Population size of the Little Auk *Alle alle* in East Greenland

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(Med et dansk resumé: Størrelsen af Østgrønlands Søkonge-bestand)

The Little Auk or Dovekie *Alle alle* breeds in huge numbers in the Atlantic sector of the high arctic. Being the only small alcid feeding on planktonic crustaceans in the area, it appears to occupy an ecological niche divided between several species of 'auklets' in the Pacific area.

Population estimates of burrow-nesting seabirds are difficult to obtain, and when further considering the remoteness of the breeding places and the harsh climatic conditions prevailing here, the general lack of accurate figures for the Little Auk is to be expected. Based on data of varying character and quality, population figures have been published for most regions, but nowhere should they be regarded as more than orders-of-magnitudes (summary in Nettleship & Evans (1985)). The general picture emerging is one of high-arctic populations numbering several hundred thousands or millions of pairs (Greenland, Spitsbergen, Franz Josef Land); high-arctic/low-arctic transition zone populations numbering thousands (Upernavik District in Greenland, Jan Mayen, Bear Island); and a few 'frontier' low-arctic colonies numbering tens or hundreds (Canada (discovered 1983, Finley & Evans 1984), Disko Bay area in Greenland, Iceland). – Toward the east (Novaya Zemlya, Severnaya Zemlya) numbers are less impressive; none the less, a few pioneers seem to have colonized the Bering Sea (Sealy et al. 1971).

Among the high-arctic populations, that of the Thule District appears exceptional, since it is generally agreed that it should be counted in tens of millions. Freuchen & Salomonsen (1958) guessed at 30 million birds, but considered this conservative; Salomonsen (1981) made it 30 million pairs. To which degree this was based on actual counts is unclear, but Salomonsen (1974) estimated 4 million 'birds' (from the context obviously meaning pairs) for the south coast of Northumberland Island alone. – Based on aerial counts, Renaud et al. (1982) concluded that at least 14 million Dovekies (belonging to the Thule population) may be present in the western Baffin Bay at one time in spring, and that the total number migrating through the area each spring may be much larger.

In East Greenland the species breeds along Liverpool Land between Scoresby Sound and Carlsberg Fjord, and along the south coast of Scoresby Sound (Volquart Boon's Coast). Based on several years' field experience, but not actual countings, Pedersen (1930) estimated the population at 'auf wenigstens fünf Millionen' pairs. In recent years there has been a tendency to adjust this figure downwards: 'at least one million pairs' (Evans 1984); 'over ... 500,000 pairs', 'certainly well below the guess of 5 million pairs made by Pedersen (1930)' (Nettleship & Evans 1985). These adjustments, however, seem not to be supported by actual field-data.

In 1985, the present authors visited the area. The aim of our work was to make a preliminary survey of the Little Auk's distribution at sea and

Tab. 1. Data on the five flights in 1985. Times are in GMT. All flights except No. 1, which went from Iceland, took place from and to Mestersvig. Flight No. 5 aimed at mapping colonies, the others at counting birds at sea.
Data for de fem flyvninger. Tidspunkter er i GMT. Alle flyvninger undtagen nr 1, der udgik fra Island, startede og sluttede i Mestersvig. Flyvning nr 5 var en kortlægning af Søkonge-kolonier, de øvrige var egentlige flytællinger til havs.

Flight No. *Flyvning nr*	1	2	3	4	5
Date *Dato*	1 June	3 June	4 June	6 June	7 June
Take-off *Afgang*	13:07	10:00	10:28	13:57	10:35
Return *Ankomst*	17:46	14:27	15:55	19:22	15:04
Start of counts *Start på tællinger*	13:54	10:31	10:59	14:20	–
End of counts *Afslutning på tællinger*	17:25	14:02	14:10	18:50	–
Flight duration *Flyvetid*	4h 39m	4h 27m	5h 27m	5h 25m	4h 29m
Duration of counts *Tælletid*	3h 31m	3h 21m[a]	2h 39m[b]	4h 30m	–

a: Interupted for 10 min *Afbrudt 10 min;* b: Interupted for 32 min *Afbrudt 32 min.*

the precise delimitation of its breeding area, in order to set the frame for more detailed studies to precede eventual oil transportations at sea, in case the on-going prospecting activities in Jameson Land should bear fruit. A brief visit was also paid to one of the breeding colonies. The population figures obtained were as rough as those available from other areas, but if anything they appear to support Pedersen's (l.c.) old estimates.

Methods

Aerial surveys

Five aerial counts were carried out by HM and CEM in the period 1-7 June 1985 (Tab. 1). All were carried out from the Mestersvig airstrip except the first, which was made while flying from Iceland to Mestersvig. The aircraft was a Partenavia Observer PN 68, fitted with an Omega navigation system. The observer in the co-pilot seat (right side) had an excellent view forward and to the right; the other observer occupied the seat behind the pilot and had an adequate view to the left. Both used dictaphones to record the observations, and also the time (the latter from a pre-prepared tape giving signals for each two-minute period) to synchronize the two sets of records later on, and to pinpoint the exact positions for the records. Position and flight altitude were recorded by the co-pilot seat observer, and ice and weather conditions by the left-side observer.

Flight altitude and speed were 45 m and 170 km/h over areas with less than 9/10 ice cover, and 60 m and 230 km/h over pack ice covering 9/10 or more (where very few birds occurred). Fog was common, but in particular along the edge of the pack ice it was often possible to go under it and observe from altitudes down to 10 m (speed 160 km/h).

Along the transects all observed birds within an inner zone of 200 m to each side of the plane were recorded. In the outer zone farther from the aircraft single birds and small flocks were omitted. Records from the two zones were kept separate, and only those from the inner zone were used in calculating densities.

Observations in a colony

Two of us (KK, CEM) visited the Little Auk colony at Kap Höegh, a promontory on the southern coast of Liverpool Land (70° 44' N, 21° 35' W), during the period 19-27 June. The population was roughly estimated by regular counts of birds visible on the surface of a naturally delimited subcolony, combined with ringing of a number of birds belonging here. Two other areas were less systematically surveyed. The estimated population density was multiplicated by the area covered by the entire colony. Details are given elsewhere (Kampp et al. 1986).

During our stay at Kap Höegh data were also obtained on the birds' daily rhythm of attendance. In this, the counts of Kap Höegh birds could be supplemented by counts of birds from colonies farther inland, travelling over Kap Höegh on their way to and from feeding areas offshore.

Tab. 2. Observed Little Auks distributed according to ice conditions.
De observerede Søkonger fordelt efter isforhold.

Ice conditions *Isforhold*	Number of Little Auks *Antal Søkonger*
Open-water areas in pack ice *Åbentvandsområder i pakisen*	458,317
Small leads and openings *Revner og små våger*	614
The pack ice edge *Pakis-kanten*	5,424
Mouth of Scoresby Sound *Mundingen af Scoresby Sund*	112

Results

Ice conditions

During the flights, and also later when we visited Kap Höegh, land-fast ice covered Scoresby Sound out to its entrance between Kap Tobin and Kap Brewster. Off Liverpool Land, land-fast ice covered all fjords and the coastal waters out to about 10 km from land. Offshore from the edge of land-fast ice a broad belt of pack ice stretched out to about 200 km from the coast, somewhat more in the northern and less in the southern part (Fig. 1). Most of the pack ice consisted of densely packed floes ranging between 100 and 10,000 m², occasionally far more. 'Ice-islands' exceeding 100 km² also occurred. The coverage varied between 5/10 and more than 9/10. Leads and openings in this pack ice belt often extended for 20 to 40 km in the flight direction (Fig. 1). It was mainly in these openings, in particular along their borders, that the Little Auks were seen (Tab. 2); bird numbers hence were more closely correlated with the linear dimensions of the openings than with their areas, and recorded bird numbers were strongly dependent on the way our transect 'cut' an opening. Even when compensating for this effect, however, it was evident that the extent to which the birds frequented different openings varied considerably.

Densities of Little Auks in the pack ice

The densities with which the Little Auks occurred in various parts of the area are shown in Fig. 2. The figures are conservative so far as the transect width used in calculating densities was set to 500 m instead of 400 m; we suspect that our counts from the 'inner zone' occasionally included some birds actually lying outside its borders.

Earlier in the season, the polynya in the mouth of Scoresby Sound forms an extremely important foraging area for the Little Auks, including those breeding along Liverpool Land, and in some years at least this hold true even in June. In 1974, Meltofte (1976) witnessed spectacular flights of Little Auks at Kap Tobin on the southern point of Liverpool Land; the birds flew NE

Foto: Kaj Kampp.

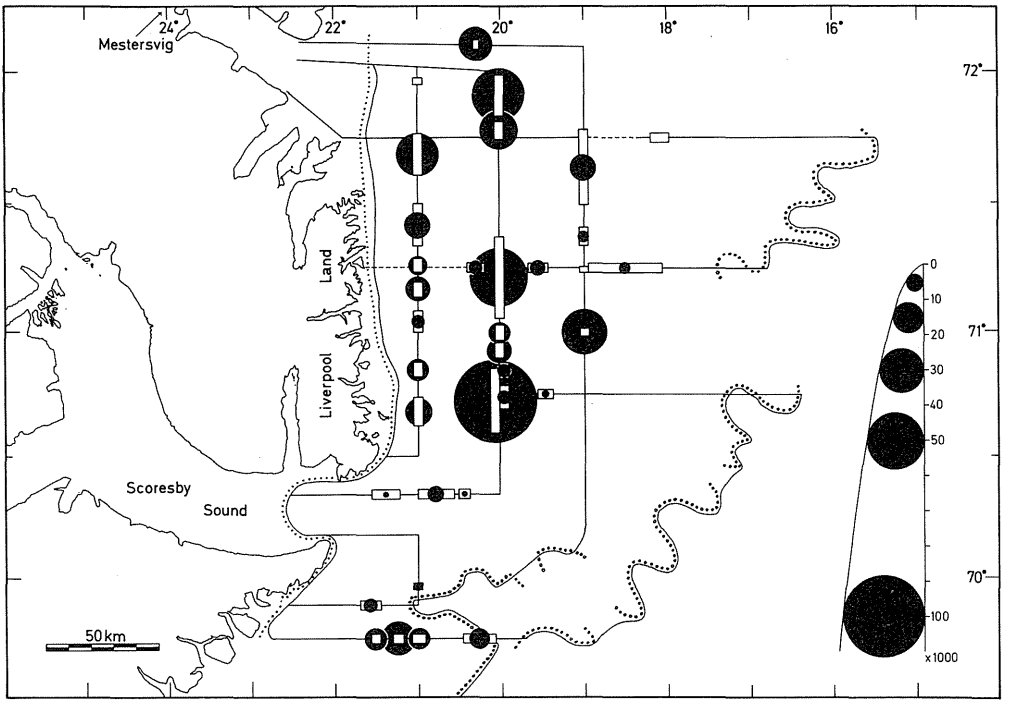

Fig. 1. Major concentrations of Little Auks in the pack ice off Scoresby Sound in early June 1985. Flight transects are full-drawn (dashed when flying over fog). Open-water areas are shown as open bars illustrating the extent of the open water along the transect. Flights along the edge of the land-fast ice are marked with dots; those along the outer edge of the pack ice are marked with open dots.
Større koncentrationer af Søkonger i drivisen udfor Scoresby Sund først i juni 1985. Fly-transekterne er vist med fuldt optrukne linier (stiplede ved flyvning over tåge). Større åbninger i isen er vist som åbne rektangler hvis længde illustrerer udstrækningen af åbentvandsområdet i flyveretningen. Flyvninger langs fastiskanten er markerede med prikker; flyvninger langs driviskanten med åbne prikker.

towards the colonies (or, on one occasion, SW towards the fjord mouth), and during a single event ½-1 million birds passed within visible range of Kap Tobin.

Breeding distribution in the area

The flight on 7 June 1985 aimed specifically at mapping the breeding distribution of the Little Auk in the Scoresby Sound area. Fig. 2 gives a coarse picture of the position of the Little Auk colonies; it shows the stretches of the coast housing colonies rather than the position of individual colonies. Some colonies were probably overlooked, for various reasons; fog caused problems locally along Liverpool Land, and not all fjords were examined; colonies may occur several kilometers inland; and during this phase of the breeding cycle, before initiation of egg-laying, colonies may at times be more or less completely deserted, and regional differences (a north-south trend towards lower attendance at colonies) were suggested by our observations during the flight.

Observations at Kap Höegh

The majority of the Little Auks at Kap Höegh breeds on the W (WNW) exposed slope, from an altitude of 100 m to the crest at 300 m. The length of this slope is 1000 m; it rises at an uniform angle of about 36°, hence the inhabited area is 340,000 m². The colony is not evenly distributed over this entire area, however; only about 40%, i.e. roughly 140,000 m², hold dense concentrations of birds.

The birds were counted in a subcolony covering 220 m² and containing 150 breeding pairs, with an additional 50 immature nonbreeders. This gives 0.7 pairs per m². Even this figure is a very rough estimate, but compares favourably with estimates obtained in Spitsbergen: up to 1 pair per m² (Norderhaug 1980); 0.5-0.7 pairs per m² (Stempniewicz 1981).

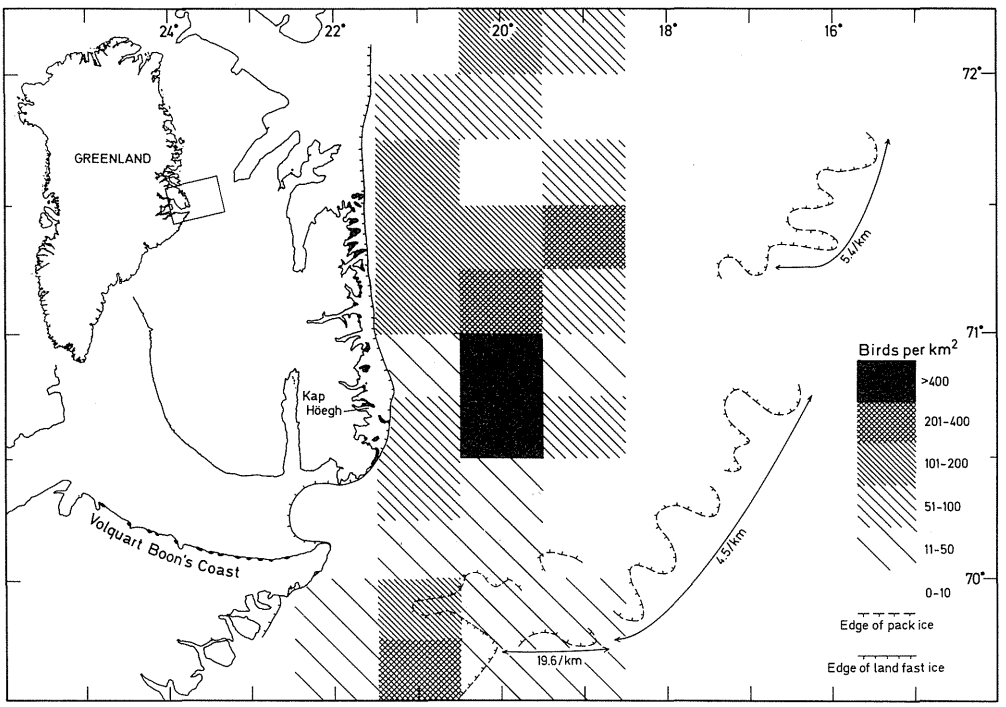

Fig. 2. Densities of Little Auks (birds per km²) in the pack ice off Scoresby Sound in early June 1985, together with colonies along the coast of Liverpool Land and Volquart Boon's Coast (marked with black). The densities were calculated from birds observed inside a 500 m wide transect. Along the edge of the pack ice densities are given as birds per km (figures).

Tæthederne af Søkonger (fugle pr km²) i drivisen udfor Scoresby Sund først i juni 1985, samt kolonier langs kysten af Liverpool Land og Volquart Boons Kyst (markeret med sort). Tæthederne er beregnede ud fra observerede fugle i en 500 m bred transekt under flyet. Tætheden af Søkonger langs driviskanten er tillige angivet som fugle observeret pr km.

These density and area estimates suggest a population of 90-95,000 breeding pairs on the W slope. Great numbers also occur along the north side and a couple of other places. The population on Kap Höegh probably totals about 140,000 pairs, with roughly two thirds nesting along the W slope.

The birds travelling east and west over Kap Höegh originated from colonies visible further inland on the Sandbach Peninsula, and probably even from colonies not visible. On 24-25 June about 95,000 birds were counted flying eastwards (and a similar number westwards) through 24 hours. This figure will include nonbreeders; on the other hand, all birds involved in these movements would hardly follow routes rendering them visible from Kap Höegh. It is not known whether each bird made the trip out and home once during the period, but it should be safe to conclude that even these colonies were large, housing an order of magnitude of 100,000 birds or more.

From the numbers travelling over Kap Höegh during 24-25 June it was calculated that the colony attendance peaked in the early forenoon, around 9 am (GMT), with 86% of the birds present, and reached a minimum by early night, around 9 pm, with 17% present. These estimates are based on a number of assumptions which could not be evaluated. But the general conclusion, that the number of birds visible on the surface in the colony peaked during the forenoon and decreased rapidly after noon, was confirmed by observations in the Kap Höegh colony. The amplitude of the attendance curve varied a good deal, however. Whether this reflected a periodicity with a longer period, e.g. 48 hours as reported for this part of the breeding cycle in Spitsbergen (Stempniewicz 1986), could not be established during our brief stay at Kap Höegh.

The egg-laying was initiated around 20 June,

when the first egg was found by egg-gathering Greenlanders staying at the place. None were found earlier though they were eagerly sought after through the previous days. During the week before our departure on 27 June, nest-chambers containing eggs rapidly became common.

Population size

From the data presented above two independent estimates of the total population size in the area can be obtained. The rather substantial uncertainties involved are discussed later.

1) From the estimated densities at sea (Fig. 2) one obtains 4.2 million birds. Two of the four flights took place around noon, and two in the afternoon (Tab. 1); the attendance pattern at Kap Höegh suggests that around 40% of the birds were at sea in the former case, 80% in the latter. Using 60%, the population should be roughly 7 million birds. To estimate how many pairs this figure represents, the proportion of immatures is needed. Unfortunately, parameters on the Little Auk's population dynamics are virtually unknown; but on the reasonable assumption that mortality is slightly higher and age of first breeding lower than for the larger alcid species, one pair could be represented by 2 breeders, 0.5 1st-year, 0.4 2nd-year, and 0.3 3rd-year immatures. In other words, 3.2 birds per pair. This would make the 7 million birds 2.2 million pairs.

2) As a rough estimate the total Little Auk population in the Scoresby Sound area (Fig. 2) is, at the very least, 25 times the number occurring at Kap Höegh. This indicates a minimum figure around 3.5 million pairs.

Discussion

Accuracy of the aerial counts

The flight altitude and speed used here are nearly identical to those used in many other aerial counts of seabirds, including Little Auks (McLaren 1982, Renaud et al. 1982). While such surveys appear to yield useful results, it is generally not possible to evaluate the accuracy. It will furthermore vary with light and sea conditions, and with the experience of the observers. Assuming that the observers are able, at a glance, to estimate the size of a bird flock correctly, other factors tend to make estimates low. Alcids are dark-backed and not easily visible in unfavourable wind and light conditions; furthermore they are diving birds, and may dive before being detected either because of the approaching plane or because they are feeding. Actively foraging Little Auks may be submerged for two thirds of the time (Kartashew 1960). For these reasons, the recorded numbers could be expected to be too low, but it is not possible to say by how much. In the present study, though, visibility might be a minor problem: among the ice, the sea surface had the appearance of a light-coloured mirror, rendering dark and moving birds very conspicuous.

Another problem concerns the view of the respective observers. This will depend on the aircraft type. The Partenavia offers the co-pilot seat observer an excellent view forward and to the right. He will therefore cover 60-65% of the transect's inner zone, where he will often be able to spot the birds before they become aware of the plane. The left-side observer behind the pilot covers the remaining 35-40% of the inner zone, and runs the risk that birds have dived before coming into his field of view. Altogether, in the present survey the right (co-pilot) observer recorded 73.2% of all Little Auks in the inner transect zone, against 53.4% of those recorded in the outer zone. This indicates that the recorded total should be increased by 15-20% to compensate for undetected (submerged) birds to the left side. Whether this correction is meaningful, considering the other and potentially grave error sources, is unclear. It has not been done here.

The problems mentioned above primarily concern situations where, as in the present study, absolute numbers are sought. If the aim is to map the distribution of the birds at sea and the importance of different areas, as was in fact the main reason for this survey, relative numbers will be quite as valuable as absolute ones.

Estimation of the population size

Both estimates of the size of the East Greenland Little Auk population given here should be considered as preliminary ones, based on meagre data sets. It should be quite feasible, however, to improve on both in the future, and the following discussion may provide some guidelines in that respect.

Concerning the aerial counts at sea, they tend to underestimate numbers, as discussed above. In the present case, furthermore, the transects were few, rendering statistical uncertainties important. Besides, the densities were calculated from flights carried out on different days, be-

Very large numbers of Little Auks may feed along the ice edge in the mouth of Scoresby Sound in May and June, although few were seen here during our study in 1985. Photo: Nanoq Film.
Meget store mængder Søkonger optræder ofte langs iskanten i mundingen af Scoresby Sund i maj og juni, afhængigt af isforholdene i området. Her sidst i maj 1986.

tween which significant movements of the pack ice – and consequently of the birds – took place. This could lead to a considerable overestimate if the transect each day happened to cover the (by that day) most densely frequented areas. The situation could quite as well be the opposite, however, and we have no a priori reasons to assume either an over- or an underestimate from this reason.

The proportion of birds occurring at sea during the counts was likewise inaccurately known, not least because the flights took place three weeks before the visit at Kap Höegh, and attendance patterns may well have changed during that period (in fact, they certainly did, if findings elsewhere are valid in East Greenland – see Stempniewicz (1986) and the review in Cramp (1985)). Finally, of course, the population parameters used to convert total numbers to breeding pairs comprise some measure of guesswork.

The population estimate based on the size of the Kap Höegh colony should be considered as a minimum figure. Even if the size of the Kap Höegh colony may have been overestimated, it could hardly contain less than 100,000 pairs. On the other hand, the coverage during the flight along the coast was incomplete, as mentioned above. For example, the colonies situated inland on the Sandbach Peninsula and visible from Kap Höegh were not seen from the air. The significance of missed colonies probably by far exceeds the significance of any possible overestimate made at Kap Höegh. Even more important, the factor of 25 between the Kap Höegh and the total population is mainly a guess, and deliberately set very low. The true value could well be more than twice that figure.

To summarize, the two independent ways of calculating the total breeding population both indicate at least a few million pairs. It appears very difficult to reconcile the data with a smaller population size; it could, however, well be substantially larger. Pedersen's (1930) old estimate of 5 million pairs then turns out to be, if anything, conservative, and recent suggestions that the figure should be adjusted downwards seem unwarranted. On the present knowledge, the population could in fact exceed 10 million pairs, which would make it comparable to the Thule population.

Postscript

The Little Auk is an extremely successful species. In the North Atlantic sector no other seabird comes close to equal it numerically, and on the entire globe only a couple of seabirds (and very few land-birds) may do that. It appears natural to regard this success as the result of the adaptations which have enabled the species to utilize – and to some extent monopolize – a vast renewable resource: the crustacean (mainly copepod) zooplankton blooms of arctic seas.

Everything in the behavioural répertoire of the Little Auk indicates that it is 'meant' to

breed in high concentrations and undoubtedly 'always' has been very numerous. Even then, it is tempting to speculate (although impossible to answer) if it has ever been so plentiful as at present. The specialized feeding method of the right whales – in this context the Greenland right whale *Balaena mysticetus* – appears adapted precisely towards the same prey that supports the thriving Little Auk populations (cf. Pivorunas 1979). In southern seas penguins and other seabirds seem to have gained greatly by the lessened competition from finner whales after depletion of the stocks in this century. The arctic right whale stocks crashed 100 years earlier, and the Little Auk populations have had that much longer to adjust to the new situation. Till now, the right whale stocks have failed to recover in spite of many years' protection; should they succeed one day, would we then witness a Little Auk crash instead?

Acknowledgments

This study formed part of environmental baseline studies carried out by the Greenland Fisheries and Environmental Research Institute in connection with oil exploration activities in Jameson Land. – Leif Petersen piloted his plane with daring competence, readily displaying the particular flexibility needed in a job like this. – Among other inhabitants of Scoresbysund we especially wish to thank Jens and Dorthe Thygesen for their hospitality and assistance in numerous ways.

Resumé

Størrelsen af Østgrønlands Søkonge-bestand

Søkongen *Alle alle* yngler uhyre talrigt i den atlantiske sektor af højarktis, fra Thule i vest til Severnaya Zemlya i øst. Specielt talrig er den i Thule-området, hvor forskellige kilder angiver en bestand på 10-30 mill. par. Den østgrønlandske bestand omkring Scoresby Sund blev af Pedersen (1930) skønnet til ikke under 5 mill. par. Dette tal er blevet justeret nedad til 1 mill. eller endog ½ mill. par i et par nyere sammenstillinger (Evans 1984, Nettleship & Evans 1985), men baggrunden herfor er tilsyneladende nogle delvist misforståede andenhånds-oplysninger.

I 1985 besøgte forfatterne området med henblik på indledende undersøgelser af Søkongerne, især deres fordeling på havet, i forbindelse med de igangværende olieefterforskninger i Jameson Land. Herunder gennemførtes dels nogle flytællinger til havs og en kortlægning af kolonierne i første uge af juni, dels et besøg i Søkonge-kolonien på Kap Höegh i dagene 19.-27. juni. De indsamlede data giver mulighed for grove skøn af bestandsstørrelsen, baseret dels på flytællingerne til havs, dels på størrelsen af Kap Höegh kolonien sammenholdt med artens totale udbredelse i området. Resultaterne, 2,2 hhv. 3,5 mill. par, er begge behæftet med betydelig usikkerhed og er at betragte som minimumsangivelser, og den virkelige bestand kan udmærket være 2-3 gange så stor. Pedersens (1930) oprindelige skøn på 5 mill. par synes således ganske fornuftigt.

Det bør måske tilføjes, at uanset hvor usikre de angivne tal er, så er de ikke ringere end dem, der haves for andre Søkonge-bestande.

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Received 2 April 1987

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