Exploitation of ringed seals (*Phoca hispida*) in Greenland

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ABSTRACT

The ringed seal (*Phoca hispida*) is the most important game for the Inuit hunters of Greenland, providing many of the basic needs in the original culture. It is distributed all around Greenland with the main distribution north of 69°N on the west coast and north of 66°N on the east coast.

During 1974-76, studies were conducted in the most important ringed seal catching area, Upernavik, Northwest Greenland, and a total of 7,089 ringed seals were sampled. The methods used for catching ringed seals were categorised into five different groups. The most common hunting method used in the municipality of Upernavik during 1974-76 was netting under the ice, accounting for almost half of the total annual catch. Seals shot on the ice and seals shot at the ice edge accounted for one fifth and one tenth of the annual catch, respectively. In this region seals shot in open water made up about one fifth of the annual catch of ringed seals, while netting in open water contributed only a few percent.

Of the seals sampled in Upernavik in 1974-76, 60% were males and 40% were females. In the ringed seal samples collected all around Greenland in the 1980s and 1990s the males comprised 56% and the females 44% (n=923). Similar ratios were found for all age classes and for all hunting methods suggesting either a skewed sex ratio in the ringed seal stock(s) around Greenland or a difference in availability to the hunters of male and female ringed seals. In tagging experiments a higher mobility was found for females than for males, which suggests differences in the behaviour of the two sexes.

Catch and trade statistics on ringed seals are reviewed and evaluated for the period of 1954 until 1994, and the seasonal and regional variation is examined. The peak season for ringed seal hunting in Greenland as a whole is from January through May. This is particularly evident for the northern regions, where relatively few ringed seals are taken during the open water season from June to September. In the southern regions, however, the great majority of ringed seals are caught in open water.

In all regions, the catch of ringed seals showed great annual and long-term variation. The variations were not identical in all regions, but similar trends were found for Northwest and Central West, and for Southwest and South. From 1954 to 1994 there was a general, significant increase in the reported catches of ringed seals in west Greenland. For Greenland overall, the catch of ringed seals was around 43,000 per year in the 1950s, peaked in the late 1970s at almost 100,000 per year, but since decreased to about 70,000 in the early 1990s.

INTRODUCTION

Excavations and written accounts reveal that the ringed seal (*Phoca hispida*) has been the most numerous and most hunted marine mammal in Greenland for centuries (e.g. Glob 1935, Degerbøl 1936a, 1936b). It can be hunted year round, and since the arrival of the first Inuit it has provided the basic nutrition for Inuit families living in Northwest Greenland, especially during winter when other prey migrate south or to open water areas. In addition to food for humans and dogs, ringed seals have provided the Inuit communities with necessities such as clothes, fuel for lighting and heating, dog harnesses, lashes, floats for hunting, and covers for tents and kayaks.

Since the beginning of the Danish colonisation of Greenland during the early 18th century, general accounts and descriptions of the ringed seal and its importance in the life and economy of the Inuit have been published, mostly in Danish (Egede 1741, Fabricius 1780, 1791, 1810, Rink 1852-57, 1877, Poulsen 1900, Winge 1902, Müller 1906, Engell 1909, Jensen 1909, Amdrup *et al.* 1921, Birket-Smith 1924, Pedersen 1926, Jensen 1928, Pedersen 1931, Anon. 1944, Vibe 1950, Rosendahl 1961, Vibe 1967, Hansen 1971, Vibe 1971, Kapel 1971, 1975, GTO 1976, Kapel and Petersen 1982, Hertz and Kapel 1986, Vibe 1990, Sandell and Sandell 1991, Glahder 1995, Hertz 1995).

Ringed seals occur all around Greenland (e.g. Anon. 1954/55-1983, Finley *et al.* 1983, Born 1989, Glahder 1995, Born *et al.* this volume). On the west coast the main distribution is north of 69°N, where solid ice forms during winter. On the east coast, where the fast ice extends farther south, a continuous high density is believed to exist from Tasiilaq (66°N) and north (Fig. 1, Anon. 1954/55-1983). Born (1983) and Dietz *et al.* (1985) reviewed relevant sources and found that ringed seals are common year round in the fjord systems of Northeast Greenland, especially near productive glaciers. The seals seem to occur in lower densities in the fjords during the open water period. The density of ringed seals is particularly high around Ittoqqortoormiit municipality (Fig. 1), but scattered information suggests that high densities can also be found along the unpopulated area to the north (Dietz *et al.* 1985). The results of an aerial abundance survey in the fjords around Ittoqqortoormiit confirm that large numbers of ringed seals haul out on the ice in late spring (Born *et al.* this volume). The ringed seal is not only a coastal species; it is widely dispersed in the ice-covered parts of Smith Sound, Baffin Bay, Davis Strait and the Greenland Sea off Northeast Greenland (Finley *et al.* 1983, Dietz *et al.* 1985, Born 1989). Abundance estimates in Baffin Bay and Davis Strait have been reviewed by Miller *et al.* (1982), Kingsley (this volume) and Reeves (this volume).

Ringed seals depend on ice cover to make dens for hauling-out and pupping. They are able to maintain open holes in fast ice up to 2.6m thick (Vibe 1950). Besides the polar bear (*Ursus maritimus*), the ringed seal is the only marine mammal that lives in areas with fast ice. The bearded seal (*Erignathus barbatus*) is also resident in areas with heavy ice cover, but it tends to move offshore when the ice becomes solid.

Despite its ecological and economic importance, little has been published about the biology of ringed seals in Greenland. Scattered information on the food of ringed seals in Greenland waters can be found in the literature (Fabricius 1780, 1791, Winge 1902, Vibe 1950, Glahder 1995). Siegstad *et al.* (this volume) performed the only detailed study of feeding habits of ringed seals in Greenland. Heide-Jørgensen *et al.* (1992) and Kapel *et al.* (this volume) describe studies on satellite and conventional tagging of ringed seals in Greenland, while Dietz *et al.* (this volume) reports on levels of heavy metals in ringed seals in Greenland.

There are no national restrictions on seal hunting in Greenland. However, hunting of ringed seals is regulated in the wildlife sanctuary in Melville Bay, the national park in Northeast Greenland, and locally in some municipalities where seal hunting is restricted by area, season or method (e.g. Anon. 1973, 1982a, 1982b, 1990). In most places ringed seals can be hunted year round by all Greenlandic citizens, provided they have a licence.

This paper summarises the history of exploitation of ringed seals during the 20th century in

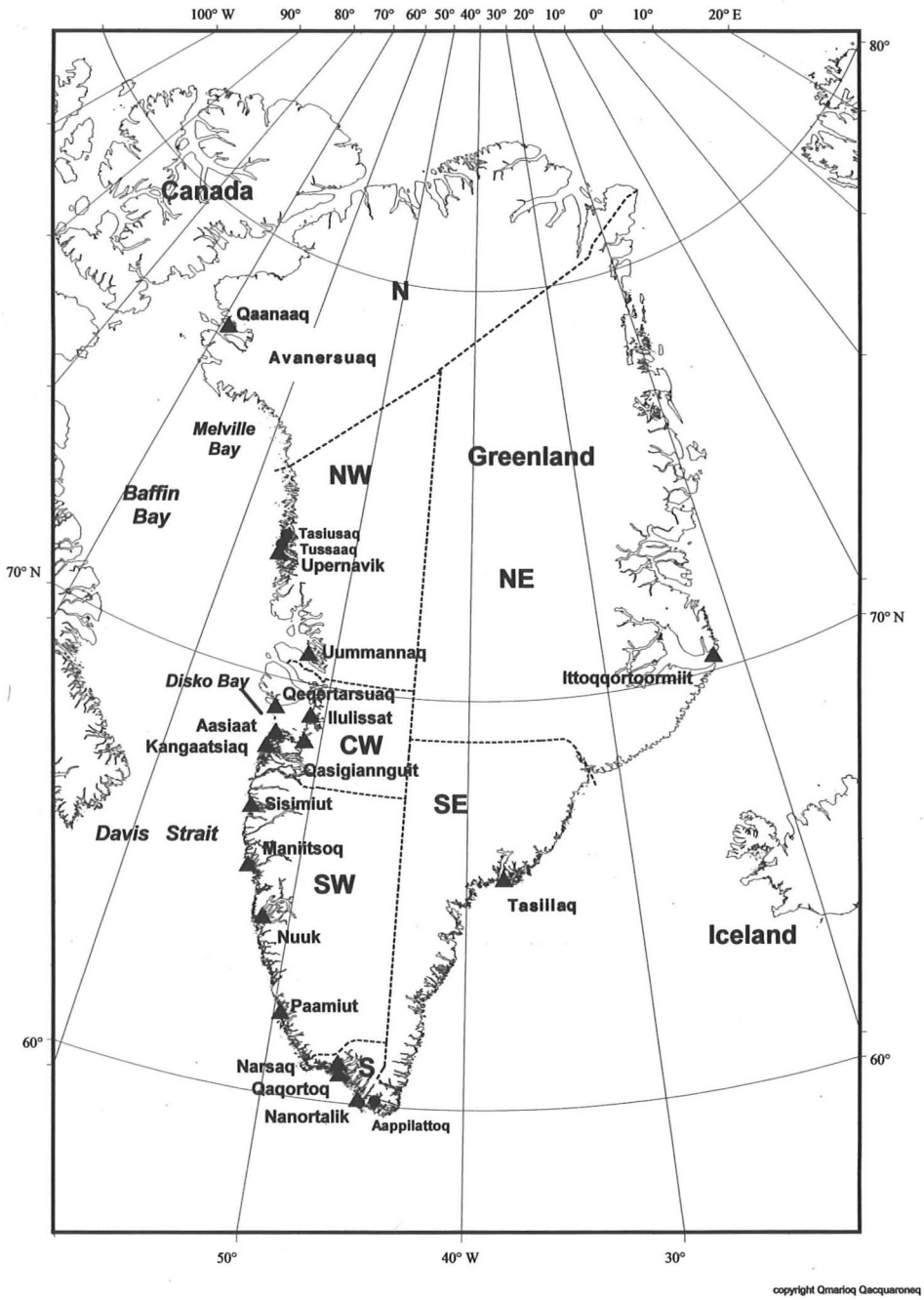


Fig. 1
Map of Greenland with locations and regions mentioned in the text.

Greenland and presents previously unpublished results from studies conducted by the Greenland Fisheries Research Institute.

MATERIAL AND METHODS

Catch statistics

For more recent decades, the published statistical material (Anon. 1942-1968, 1970-1997, 1954/55-1983) and additional unpublished data on seal catches and trade in seal skins in the periods 1938-53 and 1984-94 were reviewed. The official catch statistics, based on the Hunters' Lists of Game, date back to 1862. These catch statistics have never been used for direct management or regulation of hunters but rather as book-keeping for authorities and biologists. The principle of the system was that one person should be appointed at each settlement to keep a record of the hunting results for all of the hunt-

ers and to report the catches to the central authorities. One form (Hunters' List of Game) was used for each person engaged in hunting (Rosendahl 1961, Kapel 1975, 1986, 1991, 1993). Until 1937, catch statistics were pooled for all seals or divided into large and small seals, but from 1938 seals were listed by species for Northwest and Central West Greenland (Fig. 1). From 1954 to 1983 a more systematic and comparable system of collecting catch information was organised for all Greenland by the Ministry of Greenland (Anon. 1954/55-1983). In 1984 the responsibility for handling and publishing the summaries of the Hunters' Lists of Game was transferred from the Ministry for Greenland to the Statistical Office of the Greenland Home Rule Authority. The material for 1984 and 1985 was treated in the same way as in previous years (i.e. including estimates of non-reported catches), but never published. For 1986 and 1987 the material was still collected, but no estimate of non-reported catch was attempted. Since 1988, this system has been discontinued and catch statistics for Greenland are not available for the years 1988 to 1992, when a new reporting system was introduced (see below).

The Hunters' Lists of Game never functioned in a completely satisfactory manner for all settlements (Kapel 1975). For shorter or longer periods, reports were not received from a number of localities, or were clearly incomplete. For that reason, estimates of non-reported catch were given on a settlement by settlement basis, and pooled by district in the published summaries. The estimates of non-reported catch were based on the trade statistics mentioned below, various sources of local information, and comparisons among reports from previous years and adjacent settlements in the same year. These settlement-by-settlement estimates constituted an increasing part of the estimated total catch during the 1970s and early 1980s. For this reason, some were of the view that the statistics had become increasingly unreliable, whereas others still believed that the Hunters' Lists of Game were comparable and gave a reliable basis for monitoring trends (Kapel 1991).

In 1992 a new system for collecting hunting statistics in Greenland was introduced. This system became effective from January 1993 (Anon. 1992, 1993a. 1993b, Kapel and Rosing-Asvid 1996). The system is linked to the issuing of hunting licenses, of which two categories exist: one for full-time hunters and another for part-time hunters. Hunters in both categories have to pay a small fee for renewal of the license, at which time they are obliged to report their catches for the previous year. In 1993, about 9,500 licenses were issued (4,100 full-time and 5,400 part-time), and 7,671 reports were received (3,403 from full-time and 4,268 from part-time hunters).

Trade statistics

The statistics on the trade of hunting products began to be compiled in the 18th century by the Royal Greenland Trade Company (KGH). These statistics are independent from the catch statistics as they were collected by a different authority. Until 1900 seals were not reported by species. From 1939 to 1953, figures on the trade in ringed seal skins were not available. There has been no limitation on the number of skins that can be sold, and the purchase statistics can therefore be used for comparison with information from the catch statistics. The relationship between the catch of seals and the purchase of skins has varied from one locality to another, depending on the local use or interest in making an income from hunting.

In 1987 the Home Rule started its own tannery, Great Greenland, in Qaqortoq. Since then, all seal skins have been purchased and processed there. Unlike for other seal species, there have been no restrictions on the purchase of ringed seals. It is therefore likely that the present trade statistics are comparable over the years. However, price policy and cultural changes have certainly influenced the level of trade (e.g. Born 1983).

The reliability of, and relations between, catch and trade statistics were evaluated for various regions of Greenland. Possible trends in exploitation were examined and analysed.

Biological sampling

In the early 1970s the Greenland Fisheries Research Institute (now the Greenland Institute of Natural Resources) initiated a program for

collecting biological specimens and information on date, locality and catch method from seal hunting. A special effort was made during 1974-76 in the northern part of the municipality of Upernavik, where samples from about 7,500 ringed seals were collected (for most specimens just the lower jaw has been collected, Christiansen 1983). Additional ringed seal samples, about 2,000, were collected by the Greenland Environmental Research Institute (now the National Environmental Research Institute, Department of Arctic Environment) in the 1980s and 1990s. For the material collected in the 1970s, the age was estimated from readings of unstained cross or longitudinal sections of canine teeth of 300µm thickness (McLaren 1958, Smith 1973, 1987). For most of the samples collected in the 1980s and 1990s, the age was estimated from decalcified, stained longitudinal thin sections of canine teeth of 15-30µm thickness (Stirling *et al.* 1977, Stewart *et al.* 1996). To compare the two methods, a selected subsample (n=149) covering all age classes from the Upernavik area was prepared using both methods. The thick cross sections were read by Danish scientists while the thin stained longitudinal sections were read by Canadian researchers. The result revealed that 40% of the readings were identical. Accepting a variation of ±1 year among readers, 79% were consistent. Similar variation has been found in other age estimation studies of marine mammals (e.g. Dietz *et al.* 1991, Heide-Jørgensen *et al.* 1994). However, a certain bias was found when comparing the two sets of readings, with a tendency towards lower estimates of older specimens (+7 years) using unstained sections (as also demonstrated by Stewart *et al.* 1996). However, for the purpose of this study, the only significant difference in the estimated age frequencies of the sample appears to apply to the yearlings (0-group), the relative frequency of which seems to be somewhat underestimated when using unstained cross sections.

Since the details of the data collected in 1974-76 only is available as an internal report (Christiansen 1983), it was decided to include some of these data in this paper and present them as primary data.

RESULTS

Hunting methods

Several methods are used to catch ringed seals, depending on the season (Fig. 2). During the open-water season in summer and autumn, most ringed seals are shot from boats. Netting in open water is most effective in October-November when the seals are unable to see the net due to decreasing light intensity and when the sea ice has not yet formed. During winter, most ringed seals are caught in nets set under the fast ice. In spring when the seals haul out on the ice to bask, they are easy targets for experienced hunters with rifles. These seals are called uuttut by the hunters (Fig 3). When the ice break up, seals are shot along the ice edge or in cracks (Amdrup *et al.* 1921, Glahder 1995, Hertz 1995).

In the municipality of Upernavik, fast ice covers all the fjords and the sea from November-December until May-June, when the ice starts to break up. During 1974-76 netting under the ice was by far the most successful method (48% of the sample, Fig. 2). Seals shot on the ice, along the ice edge or in cracks, and in open water contributed almost equally (11-19%), while seals netted in open water comprised only 3% of the catch of ringed seals in the northern part of Upernavik (Fig. 2).

Catch by area

North Greenland (Avanersuaq)

North Greenland (Fig. 1) was isolated from the rest of Greenland until the 1950s. Written documentation of catches is therefore much less than for the rest of West Greenland. The catch reporting system Hunters' Lists of Game has never functioned well and data are completely missing for some years. Minimum values of the catch can be obtained from the statistics on trade in ringed seal skins, which increased from about 2,500 skins per year around 1945 to about 6,200 around 1975 (annual average of 4,140 during this period). Trade reached a peak of almost 9,000 in 1977 but decreased thereafter to about 4,400 in the early 1980s. In 1987 and in 1995 fewer than 3,000 ringed seal skins were traded in the municipality of Avanersuaq (Fig. 4). The trends shown by the trade statistic for this region correspond with trends in the trade

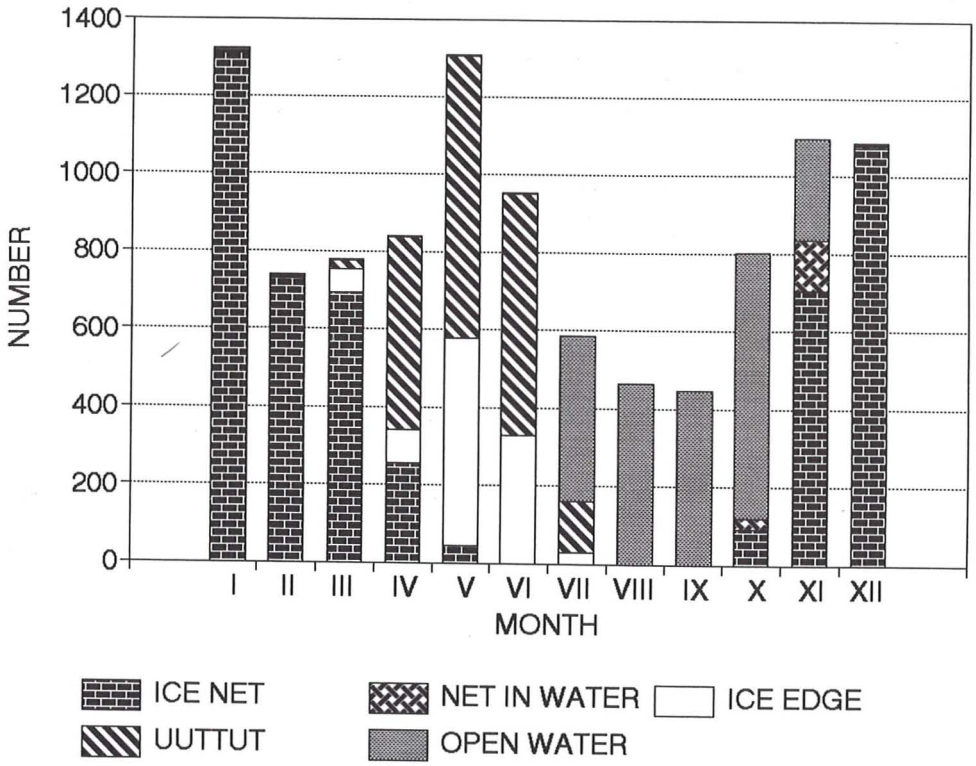


Fig. 2
Hunting methods for ringed seals by month for the northern part of Upernavik municipality in 1976. "Uuttut" are the seals that are hauled out on the ice.

Fig. 3
Uuttoq hunting in Uumannaq, 1984. (Photo: H. Siegstad)

Fig. 4
Flensing of a days catch of ringed seals from a skilled hunter in Avanersuaq, September 1987. (Photo: M. P. Heide-Jørgensen)

and catch statistics for the municipality of Upernavik (see below), but the actual level of catches in Avanersuaq can only be guessed. According to the new system of catch reporting, the annual catch of ringed seals was about 4,000 in 1993 and 1994.

Northwest Greenland (Upernavik, Uummannaq)
The annual average catch of 25,300 ringed seals (1939-94) in this region is by far the highest in Greenland (Fig. 5). Northwest Greenland accounts, on average, for about 40% of the reported catch of ringed seals in all of Greenland. Although the catch has varied greatly over the years, a significant increase ($p<0.0001$, linear regression, $r^2=0.43$) in the catch in Northwest Greenland has occurred since the late 1930s, averaging about 900 ringed seals/year (3.6% increase/year).

Central West Greenland (Qeqertarsuaq, Ilulissat, Qasigiannguit, Aasiaat, Kangaatsiaq)
According to the catch statistics, this region yields the second highest catch of ringed seals in Greenland (Fig. 5). The average annual catch over the entire period 1938-1994 was 11,200 ringed seals. The catch has increased significantly ($p<0.0001$, linear regression, $r^2=0.31$) since the late 1930s, at an average rate of 184 animals/year (1.6% increase/year). The linear increase suggested by such averaging masks, however, the large annual variations, as is true for the other areas. For Central West Greenland the catches were generally low in the 1940s and early 1950s, while peaks occurred in the late 1950s, mid-1960s and in the early 1970s.

Southwest Greenland (Sisimiut, Maniitsoq, Nuuk) and South Greenland (Narsaq, Qaqortoq, Nanortalik)
The size of, and trends in, catches of ringed seals are almost identical for Southwest and South Greenland (Fig. 5). When taking into account the number of people and the size of the two areas (Fig. 1) the catch is more intensive in South Greenland. The trends in the catch are similar to those of Central West Greenland, as described above. The two areas both show significant increases (Southwest: $p<0.0001$, linear regression, $r^2=0.57$ and South: $p<0.0001$, linear regression, $r^2=0.47$) in the catch level since the late 1940s, with average rates of increase of 73 and 49 ringed seals per year (3.0% and 2.9% increase/year), respectively. The average annual catches (1948-94) for the two areas are 2 ,400 and 1,700 respectively.

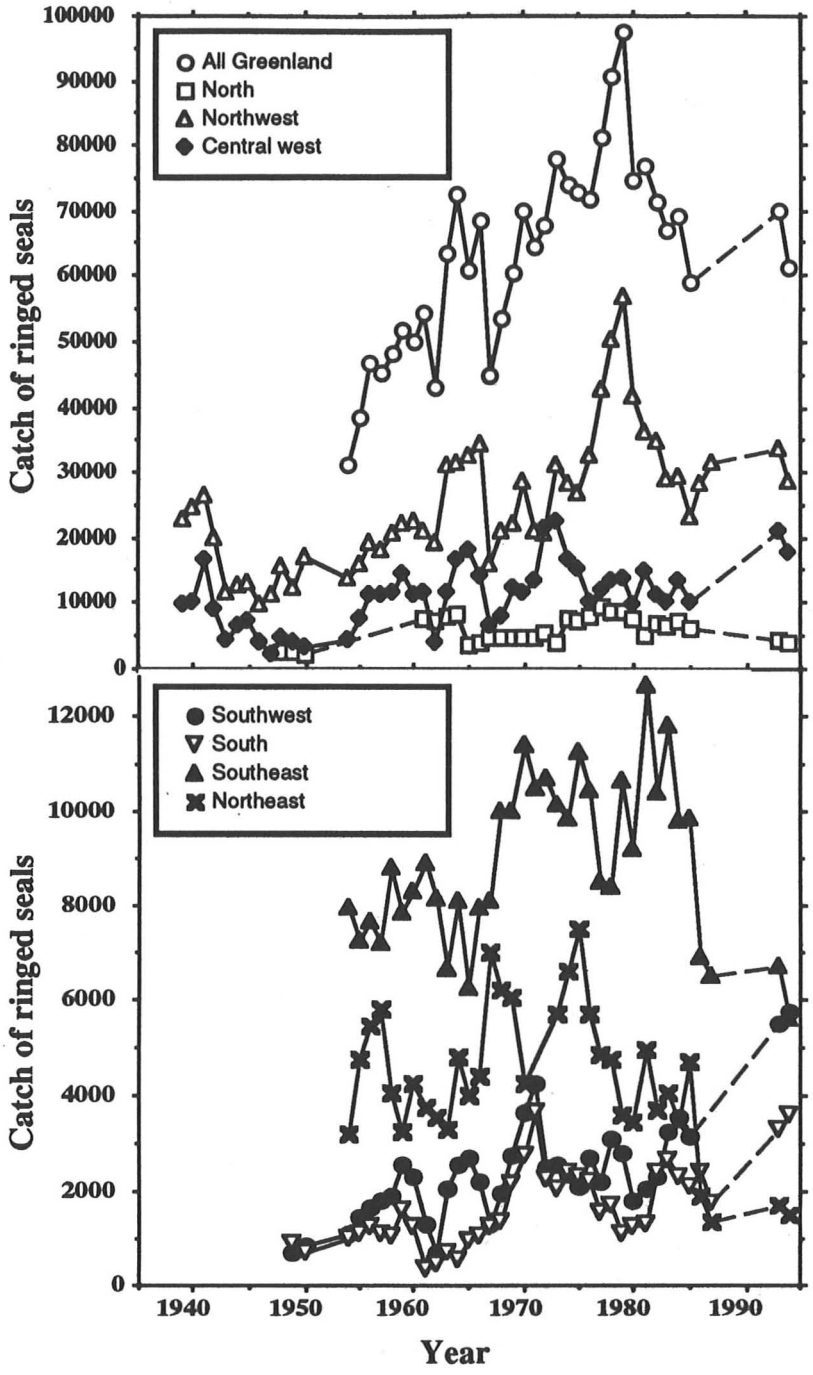


Fig. 5
Catch statistics of ringed seals by region (note the different scale on the Y-axis) in Greenland.

Southeast Greenland (Tasiilaq)
Record-keeping for Southeast Greenland has been unstable. For this reason, the figures should be viewed with caution and regarded as minimum estimates of the catch. Also, the catch figures after 1985 should be ignored since they are much lower than the numbers of skins traded. An average of 7,239 (range 4,903 – 9,192) ringed seal skins were traded in this region from 1954-85 with no obvious trend, in 1995 the trade was 9,112. The average estimated catch from 1954-85 was 9,200 ringed seals (Fig. 5).

Northeast Greenland (Ittoqqortoormiit)
Reporting of catches of ringed seals is unstable for this region and completely lacking for a

number of years. Trade statistics show generally higher values than catch statistics, giving an annual average of 5,380 (range 3,751-7,081) ringed seal skins traded during the period 1954-78, and a decrease after that, from 1979-1995 the average was 2,510 (range 1,712-3,297). The published estimate of the average catch from 1954 to 1985 was 4,700 seals per year (Fig. 5).

Overall trends in catch statistics

According to Rink (1877) ringed seals constituted 57% (about 89,000) of all seals hunted in West Greenland in the late nineteenth century. Between 1950 and today the proportion of ringed seal catches relative to the catches of all seal species was low in the 1950s and again in the 1990s (range: 54-88%, average 78%) with a peak around 1970 (88%). When it comes to the trade in seal skins, the ringed seal is even more important relative to the other species (Fig. 6). In the twentieth century, between 66% and 95% (average 85%) of all seal skins in commercial trade have been from ringed seals (Fig. 6).

The actual catch of ringed seals was rather variable from 1950 to 1970, but increased fairly consistently during the 1970s, reaching a peak in 1979 (Fig. 6). Thereafter the catch of ringed seals declined to a more or less constant level in the 1980s. For the other seal species, mainly harp seal (*Phoca groenlandica*), the catch declined from 1954 to 1970, then increased steadily for 20 years (Fig. 6). For some periods there seems to be an inverse relationship between the catch levels of ringed seals and other seals.

For all Greenland the annual ringed seal catch in the 1950s was around 43,000 (excl. North Greenland, since no catch records exist). The catch increased until the late 1970s to almost 100,000 per year (incl. North Greenland), while the annual reported catch in the early 1990s had decreased to about 70,000 ringed seals (incl. North Greenland, Fig. 5). The significant increase ($p<0.0001$) in the catch between the 1950s and the late 1970s represents an increase

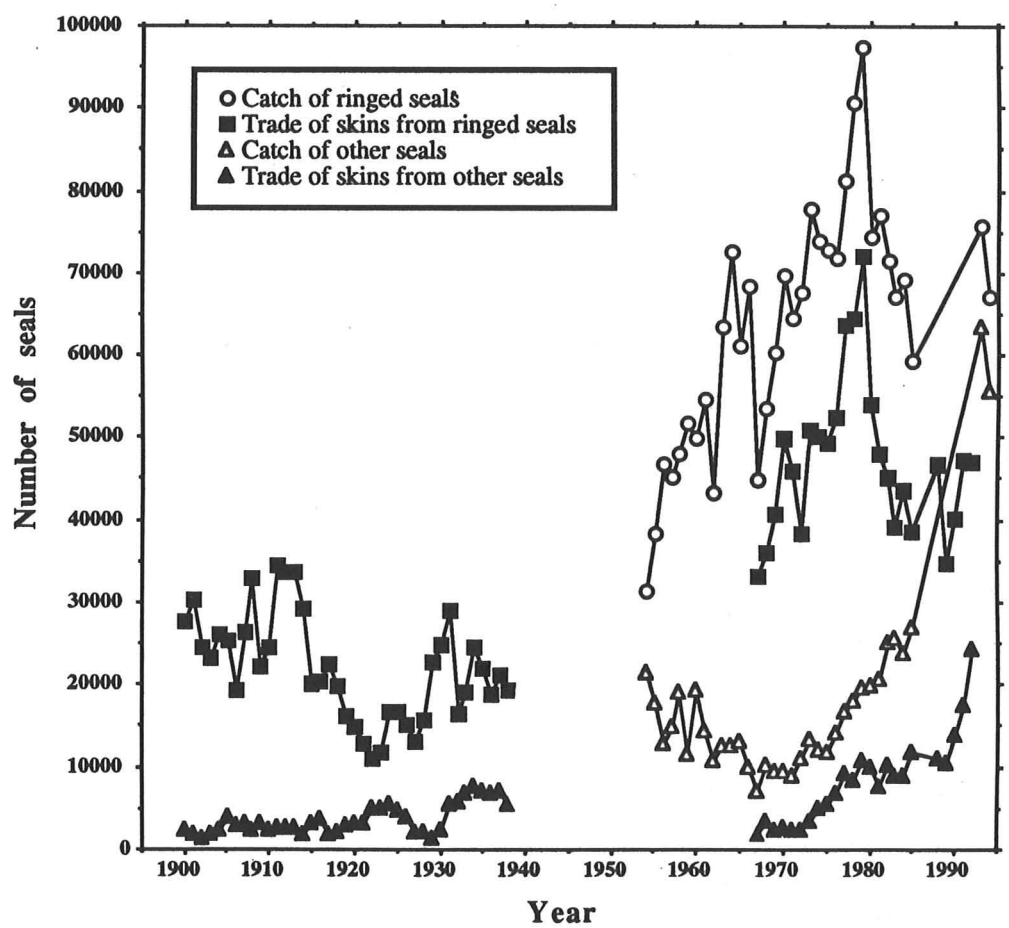


Fig. 6
Catch and trade of ringed seals and other seal species (harp, hooded, bearded, and harbour seals) in Greenland.

of about 2,000 ringed seals annually. From the late 1970s to the early 1990s the catch decreased by about 2,000 per year. The annual average catch for the whole period was c. 63,000 ringed seals.

Evaluation of catch and trade statistics

About 40% of the total catch of ringed seals in Greenland is taken in the Northwest region (Upernavik and Uummannaq municipalities, Figs 1 and 5). For the inhabitants of this region, seal hunting has always been the main occupation, although the importance of fishing for Greenland halibut (*Reinhardtius hippoglossoides*) has increased over the last decades, initially in Uummannaq since the 1950s but also in Upernavik municipality since the 1980s. In the Northwest region the catch reporting system (Hunters' Lists of Game) appears to have worked comparatively well until recently (1985). To get an idea of the reliability of the trade and catch statistics, this region has been chosen to examine the variation and development of ringed seal hunting in greater detail.

The area around two settlements in the municipality of Upernavik, Tasiusaq and Tussaq (73°00'-73°50'N, see Fig. 1), was chosen as a small-scale reference area. At the beginning of the period in question (1954-1987), these settlements were inhabited by a total population of 262 Inuit, of which 85 were reported to be hunters. During the following decades the human population increased gradually to 437, and the number of reporting hunters was 118 in the early 1980s.

Catches (not including estimates of unreported catches) of ringed seals in this area show large year to year variability (e.g. from 5,863 in 1962 to 10,650 in 1963, Fig. 7). Catches were relatively high in the periods 1963-66, 1977-81 and 1986, and relatively low during 1967-73 and 1983-85.

Comparisons between hunting and trade statistics (1972-85, Fig. 7) indicate that some under reporting of catches probably took place in the late 1970s. The variation is similar in the two

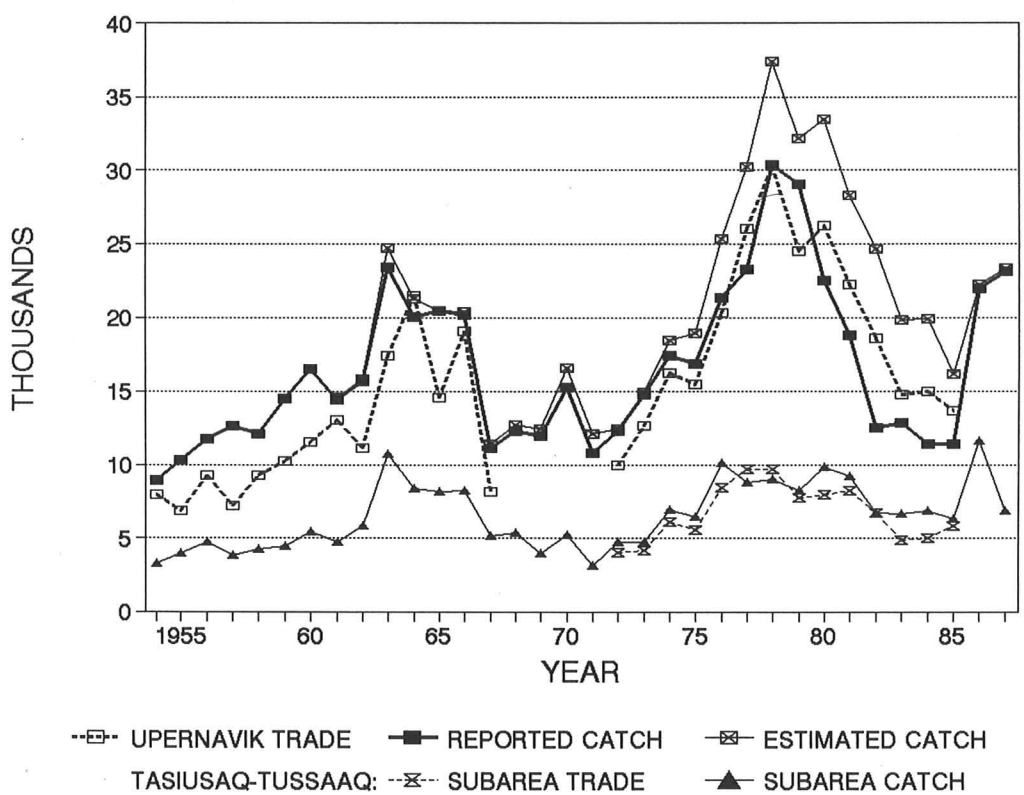


Fig. 7
Catch and trade numbers of ringed seals for Tasiusaq + Tussaaq settlements in Upernavik municipality and the total for Upernavik municipality.

independent data sets and may be taken as an indication of the reliability in the trends for the two independent sets of statistics.

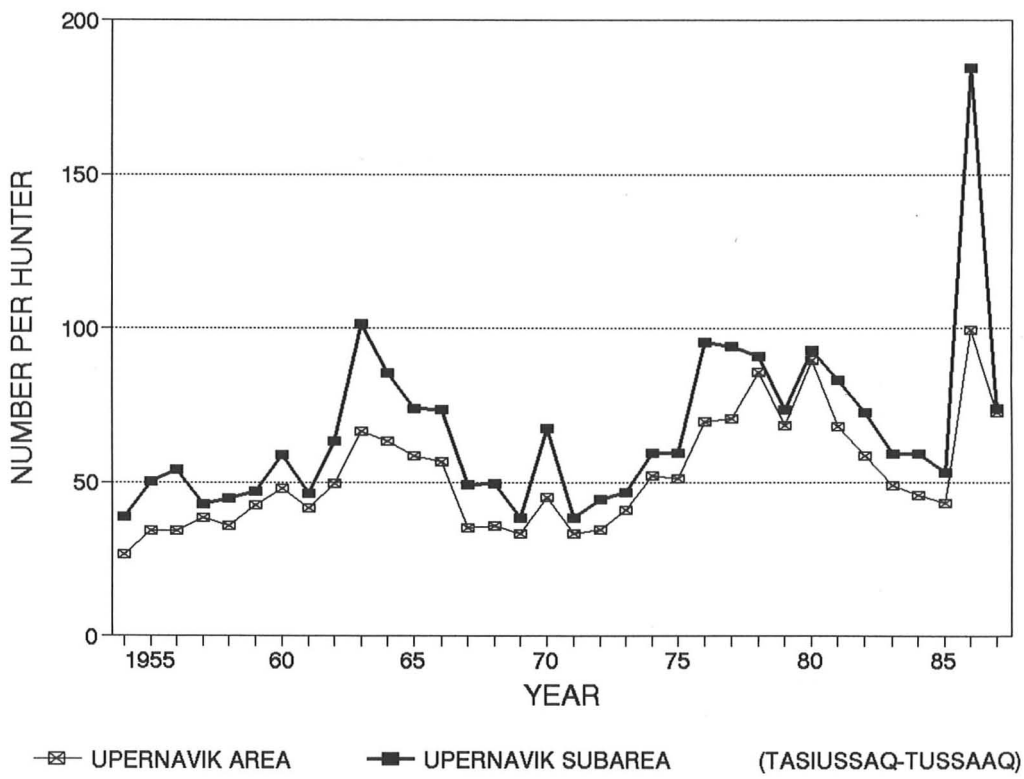
In the municipality of Upernavik as a whole the Inuit population increased from 1,294 in 1954 to 2,057 in 1985. The most pronounced population growth was in the town of Upernavik, that increased from 435 to 813 inhabitants during the period. At the same time the town changed character from a hunting settlement to a modern administrative town with health care, education, trade facilities etc. The reliability of the reporting of the hunting results presumably decreased during this period.

A comparison between the Tasiusaq-Tussaaq area and the whole Upernavik municipality shows, however, that the trends for the small area can be taken as indicative for the entire municipality, except that the peak in the late 1970s is not as pronounced (Fig. 7).

Calculation of catch-per-reporting hunter (Fig. 8) does not change this general picture: large annual variation, with certain peak periods. This means that the number of active hunters has been stable from year to year which gives a measure of the continuity in the system. Furthermore, the hunters in the Tasiusaq-Tussaaq area have a higher catch-per-hunter, probably due to the fact that a higher proportion of the hunters in the town of Upernavik hunt during their spare time rather than as fulltime hunters.

When comparing the municipality of Upernavik with the other municipality in the Northwest region, Uummannaq, roughly the same variation in the catch is evident (Fig. 9). However, the hunting returns in these two municipalities would be expected to differ in view of their different geography (e.g. differences in the distribution, timing and extent of the ice cover).

For validation of the catch statistics for all Greenland, we compared the trend in the figures for the two independently collected sets of statistics; catch and trade (Figs 6 and 10). This comparison was possible only for the periods 1967-85 and 1993-94. During these periods, there was a significant correlation between the



Figu. 8
Catch of ringed seals per hunter for Tasiusaq + Tussaaq settlements in Upernavik municipality and the total for Upernavik municipality.

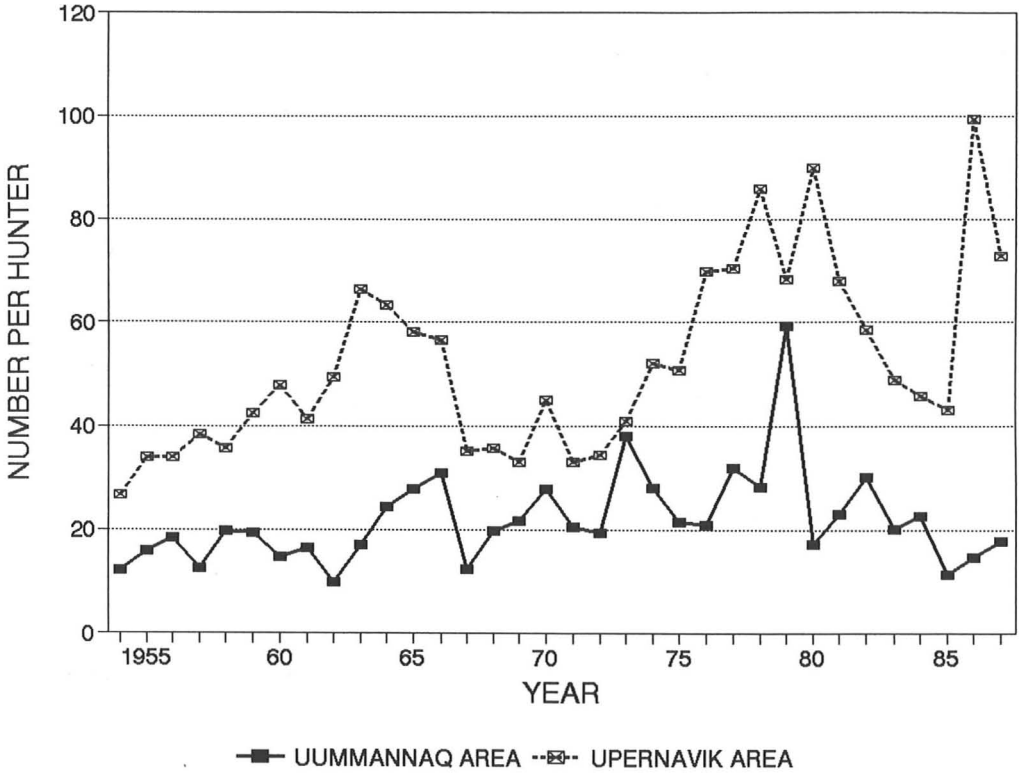


Fig. 9
Catch of ringed seals per hunter for Upernavik and Uummannaq municipalities.

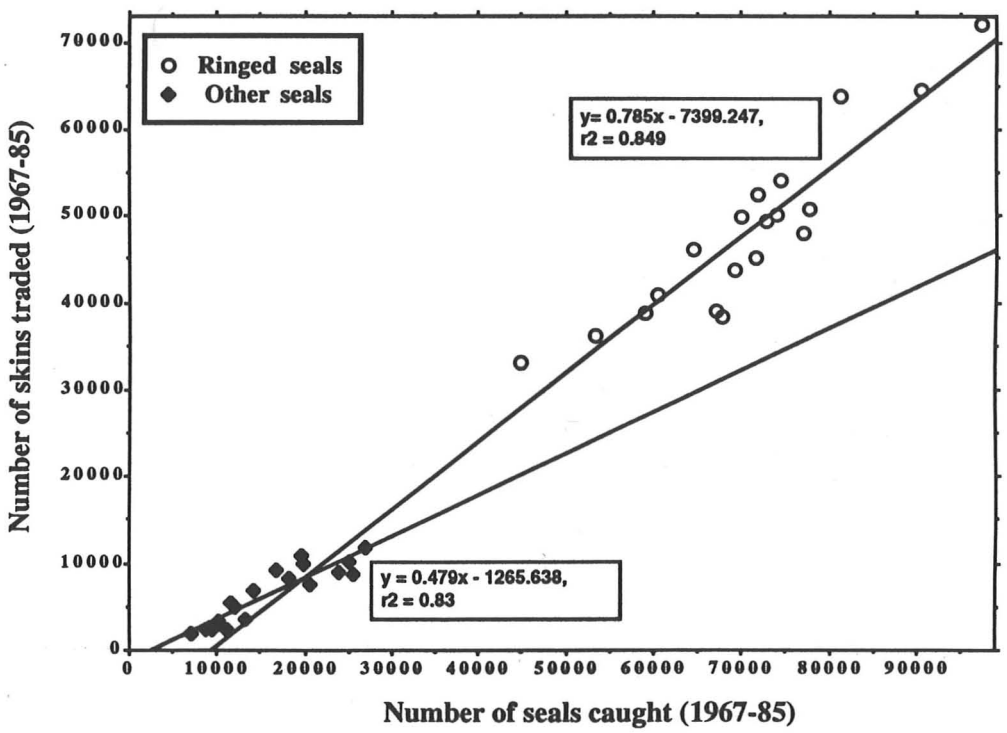


Fig. 10
Regression of catch and trade figures for ringed seals and other seal species (harp, hooded, bearded, and harbour seals) between 1967 and 1985 for all Greenland.

catch and trade figures for all Greenland for both ringed seals (linear regression (LR), $p<0.0001$) and other seal species combined (LR, $p<0.0001$; Fig. 10). If the correlation between catch and trade for ringed seals is distributed by the areas shown in Fig. 1, a more complex picture arises. The areas Northwest (LR, $p<0.0001$), Northeast (LR, $p<0.0001$), and South (LR, $p<0.0001$) show the same significant correlation as for all Greenland, while Central West (LR, $p=0.16$), Southwest (LR, $p=0.98$) and Southeast (LR, $p=0.93$) show no correlation. For North Greenland there are not enough data to carry out a similar comparison.

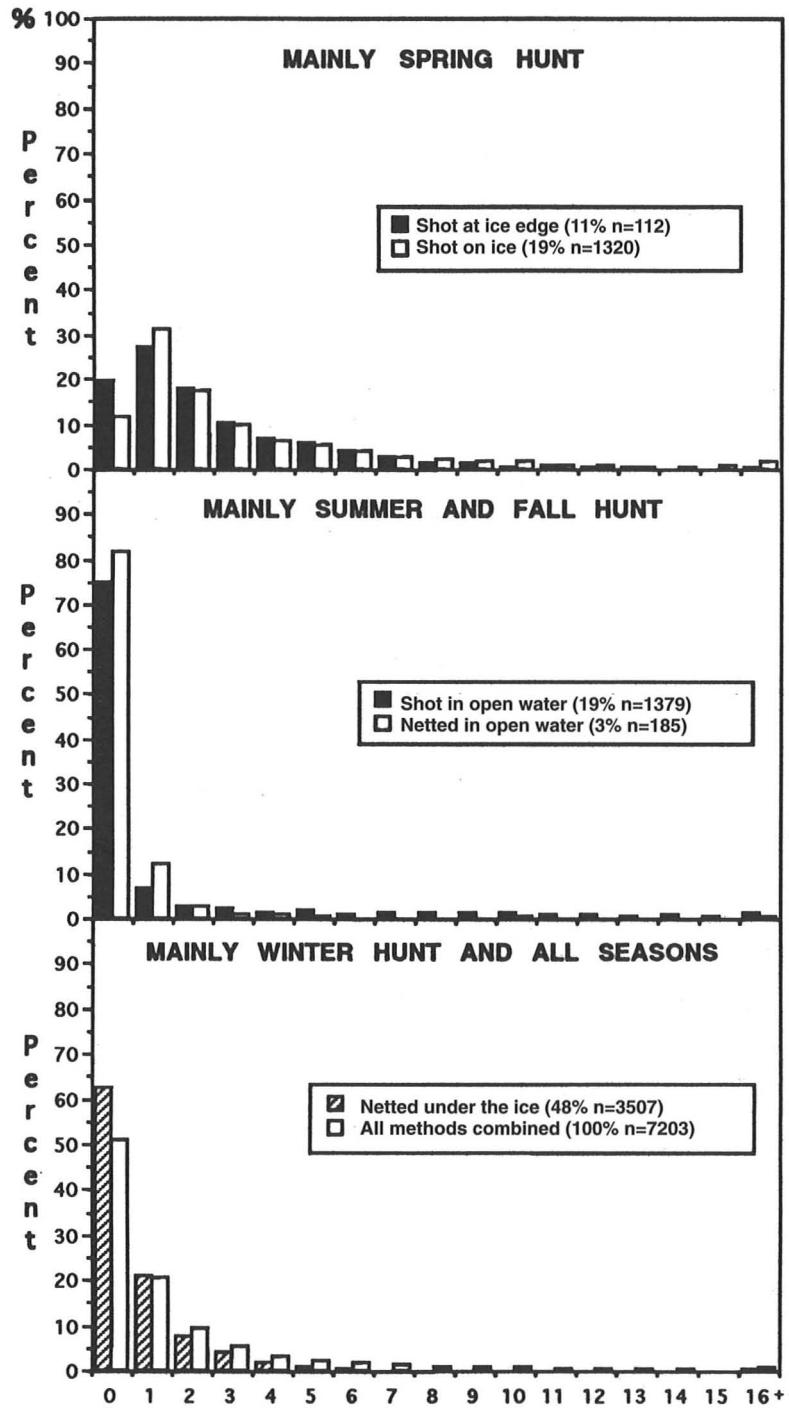


Fig. 11
Age distribution of ringed seals by hunting method in Upernavik 1974-76.

Composition of the catch

The majority of the ringed seals collected in the municipality of Upernavik in 1974-76, were yearlings (50% of the aged sample) and juveniles (Fig. 11). Netting under the ice constituted the bulk part of the harvest (c. 50%, Table 1) and mainly yearlings were caught (62%). A wider range of age groups were exploited during the spring hunt (15% yearlings, 73% adolescents and 12% adults). Of the summer and autumn hunt (22% of the annual catch, Fig. 11), when seals were shot or netted in open water, yearlings accounted for 75% of the catch, adolescents 16% and adults 9%.

Of the ringed seals collected in the municipality of Upernavik in 1974-76 (n=7,089), 59.6% were males and 40.4% were females. A surplus of males in the catch seems to be consistent for the different hunting methods (range: 55-61% for males and 39-45% for females, Table 2). Of the ringed seals collected all over Greenland in the 1980s and 1990s, 56.5% were males and 43.5% were females (n=923). The difference in sex ratio was consistent for all age classes for the samples from both Upernavik and all over Greenland.

Seasonal variation in the catch

There is large variation in the numbers of ringed seals taken and the catch methods used during the year (Fig. 2). For the two municipalities in Northwest Greenland, Upernavik and Uummannaq, the seasonal variation for three different periods is compared. For the municipality of Upernavik the peak catch during 1945-54 was in May when the seals haul out on the ice (Table 1). During 1976-78 the general catch level increased significantly, especially for the October-March period when most seals are caught in nets under the ice (55.2%, Table 1). For 1993 the picture is similar to 1976-78 except for the relative increase in proportion of seals shot on the ice and taken in open water. For Uummannaq the overall trend is similar (Table 1). However, open-water catches were significantly lower than in Upernavik, probably due to the higher level of fishing activity in this municipality.

Table 1. Seasonal and regional variation in catches of ringed seals in Northwest Greenland during three periods.

Month	November-March	April-June	July-October
Method mainly used	Ice nets	Shot on ice or at the ice edge	Netted or shot in open water
Upernavik municipality, average catch			
1945/54	3,460 (42%)	3,628 (45%)	1,054 (13%)
1976/78	13,720 (55%)	6,483 (26%)	4,671 (19%)
1993	11,041 (43%)	8,523 (33%)	6,813 (24%)
Uummannaq municipality, average catch			
1945/54	2,240 (49%)	1,874 (41%)	441 (10%)
1976/78	6,523 (63%)	3,061 (30%)	690 (7%)
1993	3,556 (49%)	2,744 (38%)	962 (13%)

Table 2. Sex distribution in ringed seal catches for different hunting methods, samples collected in Upernavik during 1974-76.

Hunting method	Males	Females	n
Shot at ice edge	61%	39%	3,435
Shot on the ice (uuttut)	61%	39%	1,329
Shot in open water	56%	44%	1,345
Netted in open water	58%	42%	798
Netted under the ice	55%	45%	182
All methods combined	60%	40%	7,089

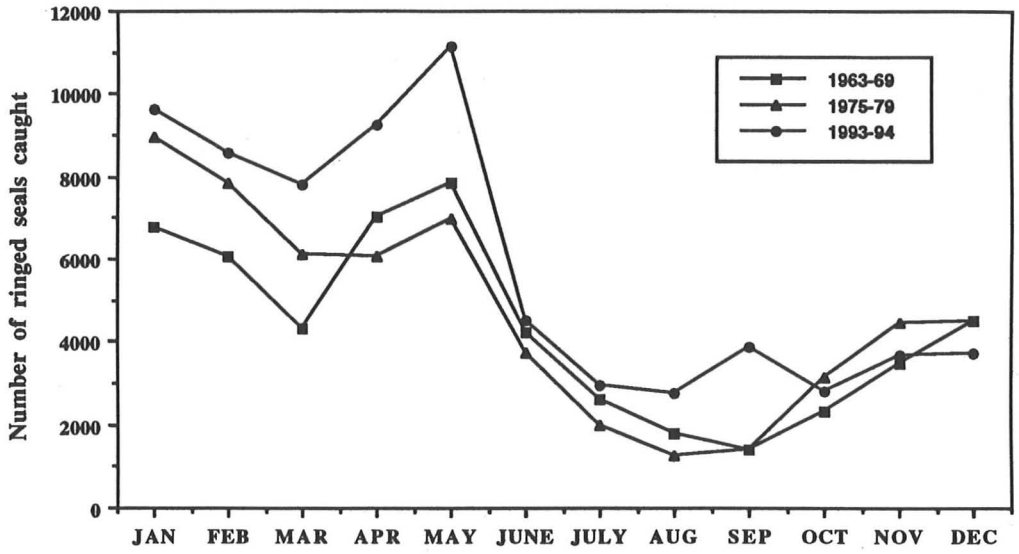


Fig. 12
Catch of ringed seals by month for all Greenland for three periods (1963-69, 1975-79, and 1993-94).

Seasonal trends in catches for all Greenland during the three periods 1963-69, 1975-79 and 1993-94 are similar, with most catches in January through May and peaks in January and May (Fig. 12). This seasonal trend is more pronounced for Upernavik and Uummannaq. In South Greenland the vast majority of ringed seals are taken during the open-water season from May to August (Dietz 1989).

DISCUSSION

The age composition found in this study differs from that described in Canadian studies, particularly as regards the frequency of yearlings in the catch. McLaren (1958) found differences in the composition of inshore and offshore samples: in the inshore samples from the fast ice 13% were yearlings, whereas an offshore sample from the same season consisted exclusively of adolescents; in an offshore summer sample 16% were yearlings. Smith (1973) found that yearlings constituted 25-27% of the open water hunt, and slightly more (27-39%) of the spring hunt on the ice. Stirling *et al.* (1977) demonstrated significant changes in the age composition from one year to the next: yearlings constituted 44% of a sample from 1972, but were practically absent in samples from 1974 and 1975.

It is not known whether the high frequency of yearlings found in the summer and winter hunt in the 1974-76 sample from Upernavik is a general feature for this municipality, or whether it also applies to other areas.

There was a larger proportion of male ringed seals (c. 60%) in the catches from Greenland and the difference was evident in all age classes. A review of the sex distribution of catches of ringed seals from other areas revealed that the proportion of females could vary from 43.8% to 53.8% (Miller *et al.* 1982). Whether the sex distribution of the catch in Greenland reflects the actual population composition, a difference in geographical distribution between the sexes or selectivity in the hunt is unknown. Of 93 animals tagged between 1976 and 1996, 57% were males and 43% females, and of 37 recoveries, 54% were males and 46% females (Kapel *et al.* this volume). For all age classes and for all hunting methods these data suggest either a skewed sex ratio for ringed seals in Greenland, or that females for some reason are less available to the hunters. A significantly higher mobility of females indicated by conventional tagging experiments (Kapel *et al.* this volume) suggests a possible difference in the behaviour of the two sexes.

The peak season for the catch of ringed seal varies between regions. For Greenland as a whole most ringed seals are taken from January to May, which reflects that the peak season in the northern regions (where the major part of

the catch is taken) is the winter and the spring, while catches are relatively small during the open water season. In the southern regions, however, the great majority of ringed seals is caught between May and August.

Two features should be noted when comparing the old and new system of catch reporting: the difference in approach and the reporting intensity. The Hunters' List of Game represented an indirect reporting procedure by which one person reported the hunting results of everyone at a given settlement. As long as the settlements were small (<300 inhabitants), this system was feasible, and it seemed to work well for a number of years at many locations. But when the size of a settlement increased it became increasingly difficult for a single person to keep track of all hunting, and at the same time the interest in doing so faded, because other occupations, such as fishing, became more important than hunting. It is obvious that the number of reports (Hunters' List of Game) received, e.g. in 1983 (2,226), did not reflect the number of people actually engaged in hunting. Such obvious problems led to the procedure of trying to estimate non-reported catches.

In the new system, reporting is linked to the renewal of hunting licenses. Each hunter must report his own catches, and this should be possible regardless of the size of the settlement. A major problem is that many hunters are not used to paper work, and they may not see the point of keeping exact notes on the dates and numbers of animals taken. Whether this leads to under-reporting, over-reporting, or just arbitrary reporting in order to have something to report when renewing the license, is not clear (Kapel and Rosing-Asvid 1996). Examples of both under-reporting and over-reporting have been identified, but so far no estimation of unreported catches or corrections has been presented.

Trade statistics have proved useful both because the numbers of skins purchased give non-biased minimum numbers for catches, and because they illustrate trends in exploitation, as long as the purchase is not limited in any way. This was previously the case when the Royal Greenland Trade Department bought all skins of a certain quality. Some skins were, however, used in the households, and some were of such poor quality that it did not pay to prepare them for trade.

The fraction of ringed seal skins traded has varied by area, season and over time, but detailed information on this variation is not available. Generally, the household use of skins is greater in the hunting regions than in the fishing regions, whereas the economic interest in preparing and trading skins is less in the fishing regions, where other sources of income are more varied or profitable. Ringed seal skins from late spring-early summer are often less suitable for trading because of moulting. Further, it has become increasingly difficult for the skin prices to comply with the general development in price indices in spite of heavy subsidising. Finally, in recent years some limitation on the purchase of skins has been introduced (although this has apparently had greater impact on the trade in skins from other seal species).

Comparison of catch and trade statistics for ringed seals in Upernavik for both small and larger areas showed good agreement in year-to-year and long-term variation. Similar agreement in trends of the two sets of statistics were found for other hunting regions, whereas the catch statistics were clearly unreliable for other regions.

The two independent sets of statistics could be used with care as relative measures of catches of ringed seals in Greenland and to monitor trends. It should, however, be borne in mind that the catch statistics are minimum estimates with some correction for unreported catches, but not for the proportion of seals killed but lost.

Significant increases in the trade and estimated catches were found between 1954 and 1994 for all regions in West Greenland, whereas the trends for North Greenland (Avanersuaq) and East Greenland are more difficult to interpret because of instability and the poor quality of the catch statistics. For all Greenland combined, the catch level between 1954 and 1994 was about 63,000 annually, with an increasing trend from the late 1950s until the late 1970s, followed by a decrease until the early 1990s. These catch trends are probably real, but it is

important to keep in mind the large inter-annual variations and the pronounced peaks in the catch that show up in long time series.

For all regions, great inter-annual variability was found, as well as long term fluctuations. The trends were similar for Northwest and (until the early 1970s) Central West Greenland, and for Southwest and South Greenland, whereas the variations in Southeast and Northeast Greenland seem to show different patterns.

The inter-annual variation in the catch of ringed seals may be related to the actual weather and ice conditions. The success of netting under the ice depends on the duration and stability of the fast ice cover, the amount of snow, and the frequency of strong wind, all of which influence the possibilities for setting and tending the nets. Similarly, weather and ice conditions in late April-June will determine the chances of hunting seals basking on the ice or seals occurring at the ice edge. During summer it is the wind force in particular that determines the hunting success, since hunting is mainly conducted from small boats (i.e. dinghies with outboard engines).

Long-term climatic changes have occurred in Greenland and elsewhere in the North Atlantic during the past century (Jensen 1939, Hansen and Hermann 1965, Vibe 1967, Buch 1982, Dunbar 1982, Drinkwater 1996, Stein 1996). Many studies have focused on the effects of these changes on fisheries (e.g. Hansen and Hermann 1965), while others have discussed the more general oceanographic and climatic aspects (Dunbar 1982, Drinkwater 1996, Stein 1996), and some have included discussion of the consequences for distribution and abundance of marine mammals (Jensen 1939, Vibe 1967).

In Northwest and Central West Greenland the average air temperature increased during the last part of the 19th century and the beginning of the 20th century. The mean annual temperature for Disko Bay (Aasiaat/Egedesminde) 1931-38 was about 2°C higher than the mean for 1876-1925, and the increase was particularly evident for the winter months (Anon. 1944). During the following decades the average temperature decreased again, and the means for 1961-90 were similar to those of the 1876-1925 period (Stein 1996).

This variation in air temperature is not in itself sufficient explanation of changes in distribution of marine mammals, but may be indicative of major environmental changes that have occurred, including variation in fast ice cover and drift ice distribution, which in turn will have an effect on hunting conditions, and possibly also on the productivity of ringed seal populations.

In his study of relations between climatic fluctuations and arctic animal populations, Vibe (1967) recognised three alternating main drift-ice stages which would play an important role in the climatic conditions in the Arctic and hence in the ecology and abundance of both terrestrial and marine organisms: a drift-ice "stagnation" stage, a drift-ice "pulsation" stage, and a drift-ice "melting" stage, each of which have a duration of approximately fifty years.

With respect to ringed seals, Vibe argued that these stages influence the distribution and abundance differently in the various regions of Greenland. During the "stagnation" stage (e.g. 1810-1860), the climate in Northwest Greenland would be relatively cold, dry and stable, i.e. favourable for ringed seals, as indicated by increasing catches in the northern parts of West Greenland during this period, while catches stagnated in South Greenland. During the "pulsation" stage (1860-1910), however, West Greenland experienced rather wet and unstable weather, which explains decreasing catches of ringed seals in central West Greenland. Also in East Greenland conditions became unfavourable for ringed seals so that, according to Vibe (1967), they left that region and moved in great numbers to South Greenland, explaining a significant increase in the catch of ringed seals in that region in the period 1860-1890. During the following "melting" stage (1910-1960), the climate in West Greenland became comparatively mild, resulting in continuously decreasing catches in central and southern West Greenland. In East Greenland, on the contrary, ringed seal catches increased during this period. According to Vibe's hypothesis, a new "stagnation" stage began around 1960.

Our analysis of ringed seal catch statistics over the past forty years in Greenland indicates an increasing trend for all regions of West Greenland between the late 1950s and the late 1970s, possibly followed by a decrease during the last fifteen years. The initial part of this development is in general agreement both with Vibe's hypothesis and the observed decline in average winter temperatures for Central West Greenland (Stein 1996). If the most recent decrease in catches is real, it seems more difficult to relate it to environmental changes, as the winter temperatures were even lower in the early 1990s than the mean for 1961-90 (Stein 1996).

Ringed seals are widely distributed in Greenland and do not occur in dense concentrations, but are dispersed over large areas. They are hunted year round by various methods, none of which appear to exercise a significant pressure upon the population. It is worth noting that available evidence indicates that exploitation in Greenland is mainly directed towards the youngest age classes, whereas the adult, breeding animals are only caught in small numbers with the methods and hunting practices used to date. As long as this situation is maintained, it is unlikely that existing exploitation pose a threat to the population of ringed seal in general. Intensive hunting activity could, however, affect occurrence and abundance on a local scale.

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