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DIET OF THE HARBOUR SEAL, PHOCA VITULINA, IN THE HVALER AREA IN 1990 AND 1991, COMPARED TO THE ABUNDANCE OF FISH IN THE AREA

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ABSTRACT

The harbour seal, Phoca vitulina, occurs in small groups along the entire coast of Norway. It is thought to interact with the commercial fisheries, both as predator and as final host for parasitic nematodes infecting fishes. In order to describe the diet and the feeding behaviour of the harbour seal, field-studies were carried out in the Hvaler area in outer Oslofjord in 1990 and 1991. The studies include both analysis of harbour seal faeces and trawling for information on prey-occurrence. In the trawl-catches the species of Gadidae and Pleuronectidae were most frequently found, with norway pout and plaice, respectively, being the most important single species. Analysis of faeces showed that the harbour seal feed opportunistic on some species but not on all. The most important groups were the Gadidae, Clupeidae and Ammodytidae, norway pout being the most important single species. Benthic trawls, constructed to catch shrimps and crayfish, were used, and Ammotydidae and Clupeidae were not found in the trawls.

INTRODUCTION

The Northeast Atlantic harbour seal (Phoca vitulina vitulina L., 1758) is distributed from northern Portugal to the Barents Sea, along the west coast of Spitsbergen, around Iceland and in the south-western parts of the Baltic Sea (Bigg, 1981). The population in Norway is estimated at more than 4000 individuals (Bjørge, 1991) and the seals occur in small groups along the entire coast.

At Hvaler in the outer Oslofjord there is a resident group of harbour seals. This local population was estimated to a minimum of 300 animals early in the 80's (Bjørge et al.1983), but in 1988 approximately 75% of the seals died due to the PDV-epizootic (Markussen, 1992). Since 1973 the harbour seals are protected from hunting in southern Norway.

In Norway conflicts between seals and fisheries are focused mainly in years when irregular migration-patterns bring large numbers of harp seal (Phoca groenlandica Erxleben, 1777) into fishing grounds in coastal waters. However, in some areas there are conflicts between the resident populations of coastal seals, the harbour seal and the grey seal (Halichoerus grypus Fabricius, 1791), and local fisheries, in particular with regard to predation on commercial species of fish and transmission of parasitic nematodes from seal to fish.

The dramatic change in population size caused by the PDV-epizootic in 1988 provided an opportunity to study the interactions between seals and local fish stocks at Hvaler in the Oslofjord. This paper reports on some of the results of a project granted by the Norwegian Fisheries Research Council (NFFR), aimed at studying the prey composition of harbour seals and the change in parasite burden in prey species in the years following the PDV-epizootic. Preliminary results on the prey composition in

comparison to the occurrence of fish species taken in trawl in the same area are presented.

STUDY AREA

The study area is sited in the outer Oslofjord and consists of a group of 7 small islands and rocks approximately 15 km off shore of the nearest larger island in the Hvaler-archipelago (Fig.1). The Torbjørnskjær lighthouse to the north and Heia nature reserve to the south-east marks the border of the area. To the south-west the Oslofjord opens to the Skagerak.

The tidal amplitude at Hvaler is less than 50 cm. The rocks and small islands used for haul out are therefore not totally submerged during high tide. However, the area is exposed to wind and open water waves, and the rocks and islands are frequently washed over by waves.

MATERIAL AND METHODS

Trawling

The occurrence of fish-species was examined by trawling, using small local fishing boats with shrimp- or crayfish-trawl. In 1990 the sampling of fish was carried out in May and September. The average trawl time was around 1 hour and 30 min, at depth ranging from 50 to 150m depending on the location. In May the trawling took place in three different areas close to the haul out area, reduced to two in September. (Fig.1). In 1991 the trawling was carried out in the periods May/June and November/December, at depths between 60 and 120m. The usual trawling-time was 1 hour. The same areas as in September 1990 were used for trawling.

Sample collection

Faeces were collected on haul out sites without taking regard of tidal state, since there are practically no tides. Preferably, the sampling was made after several days of calm sea and at a time when there were not too many seals hauling out, in order to minimize disturbance. In 1990 the sampling was carried out mainly in May and September, co-ordinated with the sampling of fish. In 1991 the sampling was carried out for one or two days every third week from April to November.

A total of 72 samples were collected in 1990, 94.4% containing otoliths (Table 1). The samples contained in total 1 584 otoliths. In 1991 a number of 121 samples were collected, 82.6% containing a total of 1 507 otoliths. The sample size varies greatly between the different months (Table 2). More effort put into the fieldwork in 1991 did not give a larger sample-size, due to long periods of bad weather and relatively small samples sizes for each day of fieldwork.

Sample processing

The samples were stored in separate polythene bags and processed as soon as possible. If not processed within twenty-four hours, they were frozen and processed later in the laboratory. The samples were washed through a set of three sieves, were the smallest net size was 0,25mm, in order to separate hard and soft remains. Hard remains, like bones and otoliths, were removed from the sieves and stored in 70% ethanol. Soft remains were collected as it was washed through the sieves and was also stored in 70% ethanol, but not used for any identification.

Faeces-analysis

For identification of fish-prey was only used the sagittal-otoliths. Other prey-species in addition to fish was not considered in this study. The otoliths were identified to the lowest possible taxon, preferably to species (Härkönen, 1986). The frequency of occurrence (FO) of each fish-species was recorded as percentage of samples which contained one or more individuals of the fish-species in question. This paper only presens preliminary results of the study and the FO as a method of estimating the dietary composition will not give a complete picture. However, it is one of the feeding indices commonly used.

RESULTS

Prey-availability

In 1990 the trawling resulted in catches of 27 different species. Information on the distribution of the different species was not available for this report. The species are listed in Table 5.

The trawling in 1991 resulted in catches of 31 different species. By rough estimates the most dominant group was Gadidae with 11 species and flatfishes with 9 species, mainly represented by 7 species of Pleuronectidae. Trawling in summer (May/June) gave 23 different species. Of the species caught in summer, 9 were Gadidae and 6 Pleuronectidae. The most numerous species of the Gadidae was the norway pout, both in summer and in winter (November/December). In summer haddock was close to the norway pout in abundance and it was also one of the dominating species in winter. Other species of Gadidae often found were cod, whiting, hake and poor cod, both in summer and in winter. Of the flatfishes plaice was most numerous in the summer. Long rough dab dominated in the trawl in winter, with plaice next dominant. The species found in winter but not in summer were saithe, angler, sole, john dory, brill, flounder and horse mackerel. Species

found in summer but not in winter were only four; ballan wrasse, blue whiting, silvery pout and dragonet. Most of the species that are represented in only one period of the year, either summer or winter, are only represented by a very few individuals.

Diet-composition

The samples from 1990 contained otoliths of 13 different species. In total, norway pout was the species found most frequently. This was mostly explained by the September samples where norway pout was found in 73.58% of the samples (Table 3). The second most frequent species in September was whiting, found in 32,07% of the samples. In May of 1990 herring was the most frequently occurring species in the samples, but also sandeel and poor cod were frequently found. Species not occurring in May but frequently occurring in September were haddock, blue whiting and whiting.

In 1991 the samples contained 18 different species. Norway pout was the most frequent species in all months of fieldwork, except from April when sandeel was slightly more frequent (Table 4). The second most frequently found species during the season as a whole was herring. In 1991 both haddock and whiting were found also in the beginning of the summer, and not only at the end as in 1990. Blue whiting appears in the samples from July, but lack of samples in June makes it difficult to know when this species first appears in 1991. Several other species occur more or less frequently during the season (Table 4).

DISCUSSION/CONCLUSIONS

The faeces-sampling of 1990 was not sufficient to show seasonal changes in the diet of harbour seals. However, there was a noticeable difference in the composition of the samples in May and in September. The difference in sample-size, 18 in May and 53 in September, may explain part of it, but the number of species found in September is not bigger even if the sample-size is. In

May there was a relative dominance of Gadidae, Clupeidae and sandeel, and in September a relative decrease in the number of Clupeidae and sandeel. Because the trawling-information was scarce for this year it was not possible to compare the slight change in diet to a possible change in the availability of prey.

All the species found in 1990 are also found in 1991 (Table 4). The difference in the time of sampling may explain the presence of some more species in 1991 compared with 1990. However, all the species found in faeces in 1991 only, occured in the trawl of 1990 as well. More probably the larger number of species in faeces from 1991 is explained by a larger sample size.

Through 1991 there seemed to be a small change in the diet of the harbour seals. Some species were present through the whole period of sampling, like herring, norway pout and cod, but, as in 1990, there were a few which are only present in parts of the sampling-season. Sandeel was not found in the faeces after August, neither was poor cod, and haddock was not found after July. On the other hand, of the species found more than once, ling, witch and dab were not found earlier than August. In comparison with 1990 the Clupeidae did not seem to decrease in occurrence in the autumn, relative to the Gadidae. However, sandeel seemed to follow the same pattern as the year before, not occurring after August.

There are some species of fish found in the faeces in 1991 which were not found in the trawl the same year (Table 5). The absence of herring, sandeel, sprat and goby is most possibly explained by the selectivity of the trawl type used. The species most frequently found in the faeces were mainly the same species found most frequently or in largest numbers in the trawl. However, there were species present in the trawl not found in the faeces, both in 1990 and in 1991, and not all of these species were represented by a few individuals. Therefor, extremely low abundance may not be an explanation for the species not being present in the faeces. This supports the theory that harbour

seals feed opportunistically on some species of fish but not on all. In general there seem to be a lack of species with rough skin or spines, like the Labridae which are often seen by divers in the area.

Examination of the faeces of the harbour seals indicate that they feed opportunisically on the most abundant prey species, but not on all. Härkönen (1987) investigated the diet of the harbour seals at Koster, an area close to Hvaler. He found that species belonging to the Gadidae made up about 50% of the diet, with cod being the most important single species of this family, both at a sandy shore habitat and at a rocky shore habitat. The Pleuronectidae and the Clupeidae were also frequently found in the faeces, with witch and plaice being the single most important species of Pleuronectidae at rocky and sandy shore habitats, respectivly. The species found most frequently in the faeces were also found to be the most abundant in the area. This confirms the findings of the investiagtion at Hvaler. The species found as most important differ, reflecting the availability of prey in the area.

Fig. 1. Map of the Hvaler area.
1=Torbjørnskjær lighthouse, 2=Heia
=trawling area used only in May 1990
=trawling area used for all trawlings

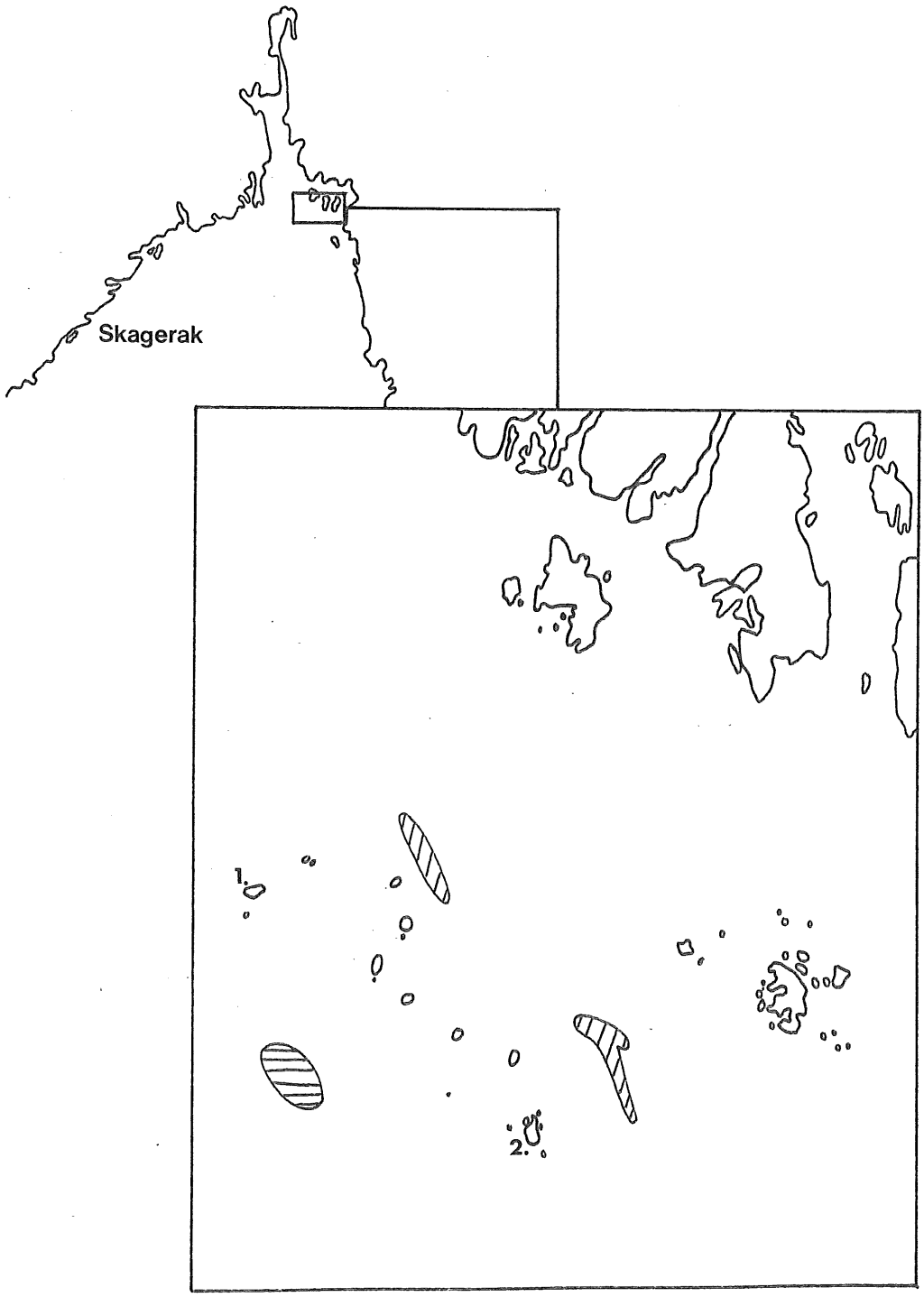

Table 1. Sampling-data. Sampling of faeces from harbour seals in the Hvaler area during 1990.

1990

	MAY	JULY	SEPT	TOTAL
# SAMPLES	18	1	53	72
# SAMPLES W/OTOLITHS	12	1	45	68
% SAMPLES W/OTOLITHS	66,66	100	84,9	94,44
# OTOLITHS	188	17	1379	1584

Table 2. Sampling-data. Sampling of faeces from harbour seals in the Hvaler area during 1991.

1991

	APRIL	MAY	JULY	AUG	SEPT	OCT	NOV	TOTAL
# SAMPLES	40	9	24	17	2	3	26	121
# SAMPLES W/OTOLITHS	35	9	17	12	1	3	23	100
% SAMPLES W/OTOLITHS	87,5	100	70,83	70,58	50	100	88,46	82,64
# OTOLITHS	620	93	187	68	9	112	418	1507

Table 3. Frequency of occurrence (FO) of species found in faeces in the Hvaler area in 1990. FO recorded as percentage of samples which contains one or more individuals of the fish-species in question.

	MAY	JULY	SEPT	TOTAL
HERRING	33,33		1,88	9,72
SPRAT	5,55			1,38
COD	5,55		11,32	11,11
HADDOCK		100	3,77	29,16
WHITING			32,07	23,61
BLUE WHITING			7,54	5,55
POOR COD	27,77		5,66	11,11
NORWAY POUT	16,66	100	73,58	59,72
SAITHE	11,11			2,77
FOUR-BEARDED ROCKLING	5,55			1,38
SANDEEL	27,77	100	9,43	15,27
PLAICE			1,88	1,38
WITCH	5,55			1,38

Table 4. Frequency of occurrence (FO) of species found in faeces in the Hvaler area in 1991. FO recorded as percentage of samples which contains one or more individuals of the fish-species in question.

	APRIL	MAY	JULY	AUG	SEPT	OKT	NOV	TOTAL
HERRING	20,00	33,33	33,33	17,64	50,00	33,33	38,46	28,09
SPRAT	15,00						26,92	10,74
COD	2,50	11,11	8,33	5,88			11,54	6,61
HADDOCK	2,50	11,11	4,16					11,53
WHITING	2,50		4,16	11,76		33,33	11,54	6,61
BLUE WHITING				29,41			3,84	5,78
POOR COD	10,00			5,88				4,13
NORWAY POUT	40,00	44,44	45,83	23,53		100,00	57,69	43,8
SAITHE	25,00	44,44			50,00		3,84	13,22
FOUR-BEARDED ROCKLING					23,53			3,30
LING					5,88		3,84	1,65
HAKE					5,88			0,82
SANDEEL	45,00		12,50	5,88				18,18
COMMON GOBY		22,22		5,88			11,54	4,95
DAB				5,88		33,33		1,65
FLOUNDER				5,88				0,82
PLAICE				5,88				0,82
WITCH				11,76			7,69	3,30

Table 5. Species occurring in trawl and/or in faeces in the Hvaler area during 1990 and 1991.

		TRAWL		FAECES	
		1990	1991	1990	1991
CLUPEIDAE					
Clupea harengus	herring			x	x
Sprattus sprattus	sprat			x	x
ARGENTINIDAE					
Argentina silus	smelt				
Argentina sphyraena	argentine	x			
GADIDAE					
Gadus morhua	cod	x	x	x	x
Gadiculus argenteus	silvery pout	x	x		
Merlanogrammus aeglefinus	haddock	x	x	x	x
Merlangius merlangus	whiting	x	x	x	x
Micromesistius poutassou	blue whiting	x	x	x	x
Trisopterus minutus	poor cod	x	x	x	x
Trisopterus esmarkii	norway pout	x	x	x	x
Pollachius virens	saithe	x	x	x	x
Rhinonemus cimbrius	four-bearded rockling	x	x	x	x
Molva molva	ling	x	x		x
Merluccius merluccius	hake	x	x		x
SCORPAENIDAE					
Sebastes viviparus	norway haddock	x			
Sebastes marinus	redfish	x	x		
TRIGLIDAE					
Trigla gunardus	grey gunard	x	x		
STRICHAEIDAE					
Lumpenus lampretaeformis	snake blenny	x			
ANARHICHADIDAE					
Anarhichas lupus	wolf-fish		x		

		TRAWL		FAECES	
		1990	1991	1990	1991
AMMODYTIDAE					
Ammodytes sp.	sandeel			x	x
CALLIONMYIDAE					
Callionymus lyra	dragonet	x	x		
GOBIIDAE					
Lesuerigobius friesii	Frie's goby	x			
Pomatoschistus microps	common goby	x			x
SCOMBRIDAE					
Scomber scombrus	mackerel	x			
CARANGIDAE					
Trachurus trachurus	horsemackerel		x		
LABRIDAE					
Labrus bergylta	ballan wrasse		x		
BOTHIDAE					
Scophtalmus rhombus	brill	x	x		
PLEURONECTIDAE					
Limanda limanda	dab	x	x		x
Platichtys flesus	flounder	x	x		x
Pleuronectus platessa	plaice	x	x	x	x
Glyptocephalus cynoglossus	witch	x	x	x	x
Microstomus kitt	lemon sole	x	x		
Hippoglossoides platessoides	long rough dab	x	x		x
Hippoglossus hippoglossus	halibut		x		
SOLEIDAE					
Solea solea	dover sole		x		
LOPHIIDAE					
Lophius piscatorius	angler		x		
ZEIDAE					
Zeus faber	john dory		x		
RAJIDAE					
Raja sp	skate		x		
SQUALIDAE					
Squalus acanthias	spurdog		x		

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