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DIETS OF HARP SEALS PHOCA GROENLANDICA FEEDING BETWEEN THE BREEDING AND MOULTING SEASONS IN THE SOUTHERN BARENTS AND WHITE SEAS.

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ABSTRACT

The harp seal Phoca groenlandica is the most abundant seal species in the Barents Sea. In order to evaluate the ecological importance of the species, diet studies have recently been carried out at various times of the year. In 1992, data were collected from seals sampled between the breeding and moulting seasons (March-May). There is no doubt that the animals feed during this period. From examinations of stomach and intestine contents, harp seals, sampled in the southwestern parts (Varangerfjord, North Norway) of the Barents Sea, appeared to have been feeding intensively on capelin Mallotus villosus. The harp seal diet in the commercial hunting areas north of the White Sea (the East Ice) consisted of prawns Pandalus borealis, capelin, cod Gadus morhua, saithe Pollachius virens, sculpins (Cottidae), snailfish (Liparidae) and long rough dab (Hippoglossoides plattessoides). Feeding in the East Ice area and in the White Sea appeared to have been less intensive than further to the west. In the White Sea the harp seals had been feeding mainly on crustaceans and the fishes sandeels (Ammodytidae), capelin and White Sea herring (Clupea harengus marisalbi).

INTRODUCTION

The harp seal (Phoca groenlandica) is the most abundant seal species in the Barents Sea, and has traditionally been exploited by Russian and Norwegian sealers in the pack ice areas in the White Sea and southeastern Barents Sea (the East Ice) (Iversen 1927, Yakovenko 1967, Benjaminsen 1979). The species has potential for considerable predation on resources in the Barents Sea, and are now included in the multispecies model, MULTSPEC, which may form the basis for a more rational management of marine resources in the area (see Bogstad et al. 1992). In order to evaluate the ecological role of the harp seals in the Barents Sea, field studies have been carried out, primarily aimed at gathering information about the feeding habits and general condition of the animals throughout the year (Nilssen et al 1991, 1992). The sampling design for these field studies is based on data on the migratory patterns of harp seals in the Barents Sea throughout the year (see Smirnov 1924, Chapskii 1938, 1961, Sivertsen 1941, Popov 1970, Benjaminsen 1979, Wiig 1988, Nilssen et al. 1991).

The Barents Sea population of harp seals welp from late February through the first half of March in the pack ice within the White Sea or off its entrance (Sivertsen 1941, Yakovenko & Nazarenko 1967). Following the whelping is a 10 day period of intensive lactation after which the females mate and desert the pups. Adults and immatures then moult after a further lapse of 4 weeks. Adult males and immatures are the first to haul out on to the ice to moult, followed by the adult females (Sergeant 1991).

Adult harp seals in the northwest Atlantic seem to reduce feeding when whelping, mating and moulting (Sergeant 1973, 1991, Kapel & Angantyr 1989). Reduced food intake during reproduction and early moult has also been reported for the Barents Sea harp seals (Smirnov 1924, Sivertsen 1941). There is, however, some evidence that feeding does not stop completely during the spring (Nilssen

et al. 1992). This may particularly apply to adult females whose energy expenditures during lactation are substantial (Timoshenko 1963, Sergeant 1991).

This paper presents results from field studies carried out in the southern Barents and White Seas from late March to early May 1992, i.e., after breeding but before the end of the moult. The study included sampling of harp seals for analyses of stomach and intestine contents. Condition parameters from the seals were also collected.

MATERIAL AND METHODS

Areas surveyed

The 1992 sampling of biological material from harp seals was carried out in three periods and areas (Fig. 1): First, between March 22 - April 4 in coastal areas of North Norway (Varangerfjord). Second, between April 11-26 during the commercial sealing season in the East Ice (the areas in the southeastern parts of the Barents Sea north of the White Sea) on board the sealer "Melshorn". And third, in four different areas in the White Sea using the research vessel "Varzuga" between April 25 - May 4.

Biological sampling

In Varangerfjord, the harp seals were captured in the water. They were either shot from the shore and picked up using Zodiac inflatable boats, or taken as bycatches in gillnets in commercial coastal fisheries. Shot animals were immediately transported to the shore to be weighed, measured and dissected, while samples from the seals taken in gillnets were taken as soon as possible after the seals were landed. The lower jaws and stomachs were

secured from all animals, but no intestines were collected in this area.

During the commercial sealing in the East Ice, all seals were shot on the ice. The animals were moved to the vessel where they were measured and the lower jaws, stomachs and intestines (colon only) were collected.

In the White Sea, an aeroplane and the reseach vessel were used to search for the harp seals on their moulting grounds. All seals were shot on the ice, and moved to the vessel where the lower jaws, stomachs and intestines (colon and c. 1 m of the small intestine) were collected.

Stomach and intestine contents analyses

In the White Sea investigations, the stomachs were examined immediately after dissection on board the vessel. The intestines were washed out in water and all remaining identifiable parts (crustacean remains, fish bones and otoliths) fixed and stored in 96 % alcohol for subsequent analyses in the laboratory.

In the Varangerfjord and in the East Ice, the stomachs and intestines were frozen for later laboratory examinations. In the laboratory, the stomachs were cut open after thawing and the total mass of the stomach contents was recorded. All fresh specimens of fish and crustaceans were identified by gross morphological characteristics. The fish material was separated from the crustaceans, and the masses of each group were recorded.

The total stomach content of crustaceans, or a subsample from each seal stomach containing crustaceans, was weighed and analyzed with respect to species composition (see Nilssen et al. 1991). The total mass and number of individuals were recorded for each species and were used to obtain crude estimates of the numerical distribution of each species in the total seal diet.

Mean masses of fresh crustaceans, obtained from random samples taken from the trawl catches, were used to obtain crude estimates of the original biomass of the crustaceans eaten by the seals.

Otoliths from the stomachs were collected (see Treacy & Crawford 1981, Murie & Lavigne 1985) and identified to the lowest possible taxon (see Breiby 1985, Härkönen 1986). The total number of each fish species was determined by adding the number of fresh specimens, the number of intact skulls and half the number of free otoliths. All otoliths were measured, and otolith length to fish mass correlations were used to estimate the original fish mass.

In the laboratory, the frozen intestine contents were thawed and washed out using freshwater. Otoliths were separated from the crustaceans and treated as described above. Identification of White Sea otoliths required the use of additional literature sources (Skalkin 1963, Gosheva 1977). The crustaceans found in the intestines were usually very digested and difficult to identify.

Feeding indices commonly used in stomach analyses of top predators (Hyslop 1980, Pierce & Boyle 1991), were used to estimate the dietary contribution of different prey items. No feeding index gives a complete picture of dietary composition. The dietary contribution of different prey items from the stomach contents (collected in the Varangerfjord and in the East Ice) were recorded as: 1) The percentage occurrence of a given dietary component, defined as the percentage of stomachs which contained one or more individuals of this component, 2) the relative frequency of occurrence of a species calculated as a numerical fraction of total numbers of all prey categories (numerical frequency), and 3) the relative frequency of occurrence was also recorded as the relative contribution of each prey species to the total seal diet expressed in terms of calculated fresh mass (i.e., biomass).

In the intestine analyses, the first index (percentage occurrence) was applied. The fish material from the intestines was also analysed with respect to the second index (numerical frequency).

Condition measurements

Measurements of blubber thickness were used as an index to evaluate the condition of the seals. The blubber thickness was measured dorsally at the mid-line between the front flippers.

Age determination

The ages of the seals were determined by incremental growth layers in the dentine of the lower canine teeth, examined in transverse sections using transmitted light (Bowen et al. 1983).

RESULTS AND DISCUSSION

Capture of the harp seals

In March-April 1992 in the ice-free Varangerfjord, most harp seals were observed along the shores, while some animals were observed pelagically in the middle and outer parts of the fjord. In periods (a few hours) during the middle of the day, seals were often observed in shallow water, floating vertically with only their snout above the surface, possibly resting. In contrast to the "invasion years" 1986-1988, when thousands of harp seals invaded the entire coast of North Norway (Haug et al. 1991), Varangerfjord seems to be the present western limit of the distribution of Barents Sea harp seals during late winter and early spring. Observations made by Russian scientists suggest that considerable numbers of harp seals are distributed along the entire coast of the Kola peninsula in March (Andrej Kondakov,

Murmansk Marine Biological Institute, Dalnie Zelentsy, Russia, pers. comm.). In Varangerfjord, data were obtained from 42 harp seals captured in March/April 1992. The age of 25 of these seals ranged between 3 and 24 years. Most of the collected seals were adult females, some of which still had milk in their mammary glands.

In the East Ice in April 1992, the seals were always observed to be confined to the pack-ice belt, both in the water and hauled out on the ice. The seals were shot on the ice and samples were taken from 438 animals taken randomly from the total catch. The age of the seals ranged between 1 and 26 years.

In the White Sea a total of 302 harp seals were shot on the ice in late April and early May in four moulting grounds between 66° N and 68° N (Fig. 1). The number of sampling stations within each moulting ground varied between 1 and 14.

Harp seal stomach contents

99 % of the diet (by number and mass) of the harp seal stomach contents sampled during the winter in 1992 in Varangerfjord was capelin Mallotus villosus (see Fig. 2). A few specimens of codfishes (gadidae) and sandeels Ammodytes sp. were also found (Table 1). These results differ from observations made February-April 1991 (see Nilssen et al. 1992) when capelin contributed to only 50 % of the diet biomass which also included herring Clupea harengus, sandeels, codfishes and redfish Sebastes sp. During the more extensive harp seal invasions in 1988 in eastern Finnmark (see Haug et al. 1991), the seal diet consisted mainly of prawns Pandalus borealis and codfishes, and very little capelin. Earlier, in 1978 - 1981, harp seals taken as bycatches in winter gillnet fisheries in Finnmark were reported to have eaten mainly capelin (Bjørge et al. 1981). The recent recovery of the Barents Sea capelin stock after the severe collapse in 1985/1986 (Hopkins & Nilssen 1991, Anon. 1992) may have contributed to the increased importance of capelin in the winter diet of the harp seals.

98 % of the stomachs and 63 % of the intestines collected in April 1992 in the East Ice, were empty. This is consistent with observations made during commercial sealing in the East Ice in 1991 (Nilssen et al. 1992). Analyses of intestines sampled in 1992, however, revealed that a certain amount of feeding had taken place, and that the diet appeared to have been, mainly prawns and capelin (Fig. 2), but also codfishes, sculpins (cottidae), snailfishes (liparidae) and flatfishes (pleuronectidae) (Table 1).

Examinations of stomach and intestine contents from the harp seals collected in the White Sea in April/May 1992, revealed a very low levels of food intake. All the examined stomachs were empty, although the intestine contents analyses revealed that crustaceans and fish had been eaten. In the southernmost parts of the White Sea (area I, see Fig. 1), the pelagic amphipod Parathemisto libellula dominated the seal diet which also included considerable amounts of capelin, White Sea herring Clupea harengus marisalbi and eelpout Zoarces viviparus (Table 1). In the areas further to the north (areas II-IV) fish (particularly capelin, sandeels and, to a lesser extent, White Sea herring, see Fig. 3) dominated the diet, although prawns were found in all seal stomachs in area III. Sticlebacks Gasterosteus aculeatus were also frequent in all areas (Fig. 3).

Blubber thickness

The mean dorsal blubber thickness in adult females were 35 mm, 38 mm and 30 mm in Varangerfjord (late March-early April), the East Ice (April) and the White Sea (late April-early May), respectively.

Concluding remarks

This study suggest that the harp seals occuring in Varangerfjord immediately after the breeding period feed intensively on capelin. During the moulting period (April/May), both the

condition studies and the examinations of stomach/intestine contents of the seals, suggest that harp seals eat, but much less intensively than between breeding and moult. The diet of the seals in the East Ice consists mainly on prawns and capelin, but also of codfishes, sculpins, snailfishes and flatfishes. In the southernmost parts of the White Sea, the pelagic amphipod Papathemisto libellula dominated the seal diet which also included capelin, White Sea herring and eelpout. In the northern parts of the White Sea capelin and sandeels dominated the diet, but also White Sea herring and prawns were eaten. Sticlebacks were eaten in all areas. Previous blubber measurements and stomach examinations have shown that the period of low food intake of the harp seals prevail at least until the middle of June (see Nilssen et al. 1992).

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Table 1. Frequencies of occurrence of empty stomachs(St) or intestines(In) and identified species of prey in stomachs/intestines of harp seals captured in coastal areas of north Norway (Varangerfjord), in the southeastern Barents Sea (the East Ice) and in 4 subareas in the White sea during March-May 1992. N = number of seals examined.

PREY ITEM	PERCENTAGE OCCURRENCE						
	VARANGER (St)	EAST ICE (St)	EAST ICE (In)	WHITE SEA (In)			
				I	II	III	IV
	N=42	N=438	N=128	N=35	N=154	N=27	N=86
Empty	16.6	98.6	63.3		6.5		
Crustacea							
Amphipoda							
Parathemisto sp.				100	8.4		
Euphausiacea							
Thysanoessa sp.		0.2					
Decapoda							
Pandalus sp.		0.9	17.2		22.7	100	
Unident. crustacean remains			12.5				34.9
Pisces							
Clupeidae							
Clupea harengus marisalbi			2.3	45.7	29.9	3.7	94.2
Osmeridae							
Osmerus eperlanus				2.9	0.6	48.1	
Mallotus villosus	83.3	0.5	32.0	48.6	35.1	100	100
Gasterosteidae							
Gasterosteus aculeatus				14.3	12.3	100	57.0
Gadidae							
Gadus morhua	2.4	0.7	26.6		1.9	3.7	2.3
Eleginus navaga					1.3		
Boreogadus saida		0.5	1.6				1.2
Melanogrammus aeglefinus	9.5		3.1				
Merlangius merlangus	2.4		0.8				
Pollachius virens	4.8		16.4				
Ammodytidae							
Ammodytes sp.	2.4		2.3	5.7	40.9	100	100
Pholidae							
Pholis gunnellus					3.2	3.7	2.3
Lumpenidae							
Lumpenus sp.					3.9		
Zoarcidae							
Zoarces viviparus				28.6	6.5		
Lycodes sp.			3.1				
Cottidae							
Unid. cottid remains		0.2	12.5	2.9	7.8	3.7	40.7
Liparidae							
Liparis sp.			14.8		5.2		
Pleuronectidae							
Hippoglossoides platessoides			14.8				
Limanda limanda						7.4	
Unidentified fish remains	4.8	0.2	3.1	17.1	2.6	48.1	10.5

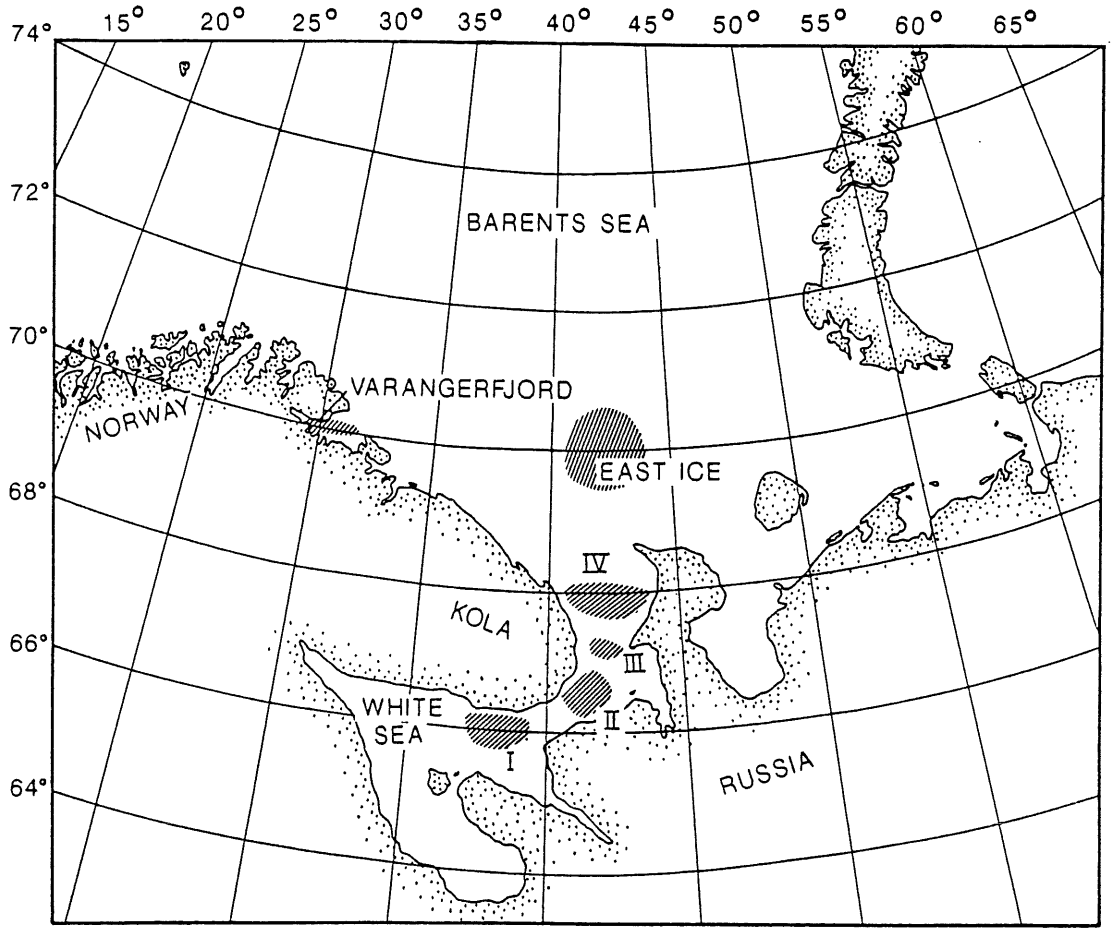

Fig. 1. Map showing the sampling areas in Varangerfjord (March-April), East Ice (April) and White Sea (April-May) during the harp seal investigations in 1992.

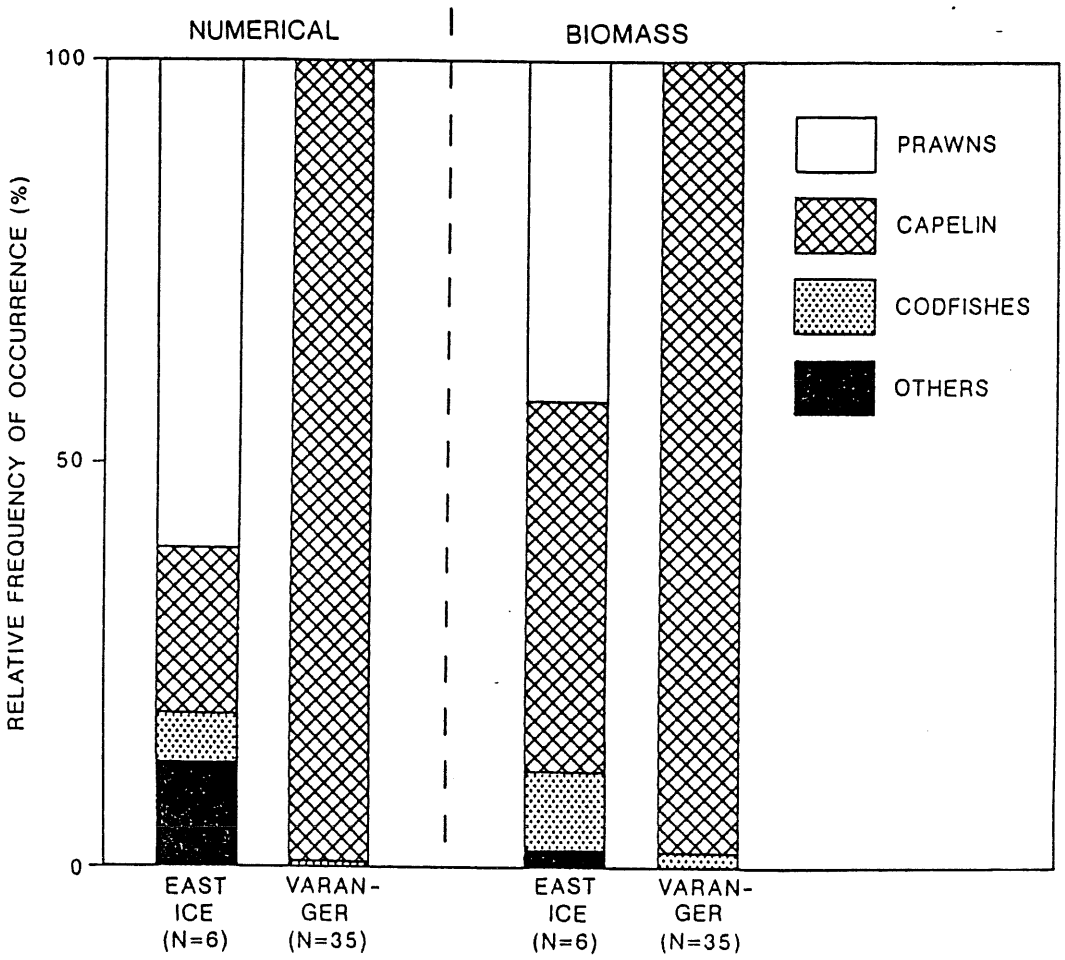

Fig. 2. Diet composition from stomach contents analyses of harp seals captured in Varangerfjord (March-April) and East Ice (April) 1992 in terms of relative frequency of occurrence of each prey item as numerical fractions and as calculated fresh biomass.

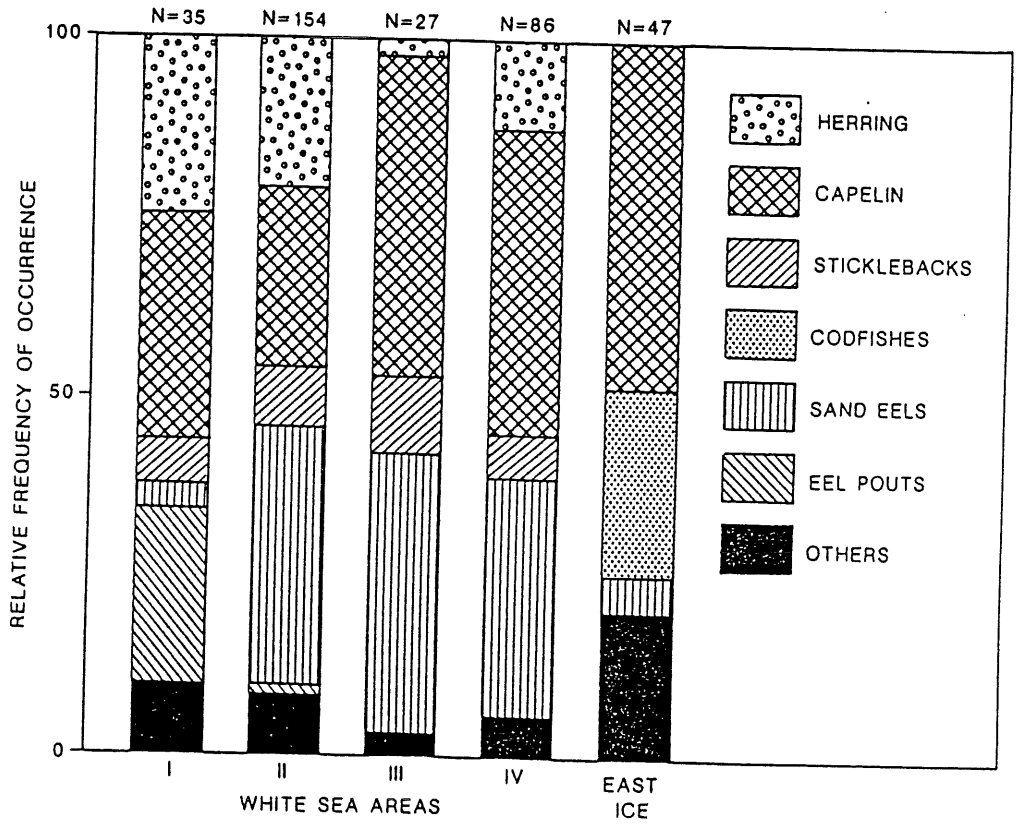

Fig. 3. The fish composition based on intestine contents analyses of harp seals collected in the East Ice (April) and White Sea (April-May) 1992 given as relative frequency of occurrence of each species (numerical frequency).