

A manual for monitoring Thick-billed Murre populations in Greenland



A manual for monitoring Thick-billed Murre populations in Greenland

by
Knud Falk and Kaj Kampp
Ornis Consult A/S



Technical Report no. 7, December 1997
Pinnngortitaleriffik/
Greenland Institute of Natural Resources

ISSN 1397-3657

Title: A manual for monitoring Thick-billed Murre populations in Greenland
Authors: Knud Falk and Kaj Kampp
Series: Technical Report no. 7, December 1997
Publisher: Pinngortitaleriffik / Greenland Institute of Natural Resources
Funding: Danish Environmental Protection Agency, The Danish Arctic Environmental Program with grants from the Danish Environmental Support Fund

Cover Photo: Census of the murre colony at Appat Appai, Avanersuaq, 1987.
Photo by Knud Falk, Ornis Consult

Orthophotos: Copyright, Ordinary Survey and Cadastre (A. 273-97)
Lay-out: Inge Speiermann, Britta Borch Egevang and Knud Falk

ISBN: 87-90024-24-9
ISSN: 1397-3657

Available from: Pinngortitaleriffik
Greenland Institute of Natural Resources
P.O. Box 570
DK-3900 Nuuk
Tel: (+299) 32 10 95
Fax: (+299) 32 59 57

This report is one of the outputs from the project Monitoring and Management of Seabird Resources in Greenland. Other outputs from the project include:

Frich, A.S. 1997. The harvest of Thick-billed Murres in Greenland 1993 (In Danish with Greenlandic summary). Technical Report no. 2, 1997. Pinngortitaleriffik / Greenland Institute of Natural Resources, Nuuk.

Frich, A.S. 1997. The commercial Thick-billed Murre harvest in Greenland 1990-96 (In Danish with Greenlandic summary). Technical Report no. 3, 1997. Pinngortitaleriffik / Greenland Institute of Natural Resources, Nuuk.

Frich, A.S. 1997: Thick-billed Murre harvest in Nuuk in the winter 1995/96 (In Danish with Greenlandic summary). Technical Report no. 4, 1997. Pinngortitaleriffik / Greenland Institute of Natural Resources, Nuuk.

Frich, A.S. & Falk, K. 1997. Hunting effort and the harvest of eiders in Nuuk (In Danish with Greenlandic summary). Technical Report no. 5, 1997. Pinngortitaleriffik / Greenland Institute of Natural Resources, Nuuk.

Falk, K., Kampp, K. & Frich, A.S. 1997. The Thick-billed Murre in East Greenland, 1995 (In Danish with English and Greenlandic summaries). Technical Report no. 8, 1997. Pinngortitaleriffik / Greenland Institute of Natural Resources, Nuuk.

Frich, A.S. *in press*. The harvest of eider ducks in Greenland 1993 (In Danish with Greenlandic summary). Technical Report no. 9. Pinngortitaleriffik / Greenland Institute of Natural Resources, Nuuk.

Frich, A.S., Christensen, K.D. & Falk, K. *in press*. Eider surveys in Kangaatsiaq and Avanersuaq 1997 (In Danish with Greenlandic summary). Technical Report no. 10. Pinngortitaleriffik / Greenland Institute of Natural Resources, Nuuk.

Kampp, K. & Falk, K 1997: Baseline census photographs from Thick-billed Murre colonies in Greenland. Original photographs with notes (in Danish) handed over to Pinngortitaleriffik / Greenland Institute of Natural Resources, Nuuk.

Table of contents

| | |
|---|----|
| <i>Preface</i> | 5 |
| 1. Introduction | 6 |
| 1.1. Murre distribution in Greenland | 6 |
| 1.2. Migration patterns for North Atlantic murre | 6 |
| 1.3. Sustainable harvest requires population monitoring | 7 |
| 2. Murre population monitoring | 11 |
| 2.1. Basic murre biology | 11 |
| 2.2. Methods in murre census and monitoring | 12 |
| Colony census | 12 |
| Timing of census and monitoring | 15 |
| Counting in study plots | 16 |
| Monitoring data storage | 17 |
| 3. How to work at each colony | 18 |
| 3.1. Baseline data from Greenlandic colonies | 18 |
| Colony census data | 18 |
| Notes on the colony account | 18 |
| 3.2. Avanersuaq (Thule) | 20 |
| Hakluyt Ø (Apparsuit) | 20 |
| Carey Øer (Kitsissut) | 26 |
| Saunders Ø (Appat) | 28 |
| Parker Snow Bugt (Issuvissuup Appai) | 31 |
| Appat Appai | 32 |
| 3.3. Upernavik | 34 |
| Apparsuit (Kap Shackleton) | 34 |
| Kippaku | 37 |
| Toqqussaaq | 42 |
| Kingittuarsuk | 43 |
| Sandersons Hope (Apparsuit) | 44 |
| Kingittoq (Apparsuit) | 47 |
| Appatsiaat | 48 |
| Timmiakulussuit | 49 |
| Extinct colonies | 50 |
| 3.4. Uummannaq | 51 |
| Salleg | 51 |
| Other extinct colonies | 52 |

| | | |
|-----------|---|-----------|
| 3.5. | <i>Ilulissat</i> | 53 |
| | <i>Ritenbenk (Innaq)</i> | 53 |
| | <i>Extinct colonies</i> | 55 |
| 3.6. | <i>Maniitsoq</i> | 56 |
| | <i>Taateraak</i> | 56 |
| | <i>Sermilinnuaq</i> | 58 |
| | <i>Isortoq</i> | 60 |
| 3.7. | <i>Nuuk</i> | 61 |
| | <i>Qeqertarsuaq</i> | 61 |
| | <i>Nunngarussuit</i> | 62 |
| | <i>Extinct colonies ?</i> | 63 |
| 3.8. | <i>Paamiut</i> | 63 |
| | <i>Fox Fald (Taateraarunnerit)</i> | 63 |
| | <i>Extinct colonies</i> | 65 |
| 3.9. | <i>Qaqortoq</i> | 66 |
| | <i>Ydre Kitsissut (Kitsissut Avalliit)</i> | 66 |
| | <i>Extinct colony</i> | 70 |
| 3.10. | <i>Ittoqqortoormiit (Scoresbysund)</i> | 70 |
| | <i>Kap Brewster (Kangikajik)</i> | 70 |
| | <i>Raffles Ø (Appalik)</i> | 74 |
| 4. | <i>Preliminary sketch of a monitoring scheme</i> | 77 |
| 4.1. | <i>Monitoring of population change</i> | 77 |
| 4.2. | <i>Reproductive success and migration</i> | 78 |
| 5. | <i>References</i> | 79 |
| | <i>Appendices</i> | 83 |
| | <i>Appendix A: Latin names of species mentioned in the text</i> | 84 |
| | <i>Appendix B: Study plot boundaries at Hakluyt Ø</i> | 85 |
| | <i>Appendix C: Study plot boundaries at Kap Brewster</i> | 88 |

Preface

Seabirds play a key role in the Greenland subsistence hunting and the Thick-billed Murre is the most important quarry in most parts of the country. In East and northwestern Greenland murrens are only available during spring and summer when they provide a welcome change in the diet of local inhabitants.

The murrens are 'shared' circumpolar resources in the sense that populations from different regions occur in different Arctic countries during their annual movements between breeding and wintering areas. Management of such shared populations call for international cooperation. In particular, studies on migration patterns and population trends are important for assessing the effect of the current kill toll and provide guidance on sustainable harvest levels. Therefore, the ministers of the eight Arctic nations in 1996 accepted an *International Murre Conservation Strategy and Action Plan* (Anon. 1996) proposed from the *Conservation of Arctic Flora and Fauna (CAFF)* programme under the *Arctic Environmental Protection Strategy (AEPS)*. The Murre Conservation Plan oblige the participants in the *AEPS* to ensure international coordination of management initiatives and legislation, and to initiate monitoring of their national murre populations.

This manual constitute a concrete step towards implementing a monitoring programme for the murre populations in Greenland. It thereby assists Greenland in fulfilling national obligations towards the international agreements, and is therefore presented in English.

The manual is one of several outputs of the project *Monitoring and management of the Seabird Resources in Greenland* funded by the Danish Environmental Protection Agency, Ministry of Environment and Energy.

1. Introduction

1.1. Murre distribution in Greenland

Both species of murres occur in Greenland. The Thick-billed Murre is the most common species, and the total population size were estimated at 535 000 birds at the colonies in the early 1990es (Kampp et al. 1994). About half of the country's population is concentrated at five colonies in Avanersuaq (see enclosed maps). The boreal Common Murre is scarce in Greenland, where an estimated 1500-2000 birds (1000-1400 pairs) breed at four or five sites. The largest colony with approximately 900 birds occur on Ydre Kitsissut (Boertmann et al. 1996; Kampp & Falk 1994). Since the Thick-billed Murre is by far the most abundant in Greenland, the term *murre* in this manual refers to this species. Currently we recognize 23 Thick-billed Murre colonies in Greenland (some of them consisting of a number of subcolonies, making the exact figure a matter of discussion).

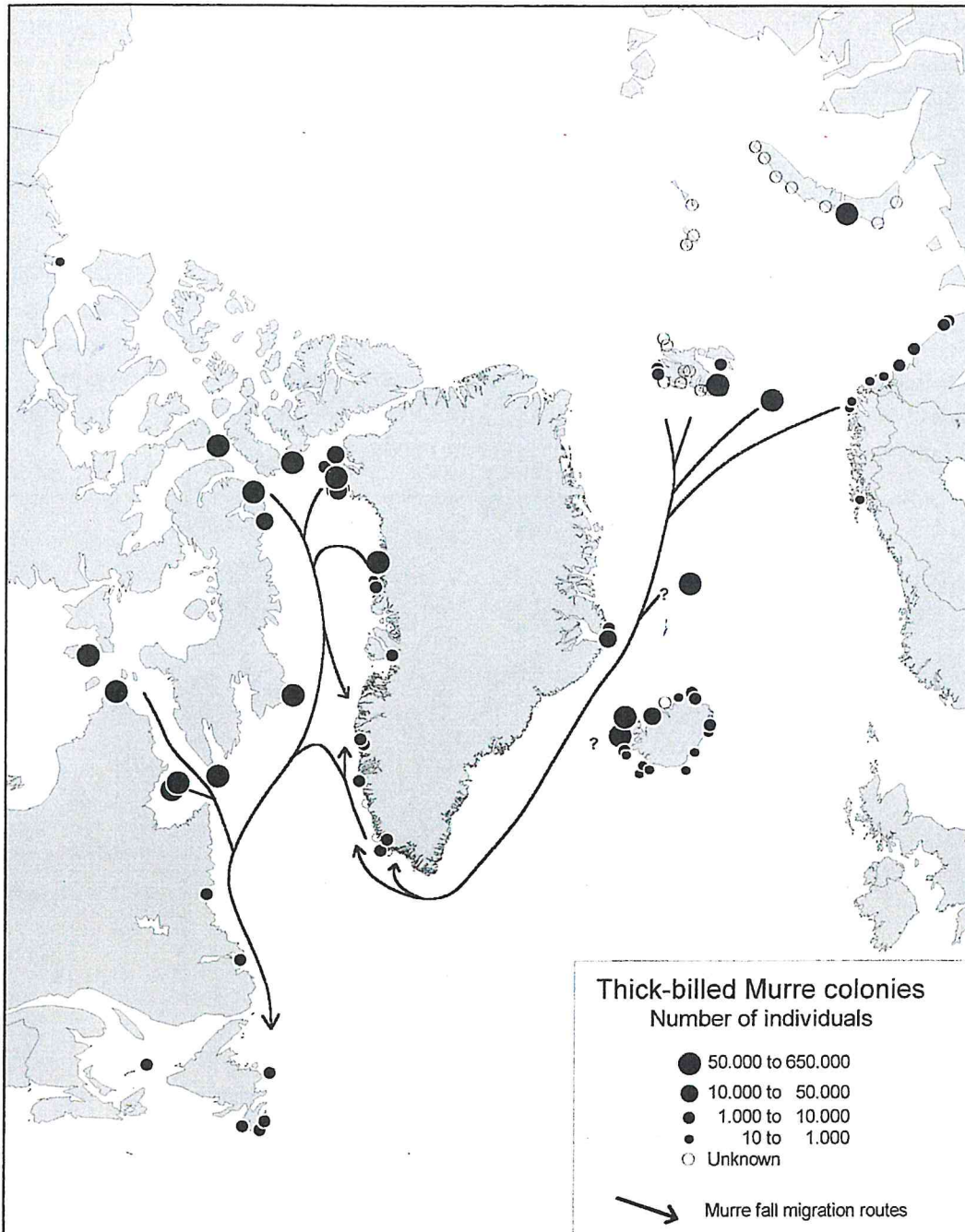
Recent summaries of the status of the murre populations in western Greenland are given by Boertmann et al. (1996), Evans & Kampp (1991), and Kampp et al. (1994), while the only updated information on the colonies in East Greenland is given by Falk et al. (1997).

All available census data on all seabird species except Dovekies are stored in a Greenland Seabird Colony Database (GM & OC 1993; see review of data for West Greenland in Boertmann et al. 1996).

1.2. Migration patterns for North Atlantic murres

Both murre species have a circumpolar distribution; in the Atlantic sector the Thick-billed Murre breeds in arctic Russia, Norway (mainly Svalbard and Bjørnøya), Iceland, Greenland, and Canada (see enclosed map). Over many decades, ringing efforts have revealed that birds from colonies at the Murman Coast and Spitsbergen migrate to the open water area along Southwest Greenland. Birds from West Greenland and eastern Canada also winter in Greenland or move to the waters off Labrador and Newfoundland (Donaldson et al. 1997). The wintering grounds for the large Icelandic population are not well known, but five recoveries of ringed birds - three from West Greenland and two from Newfoundland - suggest that some birds at least mix with the Canadian, Greenlandic, and Norwegian populations wintering in these areas.

The migration patterns may, however, be even more complicated, since first-year and older birds display different ring recovery patterns, suggesting different wintering areas, at least at a local scale. First-year recoveries also show marked interannual variation. The winter grounds of Bjørnøya murres were unknown until a sample of chicks were marked in 1995, revealing that at least the young birds migrate to Southwest Greenland just like the Spitsbergen population. In addition, since all information on the movements derives from reported ring recoveries, there is a heavy bias towards areas where the birds are hunted or caught in fishing gear. First-year birds make up the majority of the winter kill in Newfoundland as well as Greenland.

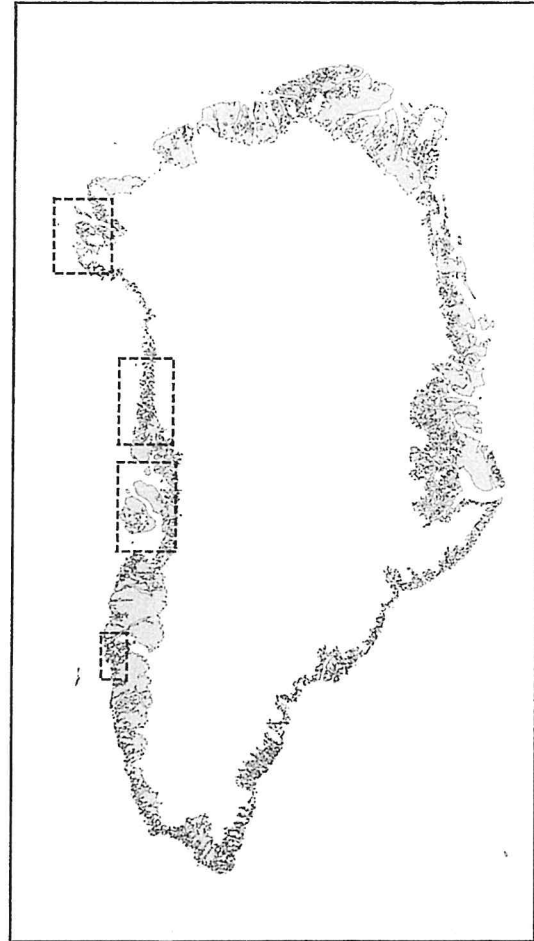
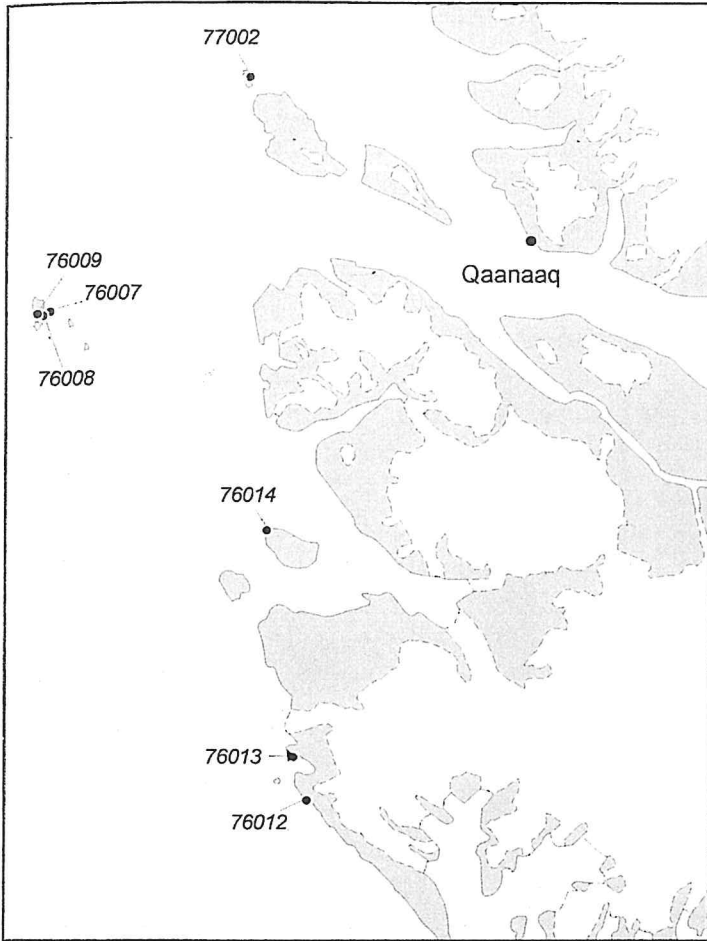


1.3. Sustainable harvest requires population monitoring

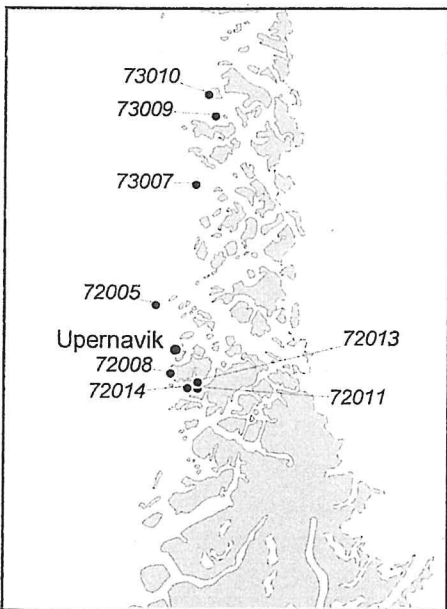
Large numbers of murres are harvested annually during the winter hunt by local hunters in Newfoundland and West Greenland (Elliot et al. 1991; Falk and Durinck 1992). In some parts of Greenland the local breeding populations have declined significantly (Kampp et al. 1994), but the main reason for this appears to be local summer hunting. Murre hunting was legal during the breeding season until 1988, and still is in Avanersuaq (where populations are not immediately threatened) and East Greenland. The regulations introduced in 1988 were a major step towards ensuring a sustainable harvest of the murres. They also included a ban of large-scale commercial trade of murres to industrial processing companies.

In order to provide guidelines for the future management of the murres, a long-term population monitoring programme is required, especially of the most vulnerable populations. In line with management of other natural resources, such as fish and shrimp stocks and sea mammal populations, harvest recommendations (and regional quotas?) for seabirds should be based on data on population trends and stock recruitment estimates.

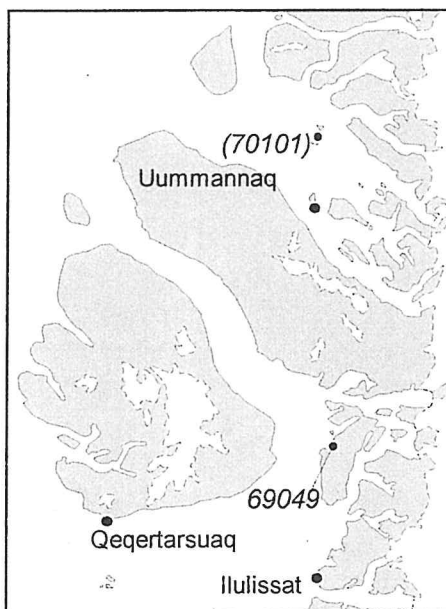
To facilitate this process, this manual summarises information on existing baseline data from each of Greenland's murre colonies, and provides a background on how to work at each colony. In the last chapter we also propose a preliminary scheme for regular field surveys at selected murre colonies. But a monitoring programme may detect unexpected population trends, so priorities may need to be changed and field schemes to be revised according to the current needs.



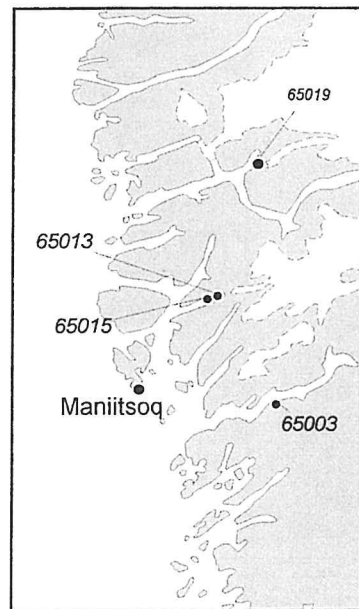
Murre colonies in the Avanersuaq region.



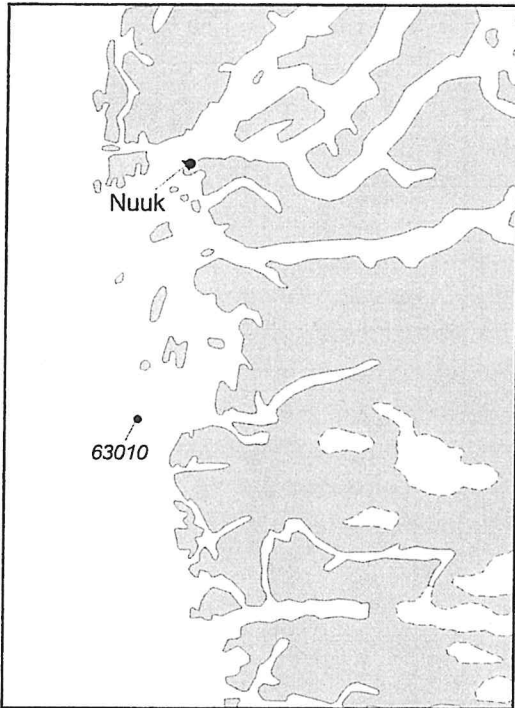
Murre colonies in the Upernavik region.



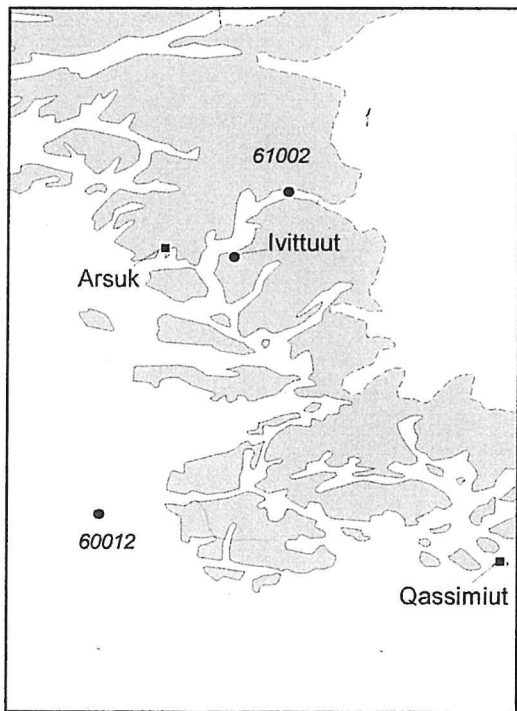
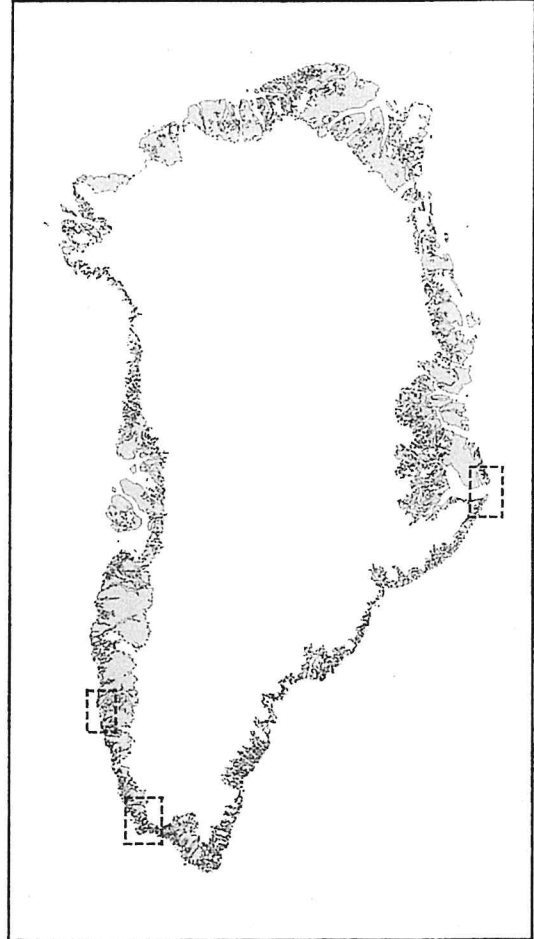
Murre colonies in the Uummannaq (extinct) and Illulissat regions.



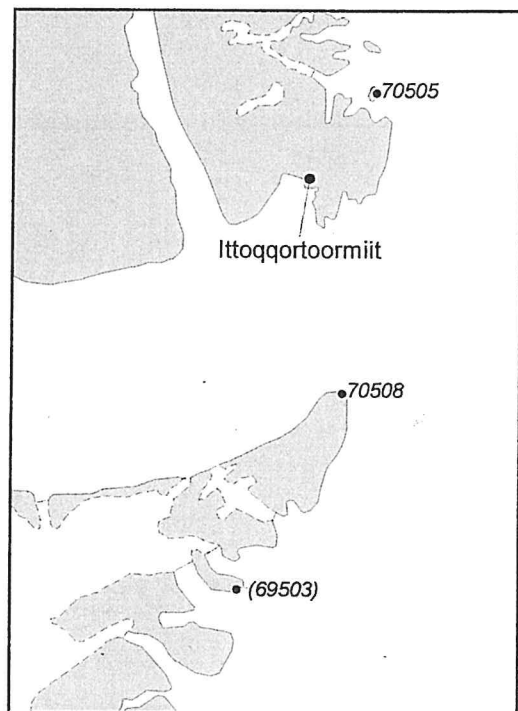
Murre colonies in the Maniitsoq region.



The remaining murre colony in the Nuuk region.



Murre colonies in the Paamiut/Qaqortoq region.



*Murre colonies in East Greenland.
Colony 69503 probably does not exist.*

2. Murre population monitoring

2.1 Basic murre biology

The life-cycle and breeding behaviour of the murres has some implications for the monitoring - and utilization - of the populations; hence a short summary is presented here.

Murres are colonial seabirds nesting on sea cliffs where they are safe from mammalian predators. Common Murres often breed on flat-top islands and broad ledges whereas Thick-billed Murres generally nest on narrower ledges. Occasionally, murres (especially Common Murres) may nest concealed in small caves or under boulders.

The young murres do not return to the colonies until they begin prospecting for possible breeding sites, usually in their natal colony, when 2 years old. A few birds will pair and sometimes breed when aged 3 or 4 years, but most birds are 5 years or older before they enter the breeding population. Murres commonly pair for life, although extra-pair copulations are frequent. A pair lay a single egg each year although a lost egg may be replaced after about two weeks. Both mates take shifts (approx. 12 hours) during the 32 day incubation period, and at least one of the parents will always be present to brood the chick and protect it against avian predators (Glaucous Gull and Raven) until „fledging“. The immature birds add to the pool of birds present, so the number of birds at any time will be slightly higher than the number of active breeding pairs. In most study populations the conversion factor, k , is approximately 0.7 breeding pairs per bird present at the cliff (see Gaston and Nettleship 1981; Gaston et al. 1983 and Harris 1989).

Murre chicks leave the nest at 16 - 28 days of age when they weigh only 200-250 g, 20-25% the weight of the adults. The chick cannot fly when it jumps from the cliff (accompanied by its father), but the wing coverts are sufficient for the chick to glide off the cliff and reach the water in a shallow angle. In some (sub)colonies, however, the chicks hit the ground and have to walk to the coast. Such sites are good for ringers to capture fledglings (and for Glaucous Gulls and foxes to feed).

With a single egg clutch a murre pair can produce almost one chick annually, but the average figure is about 0.7 chick per laying female, or 0.35 chick per adult breeder. Ring recovery (and resighting) data suggest that at most 50% of the fledged chicks survive to be recruited into the breeding population when about 5 years old. To counterbalance the low reproduction/recruitment rates, adult annual survival must exceed 90%, which has proved to be the case. The murres are typical avian examples of long-lived „ K -strategists“ - some of the birds at the colonies may well be as old as the biologists studying them.

During the breeding season the number of murres on the cliff changes. In spring, colony attendance patterns are irregular with mass-landings on some days and complete desertion on other days. Once laying commences the number stabilises and remains relatively constant until well into the fledging period (see Hatch & Hatch 1989 for a detailed account). The number also varies within a day, but the

pattern seems to differ between colonies and also changes during the breeding season. For instance, the number of Thick-billed Murres on the ledges in a high-arctic Canadian colony peaked at noon during the incubation period, whereas no clear peak was apparent during the chick-rearing period (Gaston and Nettleship 1981). Preliminary studies from Greenlandic colonies do not indicate pronounced within-day variations (see colony accounts).

2.2 Methods in murre census and monitoring

Methods and recommendations for breeding population surveys and monitoring have been given by Birkhead & Nettleship (1980), Gaston et al. (1993), Hatch & Hatch (1989), Harris et al. (1983), and Walsh et al. (1995). These papers, among others, are highly recommended and should be consulted, so here we only present summaries of techniques applicable and relevant in a Greenlandic context.

Colony census

The size of the colony is determined by counting the birds present on the cliffs - the unit being 'birds present' - either by direct counts on the site (from a boat or from land) or by counts from photographs. Each method has its pros and cons.

If sufficient time is spent, and conditions are optimal, direct counts hold the potential to be the most accurate since the observer can see the birds' movements and thereby often distinguish individuals in dense groups, or spot birds sitting in small caves or in dark shadow. The main problems with direct counts are 1) the risk of double-counting, or excluding, some sections of the colony, 2) the time needed under favourable weather conditions to carry out a complete count, especially at big colonies, and 3) difficulties with counting birds sitting very high on the cliff. Direct counts are most reliable at small colonies (<10 000 birds).

A major advantage of a photo count is that it only requires a relatively brief visit at the colony under fair conditions to collect the data, and that the count of the individual birds can be organized and carried out in-door without time constraints. Although they appear small on pictures, high-sitting birds may be easier to count on telephoto shots than through hand-held binoculars. So, photo counts may be most reliable in large colonies, and in colonies that cannot be counted from land (land based counting is possible in very few Greenlandic colonies). Drawbacks are 1) difficulties in distinguishing birds in groups, 2) difficulties in distinguishing birds in dark shadow, and 3) no opportunity evaluate data quality while still in the field (films to be developed back home).

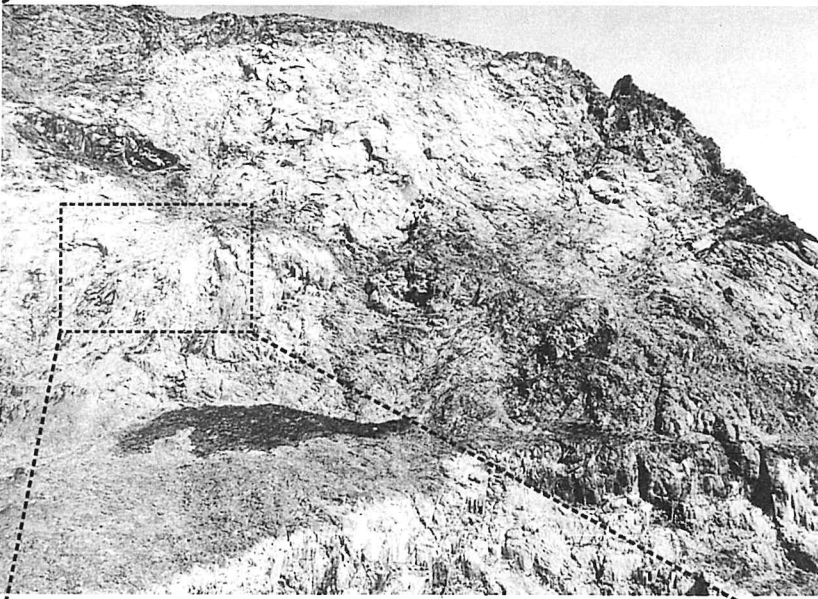
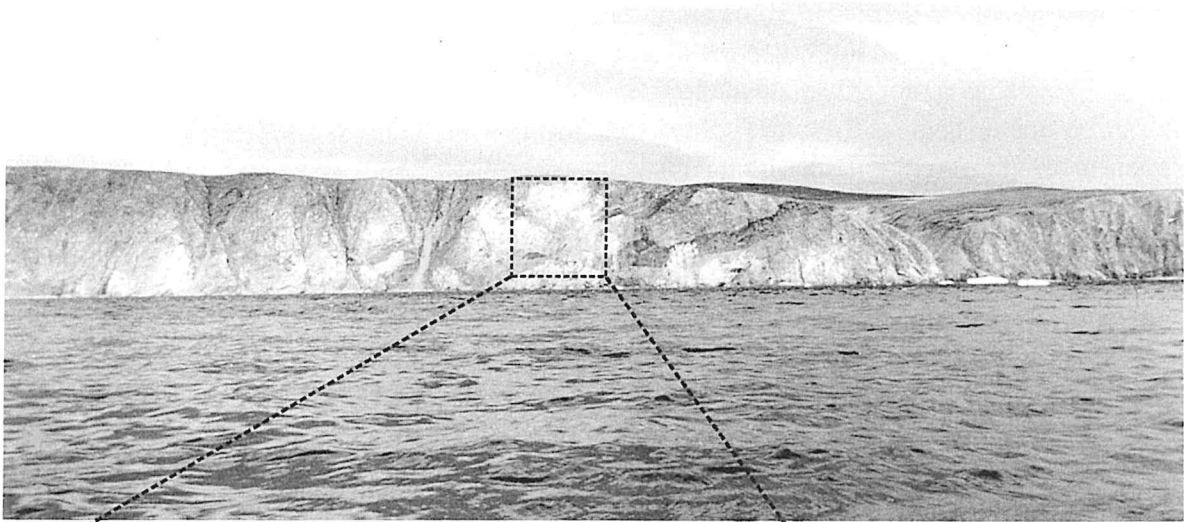
A common problem with both methods is that birds sitting on broad ledges high on a cliff, or in caves etc., may be out of view.

Both counting methods in principle provide an underestimate of the actual number of birds in the colony. For small groups of birds seen from a proper distance and angle, however, this bias is probably negligible. Birkhead & Nettleship (1980) recommend that photo counts are 'calibrated' in each colony by comparing direct and photo counts of certain distinct groups of birds (approx. 200 birds/group).

When photographing colonies for census purposes, two cameras (24 × 36 mm) are recommended: one for taking 'overviews' with a wide-angle or zoom lens, and one equipped with motor drive and a telephoto lens of approx. 200 mm to take a mosaic of 'count shots' of the entire colony (see the enclosed example from Parker Snow Bugt). For colonies on tall cliffs (birds sitting >100 m above the observer), a 300 or 400 mm lens is necessary. High-quality optical equipment is crucial to obtain useful 'count shots'. When photographing high-lying subcolonies, it is necessary to increase the horizontal distance to the cliff to get a better view (lower angle) to the birds on broad ledges. It is probably a matter of taste whether to use black/white prints or colour slides for counting, but the reference collection of 'count shots' from Greenland (1983 - 1995) almost exclusively consists of slides. Large B/W prints are recommended for the 'overviews', allowing the coverage of each 'count shot' to be marked on the print to prevent double-counting. By using slides for the 'count shots' - and a good projector - there is no loss of information from copying procedures; you work with the raw film used in the field. When taking 'count shots' with telephoto lenses, use a film of 100 ASA (maybe 200 ASA), and take plenty of pictures because some will be blurred. For the largest colonies we have used up to 20 rolls. The latest technology introduced in some telephoto lenses (Canon 300 mm f:4 L IS, and others) include electronic stabilisers serving as 'anti-shake-devices', and will probably be valuable tools in obtaining sharp census photos.

The total population counts will usually provide estimates too rough to be effective in detailed population monitoring (see below), but will be essential in substantiating major changes. Especially, photographic documentation of possible colony expansion or contraction is important to support other data on population change or stability. Furthermore, well-defined subcolonies offering good views can be identified in the photo reference collection and re-counted for comparison with new data.

The counting unit is 'number of birds present' which may be converted into an estimate of total number of breeding pairs by means of the k -factor. For Thick-billed Murres in Canadian colonies k values of 0.58 to 0.77 have been reported (Gaston and Nettleship 1981; Gaston et al. 1983). Since k should be calculated from detailed data on number of laying birds in study plots, requiring full-season field work (Type I studies *sensu* Birkhead & Nettleship (1980)), there are no colony-specific values available for the Greenlandic colonies. Furthermore, k may not remain constant between years - values of 0.73 to 0.77 were found in two subsequent years at Prince Leopold Island in Canada (Gaston & Nettleship 1981) - so unless specific values are measured, the 'average' k -factor of 0.7 may be applied for a rough estimate of the breeding population at any given colony and year.



View of the murre colony in Parker Snow Bogt (top) with one of the overview photos (middle) and one of the counting photos (bottom) used in counting the birds in 1987.

Timing of census and monitoring

For censuses intended to monitor changes in populations from year to year it is important to know the level of natural variation likely to be encountered (Gaston & Nettleship 1981). Counts in the colonies should be carried out when daily variation is low, and various studies have shown the late incubation to early fledging period to be the best period. Although there may be annual differences in local timing of breeding, the between-colony variation is greater than within-colony variation, and information on 'normal' laying/hatching/fledging dates are very useful in planning the field work. In the descriptions of each colony (or region) below, available information on breeding phenology is presented.

Also, local variation in daily attendance patterns should be considered when timing monitoring and colony census counts. Preferably, colony surveys should be carried out during periods of the day when the number of birds can be expected to be relatively constant (often mid-day). Although no long-term studies on colony attendance have been performed in any Greenlandic murre colonies, data are available from four colonies appropriate in a monitoring programme. For the sites in question we present data on day-to-day variation as well as within-day variation in number of birds in attendance, based on counts in a number of study plots. The four colonies are Hakluyt Ø (colony code 77002) in the Thule region, Kippaku (73009) in the Upernavik region, Ydre Kitsissut (60012) in Southwest Greenland, and Kap Brewster (70508) near Ittoqqortoormiit in East Greenland.

Counting in study plots

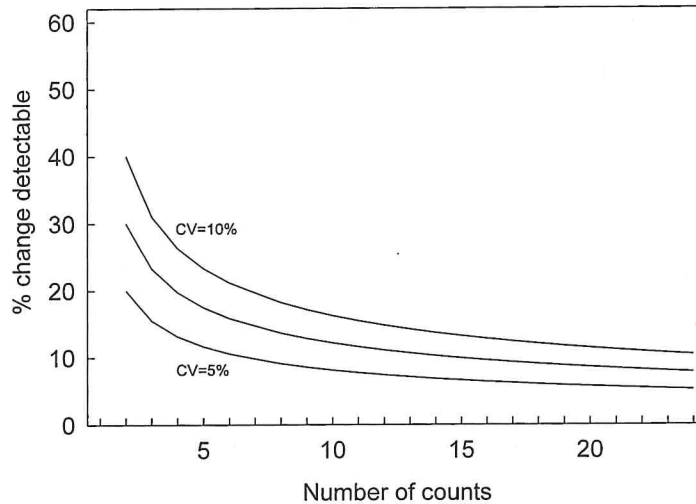
In population monitoring, repeated counts over a number of days provide average values and standard deviations of the number of birds in the colony - data that permits statistical comparisons with information from subsequent visits. For repeated counts a number of study plots should be selected and accurately defined on photos. A study plot is a selected area of the colony with natural outer limits where the birds can be accurately counted; a workable plot holds no more than 200-300 birds. Preferably the study plots should include all types of breeding ledges in densely as well as thinly populated parts of the colony, and ideally be selected at random among a large number of potential study plots (Walsh et al. 1995). In practice, however, one may just have to pick all 'usable' plots that can be viewed from land-based, safe observation points, even though they may be biased towards upper or lower parts of the colonies.

When selecting and counting study plots near cliff edges, observer safety is a major concern. Always make sure that the observation point is not dangerous to approach or sit at, and that it is not perceived as dangerous to new observers. A mountaineering harness connected to fixed 'anchors' (bolts, wedges etc. commonly used in climbing) at each observation point will provide optimal safety, and is highly recommended. Consult an experienced climber for further guidelines.

In order to use the data to monitor the populations, an observer (team) should perform daily counts approximately at the same time each day for about 10 days. Count the individual birds one-by-one. Weather affects the number of birds present, with few birds in the colony on days with very strong winds or generally foul weather, so do not force yourself to count under very poor conditions - you

will only get a larger standard deviation that will reduce the chances of detecting population changes.

Ideally, a colony should be monitored annually. That is not feasible, however. Instead, each monitored colony could be visited every two to four years, and any population trends detected by linear regression analyses of study plot data.



Even such intervals may not be possible, and monitoring may have to be based on census work carried out at five to ten year intervals. Since there is some annual variation in numbers of birds in the colonies (see example for colony 77002, Hakluyt Ø, below), baseline data should preferably be collected for at least three years in succession to assess natural variation. In Greenland no colonies have been visited that regularly, and in most cases recent information covers one census year only, calling for cautious interpretation of small colony changes. To compare baseline data with repeated study plot counts from subsequent surveys (years later), use the student's *t*-test. Based on existing baseline data and tabulated *t*-values, one can estimate how large population changes that may be detected with statistical significance, using the formula

$$\text{percent detectable change} \geq \sqrt{\frac{n_1 + n_2}{n_1 n_2}} \cdot CV \cdot (t_{\alpha/2} + t_{1-P})$$

where n_1 and n_2 are the number of (repeated) counts in the first and second census year, respectively, CV is the coefficient of variation (standard deviation * 100 / mean), P is the chosen power of the test (e.g. 80%, the probability of detecting the change), while $t_{\alpha/2}$ and t_{1-P} are values from a table of one-tailed *t*-values with degrees of freedom $df=n_1+n_2-2$ (see Hatch & Hatch (1989) and Wanless et al. (1982) for similar approaches). For example, study plots at Kap Brewster in East

Greenland were counted at nine days in 1995; the CV was 7.5%, so if the same study plots are counted for 10 days during a new monitoring survey, a population change of 11% could be detected with a significance level of 5% ($P < 0.05$); if 21 counts are carried out during the new census, a 9% change will be detectable (see enclosed graph). Since the figure improves very little with each additional count when counting more than about 10 days, it is not recommended to continue counting for prolonged periods unless the purpose is to identify optimal periods (least CV) for future surveys.

Monitoring data storage

Complete colony census data should be stored in the Greenland Seabird Colony Database (GM & OC 1993), currently managed by National Environmental Research Institute, Dept. of Arctic Environment. Although no central data storage facility (data base) has been established for data on repeated counts in study plots and other population monitoring data, these pieces of information should be kept by the Greenland Institute of Natural Resources in Nuuk.

3. How to work at each colony

3.1 Baseline data from Greenlandic colonies

This manual deals with all the known murre colonies in Greenland. Colonies unknown to us may exist, but the chance of finding any is small: the late Dr. F. Salomonsen visited the entire west coast repeatedly between 1925 and 1980 and interviewed many people in each district who had an intimate knowledge of their area and its wildlife. The few times we have ourselves been told of the existence of a small „unknown“ murre colony we subsequently found that Razorbills, not murres, were present at the site. The single putative murre colony not verified or disproven at this time is at Kap Christian (Kangersuasik, 59°48'N 44°07'W; local hunters via H.C. Petersen & H. Siegstad, pers. comm.).

It is a matter of definition when nearby cliff sections with breeding murres should be considered subcolonies or distinct colonies. This rather trivial question has not been considered in this manual, and several inconsistencies occur. For example, we treat Carey Øer as one colony although each of the three islands with murre colonies are represented by separate colony codes in the Greenland Seabird Colony Database (GM & OC 1993), and a field observer will recognize 12 subcolonies.

Colony census data

Between 1983 and 1995 all the (known) Greenlandic murre colonies have been surveyed at least once (see Kampp et al. 1994, Boertmann et al. 1996, Falk et al. 1997). Most counts have been carried out as photo counts (by Kaj Kampp), and the original photographs have been handed over to the Greenland Institute of Natural Resources, GINR (by January 1997). Since the photos are the original reference material, they are only available at the GINR in Nuuk. The collection consists of 187 'overview' photos and 1559 'count shots' accompanied by 90 hand-drawn sketch-maps of the coverage of each 'count shot' (see list below).

As a general recommendation for future monitoring, new field workers should photograph easily identifiable sections of the colonies and compare counts of the new photos with re-counts of relevant photos in the reference collection. Only observers with considerable personal experience in murre colony work should count the birds on the photos, since an effective 'search image' will depend on familiarity with live birds at breeding sites.

Notes on the colony account

In the colony account below, the 5-digit colony codes refer to the unique numbers for each colony as defined in the Greenland Seabird Colony Database (GM & OC 1993); the first two digits in the code refer to the colony's latitude zone. In Greenland local place names are replacing former names of Danish origin. But since most available maps still use the old names (even in the old pre-1973 spelling), and since some Greenlandic names are common to several colonies, we

List of photographic reference material deposited at the Greenland Institute of Natural Resources.

| Colony (code) | Year | No. of overview photos | No. of count photos |
|--------------------------|------|------------------------------|---------------------------|
| Thule | | | |
| Hakluyt Ø (77002) | 1987 | 20 | 140 |
| Saunders Ø (76014) | 1987 | 48 | 312 |
| Parker Snow Bugt (76013) | 1987 | 24 | 168 |
| Appat Appai (76012) | 1987 | 17 | 111 |
| Upernavik | | | |
| Apparsuit (73010) | 1983 | 23 | 287 |
| Kippaku (73009) | 1983 | 3 | 33 |
| Sandersons Hope (72008) | 1983 | 1 | 29c |
| Kingittoq (72014) | 1983 | 4 | 49 |
| Appatsiaat (72013) | 1983 | 3 | 11 |
| Ilulissat | | | |
| Ritenbenk (69049) | 1984 | 2 | 30 |
| Maniitsoq | | | |
| Taateraak (65019) | 1988 | 6 | 79 |
| Sermilinnuaq (65015) | 1987 | 9 | 71 |
| - annex (65013) | 1987 | 2 | 32 |
| Isortoq (65003) | 1988 | 4 | 32 |
| Paamiut | | | |
| Arsuk Fjord (61002) | 1983 | 2 | 18 |
| Scoresbysund | | | |
| Kap Brewster (70508) | 1995 | 13a | 116b |
| Raffles Ø (70505) | 1995 | 6 | 41 |

a: B/W with transparent overlays

b: incl. 10 B/W prints

c: incl. 5 „semi-overview photos“

here adhere to the old „well-known“ colony labels (alternative names are given in parentheses). For most other names (towns etc.) the Greenlandic terms are used.

An evaluation of general working conditions and logistics for each colony is included in the *general description* for each colony. For some colonies we include a section on *recommendations for monitoring*, where colony-specific details or data relevant for census and monitoring work are presented. For all other colonies the general methods and recommendations presented above should suffice.

All Greenlandic seabird colonies on cliffs are protected by a no-disturbance zone of 5 km, where shooting and noisy behaviour is prohibited during the breeding season. In the sections on *protective status* we therefore only specify if the respective site is designated as breeding refuge for birds, an 'Important Bird Area' (IBA) sensu Grimmet and Jones (1989) or a 'Ramsar site'. The IBAs are identified by Birdlife International only, whereas the Ramsar sites are designated according to an international treaty signed by Denmark/Greenland. However, none of these protection categories are implemented through Greenlandic legislation.

3.2 *Avanersuaq (Thule)*

There are five murre colonies in the Thule region that combined hold more than half of the total Greenlandic breeding population. The colonies are all situated at or near the North Water Polynya, which is a partially ice-free area between Greenland and Ellesmere Island in Canada.

Due to the large size of the colonies and a small human population in the region, the colonies are not heavily utilized, and the murre population in the area appears to be 'healthy' and probably stable (Kampp et al. 1994).

The murres of the region are breeding very late. Available information suggests that hatching occur in early to mid-August (see details below), so colony monitoring and census work should be planned to take place from late July to mid-August. Apart from the Carey Øer all the murre colonies are large, and since they are all situated at exposed coastlines where wind or ice conditions rarely permit prolonged stays in a small boat we recommend that any major census work is carried out as photo counts.

Hakluyt Ø (Appaarsuit)

Colony code 77002

Position 77°26'N 72°40'W

General description

Hakluyt Ø measures about 4.8×2.2 km and peaks at 421 m. The north and east coasts are high and steep with extensive scree below the cliffs. The south coast is low, but inland the sloping coastal plain soon meets a wall of steep cliffs and talus slopes. The western part of the island is rather low, about 100 m in height. Between it and the eastern „mountains“ is a valley with a stream.

The island lies adjacent to the North Water, a recurrent or semi-permanent polynya, so that more or less ice-free conditions prevail most of the time. Access by boat hence is possible throughout the breeding season of murres, but severe limitations for visits by sea are posed by ice conditions at the other end of the trip: fast ice blocks the North Star Bay at Thule Air Base (TAB) until mid-July, and Inglefield Bredning at Qaanaaq until mid or late July. Access before that time must use helicopter. At the moment (1997), the only helicopter normally available

in the area is Greenlandair's B 212 which is expensive to hire but on the other hand provides enough capacity for a fairly large team and/or supplies for a lengthy stay at the island. It will be difficult to find a patch of ground where Twin Otter aircraft can land and take off.

Boat landings can best be made at the south coast at the valley. On rare occasions this coast may be blocked by pack ice, as happened in 1996; in that case it is possible to enter or leave by the north coast just east of the valley, but this implies a 100 m climb of a 45° slope and can definitely not be recommended.

A helicopter can safely approach from the south, flying up the valley, provided it does not come too close to the huge Dovekie colony along the eastern and southeastern mountain slopes. It should leave by the same route and avoid the north coast where the risk of a birdstrike, and of massive disturbance of the birds, is considerable.

A flat area suited as a campsite exists just west of the upper valley, close to the stream from which freshwater should be available throughout the season.

The seabirds

By far the most abundant seabird on Hakluyt Ø is the Dovekie with probably several hundred thousand breeding pairs. They breed in scree along the entire southern mountain slope and much of the southeastern slope, more patchily on the northeastern slope, and in addition in many places in scree below the steep east and north coast cliffs. A few also breed in crevices high on the cliffs along the entire north coast.

Other alcid species (apart from murres) are Black Guillemots (80-90 birds visible from land in 1996, most along the southeastern coast, while 235 birds were counted when circumnavigating the island in 1997) and Razorbills and Puffins, 2 and 30 of which, respectively, were seen at the western tip on 5 August 1987; both species appeared to be absent in 1996, but 4 Razorbills and at least 18 Puffins were present in 1997.

The only other seabirds are Kittiwakes, a few thousand nests along the north coast and especially on the northeast stacks, and Glaucous Gulls, about 50 pairs scattered around the island.

The murre colony

The murres breed discontinuously along the north and northeast coast, from the western tip to about midway between the northeast and east points of the island. The subcolony structure is not very conspicuous owing to the existence of numerous small groups of murres and the light colour of the cliffs.

The murres are concentrated particularly around the northeast point, including the tall stacks here which are occupied right to the top about 400 m ASL. This area holds about 60% of the entire colony. West of the valley the murres are rather few, totalling less than 10% of the colony.

Murre counts

A total colony census has only been made once, from photos obtained on 5 August 1987 (Kampp 1990) on which a total of 37 000 murres present on the cliffs could be counted. The only other information is from Salomonsen (1950) who saw the island from some distance on the night of 9-10 August 1936 and listed the colony as „fairly large“, and from Vaughan (1988) who visited the island by helicopter on 19 June 1985 and counted 2500 murres high on the stacks at the northeast point. A photo survey was conducted in 1997, and the results will be presented in a separate report.

The northeastern stacks were counted by us on 2, 5 and 7 August 1996, yielding 1108+2176+1543+1169 murres for the four stacks, reckoned from the left as seen from the vantage point just below the cairn at the top of the island. The total was 5996, well above the number counted by Vaughan (1988); he probably used a vantage point close to ours, but the discrepancy could be caused by different delimitations of the counted area, counts at different times of the year, or of Vaughan's counts being made from photos and ours directly.

Study plots

Nine study plots were laid out in the 1996 season when we stayed on the island from 18 July to 12 August. Five were on the northeast stacks and, if wished, several more could be defined there. Two plots (C and D, see appendix B) were just east of the valley and two, A and B, at the western end of the north coast. All plots were well suited as counting plots but, owing to the distance from the observer, only A, B and perhaps C have potential for detailed studies of reproduction and feeding. However, to the left of plot C, a group of murres allow detailed studies from a hide. Access by rope is possible at A but difficult at the other plots, although birds outside the defined plots can be reached to the left of plot C, and below the observation point of plot C.

Breeding phenology

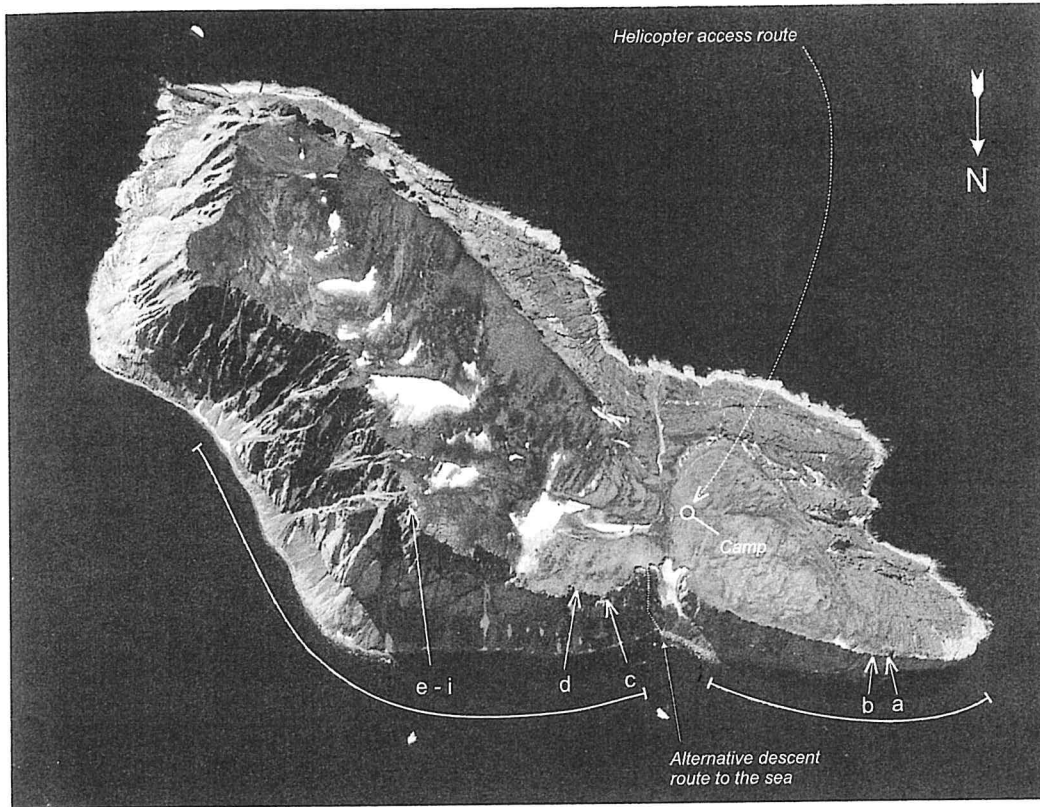
Best data are available from 1997, which may be considered a 'normal', or even an 'early' year. The median hatching date for 58 eggs was 3 August (mean 4 August); the first egg hatched 26 July and the latest at 16 August. In 1996 the birds were affected by inclement weather during the entire breeding season. Egg measurements indicated that the murres laid one week later in 1996 compared to 1997. In 1996 an egg (almost certainly a relay) was laid (and lost) as late as 28 July. The first fish-carrying murres that year were seen on 3 August, indicating that hatching had just started. A ledge visited on 4 August had 41 eggs (one pipped) and one chick.

Breeding success

No data.

Ringling

A few adult murres were ringed on Hakluyt Ø in 1996 and 1997 in connection with other study activities. Several ledges are accessible using climbing equipment so, although conditions are far from ideal, a substantial number of adults and chicks could be ringed if sufficient time and effort was set aside for the job.



The approximate extent of the murre colony at Hakluyt Ø (Appaarsuit, colony 77002) with recommended observation points (letters) for the 9 study plots (see plot boundaries in appendix B), access routes and camp location. From KMS aerial photo # 885 B/2714 of 25 July 1985.

Protective status

Hakluyt Ø (Appaarsuit) is designated an Important Bird Area.

Recommendations for monitoring

Owing to prior work done in this colony it may, better than any other, represent the 'undisturbed' colonies of the Avanersuaq region.

The 1987 photos, deposited at the GINR should be compared with new data in order to:

- assess if the colony has expanded or contracted since the 1987 base line data were collected;
- identify major population changes in selected larger sections of the main colony that can be easily identified and delineated on both sets of photos (1987 and new set).

A 400 mm telephoto lens will be required for the highest points in addition to a 180 or 200 mm lens applicable at the lower subcolonies. The photos should be taken from a boat positioned at varying distances from the coast - about 400 m for the telephoto shots of the upper sections, and about 150-200 m for other parts of the colony. Birds on the high northeastern stacks can best be counted or photographed from land, from a position about 100 m NNW from the large cairn on the highest peak of the island.

Hakluyt Ø has been selected as one of the reference colonies where population changes can be monitored by repeated counts in study plots (see boundaries in appendix B). Data on day-to-day variation as well as within-day variation are shown in graphs below.

Statistics on number of murres present in study plots during two contrasting years. Data for 1996 are from the period 25 July to 8 August, and for 1997 data derive from 19 July to 19 August.

| Plot | 1996 | | | 1997 | | | Difference |
|-------|--------|------|----|--------|------|----|------------|
| | Mean | SD | n | Mean | SD | n | % |
| A | 63.0 | 15.1 | 15 | 70.7 | 10.3 | 24 | 12 |
| B | 185.1 | 27.3 | 15 | 196.8 | 30.6 | 24 | 6 |
| C | 174.3 | 12.3 | 15 | 187.9 | 19.6 | 23 | 8 |
| D | 177.8 | 20.7 | 15 | 197.8 | 15.4 | 23 | 11 |
| E | 178.8 | 14.4 | 14 | 180.3 | 15.4 | 13 | 1 |
| F | 157.6 | 9.8 | 14 | 167.5 | 12.9 | 13 | 6 |
| G | 95.1 | 7.7 | 14 | 99.9 | 6.8 | 13 | 5 |
| H | 66.6 | 5.4 | 14 | 66.5 | 6.7 | 13 | 0 |
| I | 95.9 | 6.8 | 14 | 106.1 | 6.5 | 13 | 11 |
| A - D | 613.6 | 50.5 | 14 | 655.0 | 63.8 | 22 | 7 |
| All | 1207.6 | 70.9 | 14 | 1254.1 | 63.7 | 12 | 4 |

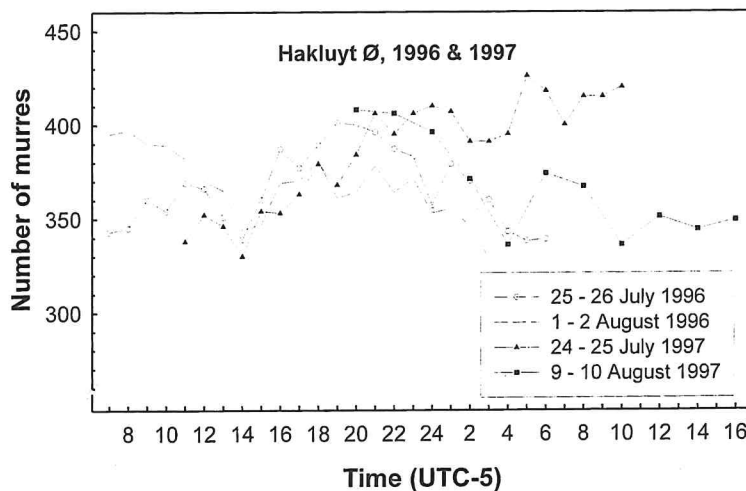
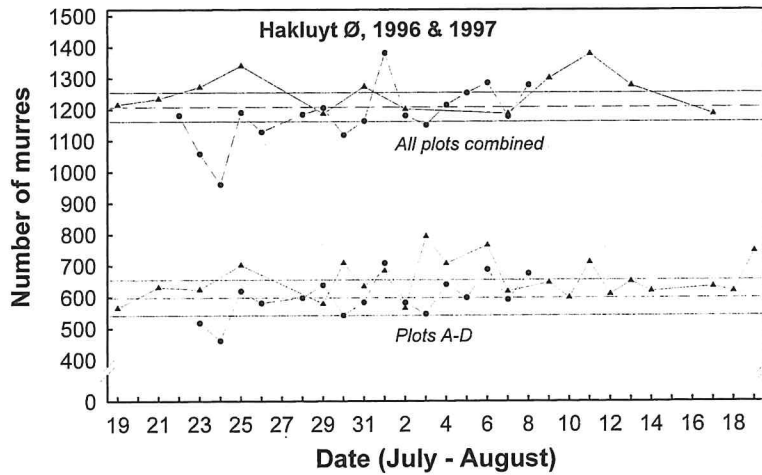
Daily counts in the defined monitoring plots at 14 days between 25 July - 8 August 1996 (mid to late incubation period) revealed: mean = 1207, SD = 70.9 (CV = 5.8%), $n = 14$. Similar counts from 1997, covering the period 19 July - 19

August, revealed: mean = 1254, SD = 63.7 (CV = 5.1%), $n = 12$. In 1997 the four study plots E-I on the top of the island were only counted every second day (weather permitting), while the lower plots at A-D were counted daily. To allow comparisons, data from A-D and all data combined are presented in the table, and in the enclosed graph; dashed lines represent 1996, and the horizontal lines indicate means for the two years. On average the study plots contained 4% more birds in 1997 than in 1996, when weather was poorer (the difference is not significant). It is well known that in periods of poor weather, fewer birds are present at the nesting ledges, and similar between-year differences have been recorded in Thick-billed Murre colonies in the Canadian high Arctic (Gaston & Nettleship 1981).

There appears to be no distinct daily variation in attendance patterns, except that a small low seems to occur about 14 hours local sun-time (see graph below). Hence, the timing of plot counts and census work is not very important. Since the murre colony is situated at a north-facing cliff, night time is best suited for boat-based census work.

References

Kampp (1990), Salomonsen (1950), Vaughan (1988).



Carey Øer (Kitsissut)

Colony codes 76007, 76008, 76009

Position 76°44'N 73°05'W

General description

Carey Øer is an archipelago of small mountainous islands situated c. 50 km from the mainland. The biggest island is Nordvestø, about 3 km across. Steep cliffs exist at many places but generally some way inland, so mostly the coasts are low. Access from the sea should pose no problems since the islands are rarely ice-bounded in summer; the major limitation is at the starting point of the boat trip because of the ice conditions at TAB and Qaanaaq (see Hakluyt Ø). Helicopter landings are fairly easy and not hampered by the presence of Dovekie colonies, contrary to the situation in most other murre colonies in Thule. Suitable campsites can be found at many places along the coasts, e.g. in northwestern Isbjørneø, and a cabin exists at the DMI automatic weather station at northeastern Nordvestø.

The seabirds

In the same area as the murre colonies are found small numbers of breeding Black Guillemots and Glaucous Gulls (30 birds and 5 pairs, respectively, on Isbjørneø). On the south coast of Hollænderhatten is a mixed colony of Razorbills and Puffins (12 and 60 birds, respectively, on 11 August 1987). The other islands have not been investigated but do not appear to house any seabirds other than Black Guillemots and Glaucous Gulls.

The murre colony

The murres are concentrated to the straits between Nordvestø, Isbjørneø and Mellemø (see attached map). F. Salomonsen (unpublished data) suggested a subdivision into subcolonies reproduced in the figure. These subcolonies were fully recognizable during our visit in August 1987 although some of those at northern Isbjørneø were small and indistinct (numbers given in next section).

Murre counts

F. Salomonsen (1950 and unpublished data) visited the Carey Øer repeatedly and estimated murre numbers: 10 August 1936, 20 000 birds; and 6-10 August 1968 and 27 July 1973, 14 150 birds. Only partial counts are available from Salomonsen's visits in 1975 and 1978. Kampp (1990) counted a total of 6700 murres on 10 August 1987, directly and from photos.

The table below compares Salomonsen's subcolony counts from 1968 (with amendments from 1973) with ours from 1987. Minor discrepancies could be due to slightly different definitions of subcolonies but this cannot explain all the differences. It is our belief that Salomonsen overestimated murre numbers considerably and that the suggested population decline is more apparent than real.

Study plots

Although it might be possible to use parts of the murre colonies at northwest Isbjørneø as study plots (especially F), it will be very difficult to find a suitable vantage point. We do not recommend detailed studies in the Carey Øer murre colony, tempting as it might seem for other reasons (access, presence of a hut and good campsites).

| Island | Subcolony | 1968 | 1987 |
|-----------------|-----------|------|------|
| Isbjørneø 76007 | A | 1200 | 400 |
| | B | 1800 | 1280 |
| | C | 200 | 180 |
| | D | 350 | 440 |
| | E | 50 | 70 |
| | F | 6000 | 2350 |
| | G | 200 | 210 |
| | H | 800 | 440 |
| Mellemø 76008 | J | 150 | 80 |
| Nordvestø 76009 | K | 2800 | 1050 |
| | L | 300 | 90 |
| | M | 300 | 110 |

Breeding phenology

About 25% of the eggs had hatched on a few ledges we climbed to on 9 August 1987.

Breeding success

No data.

Ringling

A few adult murres were ringed during our visit in 1987 and, although it would take a major effort, a good deal more could be ringed if so wished. The main attraction of the locality as a ringling site for murres, however, is that many of the chicks obviously must walk some distance overland when leaving their ledges. The breeding cliffs in question hold rather few murres but may nevertheless offer one of the best opportunities in the Thule area for ringling murre chicks.

Protective status

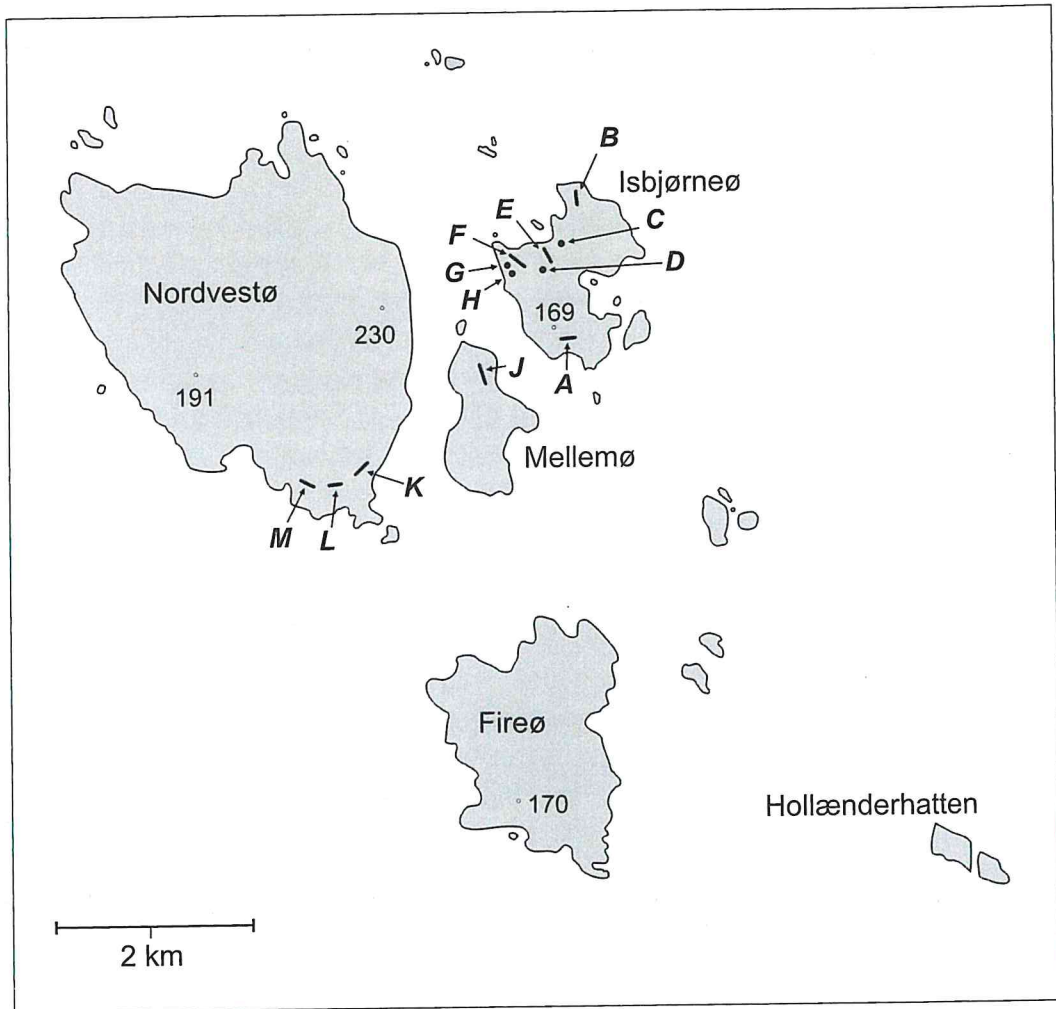
The Carey Øer is designated an Important Bird Area.

Recommendations for monitoring

Since all the subcolonies are small and can be counted from land with binoculars or telescope, no photo count has been carried out. A boat is required for navigation between the islands.

References

Kampp (1990), Salomonsen (1950).



Position of the murre sub-colonies at the western Carey Øer (Kitsissut, colony 76007 - 76009).

Saunders Ø (Appat)

Colony code 76014

Position 76°34'N 70°00'W

General description

Saunders Ø, measuring about 15×7 km, is situated just west of TAB; the distance from the western end (with the murre colony) is only about 34 km. The island is mountainous but helicopter landings are possible, making this big murre colony an attractive study site. Unfortunately, other characteristics appear less ideal, although no thorough examination of the conditions has been performed.

A stony beach just east of the west point on the south coast offers access from the sea and provides a place where an inflatable can be stored, and from where it can be launched.

The seabirds

Seabirds other than murres are Fulmars, probably about 5000 pairs, Kittiwakes (several thousand) and low numbers of Glaucous Gulls and Black Guillemots (Kampp 1990); the observation of a single Puffin flying close by on 7 August 1987 suggests that even this species breeds at the site. The description concerns the west end of the island at the murre colony; other parts of the island appears to hold few if any seabirds.

The murre colony

The murres breed in many distinct subcolonies along the western 6 km of the north coast and in a huge assemblage along the westernmost 2 km of the south coast. The subcolony structure has not been described in detail, but the southwestern main colony holds about 45% of the murres.

Murre counts

During a circumnavigation of the island on 13 August 1936 Salomonsen (1950) estimated murre numbers at 200 000 birds. Vaughan (1988) visited the island by helicopter on 19 June 1985 and „thought that there were more than 1000 but fewer than 10 000 breeding pairs of murres“ in (unspecified) parts of the colony, believing he saw the entire colony. Counts of photos obtained on 7 August 1987 yielded a total of 143 000 murres (Kampp 1990).

Study plots

It must certainly be possible to lay out study plots in this big murre colony. The major obstacle seems to be that great distances over mountainous terrain have to be walked between the camp and the likely study plots, and between plots. A closer look may prove this fear unfounded, however, since a thorough examination has yet to be carried out.

Breeding phenology

A small ledge seen during a very brief visit on 7 August 1987 had 3 eggs and one chick.

Breeding success

No data.

Ringling

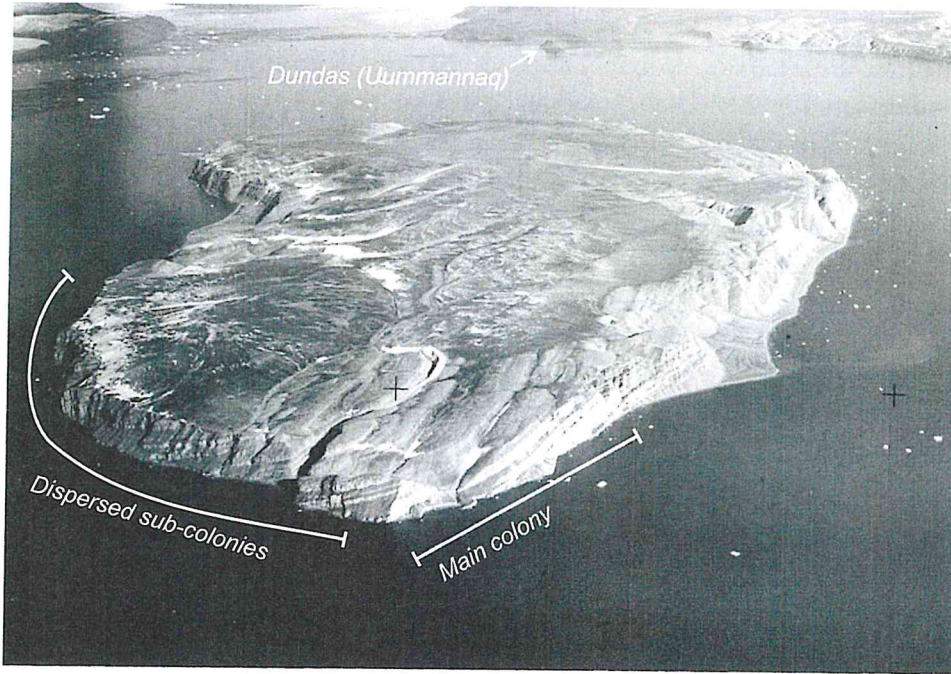
Just as the laying out of study plots „has to be“ possible in such a big colony, it should certainly be possible to find suitable areas for ringling of murres. But, again, a closer examination of the possibilities has never been made.

Protective status

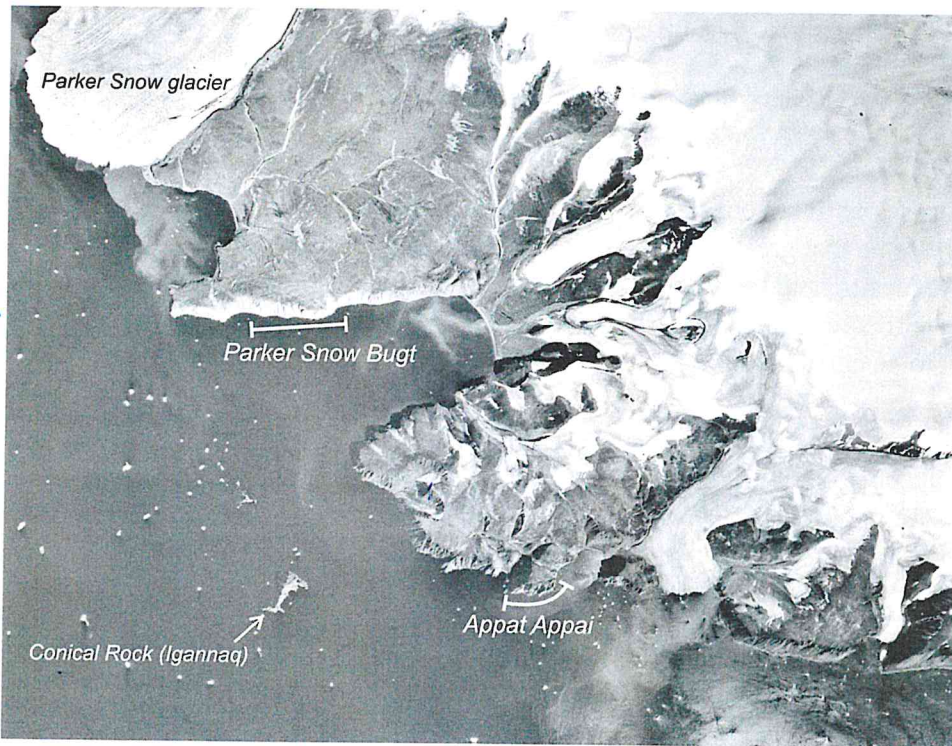
The colony is designated as an Important Bird Area.

Recommendations for monitoring

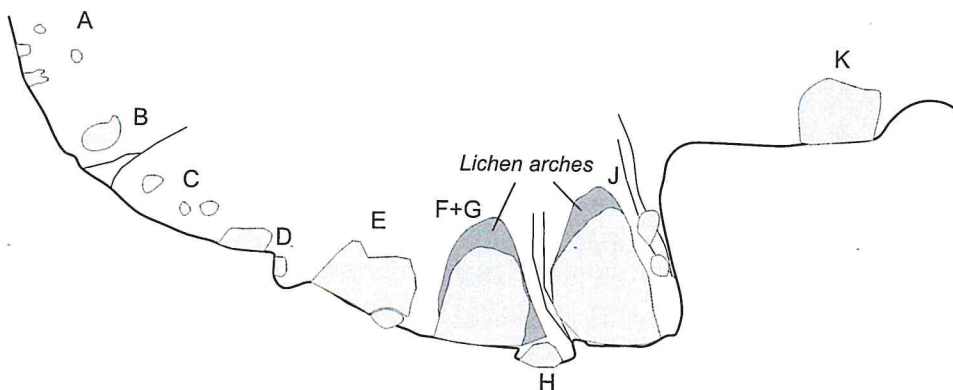
In monitoring this colony a check of the subcolonies along the northern coast would be particularly interesting. Many of these are small and quite distinct. New subcolonies may be established if the colony is increasing and the main colony



Saunders Ø (Appat, colony 76014) in Avannersuaq. From KMS aerial photo # 546A/48 of 21 August 1984.



The murre colonies Parker Snow Bugt (Issuivissuup Appai, colony 76013) and Appat Appai (76012) in Avannersuaq. From KMS aerial photo # 885 J 2917 of 25 July 1985.



Subcolonies of the Appat Appai colony (76012). Dark-shaded areas are impressive lichen arches above the main nesting areas.

'saturated', and in the case of a population decline, the subcolonies would likely be the first to show contractions.

For a photo count long telephoto lenses would be useful in the main colony.

References

Kampp (1990), Salomonsen (1950), Vaughan (1988).

Parker Snow Bugt (Issuvisuup Appai)

Colony code 76013

Position 76°10'N 68°40'W

General description

This murre colony is situated along 2-3 km of the north coast of the bay. Access to parts of the occupied cliffs may be possible by a valley just east of the colony, but generally the colony looks unsuitable for land-based studies. A possible campsite as well as a hut is at the head of fiord where landing from boat is easy. The fiord may occasionally be blocked by pack-ice in summer, even after boat traffic from TAB has been become possible.

The seabirds

Seabirds other than murres are Kittiwakes (a few thousand) and low numbers of Glaucous Gulls and Black Guillemots (Kampp 1990); also, four Razorbills were seen on the cliffs during our visit in 1987, suggesting that even this species breeds at the site. Many Dovekies breed in talus just east and west of the murre colony as well as elsewhere in the vicinity.

The murre colony

This murre colony is rather compact and, being situated along a straight coastline, can be overviewed in its entirety from a single point. A subdivision into 15-20 more or less well-defined subcolonies can be made but has not been attempted, and no subcolony codes have been given. The greatest concentration of murres (55% of the colony) is along the central 20% of the occupied coastline. This part of the colony is also the highest, with birds breeding up to several hundred meters ASL.

Murre counts

Salomonsen (1950) did not see this colony in 1936 but heard it described as a rather small colony. He saw it from a distance on 23 August 1973 and estimated its size at 100 000 birds, and suggested the same on 15 August 1978, when rough seas precluded a close approach of the colony (F. Salomonsen unpublished data). Counts of photos taken on 14 August 1987 gave a total of 50 000 murres (Kampp 1990).

Study plots

The colony has never been examined in detail with the aim of assessing its suitability for land-based studies, but from its appearance the possibilities are not good.

Breeding phenology

No data.

Breeding success

No data.

Ringling

The prospects of ringling large numbers of murres at this colony are poor.

Protective status

The colony is designated an Important Bird Area.

Recommendations for monitoring

For a photo count long telephoto lenses will be required for obtaining suitable shots of the upper cliff sections.

References

Kampp (1990), Salomonsen (1950).

Appat Appai

Colony code 76012

Position 76°05'N 68°25'W

General description

This murre colony is situated along about 4 km of the promontory Qaarusussuaq. Access to parts of the colony looks difficult but may be possible from the base of the promontory. A campsite may also be found here, most likely in the bay east of the colony. The sea around the colony may occasionally be blocked by pack-ice throughout the summer (see cover photo).

The seabirds

Seabirds other than murres are Kittiwakes (about 5000) and low numbers of Glaucous Gulls and Black Guillemots (Kampp 1990). Dovekies seem to breed nearby, but not immediately adjacent to the colony.

The murre colony

This murre colony presents a magnificent view, with a mixture of bright orange (from nitrophilous lichens) and white-chalked cliff sections. About 10 subcolonies may be distinguished, of which those of the south-exposed head of the promontory are the highest and the biggest (about 60% of the murres). From his visit in 1978 F. Salomonsen (unpublished notes) sketched the colony, with letter codes for 9 subcolonies, but these could only be approximately identified by us in 1987.

Murre counts

Salomonsen (1950) did not have the opportunity to count this colony in 1936, but estimated it very roughly at 100 000 birds from a moving ship at midnight on 16-17 August that year. When revisiting the colony on 23 August 1975 and 15 August

1978 he estimated, respectively, 100 000 and 117 000 murres on the cliffs. From photos obtained on 13 August 1987 we counted about 48 000 murres (Kampp 1990).

A comparison between our count figures and those of F. Salomonsen is as follows, broken down according to subcolonies as we interpret Salomonsen's notes:

| Subcolony | Salomonsen 1978 | authors 1987 |
|-----------|-----------------|--------------|
| A | 3000 | 1966 |
| B | 2000 | 2439 |
| C | 2000 | 1411 |
| D | 10000 | 7374 |
| E | 30000 | 6330 |
| F+G+H | 50000 | 11974 |
| J | 10000 | 9355 |
| K | 1000 | 6550 |

It is our belief that no change in numbers took place between these counts, but that different techniques and circumstances during the count visits alone explain the apparent differences. Salomonsen himself stated in his notes that he was hindered by the prevailing weather and rough seas in making a proper census.

Study plots

The colony has never been examined in detail with the aim of assessing its suitability for land-based studies, but the possibilities are probably not good.

Breeding phenology

No data.

Breeding success

No data.

Ringling

The prospects of ringling large numbers of murres at this colony are poor.

Protective status

The colony is designated an Important Bird Area.

Recommendations for monitoring

For a photo count long telephoto lenses will be required for obtaining suitable shots of the upper cliff sections.

References

Kampp (1990), Salomonsen (1950).

3.3 Upernavik

The Upernavik region holds one of the largest murre colonies in Greenland (Apparsuit), but also a number of rapidly declining or extinct small colonies. The still thriving colonies are situated in the northern part of the region far from Upernavik town, while the easy accessible colonies in the southern region (south of 73°N) suffer from decades of overexploitation (Boertmann et al. 1996; Kampp et al. 1994).

Murre eggs will normally hatch in late July in this region (see details below), so colony monitoring and census work should be planned to take place from mid-July to early August. Murres in the southern part of the region may breed slightly earlier than those in the northern part.

Most information on breeding success, phenology and *k*-factors from Greenlandic colonies stems from studies at colonies in Upernavik; the data are summarised below.

Apparsuit (Kap Shackleton)

Colony code 73010

Position 73°48'N 56°47'W

General description

The island of Apparsuit has an area of about 6×4 km and reaches a peak of 658 m. The murres breed in several subcolonies along the entire south side, from slightly above sea level to about 200 m and locally extending up to 400 m.

On the northeast coast of the island is a bay which provides an excellent landing site for a small boat, and from where there is an easy walk to the top of the island. From the edge above the murre cliffs it is possible to view many ledges from a distance, but a close approach looks difficult and has never been attempted by ornithologists. Greenlanders have climbed to occupied ledges from below, but we do not advise anybody to repeat such a stunt.

In most years ice probably breaks up around Apparsuit in mid-June or earlier. Glacier ice is found throughout the summer but will not normally restrict boat traffic. In 1987 it was possible to land a study team from the KNI ship servicing the district's northern settlements from Upernavik town.

The seabirds

Apart from the murres Apparsuit supports two thousand Kittiwake pairs, about 125 pairs of Glaucous Gulls, and a few Razorbills and Black Guillemots.

The murre colony

The colony consists of about 18 distinct subcolonies which was first described by Joensen & Preuss (1972), who introduced the letter codes adhered to even by later visitors (also see their photo mosaic of the cliff). These subcolonies vary enormously in size, and a few may be unstable - at least, some visitors have found no murres where both earlier and later visitors did record murres present.

Murre counts

Salomonsen (1950) visited the colony on 26 July 1936 and estimated the number of murres at roughly 1 000 000 birds. Joensen & Preuss (1972), on 19 July 1965, estimated 970 000 birds in the colony (see enclosed table). Counts from photos taken on 26 July 1983 indicated 112 000 murres (Kampp et al. 1994), and direct counts on 24 July 1987 and 14 July 1994 gave 187 000 and 153 000 murres, respectively (Evans 1987, Boertmann et al. 1996).

| Subcolony | 1965 | 1983 | 1987 | 1994 |
|-----------|--------|-------|--------|--------|
| A | 200 | 86 | 94 | 64 |
| B | 25000 | 7730 | 11959 | 10105 |
| C | 450 | 170 | 275 | 172 |
| D | 3200 | 1600 | 1655 | 1650 |
| E | 2700 | 1650 | 1851 | 1725 |
| F | 450 | 260 | 155 | 320 |
| G | 3500 | 780 | 975 | 1310 |
| H | 11000 | 5340 | 6811 | 7070 |
| J | 8500 | 1800 | 2549 | 4185 |
| K | 200 | ? | 89 | 75 |
| L | 1700 | 470+ | 547 | 385 |
| M | 700 | 25+ | 66 | 36 |
| N | 3000 | 400 | 436 | 500 |
| O | 3850 | 4020 | 4215 | 3485 |
| P | 896000 | 82200 | 149854 | 117400 |
| R | 11000 | 5110 | 5640 | 4500 |
| S | 450 | 210 | 0 | 5 |
| T | 1150 | 230 | 0 | 60 |

It is not easy to interpret the results summarised above. Salomonsen's figure does not seem to represent an actual estimate but rather an „impression“, since less than an hour was actually spent at the colony (F. Salomonsen unpubl. data). Vibe's (1938) description of the visit also leaves the impression that a count was not made. The more recent counts, from 1983 onwards, have given fairly similar results and the existing differences may be due to the different techniques and observers involved. Compared with the estimate from 1965 they suggest a dramatic decline of 81-88% in the colony, but the reality of such a decline may be questioned. The nearby Kippaku colony, much easier to count than Apparsuit, showed a nominal decline of only 21-35% (see below; same observers as for Apparsuit). Also, a comparison of figures and photos published by Joensen & Preuss (1972) strongly suggests that at least some subcolonies were overestimated by these authors. Finally, decimated colonies exist farther south in Upernavik

district and these colonies invariably show conspicuous signs of the reduction: sections clearly having been occupied in the past but now abandoned, thinly occupied ledges, etc. No such marks are apparent in Apparsuit.

In conclusion, the Apparsuit colony may have been reduced somewhat since 1965, but not very much. The better data from nearby Kippaku suggest a reduction by about 25%, implying that the pre-1965 size of the Apparsuit murre colony was about 200 000 birds.

Study plots

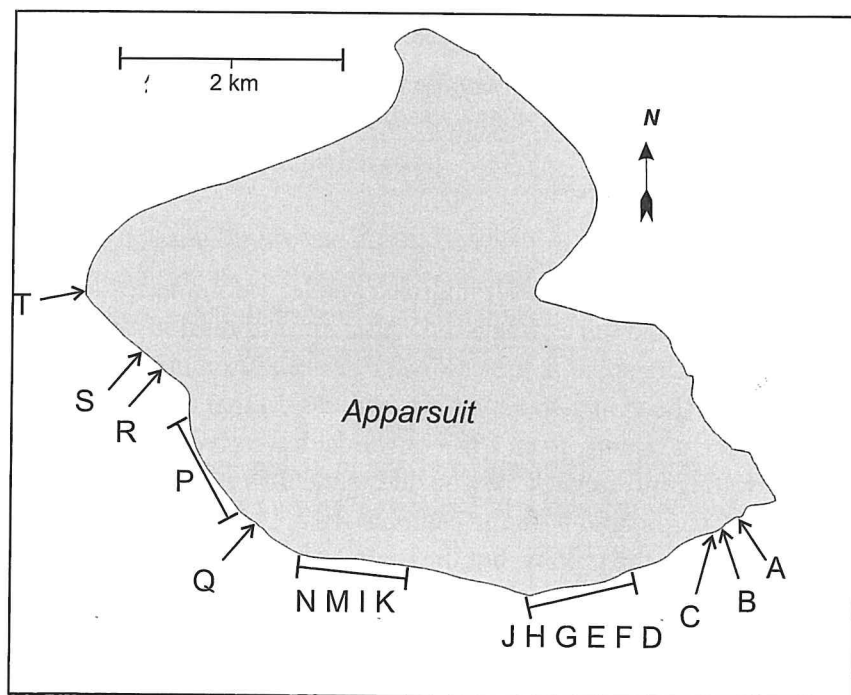
Six reproduction plots and 14 counting plots were laid out in 1987 (Evans 1987). These plots were viewed from above with a telescope and are probably useful as counting plots only, unless the observer is highly experienced. The positions and delimitations of the plots were not documented so, if new detailed studies on Apparsuit should ever be considered, investigators will have to start from scratch.

Breeding phenology

In 1987 the „most common dates“ of hatching and fledging, respectively, were 27-30 July and 19-23 August (Evans 1987). No details were given. For information from ringing reports, see Kippaku (73009).

Breeding success

A total of 550 eggs in six study plots in 1987 had a hatching success of 89-95% (mean 93%); of the 510 hatched chicks, 83-95% (mean 88%) fledged successfully (Evans 1987). Combined these figures give a breeding success of 77-88% (mean 82%) fledged young per egg laid. The first half of the incubating period was not



Subcolonies of the Apparsuit colony (73010) in Upernavik according to Joensen & Preuss (1972) which also give a photo-mosaic of the cliff.

covered, so the hatching success was strongly overestimated. Nevertheless the data suggest a fairly high reproductive success for murrens on Apparsuit in 1987, compared with published information from other colonies.

Ringling

Almost 9000 murre chicks were ringed on Apparsuit during 1965-80 by Pavia Korneliussen, Nutaarmiut. It is not known which parts of the colony were used, but undoubtedly the ledges were climbed to from below. This practice can probably not be continued by ornithologists if normal safety standards are to be upheld. Instead it may be possible to reach occupied cliff sections from above using normal climbing equipment, but the way down from the edge will be long everywhere (>150 m).

Protective status

Apparsuit is a breeding refuge for birds. Trespassing and traffic within 500 m is prohibited during 1 June - 31 August.

Recommendations for monitoring

Being a large colony, a complete census is best done by photo counts. However, in recent years the colony has been counted directly with good results during good weather conditions (Boertmann et al. 1996, D. Boertmann pers. comm.).

The subdivision of the colony into a number of subcolonies makes a comparison of new photos of well-defined cliff sections with the reference photo collection at the GINR relatively easy.

A 400 mm telephoto lenses is required for taking 'count shots' of the upper colony sections.

References

Boertmann et al. (1996), Evans (1987), Joensen & Preuss (1972), Kampp et al. (1994), Salomonsen (1950), Vibe (1938).

Kippaku

Colony code 73009

Position 73°43'N 56°38'W

General description

The island Kippaku is only 500 m long and 250 m wide, and peaks at 78 m. It is shaped like a dome cut in half, with a steep north side where the murrens are.

Landing is possible in calm weather on the south side, especially the southwest corner, where an inflatable may be pulled ashore. A well-suited campsite is halfway up the south slope near the northeast edge, but it is small and when used in 1987 and 1988 the vegetation here was severely worn down. Drinking water may be a problem late in the summer but icebergs will usually be present in the vicinity of the island.



Position of the two northernmost murre colonies in Upernavik, Apparsuit (73010) and Kippaku (73009). From KMS aerial photo # 886 C 2539 of 23 July 1985.

In most years ice probably breaks up around Kippaku in mid-June or earlier. In 1988 it was possible to land study teams from the KNI ship servicing the district's northern settlements from Upernavik town, and even persuade the crew to bring supplies for the team at regular intervals during the stay.

The seabirds

Apart from the murres Kippaku in 1988 supported one thousand Kittiwake pairs, 6 pairs of Glaucous Gulls, 25 pairs of Razorbills and 60 pairs of Black Guillemots (Kampp & Lyngs 1989). A single Puffin was repeatedly seen on the water or flying near the western point of the island.

The murre colony

The murres breed everywhere on the steep cliffs of the north side of the island, generally in high densities. From vantage points it is possible to view parts of the colony at quite close range, and owing to the relatively short distances and heights the colony offers excellent opportunities to watch fledging chicks and assess breeding success.

Murre counts

Salomonsen (1950) visited the colony on 25 July 1936 and counted 30 000 murres. Joensen & Preuss (1972), on 19 July 1965, estimated 17 500 birds in the colony. Evans & Waterston (1976) estimated the number at 5700 birds on 27 July 1974. Counts from photos obtained on 26 July 1983 indicated 11 300 birds (Kampp et al. 1994), and direct counts on 19 July 1987 and 15 July 1994 gave 13 000 and 13 800 murres, respectively (Evans 1987, Kampp et al. 1994, Boertmann et al. 1996).

It appears certain that the colony has remained stable since 1983, the differences in count figures mainly or wholly being due to the different techniques and observers involved. Compared with the 1965 count a moderate decline of about 25% is suggested and may be real. The 1974 figure must be an error; unfortunately, no details of that count are available. Salomonsen's figure from 1936 may be more accurate than his estimate from Apparsuit (see above) since he spent about four hours at Kippaku, but very likely it should rather be regarded as a 'guesstimate'; in the thirties, seabird colonies were rarely estimated by the accuracy common today.

Study plots

Three reproduction plots and six counting plots were laid out in 1987 (Evans 1987), and the reproduction plots were reused in 1988 (Kampp & Lyngs 1989). The plots are generally very well suited for study purposes, much more than almost all other plots conceivable in Greenland colonies. They are, however, rather few, and only few other (less ideal) plots can be laid out on Kippaku. The positions and delimitations of the three reproduction plots are shown at attached photos.

Breeding phenology

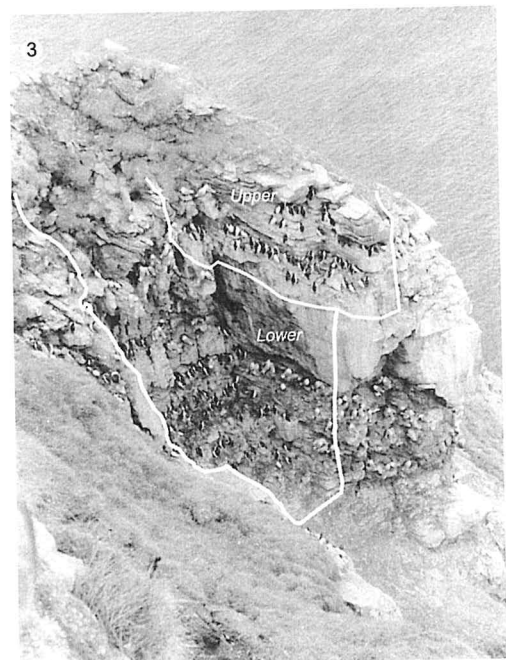
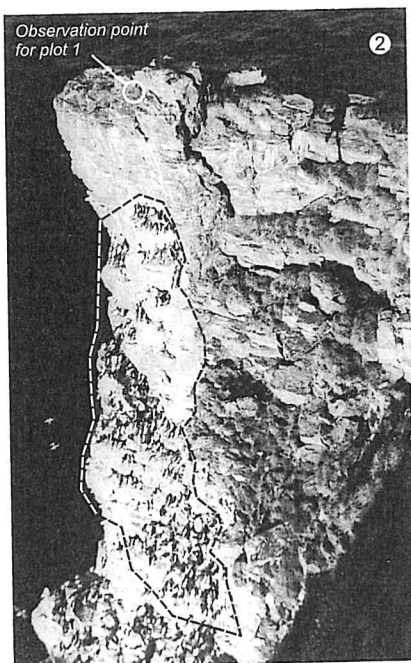
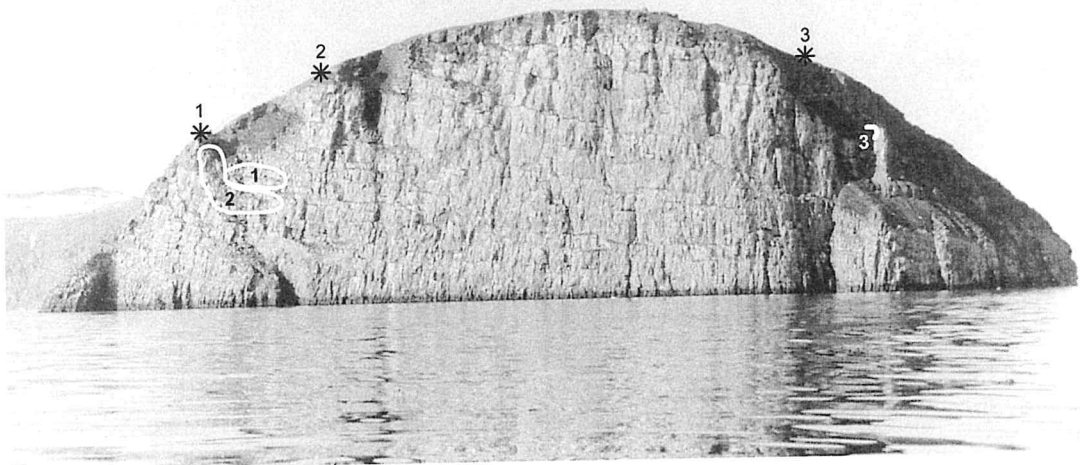
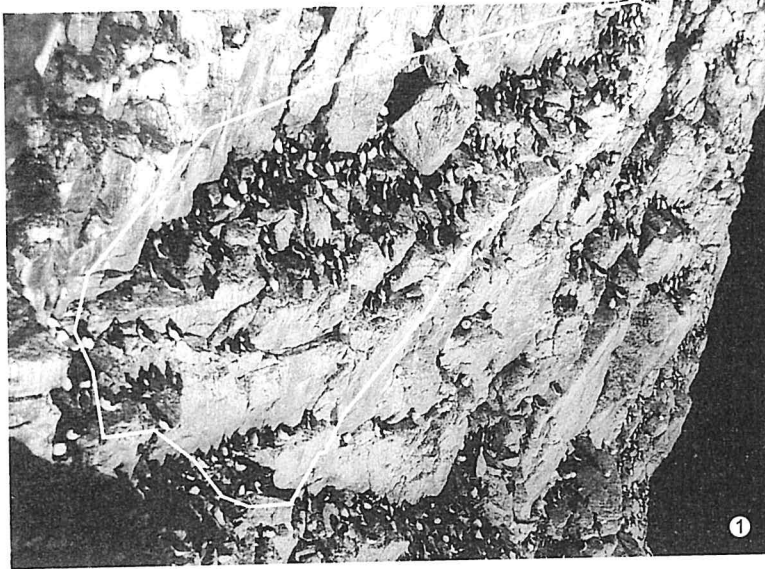
In 1987 the „most common dates“ of hatching and fledging, respectively, were 25-26 July and 16-17 August in plot 3 (undisturbed), 11-13 August and 30-31 August in plots 1 and 2 (which had been egged earlier in the season) (Evans 1987). No details were given. In 1988 the first chick fledged from plot 3 (upper part) on 28 July, and only 4 (out of 43) remained on 16 August, the median date of fledging being 10 August. Plot 2 and particularly plot 1 were later, with most chicks still present on 16 August and median hatching dates delayed by 5 and 14 days, respectively, compared with plot 3. Obviously, these plots had been egged also in 1988.

Probably the breeding phenology was about average in 1987 and early in 1988. Ringing of chicks by local Greenlanders through 1965-1980 took place between 6 August and 2 September, the median day being about 20 August (Kampp 1985), if ringers' reports are accurate. Ringing occurred on accessible ledges, i.e., ledges that were probably egged earlier in the season.

Breeding success

A total of 334 eggs in three study plots in 1987 had a hatching success of 77-85% (mean 81%); of the 270 hatched chicks, 85-99% (mean 91%) fledged successfully

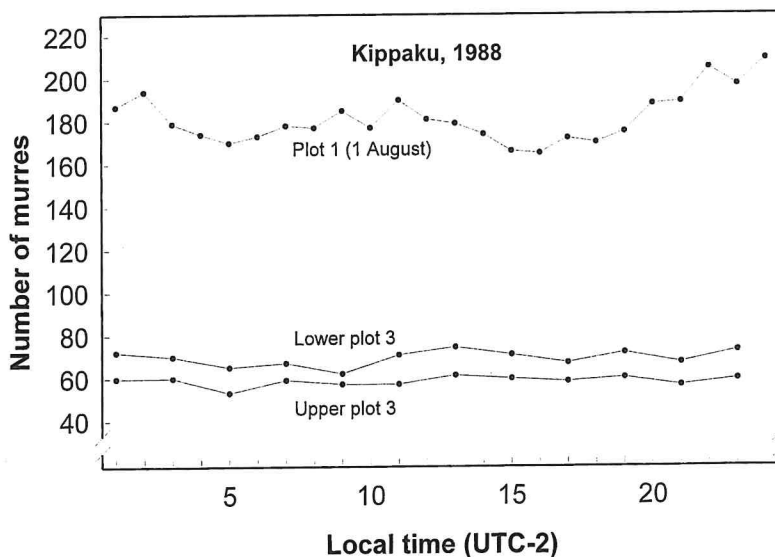
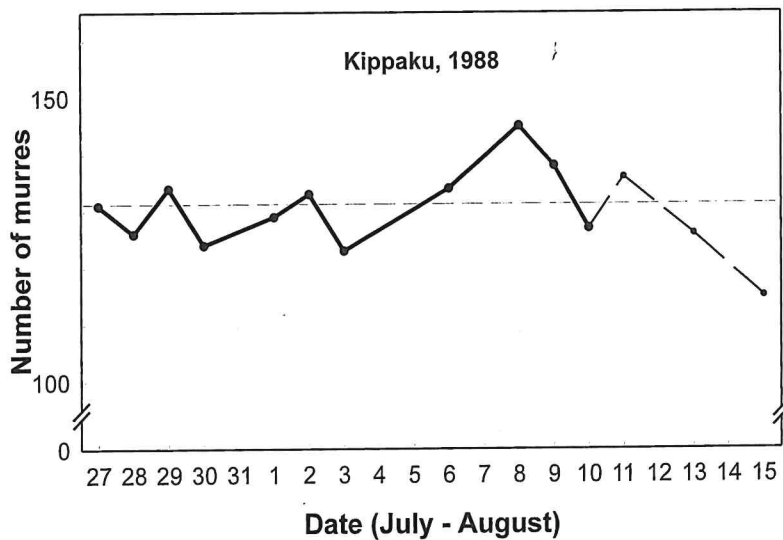
Study plots and observation points at Kippaku (73009).



(Evans 1987). Combined these figures give a breeding success of 72-76% (mean 73%) fledged young per egg laid. As was the case on Apparsuit, the first half of the incubating period was not covered, but even then the data suggest a fairly high reproductive success in 1987. In 1988 it appeared to be even higher: fledging success again was 91%, but 13% more chicks hatched in the three plots than in 1987 (Kampp & Lyngs 1989).

Ringing

As was the case on Apparsuit, large numbers of murre chicks (almost 9000) were ringed on Kippaku during 1965-80 by Pavia Korneliussen. About 100 chicks and 400 adults were also ringed by ornithologists in 1987-1989, and it would be fairly easy to ring a substantially higher number. Climbing gear would be needed, but vertical distances are short.



Protective status

The colony is designated an Important Bird Area.

Recommendations for monitoring

Under optimal weather conditions, this colony can be counted from a boat, but is also well suited for photo counts. Only 180 - 200 mm telephoto lenses are needed.

Kippaku is one of the reference colonies where population changes can be monitored by repeated counts in study plots. Daily counts in plot 3 (lower and upper plot 3 combined) at Kippaku between 27 July and 10 August 1988 (mid to late chick period) revealed: mean = 131.3, SD = 6.5 (CV = 5.0%), $n = 11$. Data from the recommended monitoring period are represented by a bold line in the graph below.

Data on day-to-day variation as well as within-day variation are shown in the attached graphs. The day-to-day variation is from counts performed between 12 and 18 hours; the within-day variation for plot 3 is average values for 27 July to 10 August (all data selected from table 1 in Kampp & Lyngs (1989)).

Since the daily attendance appear to be most stable between 12 and 18 hours, census and plot counts should preferably be made in the early afternoon.

References

Boertmann et al. (1996), Evans (1987), Evans & Waterston (1976), Joensen & Preuss (1972), Kampp (1985), Kampp & Lyngs (1989), Kampp et al. (1994), Salomonsen (1950).

Toqqussaaq

Colony code 73007

Position 73°26'N 56°35'W

General description

Toqqussaaq is a rather small island measuring about 2.5×1.5 km and peaking at 291 m, situated a little less than 20 km from the settlement of Tasiussaq. Two small murre colonies are on southern and northern ends, respectively, of the west coast. Landing is possible on the east side, and campsites are easily found. Ice probably breaks up around the island in early June or even earlier. However, the murres are not visible from land and an attempt to work the colony in 1987 was abandoned (Evans 1987). The team was landed and brought off by the KNI ship servicing the district's northern settlements from Upernavik town.

The seabirds

Apart from murres Toqqussaaq supports a large number of Black Guillemots (425 birds in 1994), 55 Razorbills, 9 Puffins and 36 pairs of Glaucous Gulls (Boertmann et al. 1996).

The murre colonies

The murres breed in two colonies on rather low cliffs on the west coast of the island, near the southern and northern end, respectively.

Murre counts

Salomonsen (1950) did not visit this colony in 1936, but estimated murre numbers to be about 8000 birds based on information from local residents. Joensen & Preuss (1972) counted 2150 birds on 16 July 1965. Later counts are from 27 July 1983 (400), 11-14 July 1987 (600), and 16 July 1994 (46) (Evans 1987, Kampp et al. 1994, Boertmann et al. 1996). The colony has obviously declined very much since 1965 and is, judged from the 1996 count figure, on the verge of extinction.

Study plots

None.

Breeding phenology

No data.

Breeding success

No data.

Ringling

The murre ledges are probably accessible without too much difficulty, but the effort will hardly be warranted, considering the small size of the colony.

Protective status

Toqqussaaq is a breeding refuge for birds. Trespassing and traffic within 500 m is prohibited during 1 June - 31 August. The colony is also designated an Important Bird Area.

References

Boertmann et al. (1996), Evans 1987, Joensen & Preuss (1972), Kampp et al. (1994), Salomonsen (1950).

Kingittuarsuk

Colony code 72005

Position 72°56'N 56°38'W

General description

Kingittuarsuk is a small island, being about 500 m across and 63 m in height. Landing is possible around much of the island in calm weather, but it will be difficult to pull an inflatable ashore. A campsite should be easy to find, and since a lake exists on the island freshwater is no problem either. Unfortunately, very few murre remain in the colony.

The seabirds

In the murre colony were about 350 Kittiwakes and a few Razorbills and Puffins on 3 July 1987; 25 Black Guillemots were counted around the island (K. Kampp unpubl. data, Boertmann et al. 1996).

The murre colony

The murre colony is on a vertical cliff wall at the island's east side; a small promontory arching out in front of it offers an excellent vantage point for viewing the colony.

Murre counts

Salomonsen (1950) estimated the murre colony at 10 000 birds when visiting it on 28 July 1949. On 15 July Joensen & Preuss (1972) counted 3500 birds, and Evans & Waterston (1976) counted 500 on 14-18 August 1974. More recent counts have been on 23 July 1983 (25), 3 July 1987 (39), and 22 June 1989 (10) (Evans 1987, Kampp et al. 1994, Durinck undated). The colony is almost extinct.

Study plots

None.

Breeding phenology

No data.

Breeding success

No data.

Ringing

Has never been attempted.

Protective status

Kingittuarsuk is a breeding refuge for birds. Trespassing and traffic within 500 m is prohibited during 1 June - 31 August. The colony is also designated an Important Bird Area.

References

Durinck (undated), Evans (1987), Evans & Waterston (1976), Joensen & Preuss (1972), Kampp et al. (1994), Salomonsen (1950).

Sandersons Hope (Apparsuit)

Colony code 72008

Position 72°42'N 56°20'W

General description

Sandersons Hope is the western peninsula of the 18×8 km big island Qaarsorsuaq situated just east and south of Upernavik town; the murre colony on the western end of the peninsula is 10 km south of the town. Owing to its closeness to Upernavik the colony is easily visited but, being on an very high vertical cliff, the colony itself is virtually inaccessible, also from above (eggers climb to it from below). There is no campsite nearby.

The seabirds

Apart from the murres, the colony supports 4 pairs of Glaucous Gulls, 500 pairs of Kittiwakes, and a few Razorbills and Black Guillemots (1994; Boertmann et al. 1996).

The murre colony

The murre colony is on the vertical west-exposed cliffs of the peninsula. It

formerly stretched along about 2 km of coast, but is now largely confined to a big fissure in the cliff.

Murre counts

Salomonsen (1950) estimated this murre colony at 100 000 birds on 18 June 1936 and, when seeing it again on 28 July 1949 from a passing ship, concluded that numbers had not changed significantly. He visited the colony briefly again on 6 August 1975 and estimated 25 000 murres to be present at that occasion (F. Salomonsen unpubl. data). Joensen & Preuss (1972) counted 27 200 birds on 7 August 1965, and Evans & Waterston (1976) recorded 18 000 birds on 8 July 1974. Counts of low-quality photos obtained on 5 August 1983 and 13 July gave 5000 and 3800 birds, respectively, and direct counts on 6 July 1987, 15 June 1989, and 18 July 1994 gave, respectively, 1615, 1700, and 1145 murres (Evans 1987, Kampp et al. 1994, Boertmann et al. 1996, Durinck undated).

It seems that many of these estimates are very coarse. Very probably there has been a continuous decline of the colony since about 1970 or even earlier, although the 1936-figure probably represents a 'guesstimate' (cf. Apparsuit 73010). The pre-1970 size of the colony seems to have been around 25 000 or a little more. Even the more recent figures show some unexpected fluctuations, probably due to poor data rather than actual changes in murre numbers. The present size seems definitely to be below 2000 birds, and if the colony is still declining - as the figures suggest - it will disappear completely within a few years.

Study plots

None.

Breeding phenology

No data, except reported ringing dates which range between 3-22 August (median 14 August) in this and other, nearby colonies. Since eggs have been taken in great numbers in these colonies, and eggng and ringing probably took place at the same (accessible) ledges, undisturbed murres probably had similarly aged chicks (1-2 weeks old) somewhat earlier and, apparently, also slightly earlier than in more northern colonies in the district (Apparsuit, Kippaku; see above).

Breeding success

No data.

Ringing

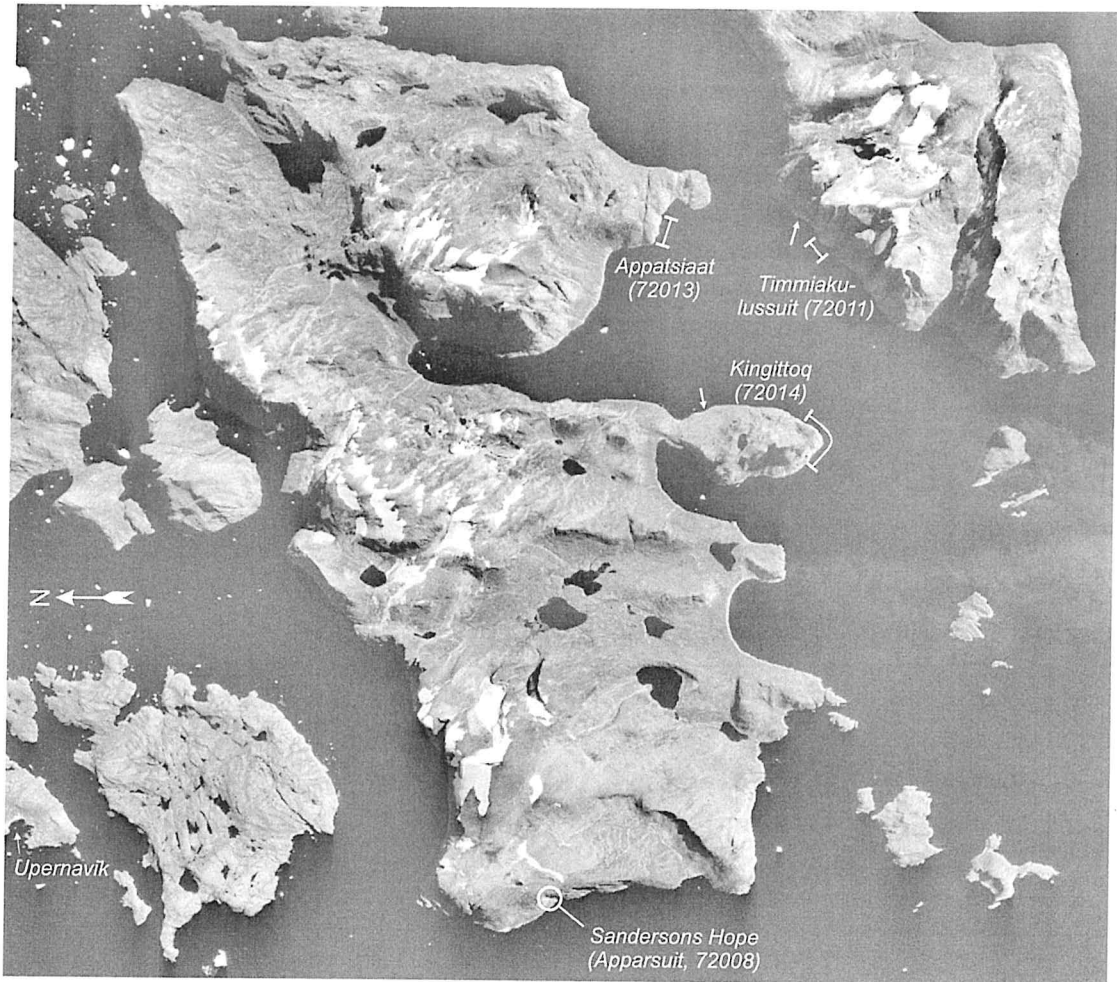
More than 11 000 murre chicks were ringed in this and nearby colonies during 1952-73.

Protective status

Sandersons Hope is a breeding refuge for birds. Trespassing and traffic within 500 m is prohibited during 1 June - 31 August. The colony is also designated an Important Bird Area.

References

Boertmann et al. (1996), Durinck (undated), Evans (1987), Evans & Waterston (1976), Joensen & Preuss (1972), Kampp et al. (1994), Salomonsen (1950).



Murre colonies in the southern part of the Upernavik region. Arrows indicate position of secondary subcolonies. From KMS aerial photo # 886 C 3962 of 7 August 1985.

Possible observation point for counting murres in study plots at Kingittoq (72014). Photo: G. Gilchrist.



Kingittoq (Apparsuit)

Colony code 72014

Position 72°40'N 55°53'W

General description

This magnificent cliff forms the southern end of a 3 km long, 1.5 km wide and 540 m high peninsula on the south coast of the island Qaarsorsuaq (see Sandersons Hope, 72008). By boat the colony is 38 km from Upernavik town. The cliff is conspicuously red-coloured and mostly smooth.

Most of the colony is inaccessible. However, Grant Gilchrist (pers. comm.) studied it in 1993 and found a way up to a vantage point on the west side, from where one or a few counting plots could be laid out (see enclosed photo). A campsite cannot be found within walking distance of the colony, but a good one is across the fiord west of the colony, from where a boat trip to the colony can be made in minutes.

The seabirds

Apart from murres, Kingittoq supports over 150 Glaucous Gulls, 2000 pairs of Kittiwakes, and a few Razorbills and Black Guillemots (1994; Boertmann et al. 1996).

The murre colony

The murres breed all the way around the tip of the peninsula, some of them very high up. Murre ledges are scattered over a large area of otherwise smooth cliff, but more densely occupied sections occur at fissures in the rock.

Murre counts

Salomonsen (1950) visited the colony briefly on 4 July 1936 and estimated 100 000 murres there; he visited it again on 6 August 1975 and recorded 90 000 murres in his (unpublished) notes, although that may have been an error. Joensen & Preuss (1972) counted 6350 birds on 14 August 1965, and Evans (1987) recorded 13 000 birds on 8 July 1974. Photo counts indicated 9700 birds on 30 July 1983, and direct counts on 5 July 1987, and 18 July 1994 gave 8450, and 6860 birds, respectively (Evans 1987, Kampp et al. 1994, Boertmann et al. 1996, Durinck undated).

As in most other Upernavik colonies, many of the estimates obviously are rather inaccurate. As a guess, murre numbers were overestimated in 1936, and the colony never held more than 15-20 000 birds. After the mid-seventies it declined gradually by, roughly, two thirds, and may still be declining.

Study plots

None (but see above).

Breeding phenology

No data, except for ringing records (see Sandersons Hope).

Breeding success

No data.

Ringling

See Sandersons Hope. Rather few of the murre chicks ringed in southern Upernavik colonies were from this colony.

Protective status

None.

References

Boertmann et al. (1996), Evans (1987), Joensen & Preuss (1972), Kampp et al. (1994), Salomonsen (1950).

Appatsiaat

Colony code 72013

Position 72°42'N 55°49'W

General description

This colony is situated on the steep cliffs of a small bay on the south coast of Qaarsorsuaq, 5 km northeast of Kingittoq. The murre ledges look quite inaccessible, and there is no obvious campsite near the colony.

The seabirds

Apart from murres, the colony supports 20 pairs of Iceland Gulls, 10 pairs of Glaucous Gulls, 465 pairs of Kittiwakes, and a few Razorbills (1994; Boertmann et al. 1996).

The murre colony

The colony is on a steep sea-cliff, with most birds around a big vertical fissure in the rock.

Murre counts

Salomonsen (1950) estimated that 10 000 murres were present in this colony on 4 July 1936. He revisited it on 6 August 1975 and recorded 5000 birds (F. Salomonsen unpubl. data). Joensen & Preuss (1972) counted 8700 on 14 August 1965, and Evans & Waterston (1976) recorded 5300 on 8 July 1974. Photo counts indicated 1200 birds on 28 July 1983, and direct counts on 5 July 1987, 15 June 1989 and 18 July 1994 gave 920, 470, and 190 birds, respectively (Evans 1987, Kampp et al. 1994, Boertmann et al. 1996, Durinck undated). The colony is nearly extinct.

Study plots

None.

Breeding phenology

No data.

Breeding success

No data.

Ringing

Not attempted.

Protective status

The colony is designated an Important Bird Area.

References

Boertmann et al. (1996), Durinck (undated), Evans (1987), Evans & Waterston (1976), Joensen & Preuss (1972), Kampp et al. (1994), Salomonsen (1950).

Timmiakulussuit

Colony code 72011

Position 72°39'N 55°38'W

General description

Timmiakulussuit (meaning „the big Fulmar colony“) is the name of the southwestern coastal cliffs of Nutaarmiut, a big (c. 30×12 km) island just east and south of Qaarsorsuaq. These very high (7-800 m) sea-cliffs are only 2-3 km west of Kingittoq across a strait. The murre ledges low on the cliffs are not easily accessible, and there is no obvious campsite nearby.

The seabirds

More than 5000 Fulmar pairs nest high on the towering cliffs, far above the other species (including murres): about 50 pairs of Glaucous Gulls, 200 pairs of Kittiwakes, and 20 Razorbills (1994; Boertmann et al. 1996).

The murre colony

Most of the murres breed on a couple of long horizontal ledges rather low on the cliff; the colony appears as two subcolonies.

Murre counts

Salomonsen (1950) estimated 5000 murres in the colony on 4 July 1936 and (F. Salomonsen unpubl. data) 4800 on 6 August 1975. Joensen & Preuss (1972) counted 6800 birds on 14 August 1965, and Evans (1987) recorded 6100 on 8 July 1974. Counts on 28 July 1983, 5 July 1987, 15 June 1989, and 18 July 1994 gave totals of 400, 370, 220 and 175 murres, respectively (Evans 1987, Kampp et al. 1994, Boertmann et al. 1996, Durinck undated).

The colony size apparently remained stable at 5-7000 birds until the mid-seventies, whereafter it suddenly decreased to a few hundred. A slow negative trend appears to continue to this day.

Study plots

None.

Breeding phenology

No data, except for ringing reports.

Breeding success

No data.

Ringing

Some chicks were ringed here by local people during 1952-73 (cf. Sandersons Hope).

Protective status

The colony is designated an Important Bird Area.

References

Boertmann et al. (1996), Durinck (undated), Evans (1987), Joensen & Preuss (1972), Kampp et al. (1994), Salomonsen (1950).

Extinct colonies

Seven small murre colonies in Upernavik district have become extinct:

73002 *Kingittuarsuk* (73°15'N 56°51'W) was estimated to comprise 500 birds on 24 July 1936 (F. Salomonsen unpubl. data) and 1000 birds on 15 July 1965 (Joensen & Preuss 1972). No murres were seen during visits in 1974 or later. This site is designated as an Important Bird Area.

72006 *Angissoq* (72°54'N 56°25'W) had 1500 birds on 28 July 1949 (Salomonsen 1950) and 200 birds on 15 July 1965 (Joensen & Preuss 1972). No murres were present at later visits (1974 onwards).

72045 *Umiasussuk* (72°45'N 55°58'W) with 100 birds on 23 June 1936 (F. Salomonsen unpubl. data) had disappeared by 1965 (Joensen & Preuss 1972).

72055 *Appallit* (72°43'N 56°10'W) on Qaarsorsuaq, 3 km north of Sandersons Hope, comprised about 200 murres when visited on 18 June 1936, according to unpublished notes by F. Salomonsen. The colony has not been mentioned since by Salomonsen. Joensen & Preuss (1972) counted 50 black guillemots there on 7 August 1965, but no murres.

72037 *Saqqarsuaq* (72°40'N 55°53'W) is a satellite of 72014 Kingittoq but situated so far from the main colony that it is here treated as separate colony. 65 murres were recorded here in 1965 (Joensen & Preuss 1972) and 25 in 1987 (Kampp et al. 1994), but none in 1994 (Boertmann et al. 1996).

72012 *Qoornoq* (72°41'N 55°45'W) near Appatsiaat and Timmiakulussuit was identified by Salomonsen (1950) in 1936 as a small murre colony, based on information from local residents. There were 525 murres present on 9 August 1965 (Joensen & Preuss 1972), but none at subsequent visits in 1974 and later.

72010 *Uummannaq* (72°38'N 55°53'W), a murre colony of 50 birds founded after 1936 and discovered by Joensen & Preuss (1972) on 9 August 1965, had disappeared already by 1974 (Evans 1987).

3.4 *Uummannaq*

This region once held a magnificent murre colony (see Salleg below), but no longer has any breeding murres. Although there is no population to monitor the former colony Salleg should be checked now and then; after all the marine environment in the area would be able to support a murre colony again, so, given time and proper protection, the few birds that still hang around could potentially revive the colony.

Salleg

Colony code 70101

Position 70°58'N 52°17'W

General description

Salleg is a very high (peak 1070 m), 5×2.5 km big island, situated 30 km north of Uummannaq town. The murre colony was on the vertical cliffs along the northwest coast. Qeqertat, a group of low islands 2.5 km north of Salleg, offers the best nearby campsite. Ice break-up at Salleg is normally in the last half of June.

The seabirds

More than 10 000 Fulmar pairs nest high on the cliffs above the former murre colony; the only other seabirds present are 10 pairs of Glaucous Gulls and a score of Black Guillemots (1994; Boertmann et al. 1996).

The murre colony

The murre colony of Salleg covered most of the 2 km long northwest side of the island. The most detailed description is that of Bertelsen (1921), a medical doctor and gifted amateur ornithologist resident in Uummannaq town since 1905.

Murre counts

Bertelsen (1921) believed that there was more than 500 000 murre pairs at Salleg, but did not actually census the colony. Salomonsen (1950 and unpubl. data) estimated 150 000 murres there on 3 August 1949, based on a count of 130 000 birds which he rounded up because chicks had already started to leave the colony. When Salomonsen (unpubl. data) returned to the colony on 3 August 1975 he only found 4500 birds there. No murres were present on the cliff on 23-27 July 1984, the only birds seen being 100-150 laying on the water below (Kampp et al. 1994); but a few years later (12 August 1987) T. Lash (pers. comm.) saw a few (about 50) in the colony. None were present on 3 July 1994 (Boertmann et al. 1996).

The colony apparently remained more or less intact at, perhaps, 100-150 000 birds until about 1950. During the next 25 years it declined to less than 5000 and

disappeared completely a few years later, although the observation by T. Lash suggests that birds occasionally attempt to resettle the colony. Till now, this is the only *major* murre colony in Greenland to be completely lost. The municipal council of Uummannaq recognized the precarious state of the Salleg colony in the late 1960's and gave it special protective status from 1969 to 1972, but the efficiency by which this was enforced may be doubted and, at any rate, it was too late and too brief a period to save the colony.

Study plots

None.

Breeding phenology

According to Bertelsen (1921), the murre chicks fledged between 12-18 August. He was, incidentally, the first to report that the accompanying adults were the males, a fact first becoming widely known to the scientific community in the 1970's.

At least in some years, however, chicks fledged somewhat earlier (cf. Salomonsen, above). Ringing dates of chicks on the cliff during 1949-1962 have been between 21 July and 13 August; fledged chicks have been ringed on the water below the colony between 29 July and 17 August.

Murre eggs were collected in great numbers at Salleg in most years, and the latest ringed chicks probably came from relaid eggs.

Breeding success

No data.

Ringing

Local Greenlanders ringed more than 5000 chicks at Salleg during 1949-62.

Protective status

Salleg is a breeding refuge for birds. Trespassing and traffic within 500 m is prohibited during 1 June - 31 August.

References

Bertelsen (1921), Boertmann et al. (1996), Kampp et al. (1994), Salomonsen (1950).

Other extinct colonies

Seven small murre colonies in Uummannaq district were identified by Bertelsen (1921). All have since become extinct.

71015 *Appatsiaat* (71°07'N 52°13'W) had 200 murres, according to Bertelsen (1921). When the colony was visited by F. Salomonsen (unpubl. data) in 1975, by the present authors in 1984 (Kampp et al. 1994), and by D. Boertmann and A. Mosbech in 1994 (Boertmann et al. 1996), no murres were present.

70098 *Nakkaleqqaap Innarsua* (70°53'N 52°06'W) formerly had 200 murres according to Bertelsen (1921), but none remained in 1984 (Kampp et al. 1994) and 1994 (Boertmann et al. 1996).

70097 *Naaajaat* (70°51'N 51°51'W) with 3000 murres according to Bertelsen (1921) still had 100 birds when visited by F. Salomonsen (unpubl. data) in 1949. None were present in 1984 (Kampp et al. 1994) or 1994 (Boertmann et al. 1996).

70095 *Umiassusuk* (70°51'N 51°44'W) with 1000 murres according to Bertelsen (1921) still had 25 birds when visited by F. Salomonsen (unpubl. data) in 1949, but none in 1984 (Kampp et al. 1994) or 1994 (Boertmann et al. 1996).

70088 *Qaqullussuit* (70°44'N 51°28'W) held 100 murres early in the century (Bertelsen 1921) but was abandoned when visited in 1949 and 1984 (Kampp et al. 1994, F. Salomonsen unpubl. data).

70069 *Qingaarsuaq* (70°44'N 51°54'W) in the past had twenty murres present (Bertelsen 1921), but none in 1984 (Kampp et al. 1994) or 1994 (Boertmann et al. 1996).

70064 *Innarsuaq* (70°40'N 51°42'W), occupied by 500 murres according to Bertelsen (1921), still had 50 birds in 1949 (F. Salomonsen unpubl. data); none remained in 1984 (Kampp et al. 1994).

3.5 Ilulissat

The region only holds one murre colony, but four small colonies have become extinct during the past 50 years.

Ritenbenk (Innaq)

Colony code 69049

Position 69°48'N 51°13'W

General description

This colony is situated 65 km north of Ilulissat on the west coast of the big island Arveprinsens Ejland (Alluttoq). The abandoned settlement Ritenbenk 2 km south of the colony is still used as a summer resort and will usually be populated in the summer months. From a small peninsula in front of it the colony may be over-viewed and, with a little difficulty, counted by use of a telescope. The peninsula also offers an acceptable campsite. Ice will usually have disappeared around the colony by May or early June.

The seabirds

Apart from the murres, the colony supports (1994) 22 pairs of Cormorants, about 150 pairs of Iceland Gulls, roughly 6000 pairs of Kittiwakes, and a few Razorbills and Black Guillemots (Boertmann et al. 1996).

The murre colony

The colony covers a 1 km long and 300 m high vertical cliff that rises directly from the sea, and in addition a smaller cliff wall south hereof, high above an extensive talus slope. Just southwest of the latter subcolony it is possible to walk to the top of the cliff and, by rope, access the murres. The murres now are thinly distributed over the main colony but more densely so in the southern 'annex'.

Murre counts

On 3 August 1946 Salomonsen (1950, unpubl. data) estimated this colony at roughly 50 000 murres, rounding his count figure of 45 000 upwards because fledging of chicks was already underway. A subsequent visit was late (10 August 1954) and only 300 murres remained, but on 21 June 1960 he counted 7000 birds in the colony. Additional counts on 1 August 1975 and 26 June 1980 produced totals of 3200 and 1680 birds, respectively.

N. Andersen visited the colony on 1-7 August 1980 and estimated that 5500 murres were present. In 1984 (5-11 July) and 1994 (28 June) there were 4500 and 3655, respectively (Kampp et al. 1994, Boertmann et al. 1996); 1900 and 1035 of the birds, respectively, were in the southern 'annex'.

Even though the colony may have been overestimated in 1946 it appears to have declined to some extent by 1960. A subsequent, slow decrease in murre numbers may have continued to this day.

Study plots

None.

Breeding phenology

Salomonsen (unpubl. data) and N. Andersen (pers. comm.) saw chicks fledge in the first week of August. Ringing dates of chicks in the colony during 1946-1963 have been between 18 July and 14 August; fledged chicks have been ringed on the water below the colony between 6-13 August. The later of these dates may have been influenced by egg collection in the colony (relays).

Breeding success

No data.

Ringing

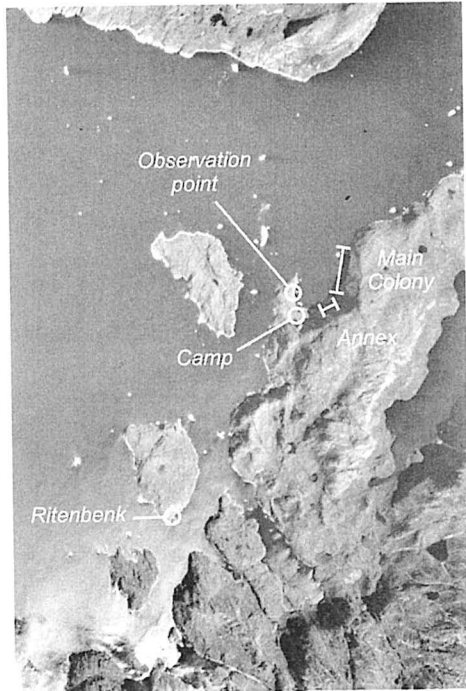
Local Greenlanders ringed about 2500 murre chicks at Ritenbenk during 1946-63, and 300 adult birds were ringed by the present authors in 1984.

Protective status

The Ritenbenk colony is a breeding refuge for birds. Trespassing and traffic within 500 m is prohibited during 1 June - 31 August. The colony is also designated an Important Bird Area.

Recommendations for monitoring

For counting the colony from the peninsula a good telescope with at least 25x



The murre colony Innaq (69049) near the abandoned settlement Ritenbenk in the Ilulissat region. From KMS aerial photo # 886 J 2216 of 22 July 1985.

magnification is required; if photo count shots are taken from this position a 500 or 600 mm telephoto lens will be needed.

References

Boertmann et al. (1996), Kampp et al. (1994), Salomonsen 1950.

Extinct colonies

Four small murre colonies in Ilulissat district have become extinct.

69045 *Oqaatsut Nuuat* (69°53'N 51°22'W) was visited by Salomonsen (unpubl. data) in 1946, 1960, 1975, and 1980; 150 murres were present in 1946 and 10 in 1960, but none at his two latest visits or in 1994, when D. Boertmann and A. Mosbech saw the colony (Boertmann et al. 1996).

69023 *Qaqulluit* (69°38'N 51°01'W), identified by Salomonsen (unpubl. data) in 1946 on basis of information from local residents, had only 15 murres present when he saw it in 1960. The colony has not been visited by ornithologists since.

69022 *Nuuluk* (69°34'N 50°59'W) had 10 murres present in 1946 but none in 1960 (F. Salomonsen unpubl. data).

69016 *Nuunnguaq (Paakitsoq)* (69°28'N 50°47'W) had 50, 20, 0, and 0 murres present in 1946, 1960, 1975, and 1980, respectively (F. Salomonsen unpubl. data).

3.6 Maniitsoq

The Maniitsoq region holds three colonies, all located in fiords and far from the outer coast.

Murre eggs in this region normally hatch in early July, and chicks begin to fledge around 25 July. Census work should therefore be carried out from late June to late July.

The fledging period in late July will potentially put the chicks from these colonies and their accompanying parents at risk from net-entanglement in Salmon fixed nets or drift nets. The Salmon fishing season in West Greenland usually does not commence until mid-August but have in some years been opened as early as 1 August. Since most local Salmon fishery takes place in the archipelago and in fiords, the murres could encounter a series of nets when initiating their swimming migration.

Taateraats

Colony code 65019

Position 66°00'N 52°22'W

General description

Taateraats is a magnificent cliff situated 35 km from the mouth of the big fiord Evighedsfjorden (Kangerlussuatsiaq), on the north shore between two small fiord arms of which the eastern ends at a glacier wall. The nearest settlement is Kangaamiut at the outer coast, just north of Evighedsfjorden. No parts of the murre colony are easily accessible although it is possible to approach a few sections from below and view them from a distance. A campsite may be found in the western fiord arm from where the colony must be approached by boat. As usual in Greenland fiords during summer, a strong breeze blows into Evighedsfjorden through most of the daytime, but mornings, evenings and nights are often calm.

The seabirds

A minor proportion of the murres breeding at Taateraats are Common Murres. Other seabirds (1989) are 12 pairs of Cormorants, about 200 Iceland Gulls, roughly 10 000 pairs of Kittiwakes, and about 100 Razorbills (Boertmann et al. 1996). A White-tailed Eagle nest is on the western edge of the colony.

The murre colony

The colony covers 1-2 km of the cliff face. To the east is a separate subcolony (and to the east of that a Kittiwake subcolony without murres), but otherwise no clear subcolony structure is apparent. Most of the murres (about 60%) are concentrated to the eastern third of the main colony.

Murre counts

F. Salomonsen (unpubl. data) heard of this colony from local residents in 1954 and later visited it twice, on 29 June 1960 and 12 July 1977, where he estimated 10 000 and 9050 murres, respectively, to be present. Counts from photos taken on

11 July 1988 indicated a total of 8915 murres at the colony (Kampp et al. 1996); 926 of the murres were in the eastern subcolony. The proportion of the birds being Common Murres has not been quantified.

Study plots

None.

Breeding phenology

Apparently much like Sermilinnuaq (see below). An adult with a chick was seen on the water below the cliff on 19 July 1989, but the chick appeared to have fallen prematurely from its ledge; another chick weighing 198 g was found dead on the following day (own unpubl. data).

Breeding success

No data.

Ringling

Never attempted.

Protective status

The colony is designated an Important Bird Area.

References

Boertmann et al. (1996), Kampp et al. (1994).



The murre colony Taateraat (65019) in the Maniitsoq region. From KMS aerial photo # 886 F 1940 of 20 July 1985.

Sermilinnuaq

Colony code 65015, 65013

Position 65°40'N 52°38'W and 65°41'N 52°35'W

General description

These two colonies are situated on the north coast of the small fiord Sermilinnuaq, about 30 km north of Maniitsoq town. The western main colony is a very big, magnificent cliff; the smaller, eastern colony is at a small bay close to the glacier front at the head of the fiord. None of the colonies appears to be accessible. A campsite may be found at a steep valley 1 km east of the main colony, but it is not a good place to pull an inflatable ashore or to leave a boat, although the fiord is often perfectly calm throughout the day.

The seabirds

A minor proportion of the murres breeding at both colonies are Common Murres. Other seabirds (1992) are, at 65015, 22 pairs of Iceland Gulls, 4420 pairs of Kittiwakes, and about 200 Razorbills; and at 65013, 51 pairs of Iceland Gulls, 579 pairs of Kittiwakes, and 250 Razorbills (Boertmann et al. 1996).

The murre colonies

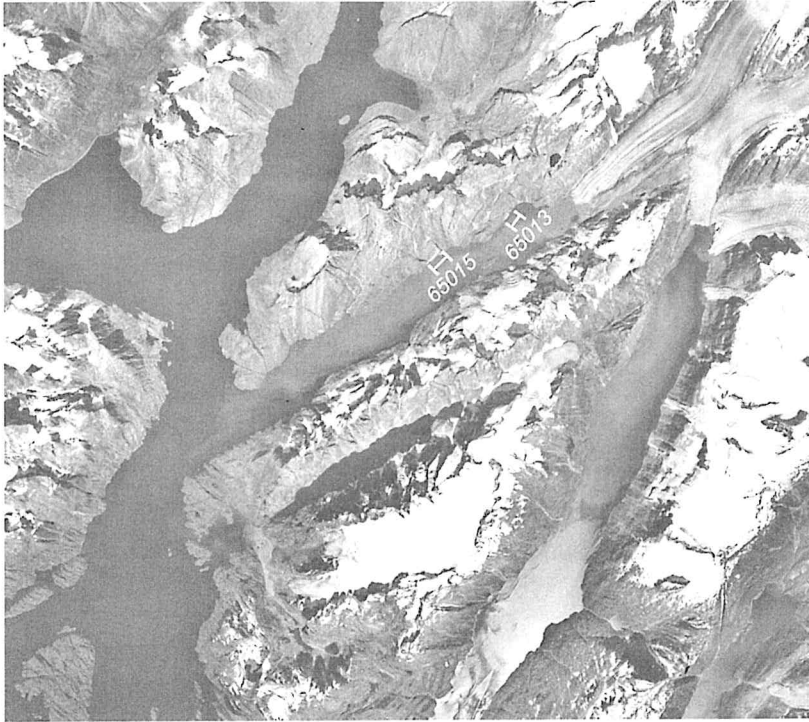
The main colony (65015) is 1-2 km long and, particularly to the east, very tall. There are no well-defined subcolonies. The smaller eastern colony (65013) is just west of, and along the western part of, a small bay.

Murre counts

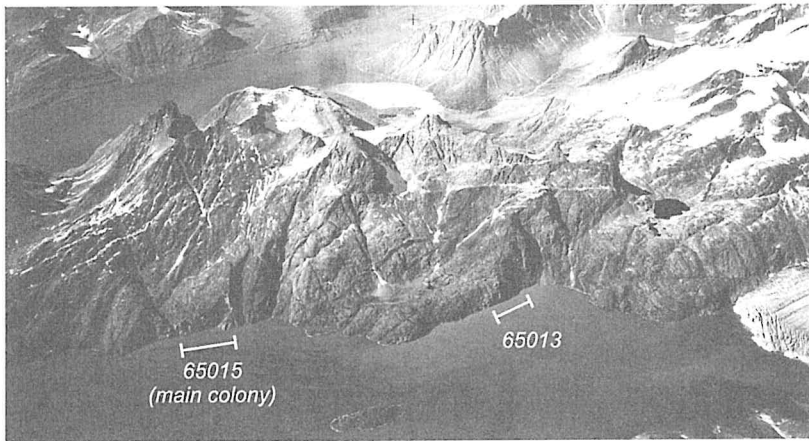
The main colony was the first murre colony F. Salomonsen saw in Greenland when he, 16 years old, joined E. Lehn Schiøler's expedition in 1925. He was, evidently, much impressed, but although he later gave a figure of 100 000 murres for the colony (Salomonsen 1950), no census was actually made (Scheel 1927, F. Salomonsen unpubl. data). It seems that the estimate was based on his memory of the locality several years after the visit, as was the statement that murres also bred on the south side of the fiord. Several small colonies of razorbills exist along the south coast, but the topography appears to be less suited for murres and no are found there today.

Salomonsen revisited and counted the main colony four times: 2 July 1946, 5000 murres; 2 August 1960, 4500 murres (a total he increased to 7000 on the fact that many adults and young had already departed); 10 August 1975, only 12 murres since most birds had departed; and 13 July 1977, 11 000 murres. During the last visit he saw the eastern colony for the first time and counted 2600 murres there.

Counts of photos obtained on 19 July 1987 gave 9600 murres for the main colony and 1900 murres for the eastern colony (Kampp et al. 1994). Some of the photos, especially from the highest parts of the main colony, were difficult to count, so the estimate is rather uncertain. A direct count on 1 July 1992 (Boertmann et al. 1996) gave 3970 murres at the main colony (with an additional 3000 on the water below the colony), and 570 at the eastern colony.



The two murre colonies in Sermilinnuaq, Maniitsoq region. From KMS aerial photo # 886 F 1935 of 20 July 1989 (upper) and # 507 C-N of 18 July 1948 (lower).



The murre colony (65003) in Isortoq fjord in the Maniitsoq region. From KMS aerial photo # B 16 B-V 71 (unknown date).

Most likely, these colonies have remained fairly stable since 1946, and perhaps since 1925. The disparate counts from 1987 and 1992 do suggest that a major decline in murre numbers took place between these years, the differences apparently being too big to be caused by counting errors alone. We nevertheless believe that they were, but urge that a renewed census is made before long of the murre colonies in Sermilinnuaq.

The proportion of the birds being Common Murres has not been quantified.

Study plots

None.

Breeding phenology

No chicks appeared to leave the main colony on the evenings and nights of 21 and 22 July 1990, but many did so on 27 and 28 July (own unpubl. data). This timing appears to be normal for Sermilinnuaq (F. Wille pers. comm.).

Breeding success

No data.

Ringling

Never attempted.

Protective status

The two colonies are designated an Important Bird Area.

References

Boertmann et al. (1996), Kampp et al. (1994), Salomonsen (1950).

Isortoq

Colony code 65003

Position 65°27'N 52°09'W

General description

This colony is situated 35 km east of Maniitsoq town, on the south coast of the big fiord Isortoq (Søndre Isortoq). It is a very tall, dark cliff. The murres are totally inaccessible, and no campsite exists nearby but must be found either at a valley 8 km east of the colony or across the 3 km wide fiord.

The seabirds

Seabirds other than murres are (1990) 100 pairs of Iceland Gulls, 5000 pairs of Kittiwakes, and about 300 Razorbills (Boertmann et al. 1996).

The murre colony

The murres breed in scattered groups high up on the north-exposed cliff, but subcolonies are indistinct.

Murre counts

F. Salomonsen (unpubl. data) heard of this colony from local residents in 1946 and, with more details given, in 1963. He visited it on 11 August 1975, too late in the season to find any murres there, and again on 14 July 1977 when he counted 365 murres. A count of photos taken on 14 July 1988 gave a total of 2200 murres (Kampp et al. 1994), a rather uncertain estimate because of the distance of the birds and the dark background colour of the rock.

Study plots

None.

Breeding phenology

No data.

Breeding success

No data.

Ringling

Never attempted.

Protective status

The colony is designated an Important Bird Area.

References

Boertmann et al. (1996), Kampp et al. (1994).

3.7 Nuuk

Although the Nuuk region is an important wintering area for murres, there is only one small colony in the area, plus a recently abandoned one.

Qeqertarsuaq

Colony code 63018

Position 63°54'N 51°32'W

General description

This small and probably extinct colony is situated in a sea-cliff cleft on the south coast of the 3.5×2 km big island Qeqertarsuaq, 30 km south of the town of Nuuk.

The seabirds

There are (were) no other seabird species than murres in the colony (Boertmann et al. 1996).

Murre counts

F. Salomonsen (unpubl. data) saw about 50 murres here on 28 July 1977, with an additional 70 birds on the water. In 1977 the ledges were covered by snow until

mid-July and no murres bred, the last disappearing from the vicinity of the colony during the last days of July.

There were only 10 murres present at the colony on 22 June 1990 (Kampp et al. 1994), and none on 12 July 1992 (Boertmann et al. 1996). The colony appears to be extinct.

Study plots

None.

Breeding phenology

No data.

Breeding success

No data.

Ringling

Never attempted.

Protective status

None.

References

Boertmann et al. (1996), Kampp et al. (1994).

Nunngarussuit

Colony code 63010

Position 63°46'N 51°43'W

General description

This colony is situated on a very small, 2-300 m long island belonging to the chain of islands called Nunngarussuit, about 12 km northwest of the settlement Kangerluarsorseq/Færingehavn. It may be possible to get ashore in calm weather, but owing to the very exposed position of the island the chance will probably not often arise. Longer stays cannot be advised.

The seabirds

The archipelago supports about 10 Glaucous Gulls, 30 Great Black-backed Gulls, 50 Razorbills, 15 Black Guillemots, and 10 Puffins, in addition to the murres (Boertmann et al. 1996).

The murre colony

The murres breed along the north side of the island.

Murre counts

F. Salomonsen (unpubl. data) first heard of this colony in 1977 and visited on 3 August in the same year, counting 500 murres. He revisited the site on 26 July 1978 and estimated that 1000-3000 murres were present; counting was difficult

because many birds flew off the cliff when the boat approached. A photo count on 22 June 1989 indicated a total of 885 murres (Kampp et al. 1994). On 12 July 1992 a direct count gave 730 birds, of which 30 turned out to be Common Murres (Boertmann et al. 1996).

The colony has probably remained stable since its discovery in 1977.

Study plots

None.

Breeding phenology

No data.

Breeding success

No data.

Ringling

Never attempted.

Protective status

None.

References

Boertmann et al. 1996, Kampp et al. 1994.

Extinct colonies ?

Salomonsen (1950) mentioned four sites in the Nuuk region where local residents had told him that murres might breed. When he later visited one of them, Qooqqut, the birds turned out to be Razorbills, and at two other sites the birds had disappeared before they were checked (F. Salomonsen unpubl. data). The fourth site may have been Nunngarussuit.

3.8 Paamiut

The Paamiut region only holds only one surviving colony, and five former colonies.

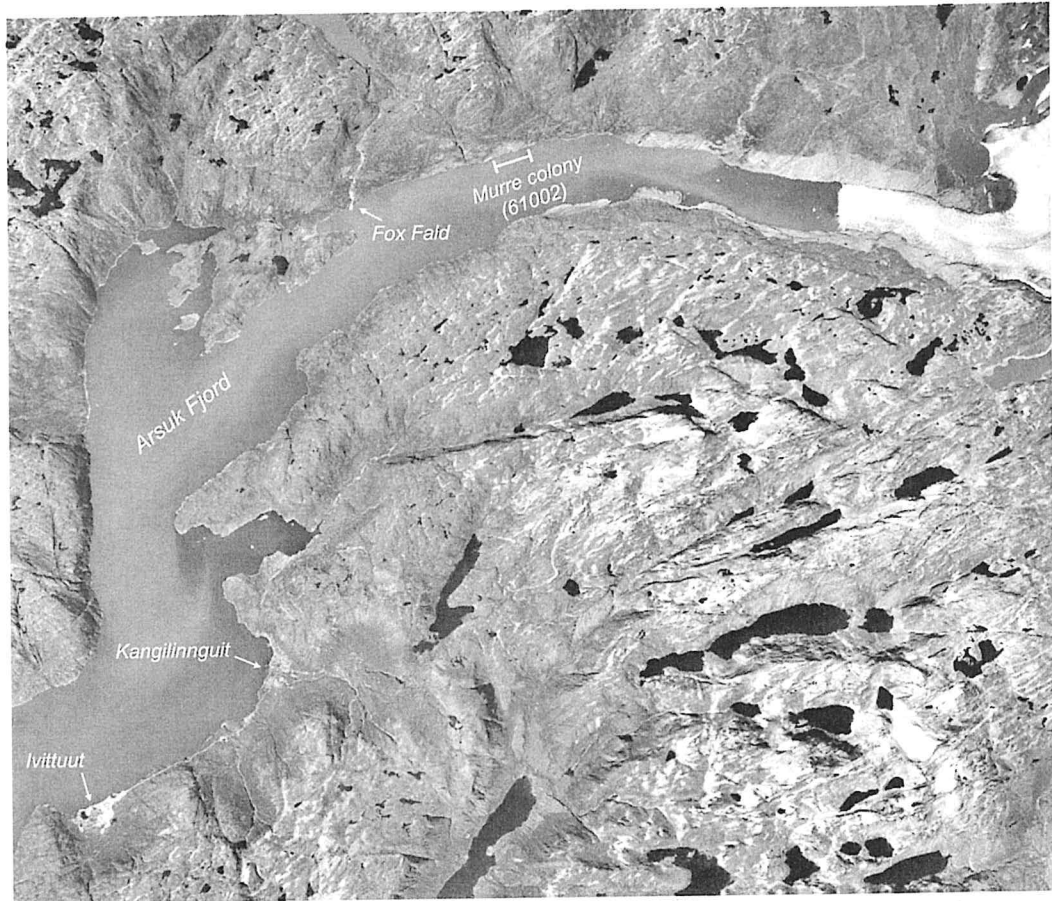
Fox Fald (Taateraarunnerit)

Colony code 61002

Position 61°20'N 48°00'W

General description

The bird cliff at Fox Fald (the name of a nearby waterfall) on the north coast of Arsuik fiord, 4-5 km from the glacier front at the head of fiord, has been known since at least 1842, but murres first settled there about 1970 (Salomonsen 1979). The murres are not accessible although, at one place, it is possible to go ashore



The murre colony (61002) near the Fox Fald waterfall in Arsuk Fjord, Paamiut. From KMS aerial photo # 886 Q 4187 of 7 August 1985.

under the birds to, e.g., watch chicks going to sea at the end of the season. A campsite may be found at the waterfall 5 km west of the colony, where there also is a cabin belonging to the NCO mess at Kangilinnguit/Grønneidal, a naval station situated 8 km to the south.

The seabirds

Apart from the murres (including a few Common Murres) the colony supports (1986) 100-200 pairs of Iceland Gulls, at least one pair of Glaucous Gulls, a few thousand pairs of Kittiwakes, one pair of Black Guillemots, and 3 Razorbills (Boertmann et al. 1996).

The murre colony

The colony covers 2-3 km of cliff face. Reckoned from the west it begins with a high-lying section where most of the Iceland gulls are and a low, densely occupied Kittiwake subcolony; towards the east it ends with a Kittiwake section high on the cliff. The murres are at the central about 1 km of the colony, breeding in a couple of large and several small groups, but not in distinct subcolonies.

Murre counts

Salomonsen (1979) had staff at Grønndal perform murre counts in the newly established colony during the early 1970es, giving totals of 100, 300, 2000, and 5000-10 000 in the four years 1973-1976. In 1974 the colony was also censused by D. Boertmann who counted 250 murres (see Kampp et al. 1994 for a review). Counts from photos taken on 17 June 1983 totalled 3300 birds, while another photo count from 26 July 1986 gave only 2300 birds. Neither series of photos were of high quality, but the somewhat uncertain count figures notwithstanding the decline appears to have been real (own unpubl. data). The count totals from the early 1970es are difficult to evaluate, but apparently the colony reached its 1983-size a few years after it was founded.

A single Common Murre was seen on the cliff in 1986 and more were probably present, but not very many.

Study plots

None.

Breeding phenology

According to I. Andersen (pers. comm.) the young usually fledge during the last days of July and the first days of August. Very few chicks remained when we visited the colony on 9 August 1985. In 1986 we followed the departure of chicks on the evenings of 27, 29, and 31 July, where fledging appeared to be near its peak.

Breeding success

No data.

Ringling

Never attempted.

Protective status

The colony is designated an Important Bird Area.

References

Boertmann et al. (1996), Kampp et al. (1994), Salomonsen (1979).

Extinct colonies

In 1949 local residents informed Salomonsen (1950, 1979) of two small murre colonies which were both abandoned when Salomonsen visited them in 1971.

61007 *Søndre Kangeq* (**Kangeq Kujalleq**) (61°21'N 48°59'W), said to comprise about 4000 murres in 1949.

61005 The islet *Appat* (61°16'N 48°57'W) off Sermersuut island, having about 1000 birds in 1949.

3.9 Qaqortoq

This region has one murre colony - the southernmost colony in Greenland and one now extinct site.

Ydre Kitsissut (Kitsissut Avalliit)

Colony code 60012

Position 60°46'N 48°28'W

General description

The Ydre Kitsissut archipelago encompasses about 50 islands and skerries which are generally low, less than 50 m in height, except that the largest island (Thorstein Islænder, or Uummanaq) reaches a peak of 116 m. The locality has been described by Salomonsen (1979) and Kampp & Falk (1994).

Most of the seabirds, including all the murre, breed in the northwestern part of the archipelago. Only these islands have been thoroughly investigated, among them Thorstein Islænder and the second largest island, Tupersuartuut; no other islands bear official names but have been assigned letter codes by Kampp & Falk (1994). Landing is difficult everywhere and possible only in calm weather, owing to the steep coastal cliffs and the exposed position of the islands. An exception is Tupersuartuut, with a sheltered bay on the east coast and a small, shallow fiord on the north coast. The fiord almost bisects the island and offers excellent opportunities for harbouring an inflatable. Also on Tupersuartuut is an automatic weather station with a cabin for the maintenance team visiting the station once or twice annually.

Ydre Kitsissut may be reached by boat through most of the year except when blocked by pack ice. The Polar Ice drift usually reaches Southwest Greenland in spring, causing foggy conditions and low temperatures at the outer coast. The extent, distribution and density of the ice fields are highly variable, and Ydre Kitsissut may occasionally be surrounded by dense ice for weeks or months, while in other years no ice at all is seen in the vicinity of the islands.

The nearest human settlements are Arsuk, 50 km to the north, and Qassimiut, 70 km to the east.

The seabirds

Ydre Kitsissut supports a diverse seabird community which, in addition to the murre (both species), includes Fulmars (125 occupied sites), Common Eiders (about 30 nests, several hundred moulting birds), King Eiders (about 100 moulting birds), Glaucous Gulls (c. 30 pairs), Great Black-backed Gulls (a few pairs), Kittiwakes (23 pairs), Razorbills (400-500 birds), Black Guillemots (roughly 150 pairs), and Puffins (200 birds). Numbers are from 1992 (Kampp & Falk 1994).

The murre colony

Murres became established on Ydre Kitsissut relatively recently, shortly after World War II, according to local residents interviewed by Salomonsen (1979). Today they are distributed in 24 subcolonies over 12 islands. All colonies are low and may be accessed from above, using a rope. Two colonies of Common Murres on Tupersuartuut are not on cliff faces; instead the birds nest in caves under big boulders. It is generally difficult to watch the murres from a close range, but for counting purposes several well-suited plots may be defined (see study plots).

Murre counts

Salomonsen (1979) visited Ydre Kitsissut for a few hours during 3 July 1971 and estimated murre numbers at 61 200 birds. The present authors stayed at the islands during three periods, 10-13 June 1983, 25 July - 8 August 1985, and 30 July - 11 August 1992; our best estimates for the various colonies yield totals of 9000 Thick-billed Murres and 900 Common Murres (Kampp & Falk 1994).

It is not easy to evaluate Salomonsen's estimate from 1971, but our interpretation is that he greatly overestimated the population and that only small, if any, changes in numbers have happened since 1971. Detailed arguments are given in Kampp & Falk (1994), but, briefly, the conclusion is based on the difficult observation conditions during Salomonsen's visit (fog), the obvious errors and inconsistencies in his report following from these difficulties, and a comparison of the only colony he photographed with its present appearance. On the map in the report of Salomonsen (1979) most murre colonies are misplaced and cannot be identified today - some are even marked at impossible sites (e.g. flat, overwashed rock), indicating that Salomonsen lost his orientation. That could easily happen in an archipelago like this, even without fog. We can only guess that the cliffs under the circumstances looked bigger than they are, and that murre numbers were 'guesstimated' from the appearance of the colonies rather than counted; the latter assumption further supported by the duration of the visit, apparently leaving insufficient time for actual counts.

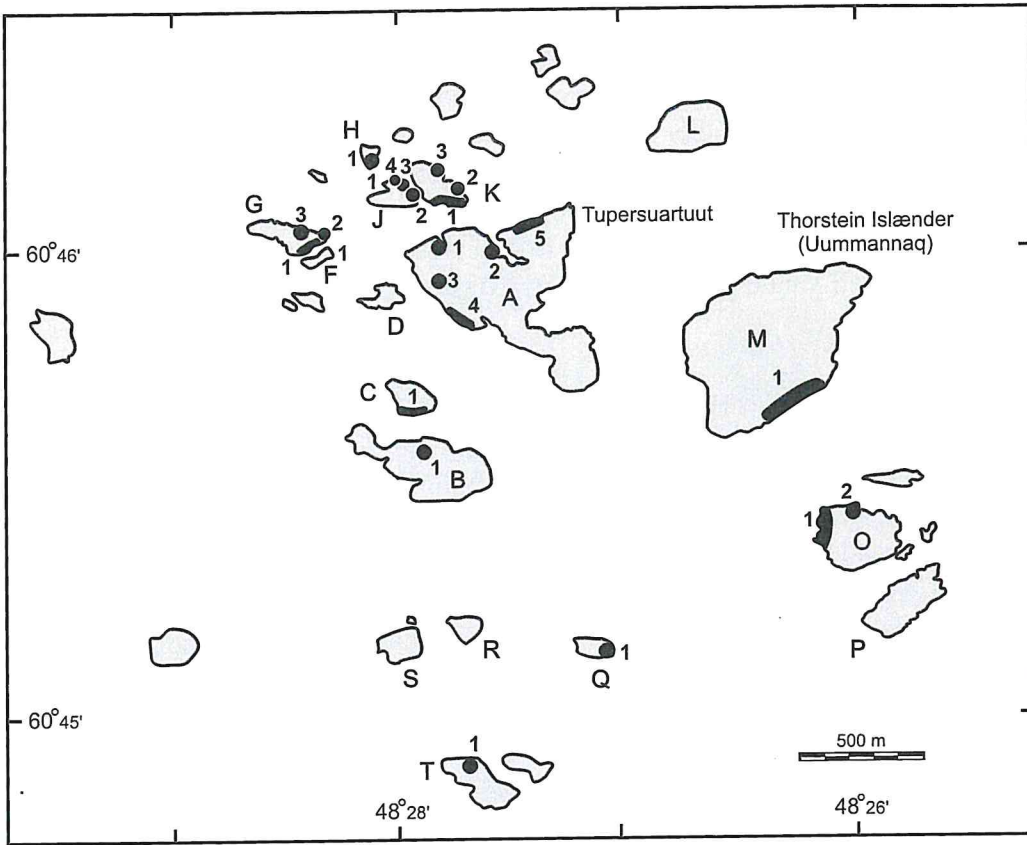
Study plots

Counting plots were defined in 1992 on the south face of island K, which can be viewed from Tupersuartuut (distance 100-125 m; Kampp & Falk 1994).

Plots for detailed studies of breeding success etc. are not easily found at Ydre Kitsissut. Parts of colony G1 (viewed from island F), and colony J1 (viewed from J) or colony J2 (viewed from J or K), are the most obvious possibilities. The main problem is safety considerations, because the observer could easily be stranded for days on a naked skerry in case of strong winds.

Breeding phenology

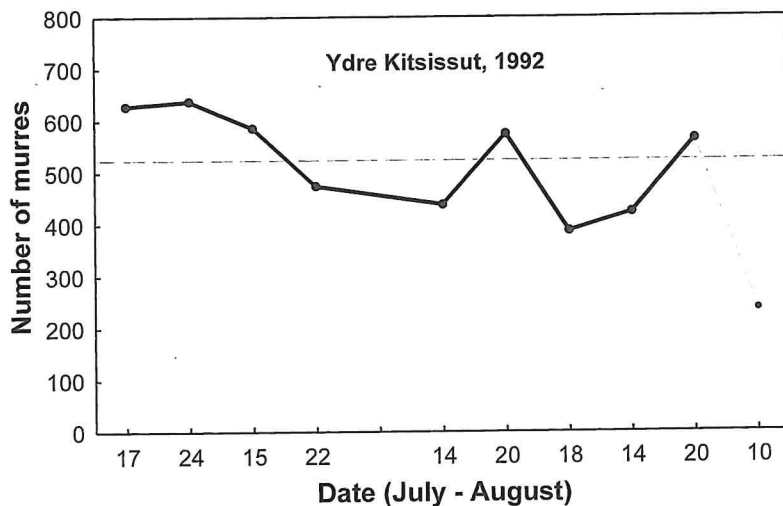
Murres breed surprisingly late at Ydre Kitsissut, with only few young fledged on 8-10 August in 1985 and 1992 (Kampp & Falk 1994). In that report it was



Map of the Ydre Kitsissut (Kitsissut Avallit, colony 61012) showing letter codes for islands and subcolony numbering as used by Kampp & Falk (1994).



The south cliff of island K with the 13 counting plots of colony K1; view from island A. The observation point for counting the plots is immediately northwest of subcolony A1 (see map above). Redrawn from Kampp & Falk (1994).



concluded that median laying occurred in the last week of June, corresponding to peak fledging during the third week of August, at least three weeks later than in other murre colonies in South Greenland. Owing to widespread (albeit illegal) egg-collecting, fledging from many ledges would be delayed even further.

Breeding success

No reliable data - a very low breeding success in 1992 apparently was a weather-related effect.

Ringling

We ringed 504 adult and 39 young Thick-billed Murres in 1985, with an additional 14 adults and 12 young in 1992. For Common Murres, numbers were 200 adults and 53 young in 1985, 31 adults and 5 young in 1992.

Protective status

Ydre Kitsissut is a Ramsar site, an Important Bird Area, and a breeding refuge for birds. Trespassing and traffic within 500 m is prohibited during 1 June - 31 August.

Recommendations for monitoring

The dispersed, mixed-species colonies of these islands are best surveyed from land-based observation points on various islands (Kampp & Falk 1994); for navigation a small inflatable is recommended.

Daily counts in the 13 small study plots at island *K* between 31 July and 9 August 1992 revealed: mean = 523.6, SD = 94.0 (CV = 18%), $n = 9$. Data on day-to-day variation are plotted in the figure above (bold line), while a discussion on within-day variation can be found in Kampp & Falk (1994).

Due to the large CV these study plot data unfortunately only permit detection of population changes of 25% or more. This provides a poor basis for assessing

future changes, and better baseline data should be compiled. Until then, a complete census of the colonies may provide a better impression of potential major population changes.

The birds breed late compared to other colonies in West Greenland, so census work should be planned to take place in late July to early August.

References

Kampp & Falk (1994), Salomonsen (1979).

Extinct colony

60011 **Qiiqit** (60°41'N 47°45'W) was visited by Salomonsen (1950, unpubl. data) on 27 June 1949. There were about 1000 murres but no eggs, and the birds left the cliff on the approach of the boat and settled on the water. Probably, the eggs had been taken by eggers. In the mid-1970's local residents told Salomonsen that the colony still existed, but no murres were present when F. Wille (pers. comm.) visited the site on 30 July 1981.

3.10 Ittoqqortoormiit (Scoresbysund)

There are two known murre colonies in this region - and no other murre colonies in East Greenland. Sølberg (1980) reported that a third, small colony existed on Steward Ø about 40 km southwest of Kap Brewster, but several local residents independently denied this when asked by us in 1985 and 1995. If there ever was a murre colony there, it seems to have disappeared several years ago.

Murre eggs in this region probably normally hatch shortly before mid-July, and chicks begin to fledge in the first days of August. Census work should therefore be carried out from mid-July to early August, although ice conditions cause logistic constraints in July (see below and Falk et al. 1997).

Kap Brewster (Kangikajik)

Colony code 70508

Position 70°09'N 22°06'W

General description

Kap Brewster forms the southern limit of the mouth of the great East Greenland fiord Scoresby Sund. The murre colony, situated on both sides of the cape, is 38 km south of Ittoqqortoormiit (Scorebysund town). The cliffs are about 300 m high with extensive scree below them; the top above the colony is flat so a camp can easily be established. With some difficulty it is possible to walk down to the shore where an inflatable may be placed, although it will be at some risk from falling stones. Since the line of sight to Scoresbysund is not obscured, it is possible to raise people in the town even by low-powered radio.

The fast ice of the fiord usually breaks up in mid-July or earlier, but the bay off Scoresbysund will often remain icebound for some time, so visits before late July are best made by helicopter. Greenlandair has a Bell Long Ranger in the area for bringing passengers to and from the airstrip at Constable Pynt.

The seabirds

Apart from the murres, the Kap Brewster colony supports (1995) more than 100 pairs of Fulmars, 10 pairs of Glaucous Gulls, about 1000 pairs of Kittiwakes, numerous Dovekies (not censused), and a few Black Guillemots (Falk et al. 1997)

The murre colony

The murres are distributed in a dozen fairly distinct subcolonies along 3 km of the cliff on both sides of the cape, from just above the scree almost to the top. Another, much smaller colony is situated 5 km west of the cape. Parts of the main colony west of the cape are visible from the top so that counting and study plots can be laid out.

Murre counts

Pedersen (1930) believed that the colony had at least 10 000 pairs of murres, but made no counts. Meltofte (1976), visiting the main colony on 14 July 1974, counted 30 900 birds there, with an assumed uncertainty of 30%. The present authors counted 14 810 birds (14470 in the main colony, 340 in the west colony) on photos taken on 2 and 5 August 1995, with an assumed accuracy of 10% (Falk et al. 1997).

Although more details from the count in 1974 would be desirable, the decline during the intervening 20 years is probably real.

Study plots

Nine counting plots and one plot for studying breeding success and feeding rates were established by the authors in 1995 (see appendix D, and Falk et al. 1997). The potential for expanding the set of plots is slight which means that, although estimates of breeding success are obtainable, they must rely on a small sample of unknown representability. Counting plots appear to have an adequate coverage.

Breeding phenology

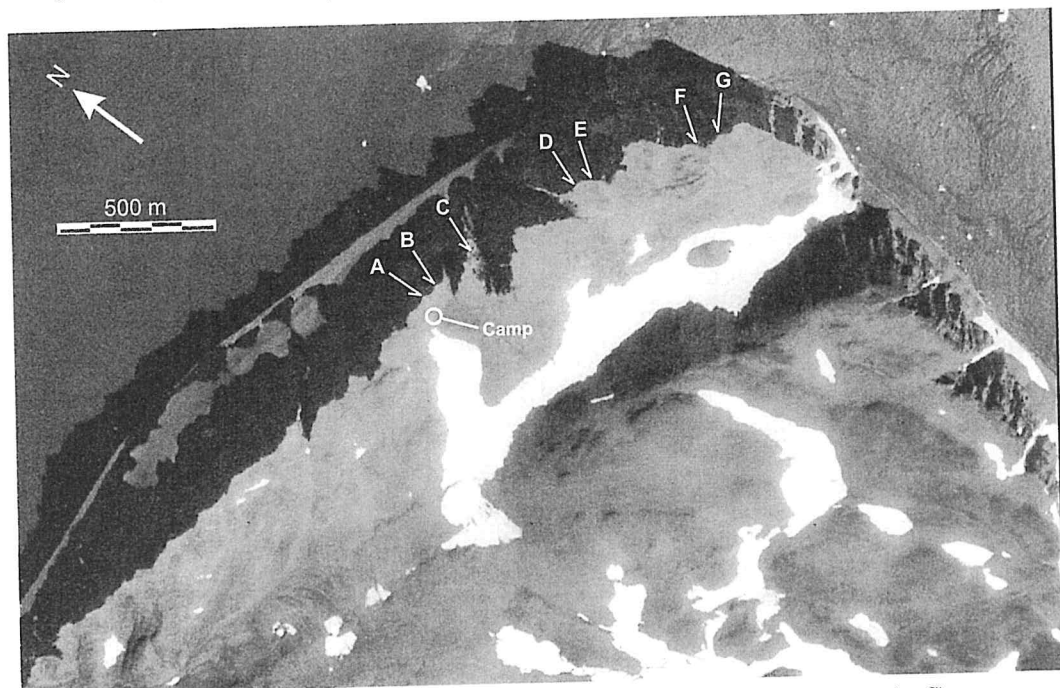
According to Pedersen (1930), fledged young become common on the fiord in mid-August. Local residents told us in 1995 that the earliest eggs are taken from Kap Brewster around 10 June, suggesting that fledging might start in the first days of August. This accords well with our observations of fledging young from 2 August onwards; also, the appearance and size of the chicks in two plots suggested that most would fledge before 10 August, and the last not later than 20 August (Falk et al. 1997). Fledging will be delayed a couple of weeks in the limited parts of the colony where eggs are collected.

Breeding success

No data, except that 65 pairs in a plot in 1995 had 43 young and one egg.



Extent of the murre colony at Kap Brewster (70508); the numbers refer to the survey photos used in the 1995 colony census by the authors.



Observation points for counting study plots at Kap Brewster (see plot boundaries in appendix C).

Ringling

Local Greenlanders ringed a nominal 1532 murre chicks at Kap Brewster on 8-22 August in 1970. Very few were subsequently recovered, perhaps suggesting that the ringing operation was improperly conducted (chicks too small to retain a ring, or too much disturbance associated with the activity), so that most ringed chicks lost their rings, or died soon afterwards. However, very few ringed murre chicks from Upernavik survived the winter 1970/71, so an alternative hypothesis is that a similar disaster struck the East Greenland birds after having spent the autumn and early winter in uninhabited areas.

Protective status

The colony is designated an Important Bird Area.

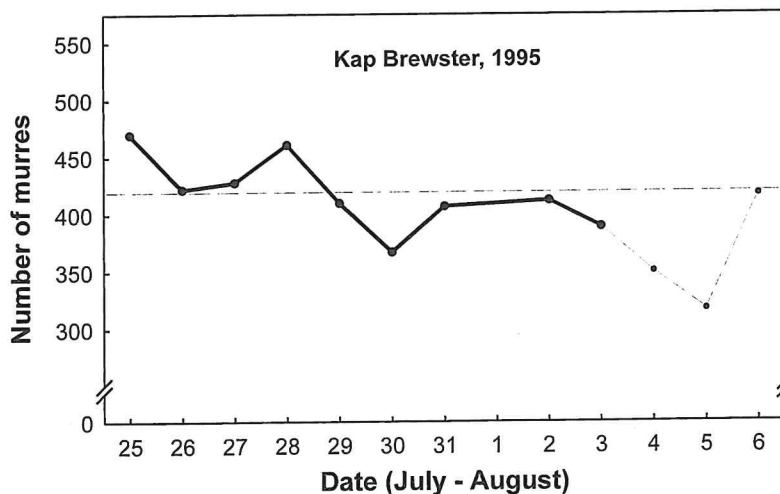
Recommendations for monitoring

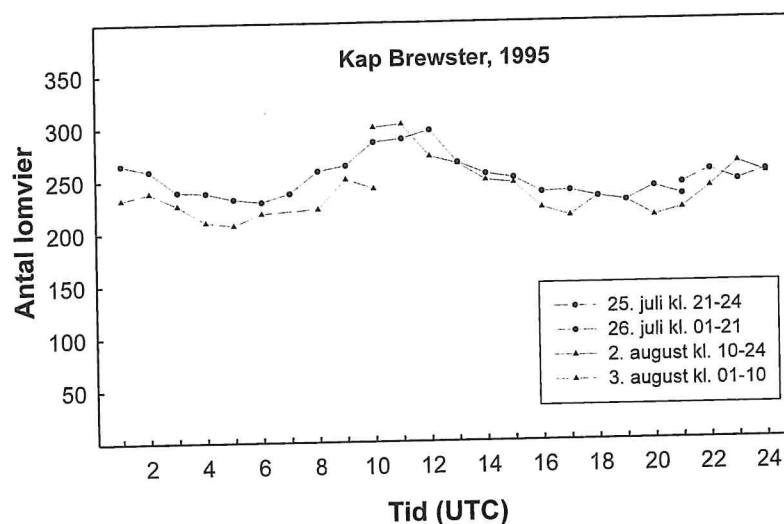
The 1995 photos deposited at the GINR should be used for comparison with new photos in order to:

- assess if the colony might be expanding or contracting;
- identify major population changes in selected sections of the main colony that can be easily identified and delineated on both sets of photos (1995 and new set).

At some cliff sections the murres breed right to the top of the 225 m cliffs. For a photo survey, a 300 mm telephoto lens will be required in addition to a 180 or 200 mm lens applicable at the lower sections. The photos should be taken from a boat positioned at varying distances from the coast - about 250-300 m for the telephoto shots of the upper sections, and about 150-200 m for other parts of the colony.

In 1995 nine study plots were defined at Kap Brewster, four of which were laid out later than the other. For the period when all plots were counted (27 July - 6 August, excluding 1 August owing to foul weather), the nine plots contained: mean = 913.4, SD = 80.9 (CV = 10%), $n = 10$. Since the period included days





with strong winds causing low attendance by the murres, and also reached into the early chick-fledging period, the CV was high, reducing the potential for detecting population changes. Therefore we recommend that future counts be compared to a subset of the 1995 counts, including only data from plots A-D + E2 from 25 July to 3 August: mean = 418.4, SD = 32.3 (CV = 7.7%), $n = 9$. These data are shown with a bold line in the graph above.

Counts in two of the study plots showed some within-day variation in colony attendance, with highest numbers about noon. The data presented in the attached graph suggest that census work should, if possible, take place between 15 and 22 hours (UTC = local daylight savings time). However, since the murre colony is situated at north- and northeast-facing cliffs, light conditions may be better for census work during night and early morning (approx 22 to 04 hours).

References

Falk et al. (1977), Meltofte (1976), Pedersen (1930).

Raffles Ø (Appalik)

Colony code 70505

Position 70°36'N 21°31'W

General description

Raffles Ø is a 3×1.5 km big, 550 m high island about 42 km from Scoresbysund (sailing distance). The east side is a vertical sea cliff where the murres are. The cliff is pale-coloured, on which background the occupied sections are rather inconspicuous.

Raffles Ø may normally be reached by sledge throughout the month of June, and by boat from late July.

The seabirds

Apart from the murres, the Raffles Ø colony supports (1995) at least 69 pairs of Fulmars, a few pairs of Glaucous Gulls, about 270 pairs of Kittiwakes, numerous Dovekies (on the west side of the island), and 25-30 Black Guillemots (Falk et al. 1997).

The murre colony

A number of generally small murre groups are dispersed over much of the vertical cliff on the east side of Raffles Ø, the only marked concentration being around a big fissure at the island's northwestern point. All ledges look completely inaccessible, but eggs are taken in the colony regularly, eggers reaching the occupied ledges from above after a walk and climb from the west side of the island.



Position of the murre colony at Raffles Ø (70505) in East Greenland. From KMS aerial photo # 888-R-0956 of 5 August 1987.

Murre counts

Pedersen (1930) believed the colony to contain about 5000 pairs of murres (no count). Very early in the season, in mid-May 1973, J. de Korte (pers. comm.) counted 3000-5000 birds in the colony. The present authors visited and photographed the colony on 7 August 1995 and subsequently counted 2523 murres on the photos, with a presumed error margin of 15% (Falk et al. 1997).

Study plots

None.

Breeding phenology

Meltofte (1976) noted that the murres had laid when he visited Raffles Ø on 16 June 1974. This observation, and the fact that a few fledging young came down during our brief visit on 7 August 1995, suggest that the breeding phenology is much the same as at Kap Brewster (see above).

Breeding success

No data.

Ringling

Never attempted.

Protective status

The colony is designated an Important Bird Area.

References

Falk et al. (1997), Meltofte (1976), Pedersen (1930).

4. Preliminary sketch of a monitoring scheme

Before a detailed plan for monitoring Greenland's murre populations can be drafted, the authorities have to set general management priorities for the harvested bird populations. However, based on personal experience - and available data - from the country-wide murre survey summarised in this report, we offer the following preliminary recommendations.

4.1 Monitoring of population change

The main field effort should be put into „problem areas“ with declining populations, where surveys should be repeated at three to five year intervals. Frequent checks would be appropriate at:

- all colonies in the southern Upernavik region (at 3 year intervals); most of the colonies are (have been) rapidly declining, and surveys at short intervals could document if the recently introduced hunting regulations are adequate to halt the downward trend;
- Ritenbenk in the Ilulissat region (every 5 years).

At colonies with a low population decline rate, or where no direct evidence suggests population reductions despite local disturbance (egging etc.), field visits could be made at somewhat longer intervals of about 6-9 years. Such „medium“ monitoring effort could be justified at:

- the two colonies in East Greenland (near Ittoqqortoormiit);
- the colonies in the Qaqortoq and Paamiut regions (2 colonies).

At colonies situated far from human settlements, in areas with a low potential hunting pressure, murre numbers appear to be (almost) stable. Fortunately, this also seems to be the case at some colonies in Southwest Greenland. These populations are unlikely to change at a rate that would be detected between frequent visits, so a census or monitoring check every 10-15 years would be appropriate. For the following colonies or regions such low-level monitoring could be justified:

- the Avanersuaq region (5 colonies);
- northern Upernavik (Apparsuit, Kippaku);
- the Maniitsoq region (3 colonies);
- the Nuuk region (1 colony).

In the Maniitsoq region however, two of the colonies have not been censused since 1988, and a census in the near future would be appropriate, considering the potential risk posed by fisheries in the archipelago west of the colonies.

When setting priorities for any monitoring programme, it should be borne in mind that plans must be dynamic and regularly updated so that a shift of focus can be made at short notice if warranted by new evidence of, e.g., unexpected declines in murre numbers at certain colonies.

4.2 Reproductive success and migration

Murre hunting has been phased out in most countries outside Greenland, the main exceptions being Iceland and the Province of Newfoundland and Labrador in Canada (and French territory near Newfoundland). If the Greenland authorities intend to ensure that viable murre populations are available for local hunters in the long term, a major goal for managers should be to identify maximum sustainable harvest levels for different murre populations. This is not an easy task, because it cannot be made alone on the basis of age-dependant mortality and reproduction in the populations, but also should consider how these parameters are influenced by changes in population size and harvest levels. Survival and reproduction estimates would be valuable, however, because they could be included in computer models that would at least provide tentative answers applicable in management decisions, e.g. in suggesting local quotas and hunting seasons.

It should, therefore, be recommended that studies of murre reproduction and survival parameters are initiated in a sample of Greenlandic colonies representing 'undisturbed' as well as declining colonies. Due to natural annual variation in reproduction, data should be collected for a number of years in succession (3-5) for baseline data, and again for comparison at a later stage.

Until more refined models and population parameters are available, recommended (sustainable) harvest levels would have to be based on more general information and some guesswork, for example along the lines suggested by Kampp (1988) for Upernavik. The major problem with harvest level estimates - apart from their identification - is how to incorporate them in a management scheme. To do so we need more precise information than is currently available on the origin of the murre killed in the Greenland hunt, and on the number of Greenlandic murre killed at Newfoundland.

Ringling is an obvious technique for clarifying these questions, so continued ringling of murre could become valuable for management purposes despite the great numbers already ringling in Greenland, particularly if ringling projects were well-planned, had specific aims, and especially if they were coordinated with similar efforts in other countries. Alternatively, satellite telemetry is about to become a feasible tool for murre-sized birds, and a few tracked murre would reveal instant information on migration routes and wintering grounds - pieces of information that will be unbiased compared to ringling recoveries that only identify areas where the birds are hunted. Finally, studies of murre genetics holds the potential for identifying the origin of individual birds hunted in different areas, and further development and application of such techniques should be promoted through international cooperation among wildlife managers in the arctic nations.

5. References

- Anon. (1993) International Murre Conservation Strategy and Action Plan. Conservation of Arctic Flora and Fauna (CAFF), Arctic Environmental Protection Strategy (Endorsed by the Arctic Ministers of Environment, March 1996).
- Bertelsen, A. 1921. Fuglene i Umánaq distrikt. Meddr Grønland 62: 139-214.
- Birkhead, T.R. & D.N. Nettleship 1980: Census methods for murres, *Uria* species: a unified approach. Can. Wild. Serv. Occ. Pap. 43:1-24.
- Boertmann, D., A. Mosbech, K. Falk & K. Kampp 1996: Seabird colonies in western Greenland (60° - 79°30' N. lat.): NERI Technical Report no. 170. Ministry of Environment and Energy, National Environmental Research Institute, Copenhagen.
- Boertmann, D., Mosbech, A., Falk, K. & Kampp, K. 1996. Seabird colonies in western Greenland. NERI Tech. Report no. 170.
- Donaldson, G.M., Gaston, A.J., Chardine, J.W., Kampp, K., Nettleship, D.N. & Elliot, R.D. 1997. Winter distribution of Thick-billed Murres from the eastern Canadian Arctic and western Greenland in relation to age and time of year. Can. Wild. Serv. Occ. Pap. 97:1-24.
- Elliot, R.D., B.T. Collins, E.G. Hayakawa & L. Métras 1991: The harvest of murres in Newfoundland from 1977-78 to 1987-88. Can. Wild. Serv. Occ. Pap. 69:36-44.
- Evans, P.G.H. (Ed.) 1987. Project studying ways to reduce the impact of hunting upon the Brünnich's Guillemot *Uria lomvia* populations of Upernavik District, West Greenland, July 1st - September 8th 1987. Unpublished report.
- Evans, P.G.H. & K. Kampp 1991: Recent changes in Thick-billed Murre populations in West Greenland. Can. Wild. Serv. Occ. Pap. 69:7-14.
- Falk, K. & J. Durinck 1992: Thick-billed Murre hunting in West Greenland, 1988-89. Arctic 45:167-178.
- Falk, K., K. Kampp & A.S. Frich. 1997: Polarlomvien i Østgrønland, 1995. Teknisk Rapport nr. 8, 1997. Pinngortitaleriffik / Grønlands Naturinstitut, Nuuk. In Danish, with English and Greenlandic summary.
- Gaston, A.J., R.I. Goudie, D.G. Noble & A. Macfarlane 1983: Observations on „Turr“ hunting in Newfoundland: age, body condition and diet of Thick-billed Murres *Uria lomvia* and proportions of other seabirds killed off Newfoundland in winter. Can. Wild. Serv. Prog. Note 141:1-7.
- Gaston, A.J. & D.N. Nettleship 1981: The Thick-billed Murres of Prince Leopold Island Monograph Series, No. 6. Canadian Wildlife Service, Ottawa.
- Gaston, A.J., L.N. de Forest, G. Gilchrist & D.N. Nettleship 1993: Monitoring Thick-billed Murre Populations at colonies in northern Hudson Bay, 1972-92. Can. Wild. Serv. Occ. Pap. 80:1-16.

- Grimmet, R.F.A. & T.A. Jones 1989: Important bird areas in Europe. ICBP Technical Publication No. 9.
- Harris, M.P., S. Wanless & P. Rothery 1983: Assessing changes in the numbers of Guillemots *Uria aalge* at breeding colonies. *Bird Study* 30:57-66.
- Harris, M.P. 1989: Variation in the correction factor used for converting counts of individual Guillemots *Uria aalge* in to breeding pairs. *Ibis* 131:85-93.
- Hatch, S.A. & M.A. Hatch 1989: Attendance patterns of murres at breeding sites: Implications for monitoring. *J. Wildl. Manage.* 53:483-493.
- Joensen, A.H. & Preuss, N.O. 1972. Report on the ornithological expedition to Northwest Greenland 1965. *Meddr Grønland* 191(5):1-58.
- Kampp, K. 1988: Lomvien i Grønland. *Tusaat/Forskning i Grønland* 1/88:2-15.
- Kampp, K. 1990. The thick-billed murre population of the Thule district, Greenland. *Arctic* 43:115-120.
- Kampp, K. & K. Falk 1994: The birds of Ydre Kitsissut (Kitsissut Avalliit), Southwest Greenland. *Meddr Grønland Bioscience* 42:1-25.
- Kampp, K., D.N. Nettleship & P.G.H. Evans 1994. Thick-billed Murres of Greenland: status and prospects. In: Nettleship, D.N., J. Burger & M. Gochfield (eds) *BirdLife Conservation Series*, No. 1: Seabirds on Islands. Threats, case studies and action plans. BirdLife International, Cambridge.
- Kampp, K., Nettleship, D.N. & Evans, P.G.H. 1994. Thick-billed Murres of Greenland: status and prospects. *BirdLife Conservation Series* no. 1:133-154.
- Kampp, K. & P. Lyngs 1989: Polarlomvier i Upernavik 1988. Det Grønlandske Fuglefjelds-projekt. Grønlands Hjemmestyre/WWF Verdensnaturfonden, Copenhagen (Unpublished report, revised 1995).
- Meltofte, H. 1976. Ornithologiske observationer i Scoresbysundområdet, Østgrønland, 1974. *Dansk Orn. Foren. Tidsskr.* 70:107-122.
- Pedersen, A. 1930. Fortgesetzte Beiträge zur Kenntnis der Säugetier- und Vögelfauna der Ostküste Grönlands. *Meddr Grønland* 77:341-507.
- Salomonsen, F. 1979. Ornithological and ecological studies in S.W. Greenland (59°46'-62°27' N.Lat.). *Meddr Grønland* 204(6):1-214.
- Salomonsen, F. 1950. Grønlands fugle. The birds of Greenland. Munksgaard, København.
- Scheel, H. 1927. Fugleekspeditionen 1925. Hage & Clausens forlag, København.
- Sølberg, F. 1980. Jagten i Scoresbysund. Borgen.
- Vaughan, R. 1988. Birds of the Thule district, Northwest Greenland. *Arctic* 41:53-58.

Vibe, C. 1938. Fangerfolk og fuglefjelde. H. Hagerup, København.

Walsh, P.M., D.J. Halley, M.P. Harris, A. del Nevo, I.M.W. Sim & M.L. Tasker 1995: Seabird monitoring handbook for Britain and Ireland. Joint Nature Conservation Committee, RSPB, ITE & the Seabird Group, Peterborough.

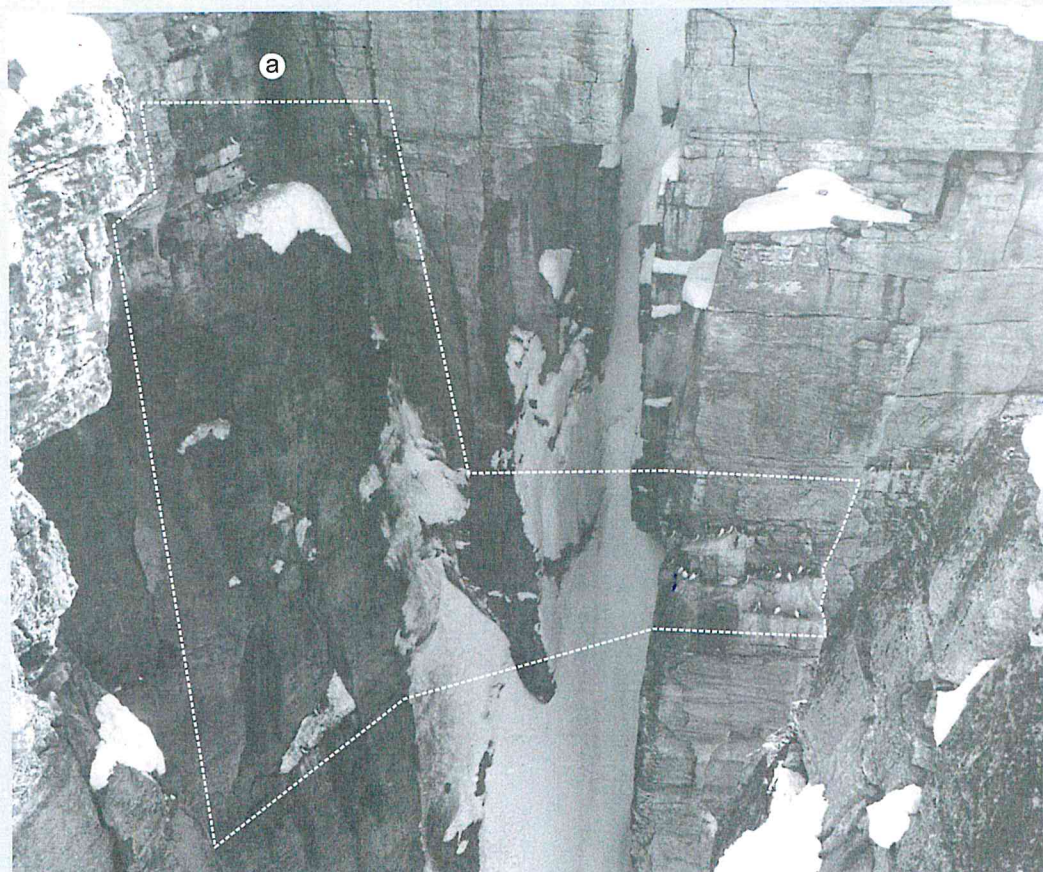
APPENDICES

Appendix A: Latin names of species mentioned in the text

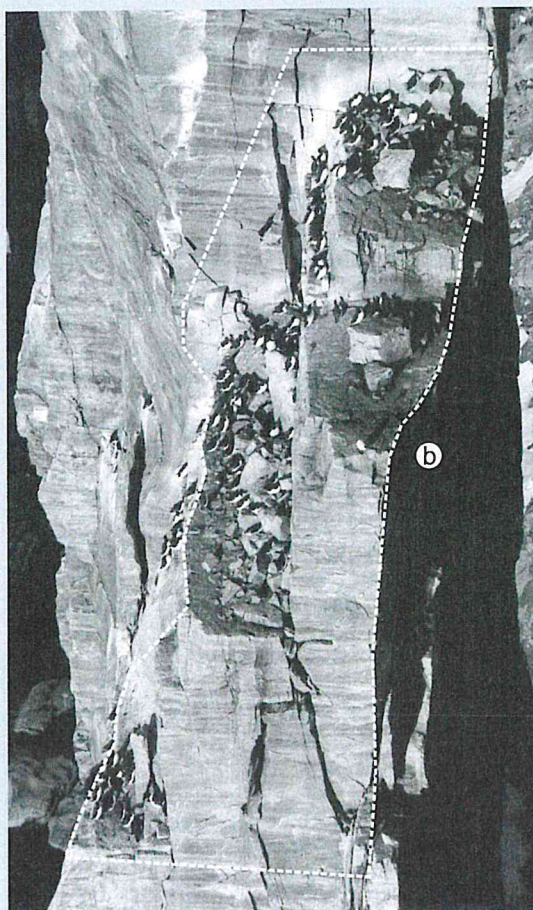
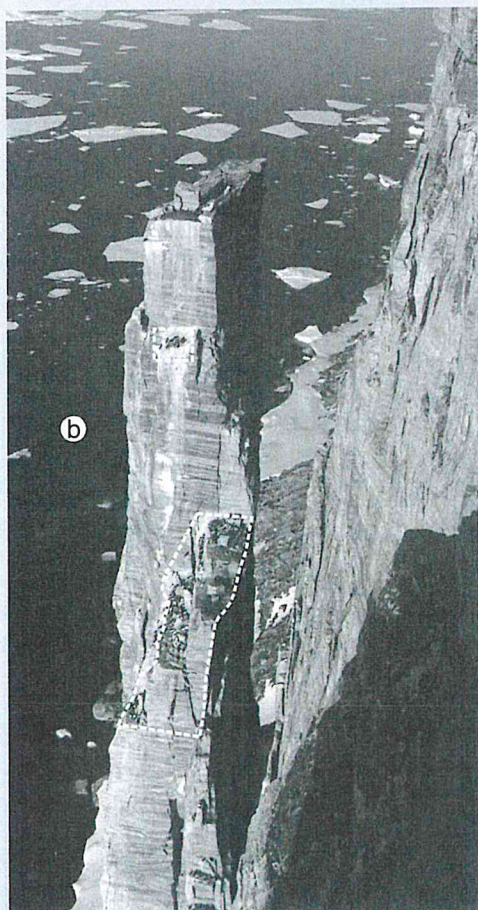
| | |
|-------------------------|------------------------------|
| Fulmar | <i>Fulmarus glacialis</i> |
| Cormorant | <i>Phalacrocorax carbo</i> |
| Common Eider | <i>Somateria mollissima</i> |
| King Eider | <i>Somateria spectabilis</i> |
| Iceland Gull | <i>Larus glaucoides</i> |
| Glaucous Gull | <i>Larus hyperboreus</i> |
| Great Black-backed Gull | <i>Larus marinus</i> |
| Kittiwake | <i>Rissa tridactyla</i> |
| Common Murre | <i>Uria aalge</i> |
| Thick-billed Murre | <i>Uria lomvia</i> |
| Razorbill | <i>Alca torda</i> |
| Dovekie | <i>Alle alle</i> |
| Black Guillemot | <i>Cephus grylle</i> |
| Puffin | <i>Fratercula arctica</i> |
| Salmon | <i>Salmo salar</i> |

Appendix B: Study plot boundaries at Hakluyt Ø

See location of each observation post in the colony account.



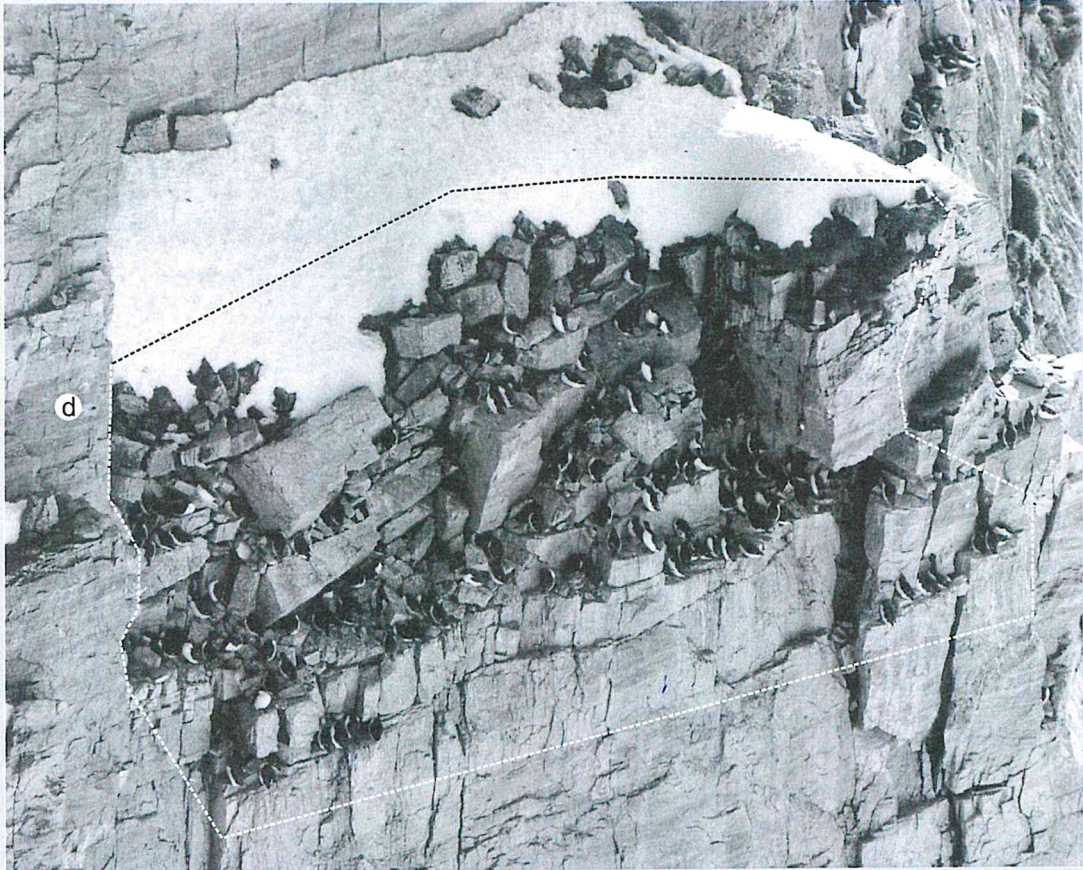
Study plots a and b at Hakluyt Ø (77002).



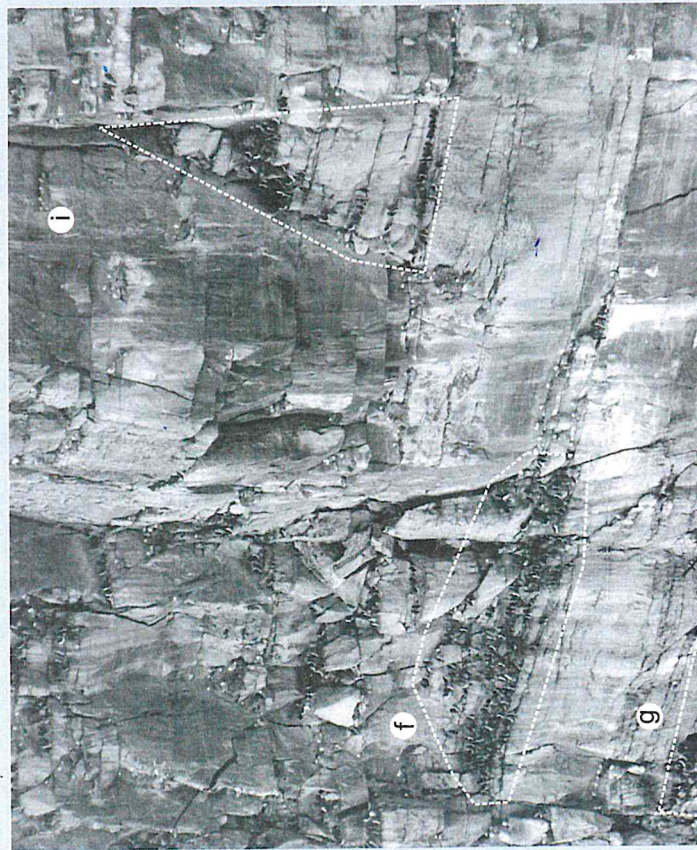
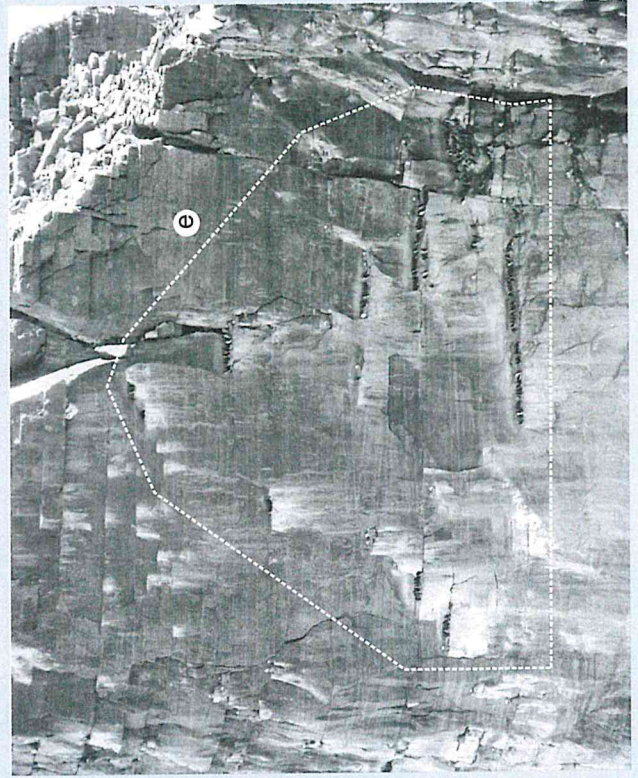


Study plot c at Hakluyt Island (77002).

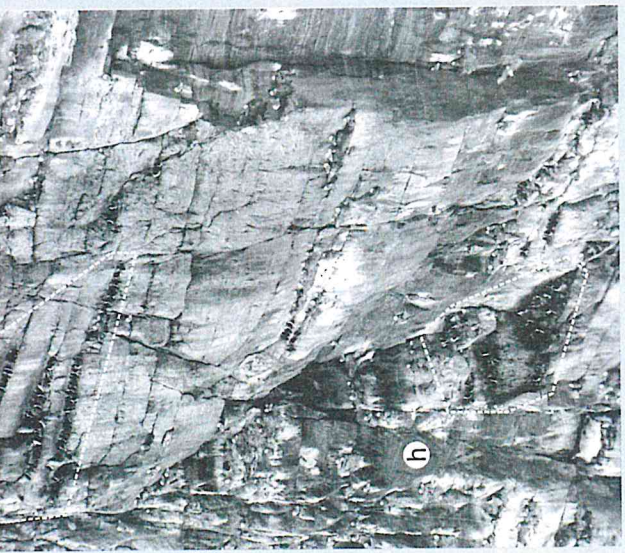




Study plot d at Hakluyt Ø (77002).

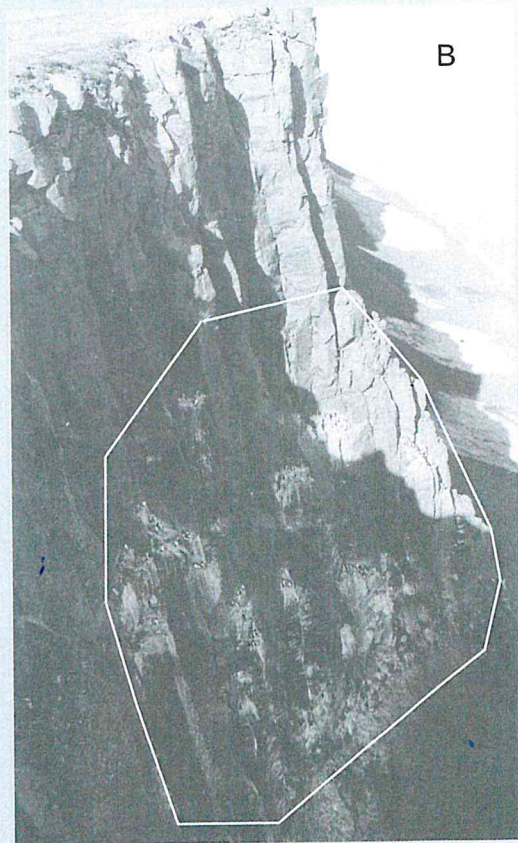


Study plots e, f, g, h and i
at Hakhyi Ø (77002).



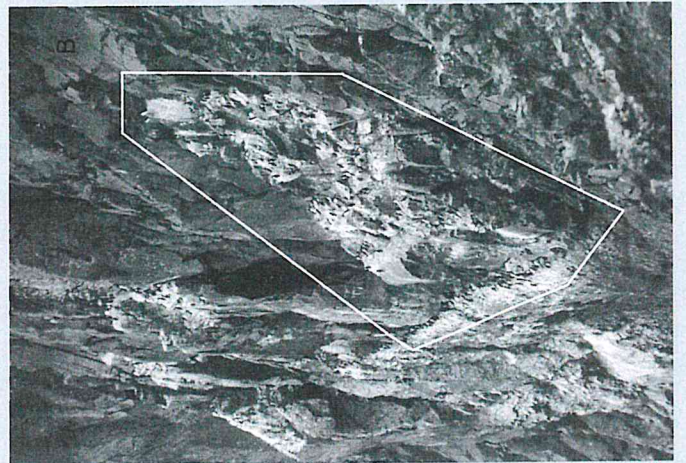
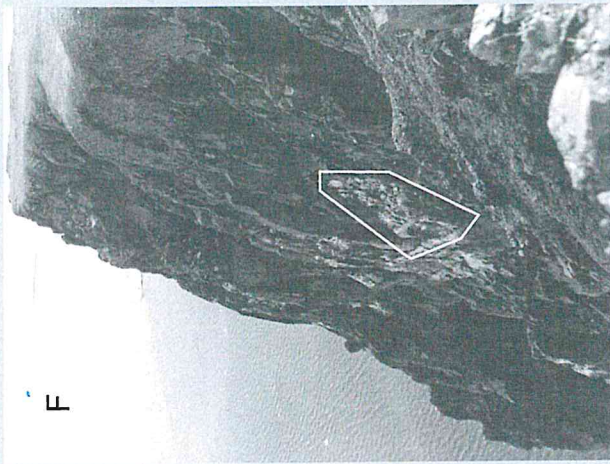
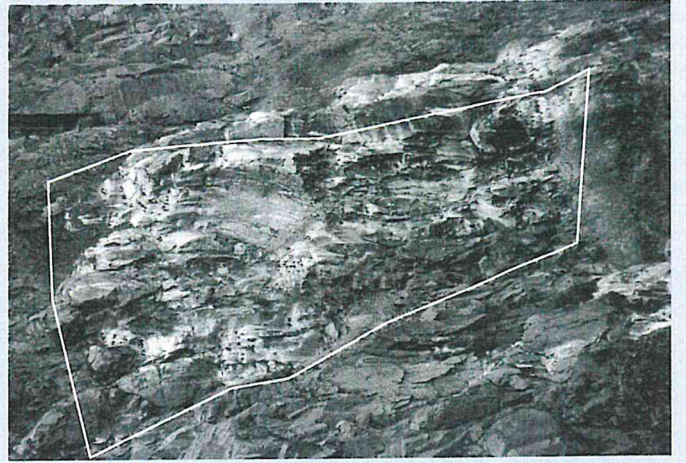
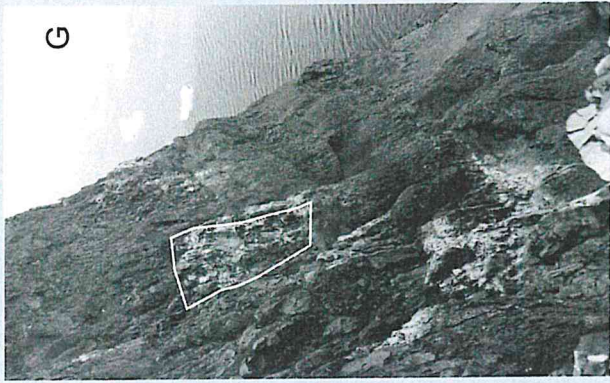
Appendix C: Study plot boundaries at Kap Brewster

Plots defined during field work in July - August 1995 (See further details in Falk et al. 1997).

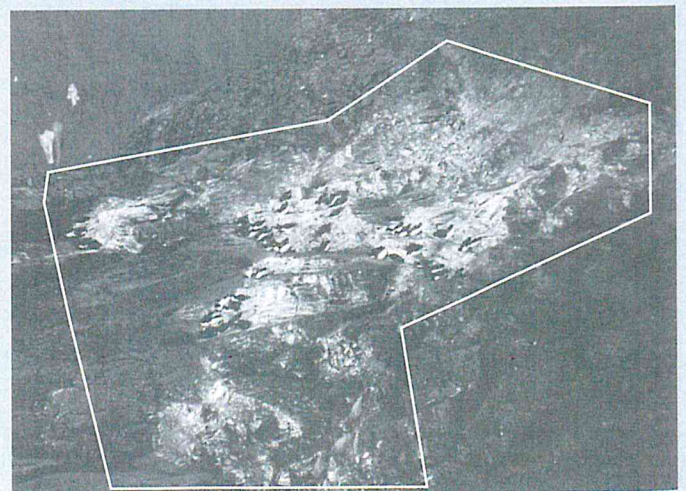
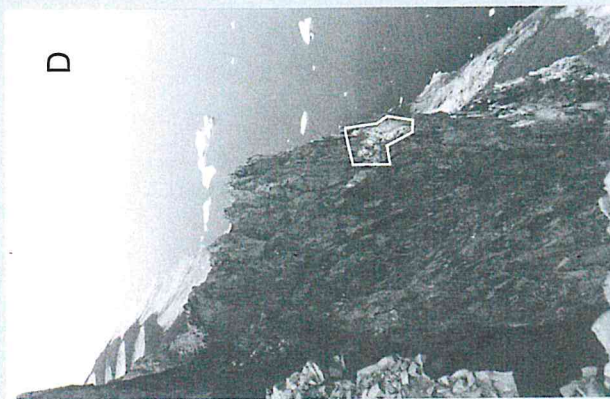


Study plots A, B, C and E at Kap Brewster (70502).





Study plots D, F, and G at Kap Brewster (70502).



Greenland Institute of Natural Resources

The Greenland Institute of Natural Resources is the center for nature research under the Greenland Home Rule. The objectives of the institute is to provide the scientific background for environmental protection including the biological diversity and sustainable utilization of the living resources in Greenland.

The Greenland Institute of Natural Resources is conducting research pertinent to the evaluation of the status of living resources in Greenland. The institute provides advice to the Greenland Home Rule and others within the field of expertise of the institute. The advice is either channelled directly to the Home Rule administration or through international organizations where Greenland participates.

The research is mainly directed towards:

- evaluation of resources (including population surveys)
- stock identification and assessment
- population biology and reproduction of selected species
- feeding habits and multispecies interactions
- evaluation and development of fishing gear

The Danish Arctic Environmental Program

The present report has been partly funded by the Danish Environmental Protection Agency as part of The Arctic Environmental Program by grants from the Danish Environmental Support Fund.

The Arctic Environmental Program was initiated in 1994 as part of the Danish Environmental Protection Strategy for the Arctic. The strategy also supports the international Arctic Monitoring and Assessment Program, AMAP, as well as indigenous people's affairs in the Arctic. The Arctic Environmental Program mainly sustains projects related to transboundary pollution problems, biodiversity, and climate change. Furthermore, initiatives to improve local environment, and raise awareness on environmental issues, are supported.

Further information on The Danish Arctic Environmental Program is available in Danish EPA News Report.