International Council for the Exploitation of the Sea

17039

C.M. 1989/N:6
Marine Mammals Committee

FEEDING PATTERNS OF HARP SEALS (Phoca groenlandica) IN COASTAL WATERS OF WEST GREENLAND, WITH A NOTE ON OFFSHORE FEEDING.

by

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SUMMARY:

The stomach contents of 661 harp seals caught in West Greenland 1985-1988 were identified, and the food composition expressed as per cent volume, and as calculated per cent weight of consumed food. These data were supplemented by information from hunters' reports. The analyses show large regional and seasonal variation in the diet, and confirm previous statements that capelin (Mallotus villosus) is the dominant prey in spring and summer in Southwest and Central West Greenland, with crustaceans (euphausids and amphipods) as other important food items, particularly for young seals. In North and North-west Greenland, polar cod (Boreogadus saida) and Arctic cod (Arctogadus glacialis) were the dominant fish species, along with pelagic euphausids and amphipods (Parathemisto spp.). The diet of harp seals wintering in Central West and South-west Greenland is more varied, comprising a number of other fish species, prawns, and squid (Gonatus fabricii). In offshore areas the harp seals appear to feed heavily on sandeels (Ammodytes sp.) in summer, possibly taking a more varied diet in the fall, but further studies are needed on this issue, and on the year to year variation.

RESUMÉ:

L'examen des contenus stomacaux de 661 phoques du Groenland pris entre 1985 et 1988 le long de la côte ouest du Groenland est présenté. On a exprimé la composition de la nourriture en pourcentage du volume des contenus aussi bien qu'en pourcentage de poids calculé de la nourriture consommée. Des rapports de chasseur de phoques ont fourni des information supplémentaires. Tout en révélant une grande variation du régime alimentaire en ce qui concerne la région et la saison les analyses confirment ce que l'on a noté précédemment: Au sud-ouest et à la partie centrale de la côte ouest du Groenland la proie dominante est le capelan (Mallotus villosus), suivi de près

par d'euphausies, surtout choisie par les jeunes phoques. Dominée par la morue polaire (Boreogadus saida) et par la morue arctique (Arctogadus glacialis) la proie au nord-ouest et nord du Groenland se compose aussi d'euphausies et d'amphipodes pélagiques (Parathemisto libellula). Les phoques du Groenland qui passent l'hiver au centre et au sud-ouest de Groenland se nourrissent d'une manière plus variée: la nourriture se compose aussi d'autres genres de poissons, de crevettes et de céphalopodes (Gonatus fabricii). En haute mer le phoque du Groenland se nourrit selon tout apparence largement de lançons (Ammodytes spp.) en été. Il est à présumer que la nourriture devient plus variée en automne, mais cette question ainsi que celle de la variation annuelle réclament des recherches supplémentairees.

1.0 INTRODUCTION

The role of harp seals in the marine ecosystem has recently attracted the attention of several meetings and authors (NAFO 1981, ICES 1985, 1988, Lavigne et al. 1985, Bowen 1985), and the issue may be particularly relevant when the seal stocks are expanding (NAFO 1985). In this context, data on population size and dynamics, on the energy requirements of the seals, and on their diet, are necessary. This paper addresses the last issue by presenting results of the recent examination of harp seal feeding habits in West Greenland. Information on the food of harp seals in Greenland waters was first presented by Fabricius (1780, 1790) and casual information collected during the following century was summarised by Winge (1902). These accounts, supplemented by a few additional observations (e.g. Vibe 1950), have since been cited in the literature where reference is given to harp seal feeding during the northern migration (Sergeant 1973, 1976). Information gathered from Greenlandic hunters indicated that the feeding pattern might be more complex than previously described (Kapel MS 1973, Kapel and Geisler MS 1979), and recent studies at Labrador and in the Canadian Arctic (Foy et al. 1981, Finley and Gibb, in press) call for a similar thorough and quantitative examination of the matter also in Greenland. For this purpose, a fairly large material of harp seal stomachs has been collected in recent years, and a preliminary analysis of these samples is presented below.

2.0 MATERIALS

(1) As a by-product of collecting harp seal jaws for analyses of the age composition of catches (Kapel 1975, 1986), information on stomach contents was obtained from Greenland hunters. These "hunter's reports" - available for most of the about 10.000 jaws collected in the period 1971-1983 - were, however, rather unspecified and of little use for quantification of the relative importance of the various food items. In the present context they are primarily used as supplemen-

tary information, when the coverage of stomach samples is insufficient.

(2) Extensive sampling of harp seal stomachs for laboratory analyses was initiated by the Greenland Fisheries Research Institute (GFR) in 1986, when collecting through local contacts was organised in S.W. Greenland (total 257 specimens). In 1988 a special expedition to offshore areas in S.W. Greenland was carried out, and samples were collected during field work in Prøven, Upernavik district, N.W. Greenland (total 211 specimens).

(3) Between September 1987 and August 1988 Lars Angantyr (LAA) collected harp seal stomachs during field work in Godhavn (Disko, Central West Greenland), and arranged similar collections in Attu (Kangaatsiaq district, C.W. Greenland) in January-February 1988. The material totals 226 specimens, and constituted the main basis for LAA's graduate dissertation at the University of Copenhagen (Angantyr 1989).

(4) Additional stomach material was obtained from the project 'Heavy Metals in the Greenland Marine Environment' (HMP) conducted by the Greenland Environment Research Institute since 1985, collecting extensive tissue material from all trophic levels in the marine ecosystem. The analyses of harp seal stomach content (total 125 specimens) were carried out by LAA, and the data made available for inclusion in his dissertation (Angantyr 1989), and for this paper.

A survey of the above-mentioned stomach samples is given in Table 1, and Fig. 1 shows the sampling localities. The seasonal and regional coverage in relation to hunting seasons in the various districts is illustrated by Fig. 2. It appears from this, that fairly large gaps exist in the available material. This fact should be borne in mind when conclusions are drawn.

3.0 METHODS:

3.1 Field work

All samples were obtained from local hunters, who received a small fee for providing material and information. For most animals sampled during field work by scientific personnel, detailed data on sex, body measurements, weight, and condition were recorded. The samples were frozen as soon as possible, and sent to Copenhagen for further examination in the laboratory.

3.2 Age determination of seals

The ages of the seals were determined using incremental growth layers examined in transverse sections of the lower canine teeth (Scheffer 1950, Laws 1952, 1953, Fisher 1954). For animals up to four years of age, the method is considered

very accurate (96-100 % correctly determined). For older animals, an increasing uncertainty and negative bias has been demonstrated (Bowen et al. 1983, Kapel unpubl. data). The age composition of the samples is shown in Fig. 3.

3.3 Stomach contents analyses

Two methods have been used to analyse the quantitative importance of the different prey items found in the stomachs: (1) mean per cent volume for each species/group (2) the mean per cent of 'the calculated fresh weight' for each species.

3.3.1 Food identification and estimation of volume %

After thawing, the stomachs were weighed and cut open. The stomach wall was rinsed, weighed, and examined for parasites. The contents was placed in a sieve, and the drained weight thereafter determined. The per cent volume of parasitic nematodes, non-edible items (gravel and stones), and food was estimated visually. In the same way, the relative contribution of all major taxonomic groups in the food was recorded as volume percentages.

The stomach contents were then placed in a tray, and washed repeatedly in cold water in order to "pan out" the otoliths (see Treacy 1981, Murie and Lavigne 1985, Murie 1987). All fresh specimens were identified by their gross morphology. When possible, the size and weight of the prey items were measured for use in later calculations. For all taxonomic groups the number of individuals was either counted or estimated.

The total number of each fish species was calculated by adding the number of fresh fish, the number of intact skulls and half the number of free otoliths. Crustaceans were counted if fresh and only present in low numbers. When present in large numbers, the amount was estimated from counting a subsample. If the crustaceans were partly digested, their number was estimated by counting telsi. Squids were counted by adding the number of fresh specimens to the highest number of either upper or lower beaks.

3.3.2 Calculation of the fresh weight of consumed food

The fresh weight of each species or taxonomic group was calculated by multiplying the number by an estimated average weight. The "fresh weight of the food consumed" was estimated by summing the calculated weights of all species identified in the stomach.

For the larger fish species, the fresh weight was calculated using 'otolith length - fish weight' correlations, mainly those presented by Härkönen (1986). Otoliths were sorted in groups of approximately equal size, and the mean otolith length determined. Each group of otoliths was then assigned a degree of degradation: fresh, lightly resolved, heavily resolved. According to this classification, correction factors were applied: no correction was made for length of fresh oto-

liths, whereas correction factors of 1.02 and 1.05 were used for slightly and heavily resolved otoliths, respectively. These values were estimated from results of otolith degradation experiments carried out by Prime (1979) and Jobling and Breiby (1986). Prime found that many large otoliths pass through the digestive system, whereas small otoliths are often digested completely. Jobling and Breiby found that more than 5 hours in strong acid were needed to reduce the length of large otoliths by more than 10 per cent.

For small fish species, and for crustaceans, standard weight values were used, i.e. applying the same weight for all the individuals. The standards were either calculated from a small number of fresh specimens found in the stomachs, or taken from information in the literature.

For squids, either a 'length of lower beak - squid weight' correlation, or a 'pen length - squid weight' correlation was used (Siegstad 1988, Angantyr 1989, Kristensen 1984).

For squids and some of the fish species, a minimum value of 1.0 gram was used because the equations gave very low or negative values for very small beaks and otoliths.

3.4 Data base and analyses

A database was created containing all the field, laboratory and food data. The database now holds information for more than 800 harp seals with about 300 variables.

Part of the database is a program that calculates the composition of the 'fresh food' given the number of prey items and, if possible, mean weight of the prey items. If no weight is specified the program uses a standard value.

The analyses of the quantitative composition of the diet were done using SAS-programs (Statistical Analysing System).

Using this database it is possible to change one or more of the factors used to calculate the composition of the diet and analyse the relative importance of each of the factors.

4.0 RESULTS

Table 2 presents a survey of the principal food items found in the stomachs (A full list of the species found is given as Appendix I). The proportional composition of the diet at different localities and seasons is presented in Table 3 (volume percentages) and Table 4 (weight percentages), and illustrated by Fig. 4. Fig. 5 illustrates an analysis of age-related variation in feeding for four age groups: yearlings (0-group), second-year juveniles (1-group), other immatures (2-4 years), and adults (5+ years).

In the spring (June) samples, capelin (Mallotus villosus) was the dominant species in S.W. and C.W. Greenland. Euphausids (Thysanoessa spp. and Meganyctiphanes norvegica) were also common food items in these samples, and were the dominant prey in the small sample of very young animals taken in May in the Nuuk-Atammik area (S.W. Greenland), as well as in July at Godhavn (C.W. Greenland), where euphausids and the

pelagic amphipod Parathemisto libellula dominated. At Godhavn capelin became the dominant food again later in the summer (August), in the fall, and in early winter.

In N.W. and N. Greenland, polar cod (Boreogadus saida) or Arctic cod (Arctogadus glacialis) were the dominant fish species in most samples, except in late summer (September) samples from Prøven (southern Upernavik district), where capelin was more important than polar cod (70 % vs. 25 %). In the Illorsuit sample (Uummannaq district), small crustaceans, particularly euphausids, but also amphipods (P. libellula), constituted a significant part of the food (38 % by weight) in August. At the northernmost localities, amphipods were generally more common than euphausids. Prawns were found at most localities, but in only a few stomachs or in low quantities.

The late winter samples (December-February) from Central Western Greenland show greater variation: capelin play an important role in the Godhavn and Kangaamiut samples, and euphausids in the Kangaamiut and one of the Attu samples (1988), but a number of other fish species were found, among which redfish (Sebastes sp.), Atlantic cod (Gadus morhua) and Greenland cod (G. ogac), Greenland halibut (Reinhardtius hippoglossoides), Long rough dab (Hippoglossoides platessoides) and lanternfishes (Myctiphidae) constituted a fairly significant fraction of the contents of some stomachs. In addition, squid (Gonatus fabricii) formed an important element of the calculated intake in the two Attu samples (12 % and 33 %, respectively). The winter sample from Kangaamiut is the only coastal sample, in which Northern prawn (Pandalus borealis) constituted a fairly large part of the calculated food (8 %).

A small sample (n = 16) collected in offshore waters in July suggests that sandeel (Ammodytes sp.) and Pandalus sp. may be important prey in some regions. A single specimen trapped during offshore trawling in October had capelin, redfish, prawns and squid in the stomach.

In S.W. Greenland, yearlings and juveniles appear to feed primarily on euphausids in late May, but in early June they take almost exclusively capelin in Maniitsoq district, like the immatures and adults. In Sisimiut district they apparently feed more on euphausids (50-66 %) than do immature and adult seals (33 and 8 %, respectively).

In Illorsuit (Uummannaq district), small crustaceans constituted a larger percentage of the summer-diet of yearlings (40-45 %) than of juveniles and immature seals (20-30 %).

In the late fall and winter samples from C.W. and S.W. Greenland, the diet is generally rather variable, as mentioned above, but yearlings seem to a higher degree to be feeding on euphausids and/or squid than do the older age groups.

The remaining samples are too small, or have too weak representation of one or more age-groups, to allow an analysis of differences in diet related to age.

5.0 DISCUSSION

Fabricius (1790) stated that harp seals in Greenland feed primarily on capelin, and listed a number of other fish species also taken: cod, redfish, halibut, Greenland halibut, sculpins, and herring. He also mentioned, that crabs, prawns, and other "sea-insects" were often found in the stomachs. Winge (1902) repeats and revises Fabricius' list, adding a report on the finding of some squid (Gonatus) consumed by harp seals in S.W. Greenland. Vibe (1950) reports that polar cod is the main food in the Thule district. Citing Nansen (1925), Dunbar (1949), Vibe (1950), Hansen and Hermann (1953), and Freuchen and Salomonsen (1958) - Sergeant (1973) stresses the importance of capelin, "with some euphausids", for harp seal feeding in (South) West Greenland and Central West Greenland, and he mentions Boreogadus, euphausids and amphipods (Parathemisto libellula) as important food items for harp seals in N.W. Greenland. Kapel (MS 1973) concluded from hunters' reports that the relative role of capelin, polar cod, and various crustacean species in the diet of harp seals in N.W. and C.W. Greenland might vary greatly from one locality to the next. This was confirmed by Angantyr (1989) who found both great regional and seasonal variation in the quantitative composition of the food in C.W. and N.W. Greenland.

The examination of harp seal stomachs presented in this paper adds a few species to the list of organisms composing the diet in Greenland waters, without changing the overall picture described previously. The quantitative analysis of the stomach contents, or rather the calculated food intake, does confirm the statement that the composition of the food varies greatly with time and place, and a pattern seems to emerge:

Sergeant (1973, 1976) and Foy et al. (1981) stated that young of the year start on a primarily euphausid diet in April. Foy et al. (1981) found that young of the year had shifted to a fish-diet in their winter samples from the bays at Labrador. No one type of fish dominated, but for the yearlings, small gadoids, including polar cod (B. saida), appeared to be the most important food item. Our data suggest that euphausids are still the main food in late May, but that they switch to capelin already in early June. At this time, all age groups seem to exploit the abundant masses of spawning capelin along the entire coastline of S.W. Greenland (Hansen and Hermann 1953, cited by Sergeant 1973). It is, indeed, a spectacular show: numerous herds of harp seals chasing the dense capelin schools, and this wellknown fact may have led all authors since Fabricius (1790) to focus on the role of capelin for harp seal feeding in Greenland.

The stomach analyses also confirm that capelin may constitute a significant part of the diet at other times of the year as well: In late summer, fall and early winter at Godhavn (C.W. Greenland) cf. Fig. 4. Hunters' reports (Appendix II) confirm this, and indicate that capelin is a dominant food item in all samples from Saqqaq (Vaigat, the northern part of the Disko Bay).

Our data suggest that small crustaceans, primarily euphau-

sids, constitute a rather significant part of the food (about 25 %) already in June, both in the northern part of S.W. Greenland and in C.W. Greenland. In July, they were dominant in the Godhavn sample, and they formed a significant part of the August sample from Illorsuit, northern Uummannaq district. According to hunters' reports (Appendix II), euphausids are even more important in the southern part of Uummannaq district (55-100 % of the stomachs were reported to contain small crustaceans). These reports, which cover the years 1970-1983, further indicate large year to year variation in the feeding pattern of the harp seals; in some years crustaceans were the dominant food, in others polar cod was found most frequently.

According to the stomach analyses, polar cod and Arctic cod were the main food items in Upernavik district (except Prøven) and in Thule, which is in good agreement with the findings of Finley and Gibb (in press) for the Canadian High Arctic. The stomach samples do not, however, cover the most important hunting season (July-August) in the central and northern parts of Upernavik district. According to the hunters' reports, small crustaceans (euphausids as well as amphipods) constitute the contents of a very large fraction of the stomachs (more than 50 %) at these localities, supplemented by various fish species, including polar/Arctic cod, capelin, and Greenland halibut.

In late fall or early winter, most harp seals are believed to migrate towards the whelping regions (Sergeant 1965). Part of the population does, however, stay in the ice-free waters of C.W. and S.W. Greenland and is subject to hunting (Fig. 2). Stomach samples reveal that these wintering harp seals are utilising a fairly wide range of food items, more varied than at other times of the year.

The analysis presented in this paper summarises the first attempts to document the variation in harp seal feeding in Greenland by qualitative and quantitative examination of stomach contents. It is obvious, that more work is needed to complete our knowledge and understanding of the feeding patterns: More sampling is necessary to improve the seasonal and regional coverage, and to illustrate possible year to year variation. Further, most samples are from the coastal waters where local hunting is carried out. Recent observations have demonstrated that many harp seals spend at least part of the summer in offshore regions, and a small sample obtained at Store Hellefiskebanke in July 1988 indicate a need for further studies in these areas as well.

6.0 REFERENCES:

Angantyr, L.A. 1989. Grønlandssælens fødevalg ved Diskobugten og Nordvestgrønland. (Feeding habits of harp seals in the Disko Bay and N.W. Greenland). Graduate dissertation in Danish. Univ. of Copenhagen.

Bowen, W.D. 1985. Harp seal feeding and interaction with commercial fisheries in the northwest Atlantic. In: J.R. Beddington, R. Beverton and D.M. Lavigne (Ed.). 'Marine Mammals and Fisheries'. G. Allan & Unwin.

Bowen, W.D., D.E. Sergeant and T. Øritsland. 1983. Validation of age estimation in harp seal, Phoca groenlandica, using dentinal annuli. Can. J. Fish. Aquat. Sci. 40: 1430-1441.

Dunbar, M.J. 1949. The Pinnipedia of the arctic and subarctic. Fish. Res. Board Can. Bull. 85: 22 p.

Fabricius, O. 1780. Fauna Groenlandica. Hafniae & Lipsiae.

Fabricius, O. 1790. Udførlig Beskrivelse over de Grønlandske Säle, 1. Stykke. Skr. Naturhist-Selsk., 1(1), IV: 78-157.

Finley, K.J. and E.J. Gibb. In press. Summer diet and feeding behaviour of harp seals in the Canadian High Arctic. In: D.M. Lavigne, K. Ronald and R.E.A. Stewart (Ed.). 'The harp seal. Perspectives in vertebrate Science'. The Hague: W. Junk.

Fisher, H.D. 1954. Studies on reproduction in the harp seal, Phoca groenlandica, in the Northwest Atlantic. Fish. Res. Board Can. MS Rep. 588.

Foy, M.G., D.A. de Graf and R.A. Buchanan. 1981. Harp Seal feeding along the Labrador Coast, 1979-1981. OLABS Program report, by LGL Limited to Petro-Canada Exploration Limited, Calgary, Alta.

Freuchen, P. and F. Salomonsen. 1958. The arctic year. G.P. Putnam's Sons. New York, N.Y. 438 p.

Hansen, P. and F. Hermann. 1953. Fisken og Havet ved Grønland. København. 128 p.

Härkönen, T. 1986. Guide to the otoliths of the bony fishes of the Northeast Atlantic. Danbiu Aps. DK. 256 pp.

ICES 1985. Report of the Working Group on Harp and Hooded Seals in the Greenland Sea. C.M. 1985/N:19. (Also: ICES Coop. Res. Rep. 148, 1987).

ICES 1988. Report of the Working Group on Harp and Hooded Seals in the Greenland Sea. C.M. 1988/Assess.8.

Jobling, M. and A. Breiby. 1986. The use and abuse of fish otoliths in studies of feeding habits of marine piscivores. Sarsia 71:265-274.

Kapel, F.O. MS 1973. Some second-hand reports on the food of Harp Seals in West Greenland Waters. ICES. C.M. 1973/N:8.

Kapel, F.O. 1975. Age analyses and catch of the harp seal in Northwest Greenland, 1953-72. ICNAF Research Bulletin no. 11.

Kapel, F.O. 1986. Trends in harp and hooded seal catches in Greenland, 1939-83. NAFO Sci. Council Studies, No. 10.

Kapel, F.O. and A. Geisler. MS 1979. Progress report on research on harp and hooded seals in Greenland 1978-1979. NAFO/SCR Doc. 79/XI/10.

Kristensen, T.K. 1984. Biology of the squid (Gonatus fabricii) from West Greenland waters'. Meddr Grønland. Bioscience 13. Copenhagen 1984-05-30. 17 pp.

Lavigne, D.M., S. Innes, R.E.A. Stewart and G.A.J. Worthy. 1985. An annual energy budget for north-west Atlantic harp seals. In: J.R. Beddington, R. Beverton and D.M. Lavigne (Ed.). 'Marine Mammals and Fisheries'. G. Allan & Unwin.

Laws, R.M. 1952. A new method of age determination for mammals. Nature (London) 169:972.

Laws, R.M. 1953. A new method of age determination in marine mammals with special reference to the elephant seal (Mirounga leonina). Falk. Isl. Depend. Surv. Sci. Rep. 2: 11 p.

Murie D.J. 1987. Experimental approaches to stomach content analyses of piscivorous marine mammals. In: J.R. Beddington, R. Beverton and D.M. Lavigne (Ed.). 'Marine Mammals and Fisheries'. G. Allan & Unwin.

Murie, D.J. and D.M. Lavigne. 1985. A technique for the recovery of otoliths from stomach contents of piscivorous pinnipeds. J. Wildl. Manage. 49 (4): 910-912.

NAFO 1981. Rep. of STACFIS Meeting, Nov. 1981. II. Assessment of seals stocks. NAFO. SCS. Doc. 81/XI/29, Ser. No. N447.

NAFO 1985. Rep. of STACFIS Meeting, Jan. 1985. I Assessment of seals stocks. NAFO. SCS. Doc. 85/I/2, Ser. No. N951.

Nansen, F. 1925. Hunting and adventure in the north. Duffild and Co., New York, N.Y. 462 p.

Prime, J.H. MS 1979. Observations on the digestion of some gadoid fish otoliths by a young common seal. ICES CM 1979/N:14.

Scheffer, V.B. 1950. Growth layers on the teeth of Pinnipedia as an indicator of age. Science 112:309-311.

Sergeant, D.E. 1965. Migrations of harp seals (Pagophilus groenlandicus) in the northwest Atlantic. J. Fish. Res. Board Can. 22:433-464.

Sergeant, D.E. 1973. Feeding, growth and reproductivity of Northwest Atlantic harp seals (Pagophilus groenlandicus). J. Fish. Res. Board. Can. 30: 17-29.

Sergeant, D.E. MS 1976. The relationship between harp seals and fish populations. ICNAF Res. Doc. 76/X/125.

Siegstad, H. 1988. Ringsælens (Phoca hispida) fødevalg i Vestgrønland. (Ringed seal feeding habits). Graduate dissertation in Danish. Univ. of Århus.

Treacy, S.D. 1981. Retrieval of otoliths and statoliths from gastrointestinal contents and scats of marine mammals. J. Wildl. Manage. 45(4).

Vibe, C. 1950. The marine mammals, and the marine fauna in the Thule district in 1939-1941. Meddr om Grønland., 150 (6):64-65.

Winge, H. 1902. Grønlands Pattedyr. Medd. om Grønland., 21 (2):439-448.

Table 1. Stomach samples of harp seals from West Greenland, 1985-1988.

DISTRICT	LOCALITY	YEAR	SEASON	SAMPLE SIZE TOTAL	SAMPLE SIZE ANALYSED	ORIGIN
Thule	Qaanaaq et al.	1985	Aug.-Sept.	12	12	HMP[2]
Upernavik	Nuussuaq/ Kraulshavn.	1985	Oct.	12	12	HMP
	Upernavik	1985	June	17	17	HMP
	Kangersuatsiaq/ Prøven	1988	Sept.	194	100	GFR[2]
Uummannaq	Illorsuit	1985	Aug.	59	59	HMP
Disko	Qeqertarsuaq/ Godhavn	1987	Sept.-Oct.	74	51	LAA[2]
	Qeqertarsuaq	'87-88	Dec-Jan	41	41	LAA
	Qeqertarsuaq	1988	June-Aug.	99	59	LAA
Kangaatsiaq	Attu	1986	Feb.-Mar.	24	24	HMP
	Attu	1988	Jan.-Feb.	12	12	LAA
Sisimiut	St. Hellef.bk.	1988	July (Oct)[1]	17	17	GFR
	Sisimiut/ Holsteinsborg	1986	June	41	41	GFR
Maniitsoq	Kangaamiut	1986	June	50	50	GFR
	Kangaamiut	'87-88	Dec.-Feb.	40	40	GFR
	Maniitsoq/ Sukkertoppen	1986	June	37	37	GFR
	Napasoq	1986	June	73	73	GFR
	Atammik	1986	May	10	10	GFR
Nuuk	Nuuk/Godthåb	1986	May	6	6	GFR
Total				818	661	

Note 1. 16 specimens were caught in July at Store Hellefiskebanke, and one specimen was caught in October at Lille Hellefiskebanke.

Note 2. HMP = Heavy Metal Project.
GFR = Greenland Fisheries Research Institute.
LAA = Lars Anker Angantyr.

TABLE 2. OCCURENCE OF PRINCIPAL FOOD ITEMS IN HARP SEAL STOMACHS IN GREENLAND.

REGION:	NORTH GREEN.	NORTH WEST GREENLAND				CENTRAL W GREENLAND		SOUTH WEST GREENLAND				
Locality: (See Table 1 for the complete names)	THULE	NUSSUAQ	UPERNAVIK	KANGERSUAT.	ILLORSUIT	QEQERTARSU.	ATTU	SISIMIUT	KANGAAMIUT	MANITSOQ	NUUK	OFFSHORE JOUCLY T.
FOOD ITEMS:												
Polar cod	■	+	■	▒	■	+	+					
Arctic cod		■	+	▒	+							
Atlantic cod				+		▒	+	+	▒	+	▒	
Greenland cod						+			+	+		
Capelin			+	■		■	+	■	▒	■	+	▒
Redfish						+	■	+	+	+		+ ▒
Sandeel						+	+			+		■
Greenl. halibut			+	+	+	+	+		+	+		
Long rough dab						+		+	+	+		+
Halibut									+			
Sea snails	+		+	+	+	+	+		+			+
Sculpins		+		+	+	+	+		+	+		+
Eelpouts									+			+
Snake blenny		+	+	+	+	+	+		+	+		
Lanternfishes			+	+		+	▒					
Wolffish									+			
Char										+		
Amphipods	▒	▒	▒	+	▒	▒	▒					+
Euphausids			+	+	■	▒	▒	▒	▒	+	■	
Prawns		+	▒	+		+	+	+	+	+		▒ ▒
Squids	+	+	+	+		+	▒		+			+ +

■ = very common or dominant food. ▒ = common food.

\+ = found in small quantities, or in few stomachs.

Table 3. Estimated composition of stomach content of harp seals caught in West Greenland (As per cent volume).

MEAN VOLUME % Visual estimate of the relative contribution of the different food items.	CAPELIN	POLAR COD[1]	OTHE. FISH	EUPHAUSIIDS	AMPHIPODS	DECAPODS	SQUIDS
THULE 1985 Aug-sept n = 9	0	76	3	0	21	0	0.1
NUUSSUAQ 1985 Oktober n = 12	0	90	4	0	5	0.2	0.1
UPERNAVIK 1985 June n = 15	0	84	1	0.1	3	11	1
KANGERSUAT.1988 Sept. n = 100	70	20	2	0	3	2	1
ILLORSUIT 1985 August n = 26	0	45	10	37	8	0	0
QEQERTARS. 1987 Sept-okt n = 50	77	0.1	16	2	3	1	1
QEQERTA.1987-88 Dec-jan n = 40	75	0	14	0.1	2	8	1
QEQERTARS. 1988							
Juli n = 39	14	0	4	48	25	5	0.1
August n = 6	83	0	0.1	0	10	1	6
ATTU 1986 Feb-mar. n = 23	0.1	0.1	74	13	0.2	0.2	12
ATTU 1988 Jan-feb n = 11	0	0	12	50	18	2	18
SISIMIUT 1986 June n = 38	62	0	0.3	38	0	0.1	0
KANGAMIUT 1988 (dec)-feb n = 38	30	0	24	41	0	5	0.1
MANIITSOQ 1986 June n = 145	92	0	4	2	0	2	0
NUUK-ATAM. 1986 May n = 15	6	0	8	86	0	0	0
OFFSHORE:							
ST. HELLEFISKE July 88 n = 16	0	0	89	0	0.3	9	0.1
Okt. 88 n = 1	1	0	33	0	0	65	1

1) Polar cod and Arctic cod.

Table 4. Calculated composition of food consumed by harp seals caught in West Greenland (Weight percentages).

MEAN WEIGHT % Estimated food from number of items found * the estimated fresh weight.	CAPELIN	POLAR COD[1]	OTHE. FISH	EUPHAUSIA	AMPHIPODS	DECAPODS	SQUIDS
THULE 1985 Aug-sept n = 9	0	91	3	0	6	0	0.1
NUUSSUAQ 1985 Oktober n = 12	0	98	0.4	0	0.7	0.5	0.1
UPERNAVIK 1985 June n = 15	0	72	20	0.3	0.3	6	1
KANGERSUAT.1988 Sept. n = 100	70	25	2	0	1	1	0.2
ILLORSUIT 1985 August n = 26	0	49	13	31	8	0	0
QEQERTARS. 1987 Sept-okt n = 50	85	0.1	13	1	0.5	0.4	0.1
QEQERTA.1987-88 Dec-jan n = 40	77	0	18	0.1	0.6	4	0.1
QEQERTARS. 1988							
Juli n = 39	17	0	3	40	34	5	0.1
August n = 6	93	0	1	1	5	0.5	1
ATTU 1986 Feb-mar. n = 23	4	0.5	72	11	0.1	0.1	12
ATTU 1988 Jan-feb n = 11	3	0	20	33	9	2	33
SISIMIUT 1986 June n = 38	73	0	0.5	26	0	0.2	0
KANGAMIUT 1988 (dec)-feb n = 38	34	0	30	28	0	8	0.3
MANIITSOQ 1986 June n = 145	94	0	4	2	0	1	0
NUUK-ATAM. 1986 May n = 15	12	0	12	76	0	0	0
OFFSHORE:							
ST. HELLEFISKE July 88 n = 16	0	0	91	0	0	8	0.5
Okt. 88 n = 1	40	0	28	0	0	24	9

1) Polar cod and Arctic cod.

Table 5. Composition of the food of different age groups of harp seals.

NUUK-ATAMMIK, S.W. GREENLAND, MAY 1986.

Nuuk-Atammik N = 15	YEARLINGS (0-group) n = 9	JUVENILES (1-group) n = 4	IMMATURE (2-4 years) n = 2	ADULTS (5+ years) n = 0
Weight % :				
Caplin	9	0.6	47	-
Cod	0	25	2	-
Other fish	9	0.9	0.5	-
Euphausids	82	74	50	-
Parathemisto	0	0	0	-
Decapods	0	0	0	-
Squids	0	0	0	-

NAPASOQ-MANIITSOQ-KANGAAIUT, S.W. GREENLAND, JUNE 1986.

Maniitsoq N = 134	YEARLINGS (0-group) n = 5	JUVENILES (1-group) n = 10	IMMATURE (2-4 years) n = 57	ADULTS (5+ years) n = 62
Weight % :				
Caplin	80	98	91	96
Cod	0	0	4	0.9
Other fish	0	0	1.5	1.9
Euphausids	20	1.9	1.8	0.1
Parathemisto	0	0	0	0
Decapods	0	0	1.9	0.1
Squids	0	0	0	0

SISIMIUT (Holsteinsborg), S.W. GREENLAND, JUNE 1986.

Sisimiut N = 38	YEARLINGS (0-group) n = 2	JUVENILES (1-group) n = 6	IMMATURE (2-4 years) n = 11	ADULTS (5+ years) n = 19
Weight % :				
Caplin	50	33	67	92
Cod	0	0	0.4	0.1
Other fish	0	1.1	0.4	0
Euphausids	50	65	32	8
Parathemisto	0	0	0	0
Decapods	0	0.6	0.2	0
Squids	0	0	0	0

OFFSHORE BANKS, S.W. GREENLAND, JULY 1986 (n = 16) AND OCTOBER (n = 1).

Off-shore N = 16 + 1	YEARLINGS (0-group) n = 1	JUVENILES (1-group) n = 1	IMMATURE (2-4 years) n = 12	ADULTS (5+ years) n = 3
Weight % :		October !		
Sandeel	27	0	91	100
Caplin	0	39	0	0
Other fish	0	28	4	0
Euphausids	73	24	5	0
Parathemisto	0	0	0	0
Decapods	0	0	0	0
Squids	0	9	0.7	0

QEQERTARSUAQ (Godhavn), C.W. GREENLAND, JUNE-AUGUST 1988 (n = 59).

Godhavn 1988 N = 52	YEARLINGS (0-group) n = 2	JUVENILES (1-group) n = 4	IMMATURE (2-4 years) n = 28	ADULTS (5+ years) n = 18
Weight % :				
Caplin	0	46	22	52
Cod	0	0	0	0.5
Other fish	0	0	2	1.5
Euphausids	99	26	34	19
Parathemisto	0.6	27	28	22
Decapods	0	0	14	4
Squids	0	0	0.1	0.3

ILLORSUIT (UUMMANNAQ), N.W. GREENLAND, AUGUST 1985.

Uummannaq N = 26	YEARLINGS (0-group) n = 13	JUVENILES + IMMATURE (1-group) (2-4 years) n = 13	ADULTS (5+ years) n = 0
Weight % :			
Polar cod[1]	48	71	-
Caplin	0	0	-
Other fish	-	-	-
Euphausids	52	29	-
Parathemisto	-	-	-
Decapods	0	0	-
Squids	0	0	-

1) both polar cod (Boreogadus saida) and Arctic cod (Arctogadus glacialis)

KANGERSUATSIAQ (Prøven), N.W. GREENLAND, SEPTEMBER 1988.

Prøven N = 98	YEARLINGS (0-group) n = 0	JUVENILES (1-group) n = 2	IMMATURE (2-4 years) n = 41	ADULTS (5+ years) n = 55
Weight % :				
Caplin	-	99	82	60
Polar cod[1]	-	0	13	35
Other fish	-	0	1.8	2
Euphausids	-	0	0	0
Parathemisto	-	0.7	1.8	0.8
Decapods	-	0	0.9	1.4
Squids	-	0	0.1	0.2

1) both polar cod (Boreogadus saida) and Arctic cod (Arctogadus glacialis)

QEQERTARSUAQ (Godhavn), C.W. GREENLAND, SEPT.-OCT. 1987 (n = 41).

Godhavn 1988 N = 48	YEARLINGS (0-group) n = 1	JUVENILES (1-group) n = 16	IMMATURE (2-4 years) n = 20	ADULTS (5+ years) n = 11
Weight % :				
Caplin	99	82	86	82
Cod	0	5	14	14
Other fish	0.5	7	0	3
Euphausids	0	3	0	0
Parathemisto	0.6	1.5	0.1	0.1
Decapods	0	1.3	0	0
Squids	0	0.3	0.3	0.3

QEQERTARSUAQ (Godhavn), C.W. GREENLAND, DEC. 1987 - JAN. 1988 (N = 59).

Godhavn 1988 N = 39	YEARLINGS (0-group) n = 1	JUVENILES (1-group) n = 4	IMMATURE (2-4 years) n = 14	ADULTS (5+ years) n = 20
Weight % :				
Caplin	94	97	87	68
Cod	0	0	0.3	2
Other fish	6	2	7	25
Euphausids	0	0	0	0
Parathemisto	0	0.4	1.2	0.3
Decapods	0	0.1	4	4
Squids	0	0.3	0.2	0.5

KANGAAMIUT, S.W. GREENLAND (DECEMBER) - FEBRUARY 1988.

Kangaamiut N = 38	YEARLINGS (0-group) n = 6	JUVENILES (1-group) n = 19	IMMATURE (2-4 years) n = 9	ADULTS (5+ years) n = 4
Weight % :				
Caplin	66	36	19	9
Cod	0	6.6	11	79
Other fish	0	15	29	9.4
Euphausids	33	30	31	1.9
Parathemisto	0	0	0	0
Decapods	1.4	12	10	0
Squids	0	0.6	0	0

ATTU (KANGATSIAQ) C.W. GREENLANND, FEBRUARY-MARCH 1986.

Attu N = 23	YEARLINGS (0-group) n = 0	JUVENILES (1-group) n = 3	IMMATURE (2-4 years) n = 20	ADULTS (5+ years) n = 0
Weight % :				
Fish	-	2	88	-
Crustaceans	-	50	5	-
Squids	-	48	7	-

ATTU (KANGATSIAQ) C.W. GREENLANND, JANUARY-FEBRUARY 1988.

Attu N = 11	YEARLINGS (0-group) n = 0	JUVENILES (1-group) n = 3	IMMATURE (2-4 years) n = 5	ADULTS (5+ years) n = 2
Weight % :				
Fish	-	14	17	48
Crustaceans	-	5	67	40
Squids	-	81	16	12

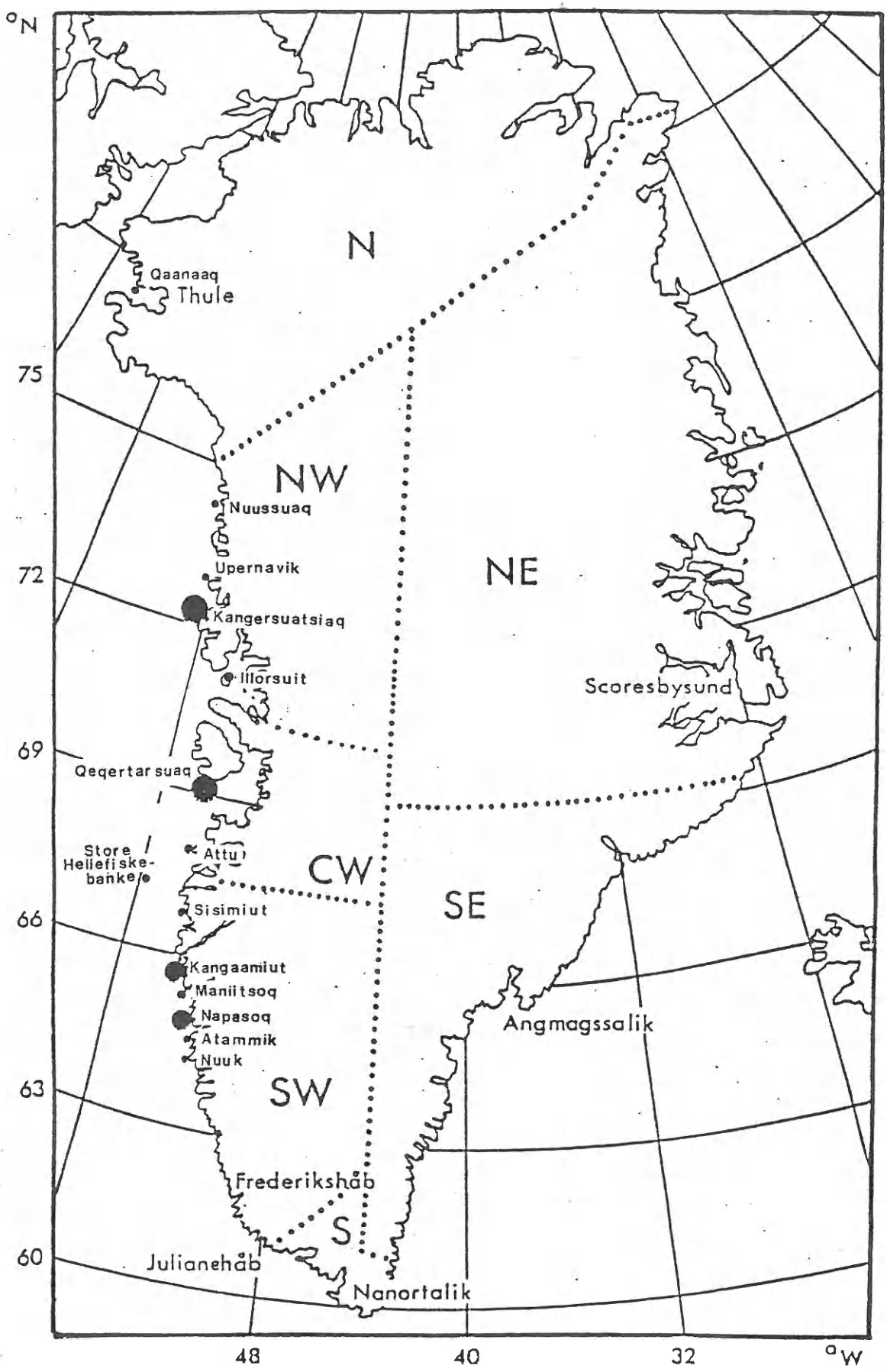

Fig. 1. Localities for sampling of harp seal stomachs in West Greenland, 1985-88. The circles indicate relative sample sizes.

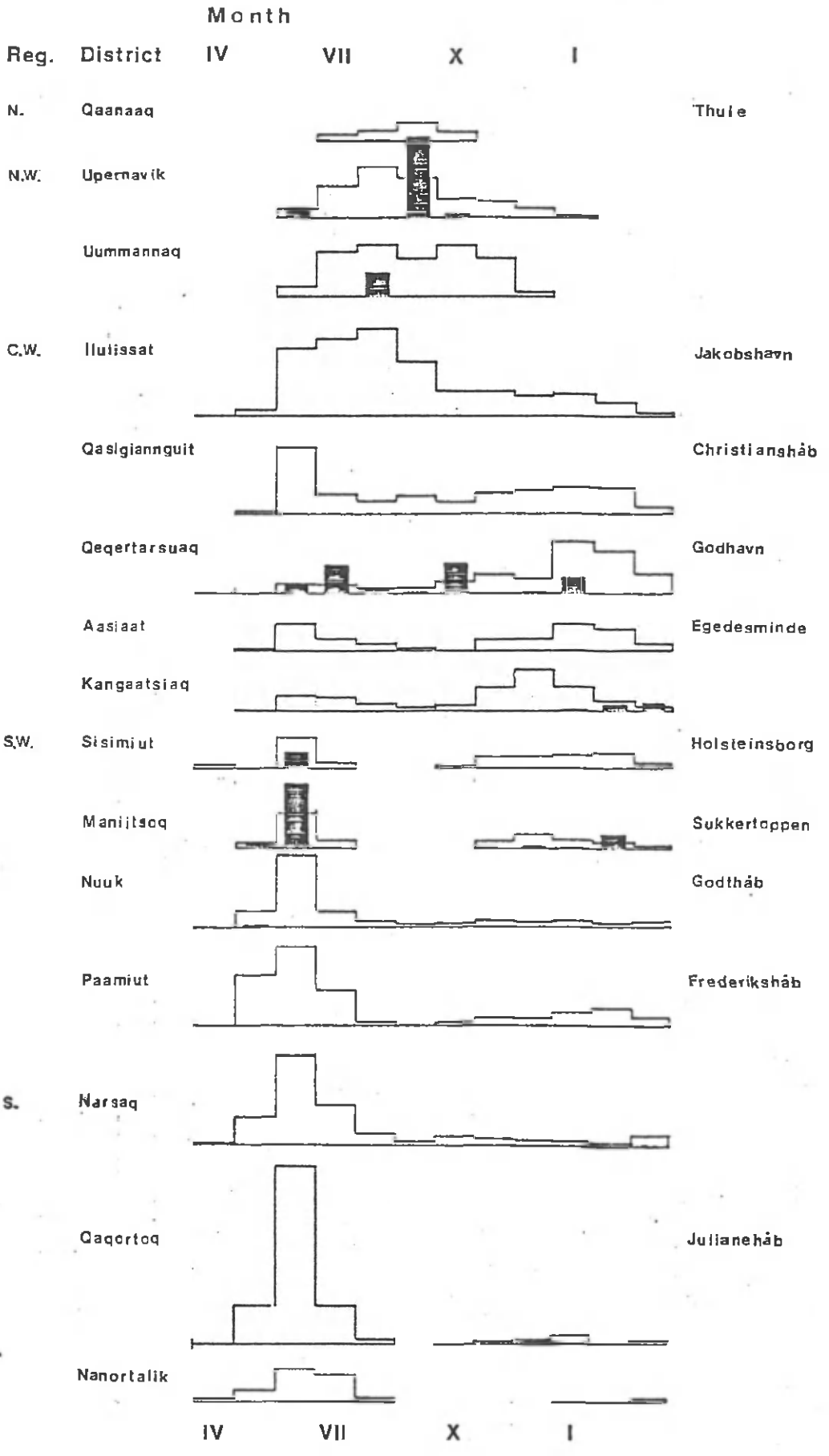

Fig. 2. Regional and seasonal distribution of the stomach samples (dark columns), and indices of average catch of harp seals in West Greenland (Open histogrammes). The scales are not identical.

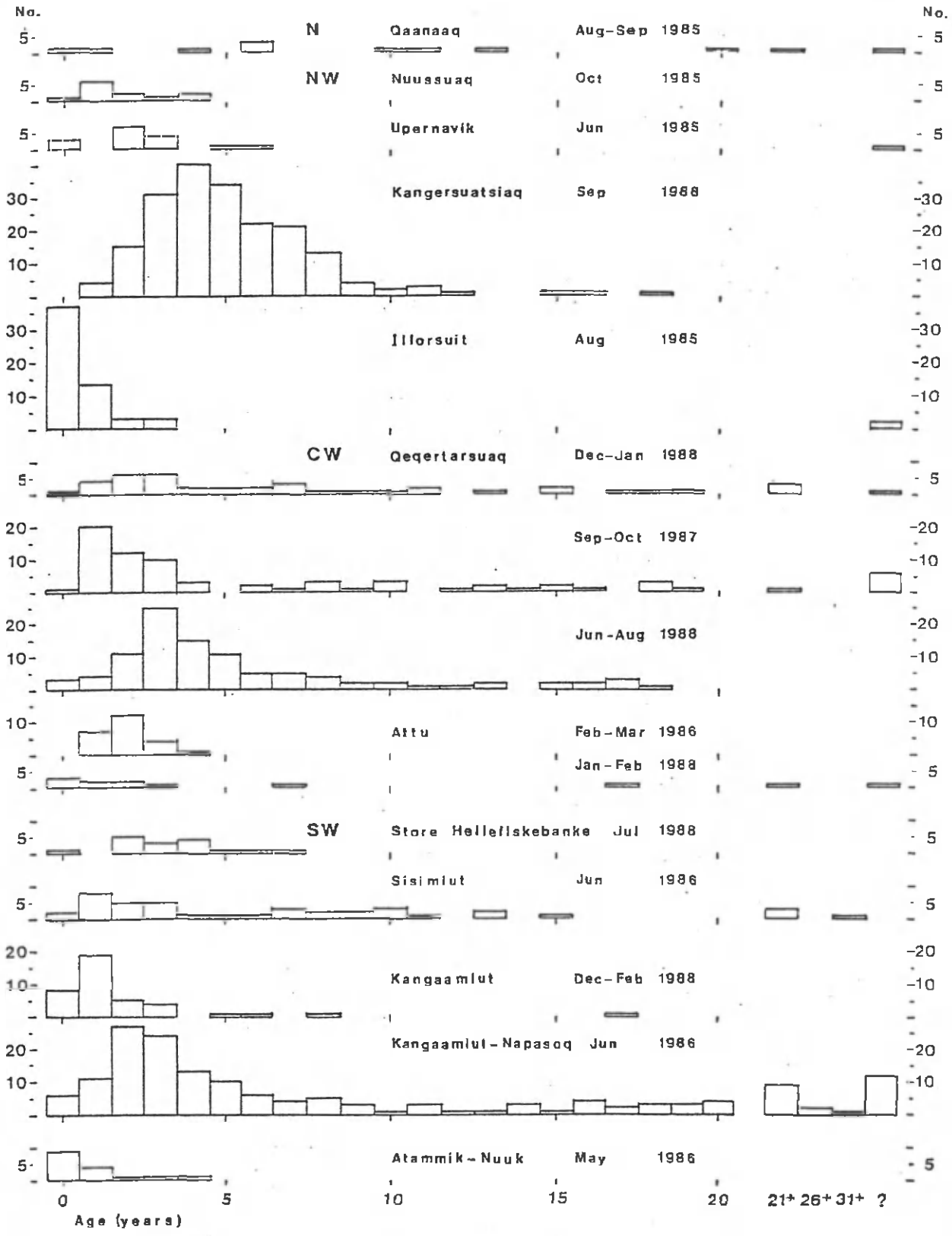

Fig. 3. Age composition in stomach samples of harp seals from West Greenland.

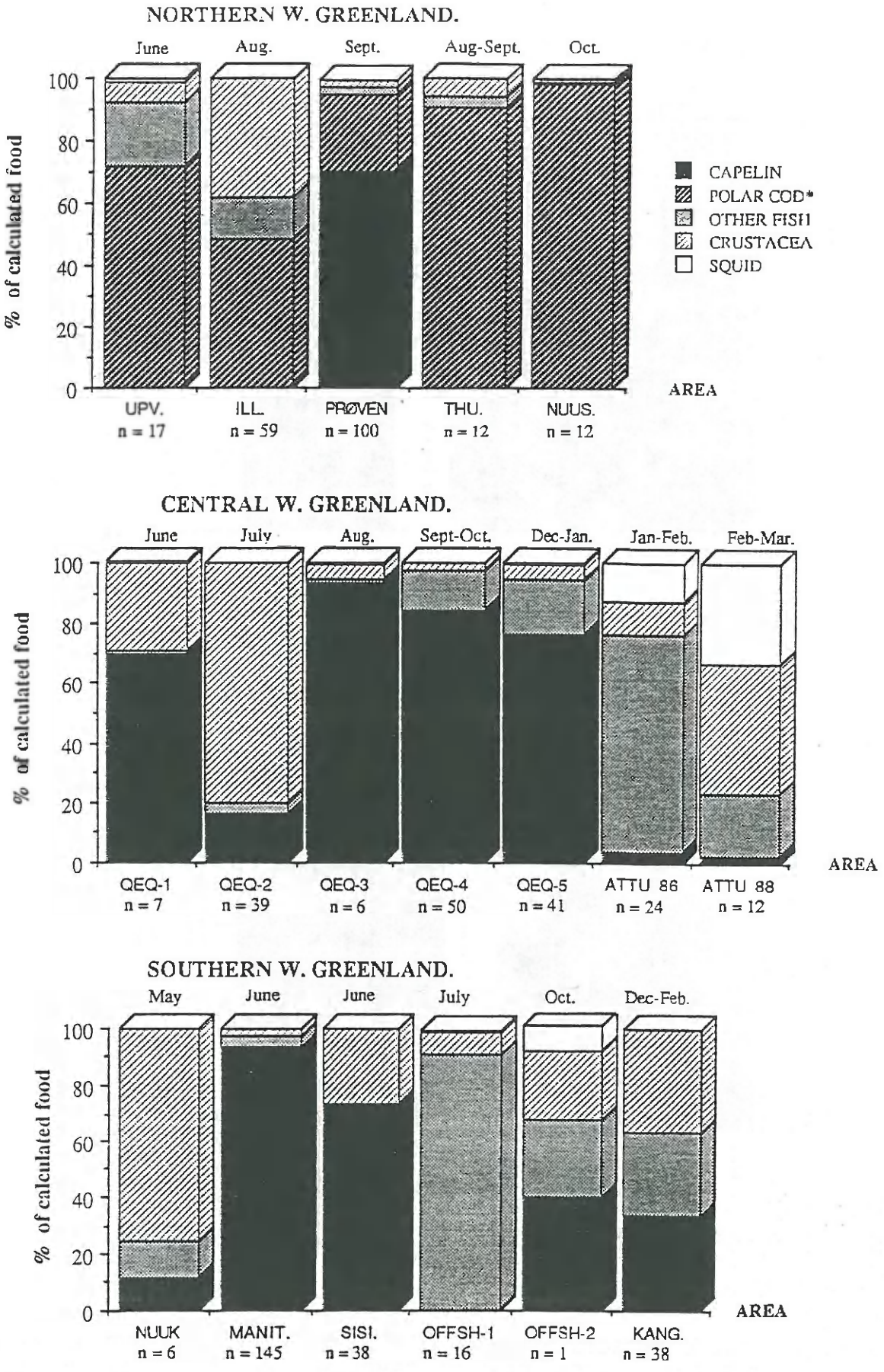

FIG. 4. FOOD COMPOSITION (weight percentages) FOR THE DIFFERENT LOCALITIES AND SEASONS IN N.W., C.W. AND S.W. GREENLAND. Upv = Upernavik. Ill = Illorsuit. Thu = Thule. Nuus = Nuussuaq. Qeq = Qeqertarsuaq. Manit = Maniitsoq. Sisi = Sisimiut. Offsh = Offshore. Kang = Kangaamiut.

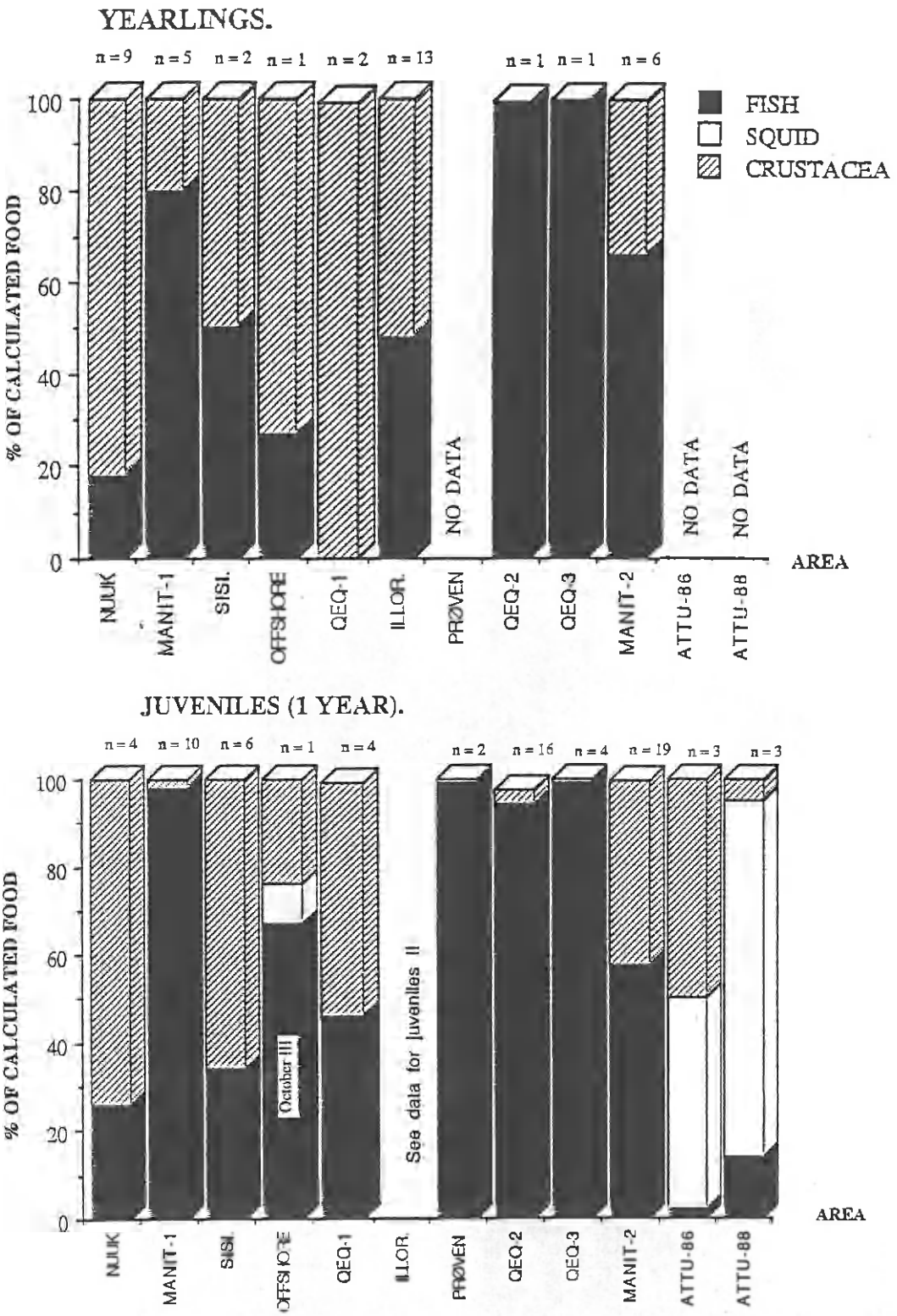

FIG. 5. FOOD COMPOSITION (weight percentages) FOR FOUR DIFFERENT AGE-GROUPS (FOR TIME OF SAMPLING, SEE TABLE 1). Manit = Maniitsoq. Sisi = Sisimiut. Qeq = Qeqertarsuaq. Illor = Illorsuit. Prøven = Kangersuatsiaq.

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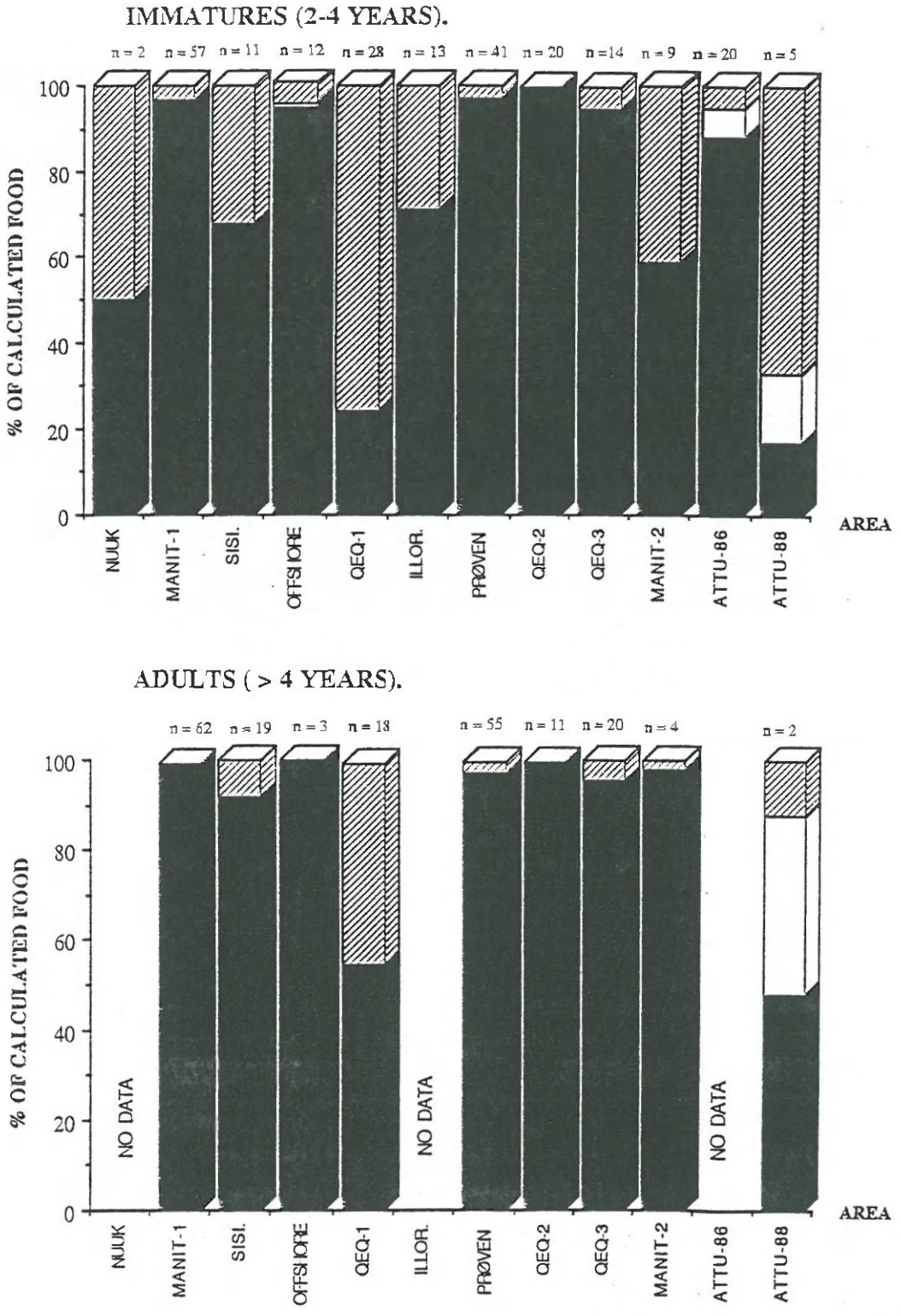


FIG. 5. Continued .....

FOOD COMPOSITION (weight percentages) FOR FOUR DIFFERENT AGE-GROUPS (FOR TIME OF SAMPLING, SEE TABLE 1). Manit = Maniitsoq. Sisi = Sisimiut. Qeq = Qeqertarsuaq. Illor = Illorsuit. Prøven = Kangersuatsiaq.

APPENDIX 1.

Food species identified in harp seal stomachs from West Greenland.

FISHES (OSTEICHTHYES):

Salvelinus alpinus	Char
Mallotus villosus	Capelin
Benthosema glaciale	Arctic lanternfish
Notoscopelus kroeyri	Krøyer's lanternfish
Gadus morhua	Atlantic cod
Gadus ogac	Greenland (Rock) cod
Boreogadus saida	Polar cod
Arctogadus glacialis	Arctic cod
Ammodytes spp.	Sandeel
Anarhichas minor	Spotted wolffish
Pholis sp.	Butterfish
Leptoclinus maculatus	Spotted snake blenny
Lycodes seminudus/reticulatus	Eelpoutes
Sebastes marinus	Golden redfish
Sebastes mentella	Beaked (Deepwater) redfish
Myoxocephalus scorpius	Bull-rout (sculpin)
Triglops nybelini	Nybelin's sculpin
Triglops murrayi	Moustache sculpin
Liparis tunicatus	Greenland seasnail
Careproctus reinhardti	Reinhard's seasnail
Reinhardtius hippoglossoides	Greenhand halibut
Hippoglossus hippoglossus	Atlantic halibut
Hippoglosscides platessoides	Long rough dab (Amr. plaice)

DECAPODS:

Pandalus borealis	Northern prawn
Pandalus montagui	Aesop shrimp
Eualus gaimardii	..
Lebbeus polaris	..
Argis lar	..
Pasiphaeidae	..
Chionoecetus opilio	Queen (Snow) crab
Hyas sp.	..

EUPHAUSIDS ("KRILL"):

Thysanoëssa inermis	..
Thysanoëssa raschii	..
Thysanoëssa longicaudata	..
Meganyctiphanes norvegica	..

AMPHIPODS:

Parathemisto libellula	..
Gammarus sp.	..

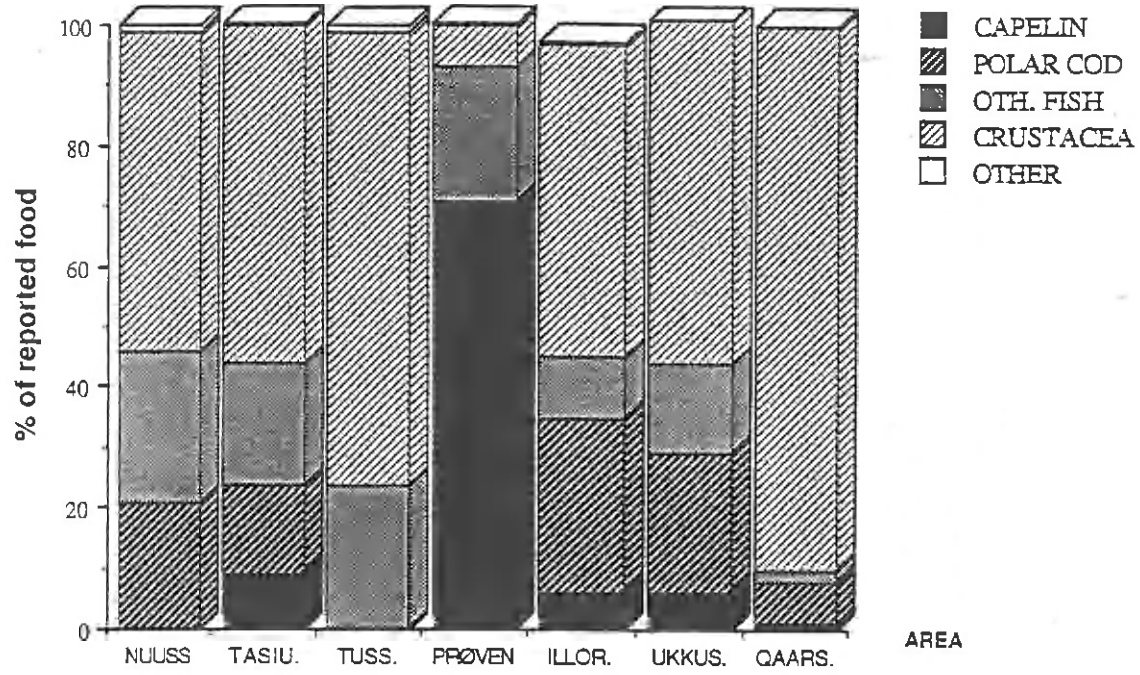
MYSIDS:

Mysis sp.	..

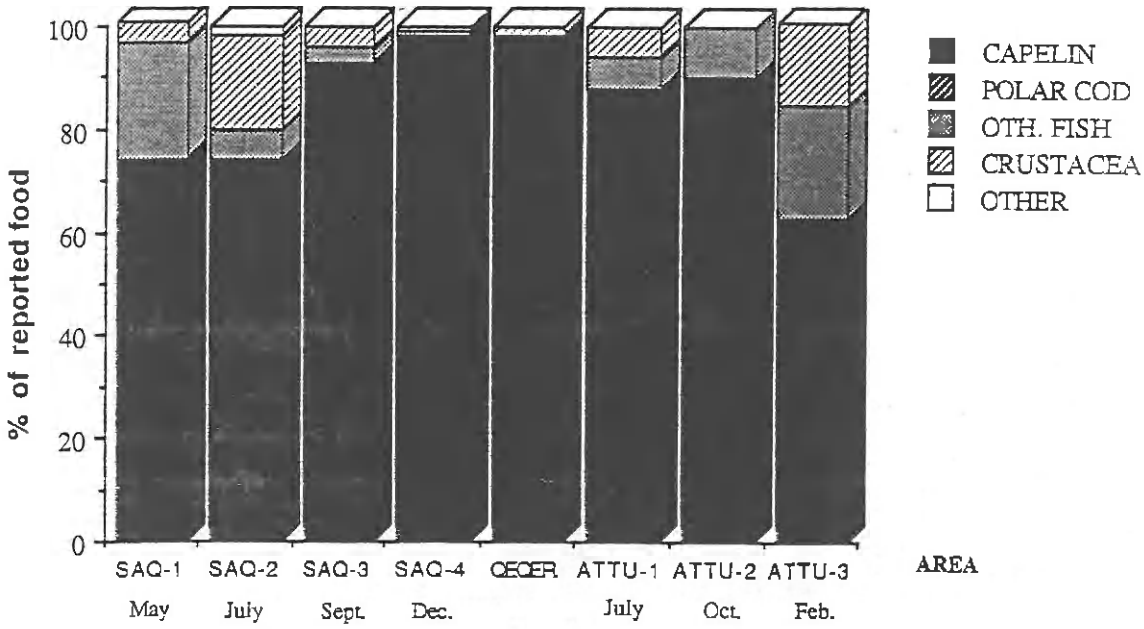
CEPHALODOPS:

Gonatus fabricii	Boreoatlantic gonate squid
Rossia sp.	..

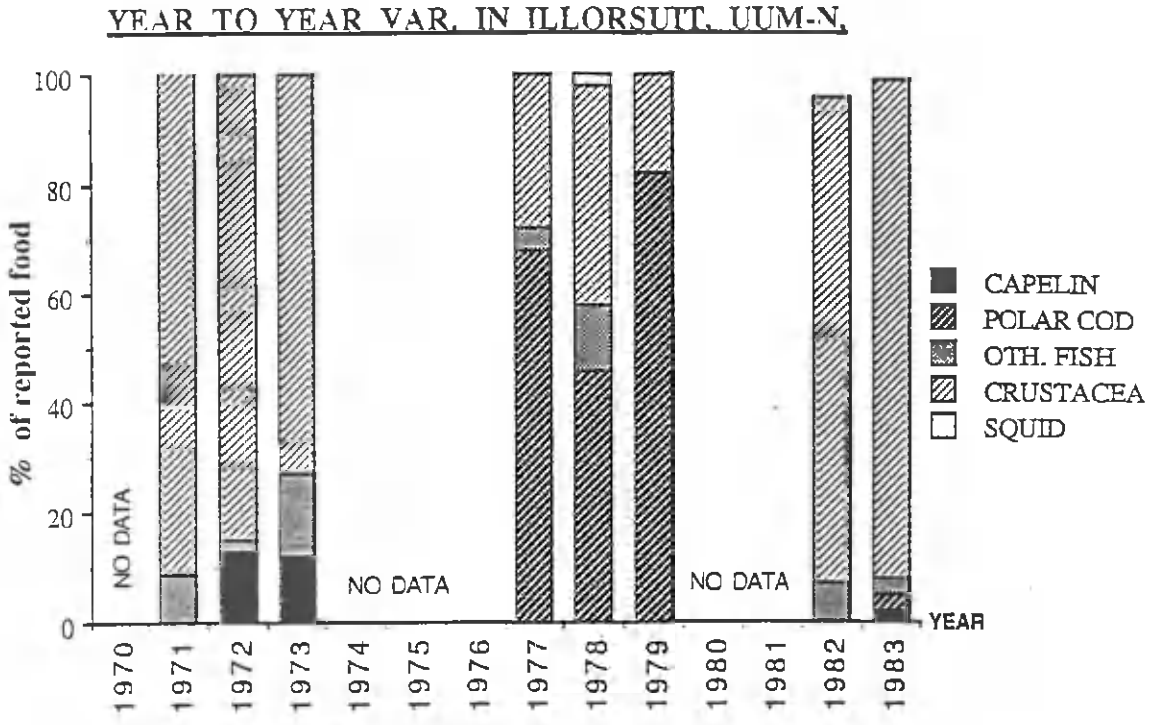
HUNTERS´ REPORTS FROM N.W. GREENLAND.

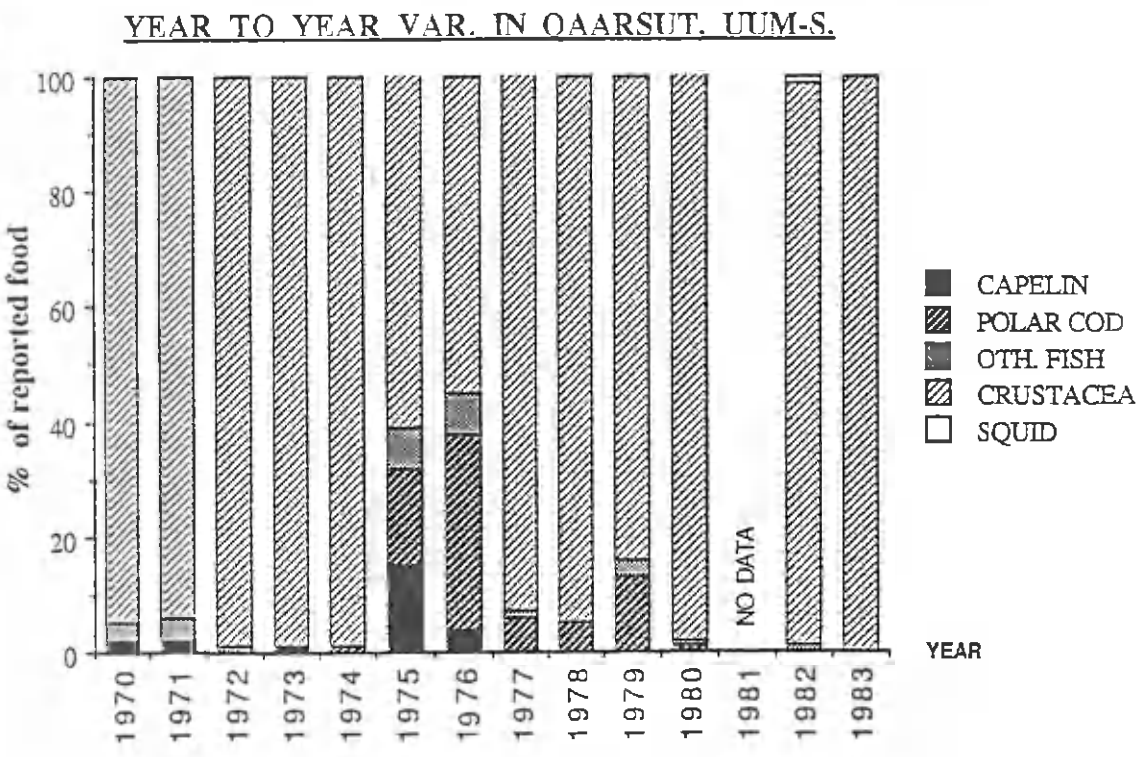


HUNTERS´ REPORTS FROM C.W. GREENLAND.



APPENDIX 2.1. SUMMARY OF HUNTERS' REPORTS FROM N.W. AND C.W. GREENLAND 1970-1983. Nuuss = Nuussuaq and Kullorsuaq. Tasiu = Tasiusaq. Tuss = Tussaaq. Prøven = Kangersuatsiaq. Illor = Illorsuit. Ukkus = Ukkusissat. Qaars = Qaarsut. Saq = Saqqaq. Qeqer = Qeqertarsuaq.





APPENDIX 2.2. YEAR TO YEAR VARIATION IN FOOD COMPOSITION AT TWO LOCALITIES IN UUMMANNAQ DISTRICT - FROM HUNTERS' REPORTS.