International Commission for the Northwest Atlantic Fisheries

Serial No. 5388

ICNAF Res. Doc. 79/VI/49

ANNUAL MEETING - JUNE 1979

Feeding Study on Silver Hake (*Merluccius bilinearis*) Taken from the Scotian Shelf and ICNAF Subarea 5

by

B. K. Swan and D. Clay
Fisheries and Oceans Canada, Fisheries and Marine Service
Marine Fish Division, Bedford Institute of Oceanography
Dartmouth, Nova Scotia, Canada

ABSTRACT

Silver hake stomachs were collected over a two year period, from the Scotian Shelf and ICNAF subarea 5. The stomach contents were studied for number and type of organisms present. These results were analysed to find relationships between feeding and time of day, month, depth, area of fishing, sex and length of fish. Crustaceans and fish make up the majority of food of silver hake with crustaceans playing an important role in feeding year round and fish becoming more important in the fall-winter period. Small fish feed heavily on crustaceans while larger fish feed more on other, smaller fish including their own species.

Squid are also found in the diet and eaten by the larger hake. Amphipods play only a minor role as a food of hake and calanoids are eaten only by small hake. Although silver hake feed mostly on crustaceans and fish, it seems they are opportunists and will feed on whatever is present at the time of feeding.

Introduction

Over the years many feeding studies have been done on Merluccius spp. for different areas and times of the year. Most studies give a good indication of what silver hake feed on in spring, summer and fall, but in most cases state that there is little or no feeding done in the winter.

Bowman (1975) in a study done off Nova Scotia, concluded that fish and crustaceans were the most common food items found in silver hake stomachs, making up 96% of the food present. Specifically he found cannibalizm to make up 1% of the diet (frequency) - but over 50% of the weight of all food eaten Euphausids were the only other important item in the diet. He found that the mean stomach volume was approximately 1 ml (1 g) and that 1/3 of the stomachs examined were empty. Everted stomachs were not collected and seem to be a problem for this type of study. Bowman (1975) found food habits to be relatively constant from year to year but did differ for areas, seasons and sex. For western Nova Scotia it was found that more crustaceans were consumed and that the mean weight per stomach was greater in the spring.

With regards to sex, Bowman (1975) found that the food habits of males and females were strikingly different. He found that males feed mainly on crustaceans and females on fish, and the mean weight of stomach contents for females was 4.9 g whereas it was only 0.6 g for males. No mention was made of size of fish in his study, but it is quite likely that females were larger in mean size.

A study done by Vinogradov (1972) shows that smaller silver hake (<21 cm) feed almost exclusively on crustaceans, and at larger lengths (>40 cm) the females feed exclusively on fish. Part of this difference in feeding attributed to sex may in fact be related to size of fish, and since females grow larger than males, they have been found to feed more heavily on fish. This latter study showed an increase in cannibalism from 1% at 20 cm to 9% at 50 cm while fish ingestion in general changed from 10%-95% frequency of occurrence, shrimp and euphausids followed the opposite pattern.

Vinogradov (1972) also showed a seasonal pattern of feeding on the Scotian Shelf. Euphausids were most important with the maximum feeding in the spring. For George's Bank, however, fish seemed to be the most important food and maximum feeding occurred in August. No indication of possible differences in size of fish sampled in these two areas was given. Maximum feeding in most areas seemed to occur in the spring period with lowest feeding in the winter.

In a study in the New York Bight area, Schaefer (1960) found that fish constituted the main portion (72% by volume) of the silver hake diet. Specifically he found that from February to May, 30% of feeding fish were cannibalizing smaller hake, whereas in January and February the level was only 1%. It was also noted that a hake can consume another fish almost half its own length. This does show the possibility that during a year where there is a shortage in the food supply, silver hake could influence its own population size.

Another variable to consider in feeding studies is solar time. A study by Alton and Nelson (1970) showed that Pacific hake (Merluccius productus) follows food items and thus undergo a vertical movement during the evening and early morning. It can be assumed feeding occurs somewhere between sunset and early morning since there was generally a marked decrease in the number of empty stomachs during this time period.

This study was an attempt to find out what silver hake feed upon during the fall-winter period, and also try to find feeding relationships from available data.

Materials and Methods

Stomachs were collected from several cruises over the past two years, generally from the Scotian Shelf and ICANF Subarea 5. Stomachs were examined in two ways; firstly, by detailed laboratory analysis, which included most stomachs, and secondly, by gross analysis on board the vessel, which included length measurements and counting of each major food type. The stomachs in this study were collected from the cruises shown in Table 1. All vessels used a bottom type otter trawl.

Stomachs for laboratory analysis were removed from the fish, put in a bag with formalin and labelled with date, fish length, sex, and location. In some cases, the whole fish were frozen and returned to the laboratory for analysis. These fish were then measured for length and weight and the stomach removed and placed in formalin for later analysis. Stomach fullness was estimated using the following subjective guidelines: 0 - empty; 1=empty to 1/4 full; 2 = 1/4 to 1/2 full; 3 = 1/2 to 3/4 full and 4 = 3/4 to full. It was found that placing the stomach in formalin aids analysis because it makes the contents firmer. The preserved stomachs were opened in the laboratory, scraped out and washed clean of all contents. The stomach contents were then broken apart and individual food items counted using a binocular microscope. Excess liquid was drained off and the contents lightly compacted in a graduate cylinder in order to record the volume to the nearest 0.1 ml.

Sources of Error and Difficulties

Probably the biggest problem in conducting a feeding study has to be accuracy and consistency of the data. This is particularly important in the identification of prey species.

Everted stomachs are a problem in any feeding study. Eversion does not seem to be directly related to depth. Davies (1949) found everted stomachs in line-caught fish from shallow waters and since there was little pressure change it is probable that the eversion habit is due to stress. If this is the case, then there is very little that can be done about this problem.

Results and Discussion

A relationship was found for the stomach volume-degree of fullness concept (Figure 1). The data were treated separately for fish lengths 0-19 cm and 20-40 cm. Table 2 and 3 show number of stomachs by degree of fullness and seem to indicate an increase in the percentage of full and nearly full stomachs with length of fish. Conversely, there also appears to be a decrease in the percentage of empty stomachs with length of fish. It can also be seen from these tables that percentage of everted stomachs is less in larger fish. This could indicate that larger fish are less affected by either the pressure drop in being brought to the surface or the stress of being caught.

Alton and Nelson (1970) in their study on Pacific hake found a marked decrease in the percentage of empty stomachs between sunset and early morning. Table 4 however does not show any clear relationship with regard to time of day, although a slight trend appears to show an increasing percentage of full stomachs (category 3 & 4) and corresponding decrease in empty stomachs (category 1 & 2) for the same time period. This poor relationship is probably because the data were mixed (i.e. different months, depths and areas are all considered together) and too unevenly spread for a time series analysis.

The average food volume in the stomach does increase with length of fish (Table 5). This large increase is likely due to the fact that larger silver hake feed on smaller hake and other fish. The number and percent empty stomachs does not indicate any particular trend in this table possibly because all data are presented together (i.e. mixed areas, times and depths).

The high average food volume at the shallower depths (Table 6) seems to indicate optimal feeding at less than 100 meters depth. This obviously depends on availablity of food and it can be hypothesized that <100 m is an optimal depth for crustaceans and/or small fish which make up the majority of food. Large food volumes are also found at 300-400 m depth, this is probably due to the larger size of hake (>40 cm) from these depths.

The percentage of fish that are multi-feeding seems to increase with length of fish (Table 7). The average number and percentage frequency of occurrence of shrimp, mysids and euphausids per stomach decreases with increasing length of fish. The percent frequency of occurrence of prey fish increases with length of predator hake. This trend is true with small *Merluccius* spp. as well as other prey fish species. The average number of fish found in a stomach is relatively constant. Cannibalism appears to be quite common in silver hake with large hake feeding on smaller fish. This agrees with what was found in several previous studies (Bowman, 1975; Vinogradov, 1972; Schaefer, 1960).

Table 8 does not have as complete a data base as Table 7 and is not as easily interpreted. However all of the major trends discussed above hold for the feeding patterns of this smaller data set.

The stomach contents separated by length and by month (Table 9) do not show any clear relationships. This may be due to the fact that all months are not represented. It appears that during the summer shrimp play an important role in the food of fish less than 40 cm, and that small prey fish become important in the latter part of the year

(Oct-Dec). Larger hake (>40 cm) seem to feed mainly on fish from October to December although shrimp also play an important role in the food of these fish. This is similar to what was found by Vinogradov (1972). Bowman (1975) found a difference in feeding habits between the sexes. Females tended to feed more on fish while males feed on crustacea. This may have been due more to the size of fish than the sex, as females tend to grow to a larger size than males and thus stratified samples will show a disproportionate number of females at larger lengths. Squid is also found in some silver hake stomachs, generally speaking, in the larger hake. Amphipods, although occasionally found in the stomachs examined, do not seem to play an important role in the food of hake and as Davies (1949) points out they are probably present in the stomachs only due to chance.

Davies (1949) also points out that scales indicate one of three things. First, the fish was actually feeding an other fish and only a few scales remain, secondly, they were taken in as food from the ocean bottom or water column, or thirdly, that the scales are present due to biting at another fish and getting only a clump of scales. For single scales the second possibility is most feasible whereas when clumps of scales are found in the stomach, the third possibility is most likely.

The food web which Hickling (1935) drew up for the European hake (*Merluccius vulgaris*) is shown here in a modified form. Davies (1949) modified this for the Cape hake (*Merluccius capensis*), and it is further modified here for silver hake (*Merluccius bilinearis*) on the east coast of North American (Figure 2).

Bowman (1975) found in his study that 1/3 of the stomach examined were empty, Davies (1949) found that approximately 74% of the stomachs were found to be empty or everted. In this study approximately 50% of the stomachs examined were found to be either empty or everted.

From the data presented and the many species found to be present in the stomachs of hake, it can generalized that: the silver hake feeds mainly on crustaceans and small fish, although it appears to be opportunistic, feeding on whatever is present at the time. This is a similar conclusion to that arrived at by Best (1963).

Acknowledgements

Thanks should go to Mike Strong and Peter Perley of the St. Andrews Biological Station, N.B. and Rick McCubbin, Fred Rahey, Jim Simon, and Geraldine Young of Marine Fish Division, Bedford Institute of Oceanography for assistance in the stomach analysis.

Peggy McCalla drafted the figures in the text. Dr. Wayne Stobo, Marine Fish Division, Bedford Institute permitted the analysis of the 885 Silver hake stomachs collected on his Cape Argos cruise of 1976.

References

Alton, M.S. and Nelson, M.O. (1970) Food of the Pacific hake, *Merluccius productus*, in Washington and northern Oregon coastal waters. Circ. U.S. Fish & Wild. Serv. 332:35-42

Best, E.A. (1963). Contribution to the biology of the Pacific Hake, *Merluccius productus* (Ayres). Calif. Coop. Oceanic Fish. Invest. Rep. 9: 51-56.

Bowman, R.E. (1975) Food habits of Atlantic cod, haddock, and silver hake in the northwest Atlantic, 1969-1972. In: Food Chain Investigations, Food Habits of Marine Fishes of the Northwest Atlantic. Data Report. US Dept. Comm. NOAA pp 1-53.

Davies, D.H. (1949) Preliminary investigations on the foods of South African fishes with notes on the general fauna of the area. Fish Mar. Biol. Survey Div., Union S.A., Invest. Rep. No. 11 pp 36.

Hickling, C.F. (1935) The hake and the hake fishery. The Buckley Lectures. London, pp 142.

Schaefer, R.H. (1960) Growth and feeding habits of the whiting or silver hake in the New York bight. N.Y. Fish & Game J. &(2): 85-98.

Vinogradov, V.I. (1972) Studies of the food habits of silver and red hake in the northwest Atlantic area, 1965-67. ICNAF Res. Bull. 9:41-50.

Table 1. Location, date and number of stomachs analysed for each cruise of this Silver hake feeding study.

Cruise/Vessel	Date	Location	Number of Stomachs	Type of Study
1. Cape Argos	Oct/Dec '76	ICNAF Division 4&5	885	laboratory
2. R/V Foton	Oct/Nov '77	Emerald Bank/Basin	411	laboratory
3. E.E. Prince	April '78	Emerald Bank/Basin	43	laboratory
4. Commercial Cuban Trawler	June '78	Emerald/Sable Isl. Banks	106	laboratory
5. R/V Lady Hammond	Oct/Nov '78	ICNAF Subarea 4W	148	laboratory
6. R/V Lady Hammond	Oct/Nov '78	ICNAF Subarea 4W	44	gross analysis
7. Commercial Japanese Trawler	Oct/Dec '78	ICNAF Subarea 4W	74	gross analysis
TOTAL			1711	

Table 2. Stomach fullness by length group for 1300 silver hake from all cruises (except R/V *FOTON*)

NUMBERS OF STOMACHS AT EACH DEGREE OF FULLNESS

Length of fish (cm)	Sex[1]	Number of fish	Everted Stomachs	Stomach fullness[2] 0	1	2	3	4
10-19	M	23	4	12	2	2	-	1
	F	32	12	12	5	2	-	1
	T	55	16	24	7	4	-	2
20-29	M	304	55	97	70	24	8	7
	F	358	69	126	73	31	5	4
	T	662	124	223	143	55	13	11
30-39	M	137	19	45	47	8	3	4
	F	325	68	108	72	34	11	9
	T	462	87	153	119	42	14	13
40-49	M	5	1	2	-	-	1	1
	F	80	6	31	20	9	3	5
	T	85	7	33	20	9	4	6
50+	M	-	-	-	-	-	-	-
	F	36	3	11	4	8	3	4
	T	36	3	11	4	8	3	4

PERCENT OF STOMACHS AT EACH DEGREE OF FULLNESS, EXCLUDING EVERTED STOMACHS

Length of fish (cm)	Sex[1]	N[3] (0 - 4)	% Everted Stomachs	Stomach fullness[2] 0	1	2	3	4
10-19	T	37	29.1	64.9	18.9	10.8	-	5.4
20-29	T	445	18.7	50.1	32.1	12.4	2.9	2.5
30-39	T	341	18.8	44.9	34.9	12.3	4.1	3.8
40-49	T	72	8.2	45.9	27.8	12.5	5.5	8.3
50+	T	30	8.3	36.7	13.3	26.7	10.0	13.3

[1] Sex of fish: M - male; F - female; T - both sexes.

[2] Stomach fullness was a subjective measurement of stomach contents:
(0) - empty
(1) - 0-25% full
(2) - 25-50% full
(3) - 50-75% full
(4) - 75-100% full

[3] N(0-4): Number of fish with stomach fullness from 0-4.

Table 3. Stomach fullness of 411 Silver hake caught in October-November 1977 on the R/V *Foton*.

NUMBERS OF STOMACHS AT EACH DEGREE OF FULLNESS

Length of fish (cm)	Sex[1]	Number of fish	Stomachs Everted	Stomach fullness[2] 0	1	2	3	4
10-19	M	73	22	25	7	4	5	10
	F	89	29	32	8	10	5	5
	T	281	53	91	49	29	29	30
20-29	M	21	9	8	2	1	1	0
	F	7	3	4	0	0	0	0
	T	29	12	12	3	1	1	0
30-39	M	11	5	6	0	0	0	0
	F	24	12	4	4	1	0	3
	T	35	17	10	4	1	0	3
40-49	M	-	-	-	-	-	-	-
	F	5	1	3	1	0	1	0
	T	5	1	3	1	0	1	0
50+	M	-	-	-	-	-	-	-
	F	61	1	10	2	10	4	34
	T	61	1	10	2	10	4	34

PERCENT OF STOMACHS AT EACH DEGREE OF FULLNESS, EXLUDING EVERTED STOMACHS

Length of fish (cm)	Sex[1]	N[3] (0 - 4)	% Everted Stomachs	Stomach fullness[2] 0	1	2	3	4
10-19	T	228	18.9	39.9	21.5	12.7	12.7	13.2
20-29	T	17	41.4	70.6	17.6	5.9	5.9	-
30-39	T	18	48.6	55.6	22.2	5.6	-	16.7
40-49	T	5	20.0	60.0	20.0	-	20.0	-
50+	T	60	1.6	16.7	3.3	16.7	6.7	56.7

[1] Sex of Fish: M - male
F - female
T - all fish combined including some unsexed

[2] Stomach Fullness, was a subjective measurement of stomach contents:
(0) - empty
(1) - 0-25% full
(2) - 25-50% full
(3) - 50-75% full
(4) - 75-100% full

[3] N (0-4): Number of fish with stomach fullness from 0-4.

Note: Everted stomachs are not always empty and thus the number of feeding fish on Table 8 is not the number of fish less the empty stomachs less the everted stomachs.

Table 4. Stomach fullness at different times of the day for 823 silver hake from all cruises (except R/V *Foton*).

Hour of Day	Number of Stomachs at each degree of Fullness: Stomach Fullness[1] 0	1	2	3	4	No Data	Everted Stomach	N[2] (0-4)
0:00- 4:59	115	61	26	1	9	34	70	212
5:00- 7:59	80	33	9	4	9	48	35	135
8:00-10:59	8	14	2	0	1	1	10	25
11:00-13:59	80	40	15	6	2	7	40	143
14:00-17:59	59	45	15	5	0	34	23	124
18:00-20:59	50	34	3	0	2	12	19	89
21:00-23:59	53	30	8	1	3	27	17	95

Hour of Day	Percent of Stomachs at each degree of Fullness: Stomach Fullness[1] 0	1	2	3	4
0:00- 4:59	54.2	28.2	12.3	0.5	4.2
5:00- 7:59	59.3	24.4	6.7	3.0	6.7
8:00-10:59	32.0	56.0	8.0	0.0	4.0
11:13-13:59	55.9	28.0	10.5	4.2	1.4
14:00-17:59	47.6	36.3	12.1	4.0	0.0
18:00-20:59	56.2	38.2	3.4	0.0	2.2
21:00-23:59	55.8	31.6	8.4	1.1	3.2

1. Stomach fullness was a subjective measurement of Stomach contents: -
(0) Empty; (1) 0 - 25% full; (2) 25 - 50% full; (3) 50 - 75% full; (4) 75 - 100% full.

2. N (0-4) - Number of fish with stomach fullness from 0 - 4.

Table 5. Average volume of stomach contents with Standard Deviation, for silver hake of each length group. (All cruises except R/V *Foton.*)

Length of Fish (cm).	Average Food Volume (ml)	± S (ml)	Sample size	# Empty	% Empty
10 - 19	.743	1.955	37	24	64.9
20 - 29	.532	1.366	352	223	63.4
30 - 39	1.105	2.814	311	153	49.2
40 - 49	3.382	8.710	67	33	49.3
50+	13.311	30.676	25	11	44.0

Table 6. The average volume of stomach contents for Silver hake caught in six ranges of depth (m). (All cruises except R/V Foton).

Depth (m)	No in Sample	No. of Sets	Average Food Volume (ml)
0-49	------------------ NO DATA	-------------------------	
50-99	212	5	3.42
100-149	53	3	0.41
150-199	237	7	0.41
200-299	185	9	0.35
300-399	66	4	2.50
400-600	8	2	0.00

Table 7. Occurrence of major food items in 348 feeding silver hake.
(All cruises except R/V *FOTON*)

Total Length (cm)	Number of Fish	Average[2] Food Volume (ml)	Multi[3] Feeding	Amphipoda (Hyperids)	Decapoda (Shrimp)	Copepoda (Calanoids)	Euphausiacea + Mysidacea	Pisces (*Merluccius*)	Pisces (Other)
				Mean Number with Standard Deviation of Organisms[1]					
10-19	9	.74 ±1.95	1	2.0±0.0	16.56±18.58	-	-	-	-
20-29	143	.54 ±1.36	25	1.77±1.54	5.48±8.88	1.67±0.98	10.48±21.80	1.25±0.71	1.0±0.0
30-39	152	1.10 ±2.81	29	7.13±15.05	6.33±9.76	4.50±6.74	11.12±14.71	1.0± 0.0	1.24±0.56
40-49	30	3.38 ±8.71	8	1.50± 0.71	1.79±1.19	-	12.33±19.63	1.0± 0.0	1.23±0.60
50+	14	13.31 ±30.67	4	-	1.5 ±0.71	1.0±0.0	1.0±0.0	1.0±0.0	1.14±0.38
				Percent Frequency of Occurrence[4,5]					
10-19	9	-	11.1	11.1	100	-	-	-	-
20-29	143	-	17.5	8.4	55.9	7.7	35.7	5.6	7.0
30-39	152	-	19.1	4.6	71.1	5.9	21.7	4.6	11.1
40-49	30	-	26.7	6.7	46.7	-	10.0	20.0	43.0
50+	14	-	28.6	-	14.3	7.1	21.4	35.7	50.0

[1] Mean number taken from fish feeding on that item.

[2] Volume of stomach contents - items were broken up and lightly compacted to exclude any spaces in the graduate cylinder.

[3] Feeding on more than one item at a time.

[4] Note: Percentages do not add to 100% due to multifeeding.

[5] Calculations based only on food items listed. Other minor food items present were: Polychaetes, Isopods, squid, starfish, crabs, egg cases, Nematodes, Scales, Tapeworms, Fish eggs, water mites, other copepods, stomach lining and unidentified remains.

Table 8. Occurrence of food items in stomachs of 252 feeding silver hake from the cruise of R/V *FOTON*

			Mean Number with Standard Deviation of Organisms[3]					
Length of fish (cm)	Number of Fish	Average[1] Food Volume (ml)	Multi[2] Feeding	Amphipoda (Hyperids)	Decapoda (Shrimp)	Copepoda (Calanoids)	Euphausiacea	Pisces (Merluccius)
10-19	177	0.9 ±1.24	21	2.4±1.1	1±0	3±2.8	18.4±22.9	-
20-29	10	0.7 ±0.7	1	-	-	-	21.2±29.8	-
30-39	12	1.1 ±1.1	4	1.6±1.4	1±0	-	3.3± 3.6	1±0[4]
40-49	3	0.1	-	-	-	-	2	1±0
50+	50	-	-	-	-	-	-	1.5±1.1[5]
			Percent Frequency of Occurrence[6]					
10-19	177	-	18%	7%	6%	2%	92%	-
20-29	10	-	10%	-	-	-	50%	-
30-39	12	-	33%	25%	17%	-	50%	17%
40-49	3	-	-	-	-	-	33%	66%
50+	50	-	-	-	-	-	-	100%

1 Volume of stomach excluding any fish - items were broken up and lightly compacted to exclude any spaces in the graduate cylinder.

2 Feeding on more than one item at a time.

3 Mean number taken from fish feeding on that item.

4 Two fish: one 10 gm and one 17.5 gm fish.

5 Fish averaged 20-22 cm with a maximum size of 30-32 cm.

6 Percent frequency that item appeared in diet of feeding fish.

Table 9. Occurrence of Food Items in Stomachs of 358 feeding Silver Hake by Month (For All cruises except R/V Foton).

Occurrence of each Food Item by Length Group by Month[1]

Length of Fish (cm)	Month	FOOD ITEMS * 1+2	3	6+7	8	9+10	11	12+13	16+17	No. Fish Feeding
10-39	4	-	2	1	-	-	-	-	-	3
40+	4	-	-	-	-	-	-	-	-	0
10-39	6	-	40	1	-	-	-	-	2	40
40+	6	-	-	-	-	-	-	-	-	0
10-39	10	5	51	3	-	10	2	2	1	66
40+	10	-	-	-	3	3	2	-	-	8
10-39	11	71	89	5	15	10	6	-	5	153
40+	11	6	15	1	8	14	1	-	2	35
10-39	12	9	16	11	-	6	1	-	15	49
40+	12	-	1	-	-	3	-	-	-	4

Percent Occurrence of each Food Item by Length Group by Month[2]

Length of Fish (cm)	Month	FOOD ITEMS * 1+2	3	6+7	8	9+10	11	12+13	16+17	No. Fish Feeding
10-39	4	-	66.7	33.3	-	-	-	-	-	3
40+	4	-	-	-	-	-	-	-	-	0
10-39	6	-	100	2.5	-	-	-	-	5.0	40
40+	6	-	-	-	-	-	-	-	-	0
10-30	10	7.6	77.3	4.5	0.0	15.2	3.0	3.0	1.5	66
40+	10	-	-	-	37.5	37.5	25.0	-	-	8
10-39	11	46.4	58.2	3.3	9.8	6.5	3.9	-	3.3	153
40+	11	17.1	42.9	2.9	22.9	40.0	2.9	-	5.7	35
10-39	12	18.4	32.7	22.4	-	12.2	2.0	-	30.6	49
40+	12	-	25.0	-	-	75.0	-	-	-	4

Note:*
Food Items 1 = Euphausiacea 2 = Mysidacea 3 = Shrimp 6 = Calanoids 7 = Cyclopoids
8 = _Merluccius_ 9+10 = Other fish 11 = Squid 12 = Star Fish 13 = Crab
16 = Hyperids 17 = Gammarids

1. Minor food items left out of Analysis
2. Total percentage may be greater than 100% due to multi-feedings. (re Table 7.)

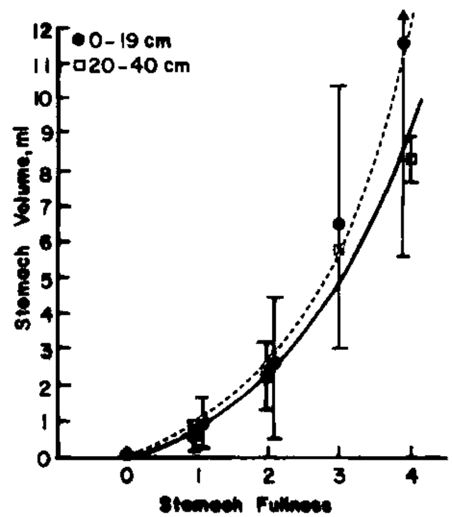

Fig. 1 Gives the relationship between Stomach Volume and Stomach fullness for two length groups of fish, 0-19 cm and 20-40 cm. Stomach fullness is a subjective measure of the amount of food present where 0 = empty, 1 = 0-25% full, 2 = 25-50% full, 3 = 50-75% full and 4 = 75-100% full.

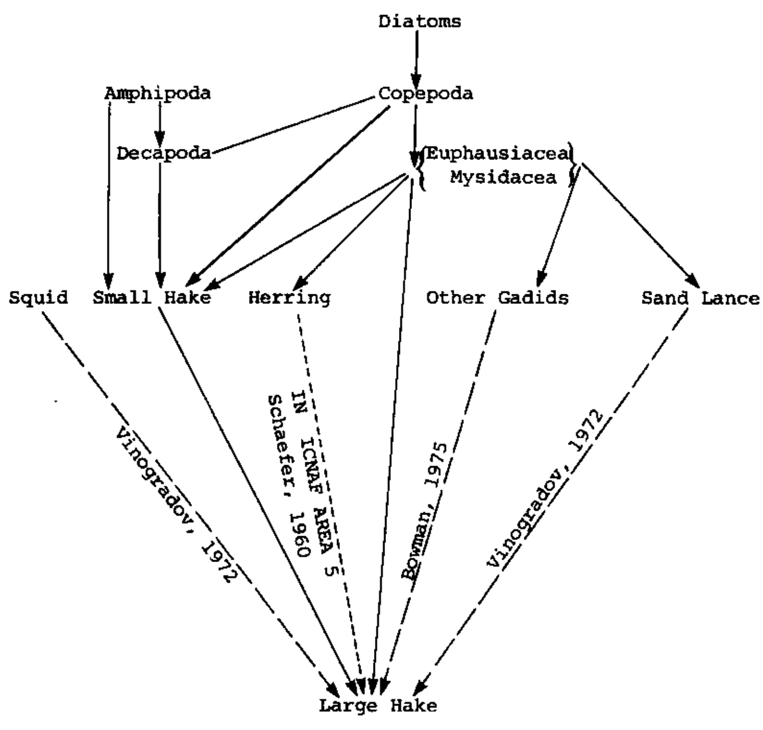

Fig. 2. Food web for silver hake (*Merluccius bilinearis*) of the Scotian Shelf and ICNAF Subarea 5 (modified after Hickling, 1935).