Migration and winter ranges of Brünnich's Guillemots *Uria lomvia* breeding or occurring in Greenland

KAJ KAMPP

(Med et dansk resumé: Vandringer og vinteropholdssteder for Polarlomvier Uria lomvia *i Grønland)*

In Greenland, Brünnich's Guillemot *Uria lomvia* is a numerous and economically important seabird. It breeds at a score of colonies scattered along most of the coast of W Greenland and the Thule area in N Greenland. Two colonies exist at Scoresby Sound in E Greenland. Until recently, only very rough population estimates were available for most colonies, but recent estimates indicate about 150,000 pairs in W Greenland (with more than 80% in Upernavik district) and 200,000 pairs in N Greenland (Nettleship & Evans 1985, Kampp 1988a, 1988b). The population in W Greenland has declined seriously during the last 50 years, in particular in Disko Bay, Umanaq and the southern part of Upernavik district, mainly owing to overexploitation by local hunters (Evans 1984, Kampp 1988a, 1988b).

The migration and wintering areas of guillemots breeding in northern W Greenland have been described by Salomonsen (1967) based on extensive ringings of the birds. In addition, due to the Greenland bird-ringing system and the awareness among Greenlanders of bird-ringing arising from that scheme, many foreign-ringed guillemots have been reported from Greenland. These were likewise treated by Salomonsen (1.c.). In an analysis of Brünnich's Guillemots ringed in Canada, however, the conclusions differed very much from those of Salomonsen (Gaston 1980). The major point of divergence concerns the role of Greenland and Newfoundland waters as wintering areas for Greenland and Canadian (Lancaster Sound) guillemots, respectively. Salomonsen concluded that Greenland birds mainly winter in Newfoundland and Canadian high-arctic birds in Greenland, whereas Gaston reached an almost opposite conclusion.

These differences in interpretation underline the need for a re-analysis of the available ringing data. An attempt to do this was done by Kampp (1982), but the major conclusions of that analysis have yet to be summarized or enlarged upon. Thus the purpose of the present paper is to take the ringing recovery data sets used by Salomonsen (1967) and Gaston (1980), update them to include ringing performed in Greenland and the eastern Canadian arctic after 1979, and perform a re-analysis of the information employing procedures that will produce results that are statistically meaningful. Such information should considerably improve our knowledge of the pattern of movements and water-habitat usage by Brünnich's Guillemots off west Greenland and add to our understanding of the population dynamics of one of the Northwest Atlantic's commonest seabird species.

Dansk Orn. Foren. Tidsskr. 1988(82): 117-130

Tab. 1. Number of Brünnich's Guillemots ringed in W Greenland 1946-80 according to ringers' reports. The corrected total excludes ringings from which none or very few recoveries have been made (see text).
Polarlomvier ringmærket i Vestgrønland 1946-80 iflg. mærkningsrapporter. Korrigerede totaltal gælder ringserier med normale genmeldingsmønstre, modsat serier uden eller med unormalt få genmeldinger (f.eks. fordi ringene har været brugt til unger, der var for små).

	Upernavik N		Upernavik S		Umanaq		Disko Bay		Total		Recovered
	ad.	pull.	ad.	pull.	ad.	pull.	ad.	pull.	ad.	pull.	*Genmeldt*
1946-50	20	0	23	36	12	699	0	773	55	1508	228
1951-60	1	0	278	6836	1	6629	23	2563	303	16028	1196
1961-70	340	17170	633	5578	6	2452	0	140	979	25340	1174
1971-80	198	31772	0	2099	0	366	0	0	198	34237	416
Total	559	48942	934	14549	19	10146	23	3476	1535	77113	3014
Corrected total	426	19651	334	11443	18	5050	20	2432	798	38576	2748

Material

The Greenland bird-ringing system has been described elsewhere (Salomonsen 1956, Mattox 1970). Initiated in 1946 and financed by the Ministry for Greenland and the Carlsberg Foundation, it involved local Greenlanders in the work. The ringers were paid according to number and species ringed; also, a bounty scheme with modest rewards for recovered rings was introduced. As the transition from subsistence to a money economy occurred, the amount paid to ring birds became too small to maintain the necessary ringing effort. As a consequence ringing achievements declined through the 1970s until in 1984 the system was terminated. Ringing in Greenland now continues only at a modest level along more conventional lines. However, rewards for recovered rings are still paid, since 1985 by the Greenland Home Rule.

The Greenland system naturally encouraged ringing of colonially-breeding birds where great numbers could be ringed easily, and Brünnich's Guillemot has by far been the most popular species. From the start in 1946 through 1980, a total of 78,648 guillemots has been reported as ringed in NW Greenland (Tab. 1). During the first decades most belonged to the now depleted populations in Disko Bay and Umanaq (now virtually extinct) and southern Upernavik districts. More recently great numbers have been ringed in northern Upernavik district. An additional 1533 guillemots were ringed in E Greenland in a single year (1970).

The actual number of ringed guillemots is somewhat less than the number reported, because – in particular during the later years – some rings were obviously dumped instead of used. (This type of fraud was to be expected, but has been uncommon through most of the period where the scheme was in existence. The incidence of cheating with recovered rings, e.g. by receiving rewards for rings put on after the birds were shot, has been infrequent.) Other ring series have produced abnormally few recoveries, perhaps because they were used on chicks that were too small to retain a ring. For this analysis a total of 2748 recoveries from 39,374 ringed birds displaying "normal" recovery patterns has been used, as well as 266 recoveries from 39,274 ringed birds with numerically aberrant recovery patterns (Tab. 1).

The data have been analysed using statistical procedures available on SAS (1985); procedures are described in detail in Kampp (1982).

Canadian Brünnich's Guillemots were ringed occasionally through the 1950s: Lancaster Sound region: Cape Hay 1957; Hudson Strait region: Coats Island 1953-54, Digges Sound 1955 (see Tuck 1961, Gaston 1980). Since these ringings took place at a time when ringing activity was high in Greenland, the recoveries are well suited for comparison with Greenland birds. More recent ringings in the Canadian Arctic (1975 onwards) have been made when activities in Greenland were low or discontinued; since recovery patterns (hunting practices, inclination to report recoveries) in various parts of Greenland and in Newfoundland may well have changed, these ringings are less suited for comparison purposes and will only briefly be referred to here.

Other foreign-ringed guillemots recovered in Greenland include those from Spitsbergen

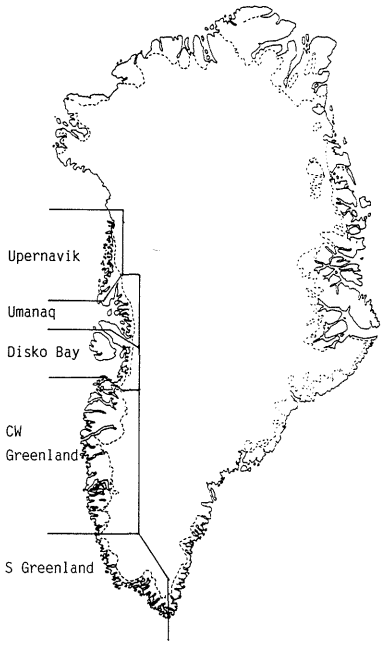

Fig. 1. Map of Greenland showing the sub-divisions of West Greenland used in this paper. North West Greenland comprises Disko Bay and Umanaq (Uummannaq) and Upernavik districts; guillemot-ringing between 1946 and 1980 was confined to these areas. Central West Greenland (CW) comprises (south to north) the districts of Godthåb (Nuuk), Sukkertoppen (Maniitsoq), Holsteinsborg (Sisimiut) and Kangaatsiaq. South Greenland (S) comprises the districts of Nanortalik, Julianehåb (Qaqortoq), Narsaq, Ivigtut (Ivittuut) and Frederikshåb (Paamiut).
Grønland, med de delområder i Vestgrønland, der henvises til i denne artikel: Nordvestgrønland (Disko Bugt, Uummannaq/Umanaq og Upernavik); Midtgrønland (CW: Nuuk/Godthåb, Maniitsoq/Sukkertoppen, Sisimiut/Holsteinsborg og Kangaatsiaq); og Sydgrønland (S: Nanortalik, Qaqortoq/Julianehåb, Narsaq, Ivittuut/Ivigtut og Paamiut/Frederikshåb).

(Norway), and from the Kola Peninsula (Murmansk Coast) and Novaya Zemlya in the USSR. The number of birds ringed in Spitsbergen can be approximately inferred from published surveys (*Sterna*, various issues 1951-77). Ringing totals from the relatively small Murmansk population have not been published; in Novaya Zemlya, "more than 50,000" were ringed between 1933 and 1950 (Uspenski 1958).

The sub-areas of Greenland referred to in this paper are shown in Fig. 1. Although Inuit names have come into common use, the Danish names are used here, because they are more familiar to readers and occur in the published literature.

Tab. 2. Causes of recovery of Brünnich's Guillemots ringed in W Greenland 1946-80 (percentages; n = 3014). Drowning in fishing nets was almost exclusively confined to the years 1965-75, particularly 1969-75. For the years 1969-75 and months September-December taken separately, the proportion of net-drowned birds was 21% (n = 261), or 6.5% for first-year birds (n = 154) and 41.1% for older birds (n = 107).
Genmeldingsmåder for lomvier ringmærket i Vestgrønland 1946-80. Drukning i fiskenet spillede alene en rolle i efterårsmånederne 1965-75 (især 1969-75), hvor et storstilet laksefiskeri med drivgarn fandt sted i Davis Strædet. For årene 1969-75 og månederne september-december alene var andelen af net-fangede lomvier 21% (n = 261), eller 6,5% for førsteårs-fuglene (n = 154) og 41,1% for de ældre fugle (n = 107).

	shot *skudt*	fish.net *fiskenet*	other *andet*	unknown *ukendt*
Total	88.4	2.4	0.6	8.7
Excl. unknown	96.8	2.6	0.6	–

Results

Method of recovery

Almost all guillemots recovered in Greenland (and in Newfoundland) were shot (Tab. 2). This certainly applies even to recoveries labelled "unknown manner". Only during 1965-75 did another cause of recovery play any role at all, namely drowning in fishing gear (salmon gillnets). These were the years when an intensive international salmon fishery took place in the eastern Davis Strait region. The serious bycatch problems associated with that fishery have been described by Tull et al. (1972) and Christensen & Lear (1977). Despite the large numbers of guillemots drowned, the salmon fishery appears to have been of secondary importance as a mortality factor for NW Greenland guillemots. At least, the number of recoveries from drowned guillemots does not exceed that from shot birds during the same autumn months; the number recovered by shooting during summer in the same years was much higher.

In the present study, only recoveries obtained by shooting are included. In Greenland,

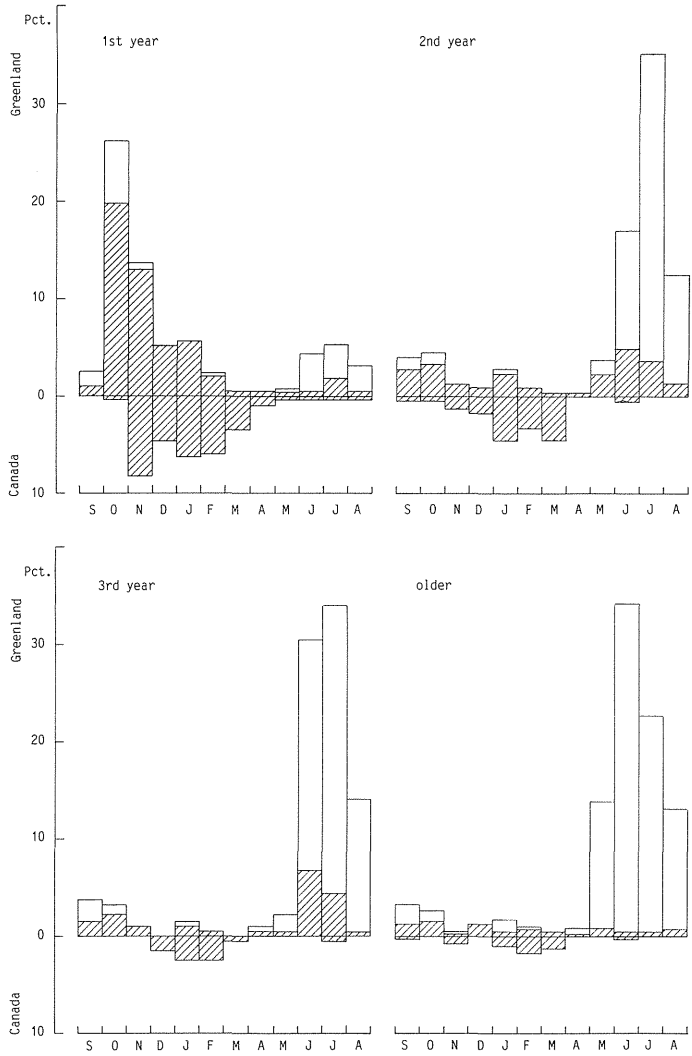

Fig. 2. Recoveries through the year of Upernavik guillemots during their first three years of life, and later (all birds more than three years old combined). The year goes from September to August. The vertical axis shows percentages within each of the four age-classes (n=610, 224, 206 and 735, respectively), with recoveries from Greenland shown upwards and those from Newfoundland downwards. Recoveries outside the home area (Upernavik) are indicated by hatching.
Genmeldinger af lomvier fra Upernavik gennem de første tre leveår og senere. Året går fra september til august. Lodrette akse viser procenter inden for hver af de fire aldersklasser, med genmeldinger fra Grønland vist opad, fra Newfoundland nedad. Skravering angiver genmeldinger uden for yngleområdet (Upernavik).

Brünnich's Guillemot has been legitimate quarry throughout the year until 1978. Since that year, it has been legally protected from 15 June to 15 August in W Greenland south of (and including) Disko Bay, but knowledge of the rules has not been widespread. The influence of the protection on recovery patterns has therefore been slight. On the other hand, recovery patterns may well have been affected by local habits and hunting traditions.

Greenland birds during the breeding season

Two thirds (66%) of all recoveries of Greenland guillemots have been made during the breeding season (May-September), mainly in the general area of ringing; 9% were first-year birds,

Tab. 3. Monthly and geographical distribution (percentages) of Brünnich's Guillemots ringed in W Greenland 1946-80 and recovered outside their home district. Nonzero values less than 0.05 are indicated by +. Note that the figures have been rounded and therefore appear not to add up correctly.
Fordeling (pct.) af Polarlomvier ringmærket i Nordvestgrønland 1946-80 og genmeldt uden for deres hjemområde. Procenter mindre end 0,05 er angivet med +.

First-year birds *Første leveår* (n = 566)

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
Upernavik	+	+											+
Umanaq	1	3	+		1					1	2	1	8
Disko Bay	1	10	5	+		1			+	+	1		17
CW Grl.	1	10	10	5	4	2	1	1		+	+		31
S Grl.			1	2	2	1							5
Newfoundland		1	10	5	8	7	4	2	+	+	+	+	39
Total	2	24	25	12	14	10	5	2	1	1	3	1	100

Third year and older *3. leveår og ældre* (n = 187)

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
Upernavik									1	1	2	1	5
Umanaq	3	3			1		1	1	5	10	4	5	30
Disko Bay	2	3			1				2	1	4		11
CW Grl.	2	4	3	1	3	4	3	2		1	1		24
S Grl.										1			1
Newfoundland	1		3	2	6	10	7			1	1		29
Total	7	10	6	3	10	13	11	3	7	13	11	6	100

91% older. The remaining 34% were recovered in "winter" (October-April), mainly in CW Greenland and Newfoundland; 69% of these birds were in their first year, 31% were older.

The monthly distribution of recoveries for the Upernavik district is given in Fig. 2. First summer birds (one year old) do occur near the breeding places, but in low numbers only. From their second summer onwards, it appears that most or all birds reach the general area in which they were hatched. Inter-district exchanges of birds appear rare. The guillemots arrive during May and leave mostly in August or early September. Occasionally, in certain years, some stay into October. There is a tendency for younger birds to arrive at the colony later in the spring than adults; apart from that, differences between age-classes (after the first year) are slight.

The patterns for the other two districts in northern W Greenland where guillemots have been ringed, Umanaq and Disko Bay, are much the same, but with peak numbers of immatures and adults occurring in June and May, respectively, instead of July and June.

The Upernavik colonies fall in two groups (southern and northern), lying 120 km from each other. Only slight and insignificant differences emerge when the recoveries from these two areas are treated separately.

Greenland guillemots outside the breeding season

Even outside the breeding season, only very slight differences exist between guillemots from the different NW Greenland sub-areas. They have consequently been combined here.

The geographic distribution of Greenland guillemots recovered through the year is presented in Tab. 3. The recoveries are separated into those made during the birds' first year of life (from September to August the following year), and those of birds older than 2 years (second year-class omitted). Preliminary analysis (Kampp 1982) showed no significant differences between age-groups after the first two years (with birds in their second year actually behaving much like older birds). In order to facilitate comparison with foreign guillemots, Tab. 3 shows recoveries made out-

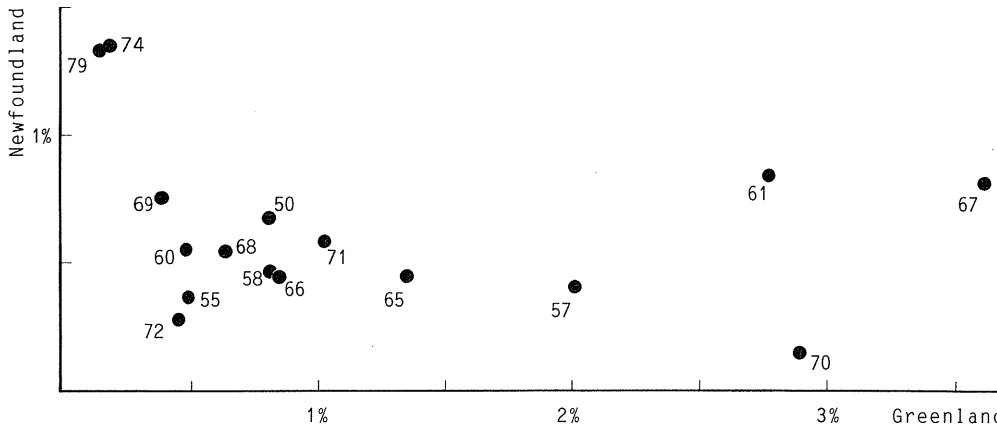

Fig. 3. Brünnich's Guillemots ringed as chicks in NW Greenland and recovered during their first winter (1 October - 30 April) in Greenland and Newfoundland, respectively. The axes show percent recovered of total ringed. The numbers indicate ringing year, i.e. 50 means birds ringed in 1950 and recovered during 1950-51, and so on. Only years with extensive ringings, resulting in at least 10 first-winter recoveries, are included. – Spearman rank correlation cofficient r_S = -0.26 (P=0.3).
Genmeldinger (pct. af antal mærkede) af Polarlomvier mærket som unger i Nordvestgrønland og genmeldt i løbet af den første vinter (1. oktober - 30. april) ved Grønland henholdsvis Newfoundland. Mærkningsåret er angivet ved hver prik (året kun medtaget, hvis mærkningerne var tilstrækkeligt omfattende til at give mindst 10 genfund i løbet af den første vinter). Der er ingen signifikant korrelation mellem de to områder (r_S = -0,26).

side the breeding area only, i.e., all Upernavik birds recovered within the Upernavik district are excluded. The Umanaq and Disko Bay ringings have been treated in the same way. On rare occasions, almost certainly due to erroneous recovery data, birds have been recorded from their NW Greenland home areas outside the normal summer season, even in mid-winter.

It appears that birds from NW Greenland are recovered mainly from W Greenland between Disko Bay and Godthåb, and from Newfoundland. Within CW Greenland, the guillemots gradually move south as the winter progresses, but the extent of this southerly movement very much depends on the severity of the winter. Recoveries in Greenland between mid-winter and early spring are few, but there is no indication that this means a progressive movement towards Newfoundland. This might be the case to some extent, but quite likely many birds stay in Greenland in areas (far from land) where hunters rarely venture, owing to weather and ice conditions.

If Greenland and Newfoundland formed alternative wintering areas for the birds, a negative correlation between recoveries from these regions could be expected. Recoveries of older birds are too scarce to allow a break-down into different years, but the number of first-year birds permits this to be done (Fig. 3). The correlation coefficient is negative, but statistically this result is insignificant and caused soleby by the years 1974 and 1979. Generally, at fairly constant proportion of the first-year birds is recovered in Newfoundland each year, whereas in Greenland the proportion fluctuates widely (variance Newfoundland 11.3, Greenland 113.6; F=10.0, P<0.001).

It is tempting to view these fluctuations as the result of varying ice and weather conditions that affect the activities of the hunters and/or the whereabouts the birds. But there is no reason to believe that the birds leave Greenland waters in years with few recoveries. However, if by chance they do, there is no indication of where they go and nothing to support the view that they go to Newfoundland.

Closer inspection discloses contrasting patterns behind the abnormally numerous recoveries in Greenland in some years (Fig. 3). The major part of the juvenile guillemots recovered in Greenland in the 1967-68 season was shot in October in the home area (Upernavik district). Geographically, the pattern was more

Photo: Frank Wille.

normal in the 1961-62 and 1970-71 seasons, with most recoveries from the open-water region (CW Greenland) in the autumn. The 1970-cohort displays another anomaly not found in the 1961-cohort: from late winter onwards, very few recoveries have turned up, even in subsequent years. Evidently, some disaster struck the juvenile guillemots that winter.

It seems natural to try to explain the anomalous recovery patterns for certain years by looking for unusually different weather or ice conditions for those years. No clear indication of any causal relationship of this sort has been found to explain these particular anomalies, however; but they warn us that results from chick-ringings in single seasons should be regarded with caution.

In 1985, 504 adult Brünnich's Guillemots and 39 chicks were ringed on Ydre Kitsigsut (60°45' N, 48°25' W), S Greenland. One chick was recovered in its first winter in Newfoundland, and 3 adults have been recovered from Godthåb, Sukkertoppen and Holsteinsborg, respectively, in autumn-winter. Also ringed were 200 adult and 53 young Common Guillemots *Uria aalge*, and one chick was recovered at Holsteinsborg in late September of the same year. It therefore appears that guillemots from the rest of W Greenland behave like those from the northern parts where most ringing has been done: they winter partly in W Greenland as far north as they find open water (but not south of Godthåb), and partly in Newfoundland. Nothing definite can be said about the proportions occurring in these two main areas because hunting pressure, as well as the probability of reporting recovered rings, almost certainly differ between Greenland and Newfoundland.

East Greenland guillemots

Very little is known about the E Greenland guillemots. Five of 1533 chicks ringed in 1970 have been recovered: two in E Greenland during spring and summer, two in winter in S Greenland (Julianehåb) and Newfoundland, and one was reported from Umanaq without data. Apart from the Newfoundland-recovery, the pattern – so far as can be concluded from these limited data – looks like that prevailing for other eastern populations (see below). The small number of recoveries is somewhat surprising and may be associated with the suspected disaster of the 1970-cohort in W Greenland (see above).

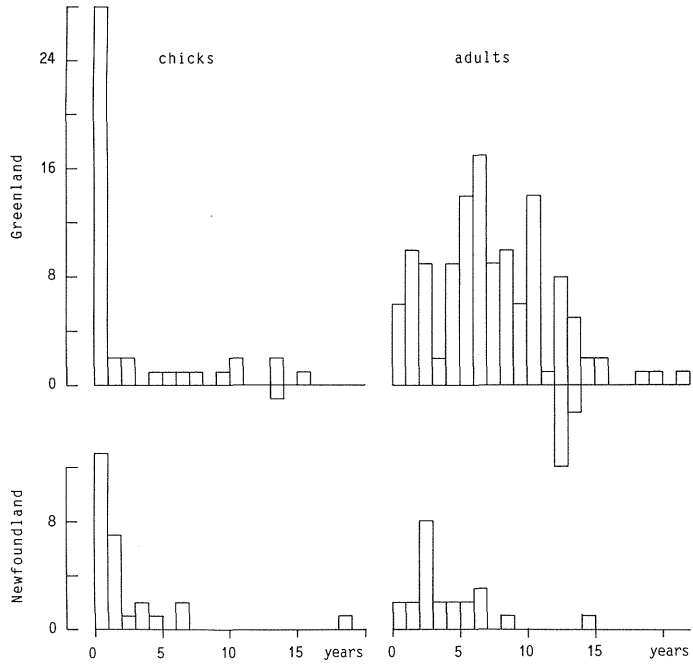

Fig. 4. Number of recoveries from Greenland and Newfoundland of Brünnich's Guillemots ringed as chicks and adults at Cape Hay, Bylot I., 1957. About 10 years after ringing, records of Newfoundland recoveries become incomplete, because partly illegible rings are not included in the records of the USFWS. – Recoveries shown below the time axis are net-drowned birds, all others were shot.
Antal genmeldinger fra Grønland og Newfoundland af lomvier mærket ved Cape Hay, Canada, 1957, som henholdsvis unger (chicks) og voksne. Efter ca 10 år er registreringen fra Newfoundland ukomplet, fordi delvist ulæselige ringe ikke er registreret af det amerikanske ringmærkningssystem. – Genmeldinger vist under tidsaksen er fugle druknet i fiskenet, alle andre er skudte fugle.

Canadian guillemots

In 1957, a total of 1363 adult and 1137 young Brünnich's Guillemots were ringed at the Cape Hay colony, Bylot Island (Tuck 1961). The recoveries of these birds are summarized in Fig. 4 and Tab. 4.

Fig. 4 clearly illustrates the very considerable differences between recovery patterns from birds ringed as chicks and adults, respectively. A general feature in the population dynamics of birds, in particular long-lived species like seabirds, is that mortality through the first year of life is very much higher than later on. Also generally true in quarry populations is that young birds run a substantially higher risk of being shot than older birds. (This, at least, is what ringing data and age-distribution of shot birds imply; that these general findings should instead be explained in terms of, e.g., different areas frequented by different age-clases appears unlikely in light of the widespread occurrence of the pattern.) In consequence, chick ringings give many more recoveries through the first year after ringing, but rather few later on, compared with ringing of adults. Very probably, proportions of young birds recovered during their first year of life are also much more variable than those of older birds. For example, the large variations found in recoveries in Greenland of Greenland guillemots (Fig. 3) may well be characteristic of first-year birds alone, or at least much more pronounced for this age-class. Unfortunately, recoveries of older birds from separate years are too few to test this assumption rigorously.

A comparison of values given in Tab. 3 and Tab. 4 reveals only minor differences. A more correct comparison would be to include only Greenland ringings from 1957, but – mainly because ringing in Greenland have mostly been of chicks – recoveries from birds ringed that year are too few to allow this. Instead, in

Tab. 4. Monthly and geographical distribution (percentages) of Brünnich's Guillemots ringed at Cape Hay, Bylot I., 1957. Cf. Tab. 3.
Fordeling (pct.) af Polarlomvier ringmærket ved Cape Hay, Canada, 1957.

First-year birds *Første leveår* (n = 41)

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
Upernavik													0
Umanaq			3										3
Disko Bay		3	23	8		3	10						45
CW Grl.		8	3	3	5								18
S Grl.			3	3									5
Newfoundland			13	8	5	3				3			30
Total		10	43	20	10	5	10			3			100

Third year and older *3. leveår og ældre* (n = 141)

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
Upernavik	1	1											1
Umanaq		2								1			3
Disko Bay		9	3	1			1	1	7	1			23
CW Grl.	1	6	10	7	10	6	7	4	1				51
S Grl.						1							1
Newfoundland			1	1	4	8	5	2					21
Total	2	18	13	10	13	15	13	7	8	2			100

Tab. 5. Number of Brünnich's Guillemots recovered November-March in Greenland and Newfoundland, respectively, for Greenland birds ringed 1946-80 and 1956-65, and for Cape Hay birds ringed in 1957. P denotes significance level for difference between Cape Hay and Greenland (chi^2-test).
Genmeldinger i månederne november-marts fra henholdsvis Grønland og Newfoundland for grønlandsk mærkede lomvier (hele perioden 1946-80 og årene 1956-65 alene) og lomvier mærket ved Cape Hay 1957. P er signifikansniveau for forskellen mellem Cape Hay og Grønland (chi^2-test).

Age at recovery	Recovered	Ringed *Mærket*			P	
Alder ved genmelding	*Genmeldt*	Grl 46-80	Grl 56-65	Cape Hay	Grl 46-80	Grl 56-65
First year	Greenland	149	64	24	0.03	0.29
Første leveår	Newfoundland	164	49	11		
4th year or older	Greenland	39	14	60	0.03	0.37
4. år eller ældre	Newfoundland	35	10	25		

Tab. 5 recoveries from birds ringed in Greenland during 1956-65 are compared with the Cape Hay data (1957). Even here, differences between the Canadian and Greenland birds are slight, with some tendency for Cape Hay guillemots to be recovered more frequently at Greenland, and less frequently at Newfoundland, than Greenland birds. If the Greenland ringings from all years are included, differences between birds from Greenland and Cape Hay become greater (Tab. 5), which suggests trends in recovery patterns through the years, probably due to altered habits of hunters rather than guillemots.

More recently, a good many guillemots have been ringed in high-arctic Canada (Cape Hay 1978-79; Prince Leopold Island 1975-78; Coburg Island 1979, 1981, 1987). A total of 37 birds from these ringings have been found in Greenland. The pattern displayed by the

recoveries agrees closely with the results from the 1957-ringings, but reported numbers suggest a lower level of hunting and/or a reduced likelihood of reporting rings recovered (cf. Gaston et al. 1987). Alternatively, the number of Cape Hay juveniles shot in Greenland may have been unusually high in 1957.

Hudson Strait guillemots have also turned up in Greenland, but compared with the high-arctic birds, in only very modest numbers. 2000 adults and 8000 chicks were ringed at Digges Sound in 1955 (Tuck 1961). Of these, 2 and 5, respectively, were shot in Greenland between Godthåb and Umanaq. The youngest was almost 2 years old, and apart from one from February, all were shot in spring (May and June). Greenland waters are obviously not part of the regular winter range of this population, but a few non-breeders turn up there occasionally, probably because they follow conspecifics from Greenland and Lancaster/Jones Sound on their spring migration from the shared winter area around Newfoundland. 26 of the adult-ringed and 55 of the chick-ringed Digges Sound guillemots have been recovered in Newfoundland.

Tab. 6. Monthly and geographical distribution of 23 first-year and 22 older Brünnich's Guillemots ringed in Spitsbergen and recovered in Greenland. 8 of 12 older birds recovered in CW Greenland and Disko Bay were immatures (less than 4 years old), compared with 1 of 10 birds recovered in S Greenland.
Fordelingen af 23 førsteårs og 22 ældre Polarlomvier ringmærket på Spitsbergen og genmeldt i Grønland. Af de 12 ældre fugle genmeldt i Midtgrønland (CW Grl.; Godthåb – Kangaatsiaq kommuner) og Disko Bugt var 8 ungfugle (mindre end 4 år gamle), sammenlignet med 1 af de 10 fugle genmeldt i Sydgrønland.

First-year birds *Første leveår*

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
Disko Bay													0
CW Grl.			3	1	2	1		1					8
S Grl.		1	7	2	4				1				15

Older birds *Ældre fugle*

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
Disko Bay	1												1
CW Grl.			3	1	1	5				1			11
S Grl.	1	1	2	1	2	1	2						10

Tab. 7. Monthly and geographical distribution of 8 first-year and 11 older Brünnich's Guillemots ringed on the Kola Peninsula, USSR, and recovered in Greenland.
Fordelingen af 8 førsteårs og 11 ældre Polarlomvier ringmærket på Kola-halvøen, Sovietunionen, og genmeldt i Grønland.

First-year birds *Første leveår*

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
Umanaq										1			1
Disko Bay													0
CW Grl.						1	1						2
S Grl.			1	1	3								5

Older birds *Ældre fugle*

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
CW Grl.		1				1	1						4[a]
S Grl.		1			3	2	1						7

a: includes one bird with unknown recovery date

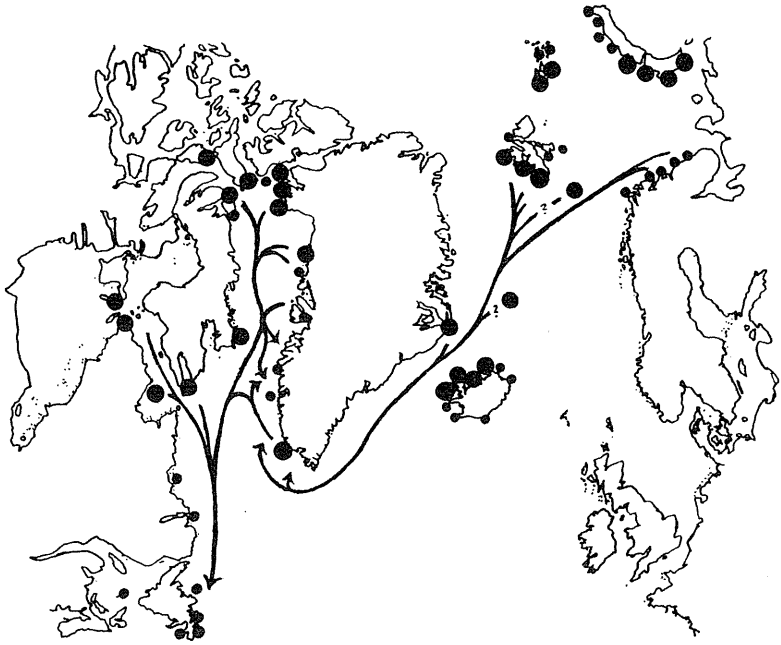

Fig. 5. Distribution of Brünnich's Guillemot in the North Atlantic region, and the fall migration of the populations occurring in Greenland waters.
Udbredelsen af Polarlomvien i det nordatlantiske område, og efterårstrækket for de bestande, der optræder ved Grønland.

Other Hudson Strait ringings (Coats Island 1953, 1981, 1985; Digges Sound 1980-1981; Hantzsch Island 1982) have given similar results (altogether 10 recoveries from Greenland). In addition, one straggler from Labrador and one from Funk Island (Newfoundland) have found their way to Greenland.

Spitsbergen guillemots

Until 1980, a total of about 750 Brünnich's Guillemots has been ringed in Spitsbergen, mostly as chicks, but some as adults. Of these, 46 have been recovered in Greenland (Tab. 6; date and place of recovery missing for one first-year bird). The data suggest no differences between the different sub-populations of Spitsbergen (see Kampp (1982) for details). It is clear from Tab. 6 that Spitsbergen guillemots are found regularly at Greenland. Their main range is the southernmost part of the country (S Greenland of Fig. 1), a region where few Canadian and Greenland birds occur (Tabs 3 and 4); some stragglers (mostly immatures) do, however, occur farther north.

Guillemots from the Kola Peninsula and Novaya Zemlya

A total of 19 guillemots from the Kola Peninsula have been recovered in Greenland. The pattern (Tab. 7) very much resembles that found for the Spitsbergen guillemots.

From the intensive Novaya Zemlya ringings performed between 1933 and 1950, only 6 birds have turned up in Greenland, between Julianehåb and Umanaq. None were in their first year of life; 3 were older immatures, the other 3 were adults.

Discussion

The pattern that emerges from the results of the re-analysis of the ringing-recovery data presented above is shown in Fig. 5.

Brünnich's Guillemots from the entire W Greenland winter partly in W Greenland between Godthåb to the south and Disko Bay to the north – or as far north as ice conditions allow – and partly off Newfoundland. (For a more

detailed description of arrival and distribution in the Newfoundland region, see Tuck (1971) – the pattern found there still holds true with the more extensive data available today).

Canadian guillemots from the high-arctic region winter largely in the same areas as those from W Greenland, apparently with the center of their range displaced slightly towards Greenland, compared with birds from W Greenland. Birds from N Greenland (Thule) most probably behave like the neighbouring populations in Lancaster and Jones Sound.

Guillemots of eastern origin occur off southernmost W Greenland in winter and appear to have "monopolized" this area. The populations known to be involved are those from Spitsbergen, the Kola Peninsula, and apparently E Greenland. Birds from Bjørnøya and Jan Mayen may also be present (no ringings). Iceland's guillemots, on the other hand, seem *not* to visit Greenland (but only few guillemots have been ringed in Iceland (Æ. Petersen in litt.)).

Apart from these populations, a few guillemots from the Hudson Strait and Labrador regions in Canada, and from Novaya Zemlya in the USSR, occur occasionally in Greenland.

One other Canadian population could contribute significantly to the guillemots wintering in Greenland, the colony near Reid Bay, E Baffin Island. No birds have been ringed in this colony, but circumstantial evidence suggests that they move across southern Davis Strait in autumn, instead of south towards Newfoundland (Orr & Ward 1982, Brown 1985). If this is the case, they could comprise an important fraction of the large number of guillemots shot in SW Greenland each year, and, perhaps, they may have been greatly affected by the extensive bycatches of guillemots in the west Greenland salmon fishery before 1975 (cf. Tull et al. (1972), Christensen & Lear (1977), Piatt & Reddin (1984)). Although it is known from ringing recoveries that guillemots from NW Greenland and Lancaster Sound were involved in that enormous kill of birds, the data do not indicate that this was a major mortality factor for these populations. At least, many more birds were reported shot than drowned.

In general, the pattern shown in Fig. 5 is one of guillemot movements following sea surface currents. This is not always the case when viewed at a fine scale, and neither does it necessarily imply that the birds drift passively with the currents, although they must perform the first weeks of the migration swimming on the water (while moulting (adults) or growing (chicks) remiges). But overall, the correspondence between the pattern of ringing recoveries and flow pattern of the principal sea-surface currents is impressive.

The only apparent difference between age-classes when movements are considered is that (older) immatures and sometimes adults occasionally straggle far from their normal ranges. No juveniles from the Hudson Strait region, Labrador, or Novaya Zemlya have turned up in Greenland.

The migration patterns described here fall somewhere in between the diverging opinions of Salomonsen (1967) and Gaston (1980). Salomonsen characterized the situation as a clear case of "allohiemy" (i.e., different populations having different winter ranges) with Greenland guillemots occurring in Newfoundland and Canadian high-arctic birds in W Greenland. In contrast to this, Gaston suggested that most of the Lancaster/Jones Sound population (75%) winters off Newfoundland, whereas only first-year and second-year birds and about 25% of older birds from Greenland occur there during winter.

Salomonsen (1967) was impressed by the number and frequency of winter recoveries of Greenland birds from Newfoundland, and the rather few recoveries from Greenland, especially when compared with numbers taken during summer. However, when the recovery data are examined systematically, the numbers found in the two regions are similar (see Tab. 5). The key point to be underlined is that almost all Greenland birds were ringed as chicks, a procedure which gives many recoveries in the first year after ringing. The only high-arctic Canadian data available for comparison with those from Greenland for the same time period are from ringings (at Cape Hay) in a single season (1957), of roughly equal numbers of chicks and adults (in fact, as many adults as have ever been ringed in NW Greenland). Also, the number of "harvested" first-year birds appears to fluctuate a good deal from year to year, and young from Cape Hay may well have been particularly frequent along Greenland in the autumn of 1957 – at least, this is what is sug-

gested when more recent ringings in the Lancaster/Jones Sound region are considered.

Part of the difference between interpretations may also be due to the limited access Gaston (1980) had to the data on guillemots ringed in Greenland. Moreover, he may also have been misled to some extent by the contrasting recovery patterns resulting from birds ringed as chicks versus those ringed as adults. Without separating these groups, the frequency of Greenland birds recovered in Newfoundland through the years is not that impressive, especially not of non-juveniles, when ringing numbers are considered. Birds ringed as adults at Cape Hay in 1957 resulted in a steady return of recoveries over many years, reaching a total of about 2% of those ringed. Mid-winter recoveries in Greenland were few (as is the case for Greenland birds), which might suggest that the Greenland recoveries were migrating birds en route to Newfoundland.

The lesson to be learned seems to be that extreme care must be taken when comparing ringing data to ensure that the data sets actually are comparable. It has long been standard when investigating mortality from ringing data not to combine data sets comprising birds of different ringing ages or different recovery methods, particularly not to combine shot birds with those otherwise recovered (see Brownie et al. (1985) for a detailed review of this subject). This *modus operandi* also applies to traditional studies of migration.

Acknowledgments

The main part of this work was made while preparing for the cand.scient. degree at the Zoological Museum, University of Copenhagen. A. Gaston kindly supplied data on Canadian ringings. Supplementary ringing at Ydre Kitsigsut, S Greenland, was made possible through a grant from the Commission for Scientific Research in Greenland, and by a generous offer of transport with inspection vessels from the Marine Command of Greenland. K. Falk and S. Møller assisted in that work and actually did most of the ringing. D.N. Nettleship kindly commented on the manuscript and suggested many improvements.

Resumé

Vandringer og vinteropholdssteder for Polarlomvier *Uria lomvia* i Grønland

Polarlomvien optræder meget talrigt i Grønland og spiller en stor rolle i den grønlandske husholdning. Den jagtlige udnyttelse har medført en betydelig bestandsnedgang i store dele af landet (Kampp 1988a, 1988b). Det er især jagten i fuglenes yngletid, der har skabt problemerne. Jagten var fri hele året indtil 1978, da der indførtes en sommerfredning i Vestgrønland syd for Umanaq; fredningens betydning har dog været begrænset, da kendskabet til reglerne generelt har været meget mangelfuldt. Siden 1988 er fredningstiden udvidet og gælder hele Vestgrønland.

Omfanget af jagten uden for fuglenes yngletid har et langt større omfang end sommerjagten. Når den trods dette synes at have været mindre skadelig for bestanden i Grønland, hænger det åbenbart sammen med to forhold. Blandt de nedlagte fugle er andelen af årsunger langt større og andelen af gamle ynglefugle langt mindre om "vinteren" end om sommeren. Og jagten uden for yngletiden omfatter ikke blot grønlandske fugle, men også flere andre bestande.

Der er imidlertid behov for et langt bedre kendskab både til jagtens omfang og udøvelse og til fuglenes biologi og trækforhold, hvis udnyttelsen af lomviebestanden skal baseres på et rationelt grundlag. Som et første skridt i den retning analyserer denne artikel de tilgængelige ringmærkningsdata for de lomviebestande, der optræder ved Grønland.

En sådan analyse er tidligere foretaget, dels af Salomonsen (1967), dels af Gaston (1980). De to undersøgelser resulterede imidlertid i næsten diametralt modsatte konklusioner, hvorfor der er god grund til at tage opgaven op endnu engang. Salomonsen mente, at Grønlands lomvier helt forlod landet om vinteren og søgte til Newfoundland-området, mens Vestgrønland nord for Paamiut/Frederikshåb var vinterkvarter for de lomvier, der yngler i Lancaster Sound området i Canada. De sydligste dele af Vestgrønland opsøges i stedet af lomvier af østlig oprindelse, især fra Spitsbergen. Gaston, der specielt behandlede Newfoundlands betydning for forskellige lomviebestande, mente derimod, at hele bestanden fra Lancaster Sound, men kun ungfuglene og en mindre del af de ældre fugle fra Grønland, overvintrede ved Newfoundland.

Min egen konklusion (Fig. 5) er en mellemting mellem de to skitserede modeller. Der synes i virkeligheden ikke at være større forskel på Vestgrønlands og Lancaster Sound regionens lomvier hvad trækforholdene angår, og begge bestande overvintrer i stort tal i farvandene ved såvel Vestgrønland som Newfoundland. Herudover er Salomonsens model stadig korrekt, idet dog den store bestand fra Novaya Zemlya *ikke* skal medtages blandt de østlige bestande, der overvintrer i den sydligste del af Vestgrønland.

I det store og hele er det de samme ringmærkningsdata, der har ligget til grund for de modstridende konklusioner. Det har været muligt, fordi analyse af ringdata rummer forskellige faldgruber, hvis betydning ofte undervurderes eller overses. I dette tilfælde synes en væsentlig del af forvirringen at kunne tilskrives den meget store forskel i genmeldingsmønster, man finder ved mærkning af hhv. unger og gam-

le fugle, især for jagtligt udnyttede arter (jvf. Fig. 4). De grønlandske mærkninger gælder næsten udelukkende unger, mens de canadiske omfattede både unger og gamle fugle. De canadiske stammer desuden fra et enkelt år (1957), og det store antal unger genmeldt fra Grønland det følgende år er ikke nødvendigvis "typisk". Der er store forskelle fra år til år i genmeldingsprocenten fra Grønland, i hvert fald når det gælder ungfugle (Fig. 3).

References

Brown, R.G.B. 1985: The Atlantic Alcidae at sea. Pp. 383-426 in: Nettleship, D.N. & T.R. Birkhead (eds): The Atlantic Alcidae. – Academic Press.

Brownie, C., D.R. Anderson, K.P. Burnham & D.S. Robson 1985: Statistical inference from band recovery data – a handbook. 2nd edition. – US Dpt Interior, Fish and Wildlife Serv., Res. Publ. 156. (305 pp).

Christensen, O. & W.H. Lear 1977: Bycatches in salmon drift-nets at West Greenland in 1972. – Meddr Grønland 205 (5). (38 pp.).

Evans, P.G.H. 1984: The seabirds of Greenland: their status and conservation. Pp. 49-84 in: Croxall, I.P., P.G.H. Evans & R.W. Schreiber (eds): Status and conservation of the World's seabirds. – ICBP Techn. Publ. 2.

Gaston, A.J. 1980: Populations, movements and wintering areas of Thick-billed Murres (*Uria lomvia*) in eastern Canada. – Can. Wildl. Serv. Progr. Nts 110. (10 pp.).

Gaston, A.J., D.N. Nettleship & R.D. Elliot 1987: Movements and wintering areas of first-year Thick-billed Murres reared in the eastern Canadian arctic. – Canadian Wildlife Service "Studies on Northern Seabirds" Manuscript Report No. 204: 1-15.

Kampp, K. 1982: Den Kortnæbbede Lomvie *Uria lomvia* i Grønland. [The Thick-billed Murre in Greenland]. – Unpubl. dissertation, the Zoological Museum, University of Copenhagen. (Translated from Danish 1983 by R.G.B. Brown, Can. Wildl. Serv.).

Kampp, K. 1988a: Grønlands lomvier. [The guillemots of Greenland]. – Tidsskr. Grønland 36:13-27. (In Danish).

Kampp, K. 1988b: Lomvien i Grønland. [The guillemot in Greenland]. – Tusaat 1988 (1): 2-15. (In Danish, with a Greenlandic translation by R. Hard).

Mattox, W.G. 1970: Bird-banding in Greenland. – Arctic 23: 217-228.

Nettleship, D.N. & P.G.H. Evans 1985: Distribution and status of the Atlantic Alcidae. Pp. 53-154 in: Nettleship, D.N. & T.R. Birkhead (eds): The Atlantic Alcidae. – Academic Press.

Orr, C.D. & R.M.P. Ward 1982: The fall migration of Thick-billed Murres near southern Baffin Island and northern Labrador. – Arctic 35: 531-536.

Piatt, J.F. & D.G. Reddin 1984: Recent trends in the west Greenland salmon fishery, and implications for Thick-billed Murres. Pp. 208-210 in: Nettleship, D.N., G.A. Sanger & P.F. Springer (eds): Marine birds: their feeding ecology and commercial fisheries relationships. – Minister of Supply and Services Canada.

Salomonsen, F. 1956: The Greenland bird-banding system. – Arctic 9: 258-264.

Salomonsen, F. 1967: Fuglene på Grønland [The birds of Greenland]. – Rhodos, Copenhagen. (Transl. from Danish 1981 and 1982 by R.G.B. Brown, Can. Wildl. Serv.).

SAS 1985: SAS user's guide. – SAS Inst. Inc., Cary, N.C.

Tuck, L.M. 1961: The Murres. – Can. Wildl. Serv. (260 pp.).

Tuck, L.M. 1971: The occurrence of Greenland and European birds in Newfoundland. – Bird-Banding 42: 184-209.

Tull, C.E., P. Germain & A.W. May 1972: Mortality of Thick-billed Murres in the West Greenland salmon fishery. – Nature (London) 237: 42-44.

Uspenski, S.M. 1958: The bird bazaars of Novaya Zemlya. – Can. Wildl. Serv. (159 pp.).

Received 10 May 1988

Kaj Kampp,
Zoological Museum,
Universitetsparken 15,
DK-2100 Copenhagen Ø