lose or drop something, say in the water, the gulls will pick it up and take it back or give it to a mitiq .... that's what I used to see when hunting.
>
> Isaac Amitook, Sanikiluaq

# 16.0 APPENDIX

## Appendix 16.0
Summary of census results for all species found breeding in eastern Hudson Bay

| Subregion | LOONS[1] | BLACK GUILLEMOT | CANADA GOOSE | PINTAIL | COMMON EIDER | KING EIDER | OLDSQUAW | SCAUPS | MERGANSERS | GULLS[2] | ARCTIC TERN | PLOVERS SANDPIPERS[3] | SONGBIRDS[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Long Island | - | 80 | 7 | 2 | 115 | - | 51 | 2 | 2 | 238 | 686 | 8 | 5 |
| Nastapoka I. | - | 65 | 10 | - | 998 | - | - | - | - | 340 | - | 2 | 1 |
| Salikuit I. | - | - | 2 | - | 602 | - | 2 | - | - | 105 | 100 | - | - |
| Laddie I. | - | 50 | 2 | - | 872 | - | 5 | - | - | 66 | 123 | - | 1 |
| Split Island | - | 2 | - | - | 649 | - | - | - | - | 41 | 80 | - | - |
| Sleeper I. | 1 | 9 | 2 | | 2842 | - | 14 | - | - | 161 | 753 | 1 | - |
| Koktac River | 3 | 33 | 30 | 20 | 1176 | 22 | 57 | - | 6 | 94 | 852 | - | 1 |
| ALL SUBREGIONS | 4 | 239 | 53 | 22 | 7254 | 22 | 129 | 2 | 8 | 1045 | 2594 | 11 | 8 |

1. Gavia immer (1 nest); G. stellata (3 nests)
2. including L. argentatus, L. hyperboreas
3. Charadrius semipalmatus (4 nests), Calidris minutilla (1 nest), Calidris spp. (6 nests)
4. Calcarius lapponicus (3 nests), Plectrophenax nivalis (2 nests), Anthus spinoletta (1 nest); unidentified (2 nests).

## 17.0 REFERENCE LIST


Abraham, K.F.; Ankney, C.D. 1986. Summer birds of East Bay, Southampton Island, Northwest Territories. Can. Field. Nat 100:180-185.

Abraham K.F.; Finney G.H. 1986. Eiders of the eastern Canadian Arctic. Pages 55-73, in Reed, Austin (ed.). Eider ducks in Canada. Canadian Wildlife Service. Report Series No.47. 177 pp.

Ahlen, I.; Andersson, A. 1970. Breeding ecology of an eider population on Spitsbergen. Ornis Scand. 1:83-106.

Beals, C.S. 1968. On the possibility of a catastrophic origin for the great arc of eastern Hudson Bay. In: Theories of the origin of Hudson Bay, Chapter 15 in Beals, S.C., Science, History and Hudson Bay - Vol 2. Queen's Printer, Ottawa.

Blood, Donald A. 1977. The Beaufort Sea and the Search for Oil: Birds and Marine Mammals. Beaufort Sea Project. Department of Fisheries and the Environment. Ottawa.

Canadian Hydrographic Service 1983. Sailing Directions. Labrador and Hudson Bay. Fifth edition. Department of Fisheries and Oceans, Ottawa.

Chapdelaine, G.; Bourget, A.; Kemp, W.B.; Nakashima, D.J.; Murray, D.J. 1986. Population d'Eider à duvet près des côtes du Québec septentrional. Pages 39-50, in Reed, Austin (ed.). Eider ducks in Canada. Canadian Wildlife Service. Report Series No.47. 177 pp.

Chapdelaine, G.; Tremblay, G. 1979. Indices de la distribution et de l'abondance de l'Eider à duvet *(Somateria mollissima sedentaria* et *S. m. borealis)* le long de la côte est de la baie d'Hudson, du détroit d'Hudson et de la baie de l'Ungava. Serv. can. de la faune. Québec. Manusc. inéd. 21 pp.

Cochrane, W.G. 1977. Sampling Techniques. 3rd ed. John Wiley and Sons. New York, N.Y. 428 pp.

Cooch, F.G. 1954. Eider duck survey, eastern Arctic, 1954. Canadian Wildlife Service. Ottawa. Unpublished manuscript. 19 pp.

Cooch, F.G. 1986. The numbers of nesting Northern Eiders on the West Foxe Islands, N.W.T., in 1956 and 1976. Pages 114 to 118. In: Reed, Austin (ed.). Eider Ducks in Canada. Canadian Wildlife Service Report Series no.47. 177 pp.

Davidson, L.W. 1985. Oil spill trajectory scenario for the proposed Canterra Energy Ltd. Hudson Bay acreage well-sites. Seaconsult Ltd. St John's, Newfoundland.

Donaldson, Judy. 1983a. 1982 Wildlife Harvest Statistics for the Baffin Region, N.W.T.. BRIA Technical Report No.2.

Donaldson, Judy. 1983b. Wildlife Harvest Statistics for the Baffin Region, N.W.T. BRIA Technical Report No.1.

EAG (Environmental Applications Groups Ltd.) 1984. Environmental literature review: Hudson Bay offshore petroleum exploration. Draft final report prepared for Canadian Occidental Petroleum Ltd. Toronto.

Eifrig, C.W.G. 1906. Notes on some northern birds. Auk 23: 313-318.

Freeman, M.M.R. 1970. Observations on the seasonal behaviour of the Hudson Bay Eider *(Somateria mollissima sedentaria)* Canadian Field - Nat. 84: 145-153.

Furneaux, J.D. 1962. Report on investigation of eiderdown-gathering. Povungnituk- 1962. Dept. Northern Affairs. Internal Report.

Godfrey, W.E. 1966. The birds of Canada. National Museum of Canada. Ottawa. Bull. 203. 428 pp.

JBNQHFC (James Bay and Northern Québec Harvesting Research Committee) 1982. Research to establish present levels of native harvesting. Harvest by the Inuit of Northern Québec. Phase II (1979 and 1980). Montreal.

Larnder, M. Montgomery 1968. The Ice. In: The water and ice of Hudson Bay. Chapter 6 in Beals, C.S., Science, History and Hudson Bay - Vol. 2. Queen's Printer, Ottawa.

Larson, S. 1960. On the influence of the arctic fox, *Alopex lagopus*, on the distribution of arctic birds. Oikos 11: 276-305.

Leighton, F.A.; Butler, R.A.; Peakall, D.B. 1985. Oil and arctic marine birds: an assessment of risk. In: Englehardt, F.R. (ed.) Petroleum effects on the arctic environment. Elsevier Applied Science Publ., London.

Manning, T.H. 1946. Bird and mammal notes from the east side of Hudson Bay. Canadian Field - Nat. 60:71-82.

Manning, T.H. 1976. Birds and mammmals of the Belcher, Sleeper, Ottawa and King George Islands, N.W.T. Canadian Wildlife Service. Occas. Pap. No. 28. 40 pp.

Marsh, J. 1985. Hudson Bay. In: The Canadian Encyclopedia. p.842-843. Hurtig Publishers, Edmonton.

Nakashima, D.J. 1986. Inuit knowledge of the ecology of the Common Eider in northern Quebec. Pages 102-113. In Reed, Austin (ed.). Eider ducks in Canada. Canadian Wildlife Service. Report Series No. 47. 177 pp.

Palmer, R.S. (ed.) 1976. Handbook of North American birds. Vol III. Yale Univ. Press. New Haven, CT. 560 pp.

Pelletier, B.R.; F.J.E. Wagner, and A.C. Grant 1968. Marine geology. In : Geology. Chapter 9 in Beals, C.S., Science, History and Hudson Bay - Vol.2. Queen's Printer, Ottawa.

Percy, J.A.; Wells, P.G. 1984. Effects of Petroleum in Polar Marine Environments. Marine Technology Society Journal 18: 51-61.

Prach, R.W.; Smith, A.R.; Dzubin, A. 1986. Nesting of the Common Eider near the Hell Gate - Cardigan Strait polynya, 1980-81. Pages 127-135. In Reed, Austin (ed.). Eider Ducks in Canada. Canadian Wildlife Service. Series Report No.47. 177 pp.

Reed, A.; Erskine, A.J. 1986. Populations of the Common Eider in eastern North America: their size and status. Pages 156-175. In Reed, Austin (ed.) Eider ducks in Canada. Canadian Wildlife Service. Report Series No.47. 177 pp.

Robinson, J. L. 1968. Regional geography. In: Geography of Hudson Bay. Chapter 4 in Beals, C.S., Science, History and Hudson Bay - Vol.1. Queen's Printer, Ottawa.

Todd, W.E.C. 1963. Birds of the Labrador peninsula. Univ. Toronto Press. Toronto, Ontario. 819 pp.

Walpole, R.E.; Myers, R.H. 1978. Probability and statistics for engineers and scientists. Second ed. Macmillan Publishing Co., New York.