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Stomach contents of cod, haddock and saithe on the Møre coast in 1982 and 1983.

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Abstract:

As part of a biological investigation of important demersal fish species, stomachs have been taken from cod, haddock, saithe and a few other species in 1982 and 1983. Also observations of stomachs have been made in the field. Some of the data from this sampling programme are presented in this paper. Data have been collected in spring, when the spawning of cod and herring take place and in summer. The stomachs have been preserved one by one together with data on each individual fish. In 1982 the stomachs were mainly put on formalin but in 1983 they were frozen. Data collected together with the stomachs are length, weight, age, sex and maturity. For cod also an index describing them as coastal or oceanic type have been given by otolith readings. The stomach content have been analyzed for important prey groups. Tables showing total stomach content both in numbers and weight and divided on the various prey categories are given. A distinct seasonal shift in preference of prey is illustrated.

## INTRODUCTION

In the years 1981 to 1983, Departement of Fisheries Biology, University of Bergen have been undertaking an investigation on commercially important demersal fish species. The area under study lies off Møre on the western coast of Norway, between 62°N and 64°N. The aim of the project was to increase the knowledge on the coexistence of cod, haddock, saithe, herring and other species in the area and their competition for food. One assumed that the competition mainly takes place as a fight for the same food or as a prey/predator interaction. One central problem in this context was how the immigrating biomasses of herring and cod that comes to the area to spawn would interact with the stocks that are in the area all year round.

Historically the Møre region in some years have had a considerably seasonal catch of cod during the spawning period in spring. In the 1920's the catches was equal with those taken in the "Lofoten fisheries" in northern Norway. The cod caught in this area has been divided into 2 main types, coastal less migratory cod and the highly migratory north-east arctic cod (Godø 1984). These groups of cod have different growth and size at same age.

The most important species in the region, historically and as a comming resource, is the herring. In the spring it comes into the offshore waters at Møre to spawn. In this paper the herring is only considered important as to the amount of food it represents to cod, haddock and other species.

A more detailed description of the species composition in the area is given in Øax et.al. (1984).

## MATERIAL AND METHODS.

The material have been collected using bottom and pelagic trawl from various research vessels in 1982 and 1983. Three periods of sampling can be given each year - spring - consisting of March and first half of April - summer - consisting of June and - autumn - the first half of August.

Two types of data have been collected - observations and preserved stomachs. The observations are the following: Degree of filling, degree of digestion, percentage distribution of prey items in the stomach based on weight and visual judgement. The degree of filling is as follows: Empty (1), up to 1/3 full (2), between 1/3 and 2/3 full (3), more than 2/3 full (4), extreme full (5) and regurgitated (6). The category "regurgitated" is based on visual judgement when the belly of the fish is opened. If part of the stomach is found up the pharynx or the stomach is large and relaxed it is assumed to have been regurgitated. The category "empty" is given when the stomach is empty and tight. Some source of error could arise if the fish is handled too much after comming on deck because this will make the stomach contract and thus a regurgited stomach would be classified as empty.

The degree of digestion is as follows: Newly ingested (1), partly digested (2) - skin and fins destroyed, more digested (3) - individuals cannot be identified to species (dependent of the size of the individual) and fully digested (4) - a soup where one can identify large individuals in some cases.

The percentage distribution of prey items was done according to the same prey categories that have been used in grouping the analyzed material. These groups are given in Table 2. The visual judgement of the content of the stomachs have been done to increase the amount of data that could be collected during a cruise.

When a stomach was preserved for later analyzing in the laboratory one also noted the degree of filling. The degree of digestion was recorded when the stomach was analyzed. This provides the possibility of performing a regression analysis of stomach content versus degree of filling and thus to use the observations to extend the information on stomach content.

The stomach data was always taken together with a standard biological sample, i.e. the collection of length, weight, maturity and the otolith for age reading. The data was linked together by giving a unique number to each fish and its stomach.

Due to insufficient time some of the age samples have not been processed and therefore some of the data sets are without information on the age. Other unfortunate events led to the disappearance of some preserved stomachs in 1982. The actual numbers of stomachs in the different years are given in Table 1.

The prey categories that we have been using in this analysis are not detailed as to the species composition of benthos and plankton, nor to the less abundant fish species. One should regard this investigation as a pilot investigation to get more knowledge about the main differences of food preference of cod, haddock and saithe in this area.

#### RESULTS AND CONCLUSIONS.

In Table 2 is given the results on the stomach content of saithe, haddock and cod. In the first half of each table is given the percentage distribution of the filling degree and the useful stomachs for further analysis. Also the mean content within each degree of filling is given. The numbers of stomachs given are those stomachs found in the data that contains data that could be used in the different calculations.

The lower half of the table gives the data for each prey group. The first column tells which prey groups are found. For further calculations the numbers of stomachs are reduced and therefore some of the prey categories are lacking. The numbers in calculating the mean weight of prey per fish have been calculated taking into account the numbers of regurgitated stomachs in the sample. The formula is as follows:

$$N = N_w \cdot \frac{N_T}{N_T - N_e}$$

where

$N$  is the number of fishes that would have produced a sample of  $N_w$  filled and regurgitated stomachs where  $N_w$  is the numbers of weighted stomachs of a sample of  $N_T$ .  $N_e$  is the number of empty stomachs in a

sample of  $N_T$  fishes with  $N_R$  regurgitated stomachs. The sample of  $N$  fishes will then have the same proportion of empty stomachs as the sample of  $N_T$ .

The mean weight of prey per fish is then the number that multiplied with the number of fishes in the area will give the amount eaten of that prey group in grams. Again should be mentioned the source of error resulting from a wrong proportion of empty and regurgitated stomachs.

In Table 3 is shown the same type of results but this time for haddock splitted on basis of length. The deviding length of 30cm is due to the work of Toresen (1981) who found that haddock smaller than 30cm predated the herring eggs spent on the Buagrunden to a very small extent. The larger haddock was found to predate heavy on herring eggs. The same result can be observed from Table 3.

To see if the migrating north-east arctic cod had a different feeding habit than the more stationary coastal cod a split was performed from the aged data on cod and the result is given in Table 4. It seems as if the migrating cod has a higher preference for herring than the coastal cod. When it comes to the portion of the diet it is quite clear that herring plays a very important role in the diet of the migrating cod.

Looking at Table 2 again it seems that over the year the saithe is not shifting to much in diet. Krill seems to be important in any time periode, but when sandeel or norway pout are present they are eaten in some amount. Haddock is eating mostly benthic organisms but when herring eggs are present the larger individuals prefer that. Haddock seem to eat some krill in the spring.

The cod is probably the species that has the greatest tendency to make shifts in their diet. In spring they eat herring or other fishes but when sandeels are present they feed almost exclusively on those. Again, in autumn they seem to eat what is available but very little benthic organisms.

In Tables 5,6,7 and 8 are presented the data on filling degree versus stomach content for the various age groups and length groups. Those data can be used to evaluate the contents in weight for the percentage observed stomachs by applying some regression methods.

#### CLOSING REMARKS.

It should be stressed that this report is preliminary and only meant to present some data without too many calculations performed. This investigation have partly been financed by the Norwegian Fisheries Research Council (NFFR).

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Table 1. The total numbers of fish divided on various categories

Total numbers of fishes observed or analyzed: 3879

	Fishes with age and length data 2015		Fishes with only length data 1864			
Empty	629		597			
Regurgitated	245		68			
Otherwise missing	37		67			
Data present	Observed 912	Analyzed 220	Observed 558	Analyzed 546		
	Divided on species and years					
	Cod		Haddock		Saithe	
Years	1982	1983	1982	1983	1982	1983
Total numbers	1564	322	926	375	506	284
Empty	684	64	231	65	221	37
Regurgitated	62	91	16	60	21	50
Otherwise missing	16	-	21	2	-	-
Observed	640	21	617	18	161	2
Analyzed	29	177	38	235	42	196

Table 2. Distribution of filling and prey categories within species and time periods.

Saithe, spring				Saithe, summer			
Degree of filling	% of total	% of filled	Mean weight of content	% of total	% of filled	Mean weight of content	
Empty	33.9			44.4			
0 - 1/3		23.2	13.8		39.0	10.7	
1/3 - 2/3		25.6	28.9		45.0	26.9	
2/3 - 1		36.8	66.7		16.0	97.6	
Extreme		14.4	127.8		-		
Unknown	0.4			-			
Regurgitated	12.7			-			
Total num.	472	250	128	180	100	8	

  

Prey categories	Occuring in % of fishes	Mean weight when occuring(g)	% weight of diet	Mean weight of prey per fish(g)	Occuring in % of fishes	Mean weight when occuring(g)	% weight of diet	Mean weight of prey per fish(g)
Krill	81.6	66.9	87.6	26.0	48.0	22.6		
Herring	0.4	++	++	++	1.0	++		
Sandeel	1.2	++	++	++	10.0	++		
Norw. pout	13.2	35.8	11.5	3.4	1.0	++		
Other fish	6.6	15.4	0.8	0.3	43.0	++		
Herring eggs	1.6	++	++	++	-			
Benthos	-				-			
Others	0.4	++	++	++	-			
No. in calc.	252	147	147	222	100	8		
Mean weight				29.7				

- means that the category or prey item is not observed in the data  
 ++ means that the category or prey item is observed in the data but the data for the actual calculation is missing. If present it can change other numbers in that column.  
 + means that the calculated number is too small to be given with the number of decimals.

Table 2. continued.

Saithe, autumn				Haddock, spring			
Degree of filling	% of total	% of filled	Mean weight of content	% of total	% of filled	Mean weight of content	
Empty	11.5			21.3			
0 - 1/3		65.9	8.5		32.5	7.0	
1/3 - 2/3		20.7	144.6		24.2	15.6	
2/3 - 1		7.3	47.8		31.5	49.7	
Extreme		4.8	139.3		12.1	91.7	
Unknown	-			9.1			
Regurgitated	10.6			6.5			
Total num.	104	82	82	1142	719	214	

  

Prey categories	Occuring in % of fishes	Mean weight when occuring(g)	% weight of diet	Mean weight of prey per fish(g)	Occuring in % of fishes	Mean weight when occuring(g)	% weight of diet	Mean weight of prey per fish(g)
Krill	64.6	6.7	15.0	3.8	31.6	23.2	44.2	7.1
Herring	-							
Sandeel	2.4	23.6	2.0	0.5	0.3	++	++	++
Norw. pout	14.6	57.3	24.0	6.1	5.7	15.9	7.6	1.0
Other fish	24.4	70.4	59.0	15.1	7.0	14.8	1.8	0.3
Herring eggs	-				47.3	56.1	42.8	6.8
Benthos	-				25.2	2.2	3.5	0.7
Others	1.2	0.7	+	+	1.6	++	++	++
No. in calc.	82	82	82	93	824	242	242	307
Mean weight				25.6				16.0



Table 2. continued.

Haddock, autumn				Cod, spring			
Degree of filling	% of total	% of filled	Mean weight of content	% of total	% of filled	Mean weight of content	
Empty	26.5			43.9			
0 - 1/3		67.4	5.0		24.6	37.6	
1/3 - 2/3		32.7	6.4		24.4	81.4	
2/3 - 1		-			38.1	223.2	
Extreme		-			12.8	247.8	
Unknown	-			14.0			
Regurgitated	1.5			6.7			
Total num.	68	49	49	1585	561	561	

  

Prey categories	Occuring in % of fishes	Mean weight when occuring(g)	% weight of diet	Mean weight of prey per fish(g)	Occuring in % of fishes	Mean weight when occuring(g)	% weight of diet	Mean weight of prey per fish(g)
Krill	-				19.1	4.7	0.3	+
Herring	-				58.5	105.6	74.9	2.5
Sandeel	-				2.0	++	++	++
Norw. pout	4.0	45.5	35.2	1.4	1.1	38.8	1.4	0.1
Other fish	2.0	0.3	0.1	+	18.1	98.8	23.1	0.7
Herring eggs	-				2.3	27.1	0.3	+
Benthos	98.0	3.5	64.8	2.5	4.8	++	++	++
Others	-				7.6	++	++	++
No. in calc.	49	49	49	68	891	86	89	153
Mean weight				3.9				3.3

Table 2. continued.

Cod, summer				Cod, autumn			
Degree of filling	% of total	% of filled	Mean weight of content	% of total	% of filled	Mean weight of content	
Empty	51.6			13.3			
0 - 1/3		25.0	28.2		48.2	25.0	
1/3 - 2/3		37.7	65.2		23.5	50.0	
2/3 - 1		39.3	75.7		24.7	91.1	
Extreme		-			3.5	224.5	
Unknown	-			-			
Regurgitated	3.2			30.0			
Total num.	62	28	25	150	85	64	

  

Prey categories	Occuring in % of fishes	Mean weight when occuring(g)	% weight of diet	Mean weight of prey per fish(g)	Occuring in % of fishes	Mean weight when occuring(g)	% weight of diet	Mean weight of prey per fish(g)
Krill	-				15.9	++	++	++
Herring	2.7	107.0	7.2	0.8	0.9	161.0	4.6	1.4
Sandeel	78.4	54.6	92.3	11.1	17.8	15.1	7.6	2.3
Norw. pout	-				29.0	66.9	46.2	14.0
Other fish	2.7	++	++	++	26.2	54.8	37.8	11.4
Herring eggs	-				-			
Benthos	4.7	3.6	0.5	0.1	6.5	17.8	3.6	1.0
Others	-				0.9	++	++	++
No. in calc.	28	25	25	51	85	65	65	75
Mean weight				12.0				30.4

Table 3. Distribution of filling and prey categories for haddock of different size.

Haddock, spring, smaller than 30 cm				Haddock, spring, 30 cm and larger			
Degree of filling	% of total	% of filled	Mean weight of content	% of total	% of filled	Mean weight of content	
Empty	34.4			16.9			
0 - 1/3		45.7	2.9		28.0	9.6	
1/3 - 2/3		29.6	4.8		22.3	18.9	
2/3 - 1		18.3	4.9		35.7	58.2	
Extreme		6.4	6.8		14.1	102.3	
Unknown	0.3			12.1			
Regurgitated	-			8.7			
Total num.	285	186	58	857	633	141	

  

Prey categories	Occuring in % of fishes	Mean weight when occuring(g)	% weight of diet	Mean weight of prey per fish(g)	Occuring in % of fishes	Mean weight when occuring(g)	% weight of diet	Mean weight of prey per fish(g)
Krill	21.0	6.5	69.4	1.5	29.2	28.0	53.6	12.1
Herring	-				-			
Sandeel	1.1	++	++	++	0.2	++	++	++
Norw. pout	0.5	++	++	++	4.4	27.3	0.7	+
Other fish	6.4	++	++	++	4.8	9.4	1.2	0.4
Herring eggs	2.7	3.5	1.8	+	49.0	76.7	41.6	9.4
Benthos	66.7	1.5	28.8	0.6	11.3	2.8	2.8	0.4
Others	1.6	++	++	++	1.1	++	++	++
No. in calc.	186	56	56	85	637	141	141	169
Mean weight				2.1				22.5

Table 4. Distribution of filling and prey categories for cod of different types.

Cod, spring, coastal type				Cod, spring, north-east arctic type			
Degree of filling	% of total	% of filled	Mean weight of content	% of total	% of filled	Mean weight of content	
Empty	37.9			42.0			
0 - 1/3		36.6	80.2		21.5	26.2	
1/3 - 2/3		25.4	89.6		23.9	75.3	
2/3 - 1		22.5	289.0		40.2	215.4	
Extreme		15.5	++		14.4	247.8	
Unknown	10.9			3.0			
Regurgitated	10.3			7.4			
Total num.	174	71	28	889	423	40	

  

Prey categories	Occuring in % of fishes	Mean weight when occuring	% weight of diet	Mean weight of prey per fish	Occuring in % of fishes	Mean weight when occuring	% weight of diet	Mean weight of prey per fish
Krill	17.8	5.6	0.6	0.2	15.6	4.1	0.2	0.1
Herring	51.1	51.8	31.2	11.2	67.6	118.0	86.1	47.5
Sandeel	-				-			
Norw. pout	3.3	38.8	7.0	2.5	0.4	++	++	++
Other fish	26.7	72.5	61.1	22.1	12.9	172.0	13.3	7.4
Herring eggs	4.4	++	++	++	2.8	0.4	0.4	0.2
Benthos	4.4	++	++	++	2.0	++	++	++
Others	4.4	++	++	++	6.9	++	++	++
No. in calc.	71	28	28	46	423	40	40	73
Mean weight				36.1				55.3

Table 5. Age an length versus degree of filling and stomach content for saithe, all year round.

Age yr	Degr. of filling	Numb. of fishes	Content of stomach	Length cm	Degr. of filling	Numb. of fishes	Content of stomach
1	2	-		00 -19	2	-	
	3	-			3	-	
	4	-			4	-	
	5	-			5	-	
	Mean	-			Mean	-	
2	2	-		20 -39	2	-	
	3	-			3	1	44.5
	4	-			4	12	50.3
	5	-			5	1	63.8
	Mean	-			Mean	14	50.8
3	2	6	4.9	40 -59	2	45	7.3
	3	3	20.8		3	24	28.1
	4	24	53.9		4	40	61.1
	5	7	69.5		5	20	106.2
	Mean	40	46.8		Mean	129	43.2
4	2	29	7.1	60 -79	2	31	13.3
	3	10	27.1		3	18	35.8
	4	12	47.1		4	22	64.9
	5	6	98.1		5	12	182.8
	Mean	57	28.6		Mean	83	56.3
5	2	23	10.5	80 -99	2	-	
	3	9	31.3		3	2	160.4
	4	5	82.1		4	1	392.7
	5	5	169.5		5	-	
	Mean	42	42.4		Mean	3	237.8
6	2	10	12.6	100 -119	2	-	
	3	2	52.9		3	6	371.0
	4	4	46.7		4	-	
	5	3	151.3		5	-	
	Mean	19	45.9		Mean	6	371.0
7	2	7	17.5	120+	2	-	
	3	10	27.2		3	-	
	4	9	71.7		4	-	
	5	4	163.8		5	-	
	Mean	30	56.5		Mean	-	
8	2	1	13.4				
	3	-					
	4	3	50.8				
	5	2	130.4				
	Mean	6	71.1				
9+	2	-					
	3	8	318.3				
	4	3	165.4				
	5	-					
	Mean	11	276.6				

Table 6. Age and length versus degree of filling and stomach content for haddock, all year round.

Age yr	Degr. of filling	Numb. of fishes	Content of stomach	Length cm	Degr. of filling	Numb. of fishes	Content of stomach
1	2	8	0.8	00 -19	2	-	
	3	5	0.9		3	-	
	4	-			4	-	
	5	-			5	-	
	Mean	13	0.8		Mean	-	
2	2	53	3.2	20 -39	2	82	3.6
	3	33	5.5		3	51	8.4
	4	6	5.8		4	20	13.6
	5	1	6.8		5	6	24.6
	Mean	93	4.4		Mean	163	7.3
3	2	22	8.4	40 -59	2	27	13.8
	3	20	19.0		3	22	21.9
	4	14	30.0		4	23	60.0
	5	3	29.2		5	-	
	Mean	59	18.2		Mean	74	30.4
4	2	6	9.3	60 -79	2	6	11.2
	3	5	19.5		3	7	27.3
	4	8	40.8		4	7	118.7
	5	-			5	3	225.9
	Mean	19	25.2		Mean	26	69.7
5	2	5	23.3	80 -99	2	-	
	3	3	27.8		3	-	
	4	1	80.6		4	-	
	5	-			5	-	
	Mean	9	31.2		Mean	-	
6	2	4	7.7	100 -119	2	-	
	3	1	37.8		3	-	
	4	2	112.6		4	-	
	5	-			5	-	
	Mean	7	41.9		Mean	-	
7	2	4	12.6	120+	2	-	
	3	10	26.2		3	-	
	4	6	68.3		4	-	
	5	3	225.8		5	-	
	Mean	23	60.8		Mean	-	
8	2	1	6.6				
	3	-					
	4	-					
	5	-					
	Mean	1	6.6				
9+	2	-					
	3	-					
	4	-					
	5	-					
	Mean	-					

Table 7. Age versus stomach content

Coastal cod, all year round.				North-east arctic cod, all year round			
Age yr	Degr. of filling	Numb. of fishes	Content of stomach	Age yr	Degr. of filling	Numb. of fishes	Content of stomach
1	Mean	1	1.4	1	Mean	-	
2	Mean	17	16.8	2	Mean	-	
3	Mean	19	43.2	3	Mean	-	
4	Mean	15	70.2	4	Mean	-	
5	Mean	5	84.1	5	Mean	-	
6	Mean	8	127.6	6	Mean	1	2.0
7	Mean	5	130.2	7	Mean	11	61.3
8	Mean	4	70.7	8	Mean	22	129.9
9+	Mean	-		9+	Mean	18	124.7

Table 8. Length versus degree of filling and stomach content.  
for cod, both types, all year round.

Length cm	Degr. of filling	Numb. of fishes	Content of stomach
00 -19	2	-	
	3	-	
	4	-	
	5	-	
	Mean	-	
20 -39	2	1	4.1
	3	1	3.9
	4	1	1.4
	5	-	
	Mean	3	3.1
40 -59	2	14	6.6
	3	17	26.8
	4	18	59.4
	5	1	142.5
	Mean	50	35.2
60 -79	2	23	34.2
	3	9	73.6
	4	17	131.9
	5	3	275.2
	Mean	52	86.8
80 -99	2	14	39.1
	3	8	118.6
	4	9	211.3
	5	3	232.3
	Mean	34	120.5
100 -119	2	8	11.1
	3	-	
	4	4	186.7
	5	-	
	Mean	12	69.6
120+	2	-	
	3	-	
	4	1	872.0
	5	-	
	Mean	1	872.0