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Food of Silver Hake (*Merluccius bilinearis*)

by

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ABSTRACT

The stomach contents of 2,622 silver hake collected in the Northwest Atlantic have been analyzed. Fish were collected on bottom trawl surveys conducted from 1973 to 1976. The mean fish fork length (FL) was 20.3 cm and the average stomach content weight was 1.477 g. Silver hake <20 cm FL prey mostly on amphipods, decapod shrimp, and euphausiids. Fish 20 cm FL and longer tend to take increasing proportions of fish and squid as part of their diet. The stomach contents of male and female fish of similar size indicate that females eat larger quantities of food (mostly fish) than the males. The females are also, on the average, larger than the males. Silver hake feed primarily at night. Feeding begins near dusk and continues until just after midnight. In the spring a second feeding period occurs near noon. Silver hake feed intensively during the spring. Their stomachs contained almost twice as much food in the spring as they did in the autumn. Significant differences occurred in the intensity of feeding between areas. The stomachs of fish caught in the Middle Atlantic contained the largest quantities of food. The species of prey taken by silver hake are highly variable and likely reflect prey availability during different years, seasons, and areas. When silver hake spawn their dietary intake is reduced. Euphausiids and squid comprised a large portion of the diet of fish taken in deep water (>150 m), but the quantity of food found in their stomachs was less than that found in stomachs taken from fish collected at depths <150 m. The composition and quantity of the food of silver hake collected at various bottom water temperatures was extremely variable.

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INTRODUCTION

Silver hake, Merluccius bilinearis (Mitchill 1814), is a Northwest Atlantic gadiform fish whose range extends from the continental shelf waters off South Carolina, southerly, to the Newfoundland Banks, northerly. It is most abundant in offshore waters extending from New York, USA, to Cape Sable, Nova Scotia (Bigelow and Schroeder 1953).

Previous investigations have shown that large silver hake eat mostly fish and/or squid, while smaller silver hake feed on euphausiids, amphipods, and decapod shrimp. Among the first to report these findings were Nichols and Breder (1934), who noted 75 herring ~7 cm long in the stomach of one 59 cm fish. Bigelow and Schroeder (1953) reported that silver hake are extremely voracious and will prey on smaller silver hake or any other of the schooling fishes such as young herring, mackerel, menhaden, alewives, or silversides. Evaluation of other studies on the diet of silver hake caught in various areas and during different years establishes that the prey of silver hake is very predictable in that it is usually comprised of a variety of fish, squid, and crustaceans (Jensen and Fritz 1960; Schaefer 1960; Vinogradov 1972; Noskov and Vinogradov 1977; Bowman and Langton 1978; Langton and Bowman 1980). Investigations by Swan and Clay (1979), Edwards and Bowman (1979), and Bowman and Bowman (1980) have shown that silver hake feed mostly at night.

Until recently the impact of silver hake on the Northwest Atlantic ecosystem had not been determined. Research by Edwards and Bowman (1979), who estimated the annual consumption of the principal predators in the Northwest Atlantic, indicated that silver hake alone could potentially

consume almost 10 percent of the standing crop of all fish within the study area annually, the bulk of which would be small or juvenile fish. They went on to suggest that silver hake, more than any other species, plays the principal predatory role in regulating the Northwest Atlantic ecosystem. This report examines the quantities and types of food eaten by silver hake during the years 1973-1976.

METHODS AND MATERIALS

A total of 325 samples representing 2,622 silver hake stomachs was collected during eight bottom trawl survey cruises conducted during the spring and fall from 1973 to 1976 (Table 1). The cruise periods were as follows: 16 March-15 May 1973; 26 September-20 November 1973; 12 March-4 May 1974; 20 September-14 November 1974; 4 March-12 May 1975; 15 October-18 November 1975; 4 March-8 May 1976; 20 October-23 November 1976. On spring cruises a two-seam modified Yankee No. 41 trawl was fished, and during fall cruises a standard Yankee No. 36 was used. The cod end and upper belly of both trawls were lined with 13 mm mesh netting to retain smaller fish. A scheme of stratified random trawling was conducted within the study area (Figure 1) and fishing continued over 24 hr per day[1]. All tows were 30 min in duration at a vessel speed of 3.5 kn in the direction of the next station.

Sampling of stomachs was concentrated in three areas, namely the Middle Atlantic, Southern New England, and Georges Bank (Figure 1). Two

[1]Further details of the bottom trawling techniques may be obtained from the Resource Surveys Investigation, Northeast Fisheries Center, Woods Hole Laboratory, Woods Hole, MA 02543.

length groups of fish (≥20 cm and <20 cm) were randomly selected (50 fish per group) during each cruise from the bottom trawl survey catches in each area. At each station within a particular area no more than 10 fish were taken for each of the two length groups, and fish were not sampled at two consecutive stations. The only exception to this collection method occurred when it appeared (during the cruise) that 50 large or 50 small fish would not be collected within a particular area. In this case fish were collected as necessary to obtain the minimum sample size. Stomachs of large fish were excised aboard ship, individually wrapped in gauze with a label denoting vessel, cruise, species, sex, and maturity, and preserved in 10 percent Formalin (small fish were preserved whole).

In the laboratory the preserved stomachs were individually opened and their contents emptied onto a 0.25 mm mesh opening screen sieve to permit washing without the loss of any food items. The stomach contents were sorted, identified, counted and damp dried on absorbent paper. Major prey items and commonly occurring but relatively minor prey, in terms of weight, were identified to species whenever possible. The wet weight of all stomach content groups was determined to the nearest 0.001 g and all information recorded. A stomach was considered empty when no food items could be identified and the material found in the stomach weighed <0.001g. Data were analyzed with FORTRAN IV programs written for use on a Honeywell SIGMA 7 computer system located in Woods Hole, Massachusetts.

Food data are presented in terms of the mean stomach content weight, adjusted stomach content weight (discussed below), and the percentage

weight each prey group made up of the total stomach content weight. All tables follow a standard format to aid in making comparisons. In the tables, subtotals of the percentage weight of major stomach content groups are offset to the left. The minor prey groups are discussed in further taxonomic detail in the text. Other data such as the number of fish stomachs examined, number of empty stomachs, mean fish FL, length range, mean stomach content weight and the adjusted stomach content weight are given at the bottom of all appropriate tables.

Adjusted stomach content weights are weights adjusted by a correction factor allowing direct comparison of the stomach content weights of different size fish. Adjustment of the stomach content weights was necessary before any quantitative comparisons could be made between variables such as sex or area. Based on the stomach tissue weight, mean stomach content weight, and whole fish weight (data presented in Figure 2), neither the mean stomach content weight nor the stomach tissue weight is proportional to the body weight of different size fish. Stomach tissue weights of 526 silver hake were gathered during a study jointly conducted by American and Soviet scientists on Georges Bank in September of 1978 aboard the Soviet research vessel BELOGORSK (operated by the Atlantic Research Institute of Marine Fisheries and Oceanography, Kaliningrad, USSR). Mean stomach content weight data were derived from the 1973-1976 food data given in this report, and the fish body weights were calculated using the silver hake length-weight equation described by Wilk (1978). Silver hake weighing less than 100 g, or more than 300 g, have larger stomachs (weight is an indication of stomach size), and stomachs which contain (on the average)

more food in terms of percentage body weight, than fish weighing between 100-300 g. Since both the stomach tissue weight and the mean stomach content weight were disproportionate when presented as a percentage body weight for different size fish (but were generally proportionate relative to each other), and because the mean stomach content weight data was much more variable than the stomach tissue weight data, the data adjustment was based on the stomach tissue weights rather than on body weight or mean stomach content weight. The following equation was used to adjust the stomach content weights:

$$\overline{A}_L = \frac{\overline{x}\ell}{\overline{w}\ell}$$

where:

$\overline{A}_L$ = Adjusted stomach content value. The adjusted stomach content value was converted to grams by multiplying it times the stomach tissue weight of a 30 cm FL fish.

$\overline{x}\ell$ = Mean stomach content weight of all fish at a given length.

$\overline{w}\ell$ = Mean stomach tissue weight of silver hake at a given length.

The adjusted stomach content data for fish 4 to 15 cm FL and 24 to 35 cm FL are presented separately in forthcoming sections. These two length groups were chosen because the food consumption of fish less than one year old (fish 4-15 cm FL) differs substantially from the food consumption of older fish (evident from Figure 2). In addition, too few fish outside these length ranges were sampled to warrant inclusion in any of the calculations dealing with comparisons between data sets. An analysis of variance (one way) was used to test the observed differences among sample means (e.g., between geographic areas).

RESULTS

The contents of 2622 silver hake stomachs, of which 803 (30.4%) were empty, were analyzed. Fish sampled averaged 20.3 cm FL and had, including the empty ones, a mean stomach content weight of 1.477 g. Sources of potential variation in the data presented below include size, sex, and maturity stage of fish, as well as the time of day, area, year, season, bottom depth, and temperature when or where the fish were caught. Each of these variables is treated separately in the analysis, i.e., the data were pooled over all other variables and no attempt was made to determine the possible confounding of different variables. Dietary trends noted within each particular variable should be considered only as preliminary observations.

Composition of the diet - Overall, in terms of percentage weight, the diet of silver hake consists almost entirely of fish (80.0%), crustaceans (10.2%), and squid (9.2%), as can be seen in Table 2. The importance of crustaceans to the diet is overshadowed by the fish portion because large silver hake eat heavier meals consisting primarily of fish. However, Table 2 is useful because it serves as a composite list of the prey types commonly found in the stomachs of silver hake. Fish such as silver hake (*Merluccius bilinearis*), Atlantic mackerel (*Scomber scombrus*), butterfish (*Peprilus triacanthus*), herring (Clupeidae), American sand lance (*Ammodytes americanus*), scup (*Stenotomus chrysops*), Atlantic saury (*Scomberesox saurus*), and longfin hake (*Phycis chesteri*) each make up >0.1% of the stomach contents. The "Other Pisces" category, most of which could not be identified, accounts for a substantial portion (52.0%) of the "Pisces" group. Species

identified within this category (all contributed <0.1% to the diet) include: summer flounder (Paralichthys dentatus), redfish (Sebastes marinus), codfishes (unidentified Gadidae), and flatfishes (unidentified Pleuronectiformes).

Crustacea in the diet are represented principally by euphausiids [mostly Meganytiphanes norvegica (3.7%) and Euphausia (<0.1%)] and decapods such as the Crangonidae [mainly Crangon septemspinosa (1.4%) and Sclerocrangon boreas (<0.1%)], Pandalidae [almost exclusively Dichelopandalus leptocerus (2.0%), although some Pandalus borealis (<0.1%) were also found], Pasiphaeidae [only Pasiphaea multidentata (0.1%)], and other unidentified decapods (0.4%) which were mostly shrimp (0.3%). Amphipods found in the stomachs consist primarily of the families Ampeliscidae (<0.1% each of Ampelisca agassizi, A. spinipes, A. vadorum, and Byblis serrata), Oedicerotidae (<0.1% of Monoculodes edwardsi and M. intermedius) and Hyperiidae [exclusively the genus Parathemisto (0.1%)]. The remaining crustacean groups are the Mysidacea [comprised of Neomysis americana (0.7%) and <0.1% of Erythrops], Cumacea [mostly Leptocuma (+) and some unidentified diastylids (+)], Copepoda [almost all identified as calanoids (+)] and "Other Crustacea" [all of which was well digested crustacean remains (0.3%)].

The only other stomach contents identified were the cephalopods [Loligo pealei (4.7%) and Rossia (<0.1%) were the only ones identified] and the "Miscellaneous" category, which consisted of small amounts (<0.1%) of Echinodermata, Chaetognatha, unrecognizable digested matter and sand.

The percentage weight of the various prey of silver hake for each length group is listed in Table 3. Silver hake <20 cm FL eat mostly crustaceans (>80% on the average), whereas the food of individuals >20 cm FL is mostly fish and squid (average over 50%). The stomachs of silver hake

3-5 cm FL contain the largest percentages of the smaller crustacean forms such as amphipods and copepods. Decapods, euphausiids and mysids, which are generally larger organisms (see Gosner 1971), make up the largest percentage of the diet of fish 6-20 cm FL. Silver hake ranging from 21 to >50 cm FL eat increasingly greater percentages of fish and squid.

Differences between males and females - The diet of male and female silver hake differs in both quality and quantity of food (Table 4). The stomachs of males contain the largest percentage of crustaceans while those of females have the largest percentages of fish and squid. The mean stomach content weight of the males is only about one-fifth that of the females. Males also occur less frequently in the samples (42% of the fish collected were males) and were generally smaller than the females (mean FL males, 28.4 cm; females, 31.2 cm). Since female fish were on the average longer than the males, the differences noted above had to be dealt with in considerably more detail.

A comparison of the data in Tables 5 (food of males) and 6 (food of females) indicates that males and females within the same size groupings consume different types and amounts of food. The same dietary patterns noted for male and female fish in the preceding paragraph can be seen in most of the individual length groups in these two tables (e.g. when males and females within the same size groups are compared, the stomachs of the females tend to contain larger quantities of food and higher percentages of fish and squid). The number of males generally exceeds the number of females at length groups <30 cm, and females dominate the length groups >30 cm.

A subset of the data were analyzed separately using only individual lengths comprised of 20 or more individuals each of male and female fish (Figure 3). This group of fish (ranging in FL from 24-34 cm) is fairly representative of the adult silver hake population sampled. The mean stomach content weight (Figure 3a), percentage crustaceans (Figure 3b), and percentage fish and squid (Figure 3c) data graphically illustrate the differences between the diets of male and female silver hake at each length. Again the stomachs of males contain higher percentages of crustaceans than females, and the stomachs of females contain more fish and squid than those of the males. Adjustment of the mean stomach content weights shown in Figure 3a (by stomach tissue weight) revealed that the stomachs of females contain, on the average, 1.52 times the quantity of food found in the stomachs of males.

Diurnal variation in feeding intensity - The adjusted mean stomach content weight data presented in Figures 4 and 5 indicate the feeding periods of silver hake vary by season and size of fish. In fall the stomachs of the larger fish (24-35 cm FL) are fullest just after midnight, while smaller fish (4-15 cm FL) have the fullest stomachs in late afternoon and just after midnight (Figure 4). During springtime large silver hake had substantial quantities of food (almost twice as much as during the fall) in their stomachs for two time periods, one near dusk and the other just before noon. Smaller fish had the most food in their stomachs just after midnight (Figure 5). No indication of a particular prey being eaten at a particular time of day was noted (Table 7).

Diet within geographic areas - The stomach contents of silver hake for each geographic area (i.e., Middle Atlantic, Southern New England and Georges Bank) are presented in Table 8. Similarities and differences of the organisms noted in the stomachs of silver hake caught in the different areas are treated below. Analysis of the quantity of food taken by silver hake in each area is treated separately at the end of the section.

Fish was by far the dominant prey of silver hake within all geographic areas. Silver hake caught in the Middle Atlantic had the highest percentage of fish in their diet (Middle Atlantic, 87.5%; Southern New England, 78.4%; Georges Bank, 76.4%), but most were unidentified (60.4%). Silver hake (*Merluccius bilinearis*, 20.8%) and herring (Clupeidae, 3.2%) made up the majority of the identified fish prey. The stomachs of silver hake caught in Southern New England contained fairly high percentages of silver hake (7.9%), Atlantic mackerel (*Scomber scombrus*, 6.0%), and scup (*Stenotomus chrysops*, 4.1%). Silver hake caught on Georges Bank ate mostly Atlantic mackerel (21.1%), butterfish (*Peprilus triacanthus*, 8.9%), Atlantic saury (*Scomberesox saurus*, 6.1%), herring (Clupeidae, 5.0%), and American sand lance (*Ammodytes americanus*, 4.8%). The cannabilistic nature of silver hake is evident in that silver hake ate silver hake in all three areas. In addition, silver hake taken as prey made up the highest percentage of identified fish in both the Middle Atlantic and Southern New England (Table 8).

Crustaceans were most important in the diet of silver hake collected from Georges Bank (16.4%). Euphausiids (7.9%), decapods (mostly pandalid shrimp, 4.4%; and crangonid shrimp, 1.3%) and mysids (1.2%) accounted for

the majority of crustacean prey consumed on Georges Bank. In the Middle Atlantic and Southern New England, Crustacea was of equal importance (7.3%) as a food. Decapods (4.9%) and euphausiids (1.2%) made up the majority of crustacean prey in the stomachs of fish from the Middle Atlantic. In Southern New England, euphausiids (3.4%) and decapods (2.6%) comprised most of the Crustacea.

The Cephalopoda was the only other prey group recognized as an important food of silver hake. Fish collected in Southern New England ate the largest quantities of squid (13.7%). Silver hake sampled on Georges Bank and in the Middle Atlantic also took fairly large amounts of squid as prey (6.7% and 4.3%, respectively).

A comparison of the quantity of food in the stomachs of fish from each area revealed that Middle Atlantic silver hake had approximately two to three times more food in their stomachs (on the average) than fish from Southern New England or Georges Bank. Stomach content data for fish 24-35 cm FL from each area were adjusted for length; adjusted mean stomach content weights were: Middle Atlantic 1.328 g, Southern New England 0.593 g, and Georges Bank 0.707 g. The quantity of food in the stomachs of Middle Atlantic silver hake was significantly different from the quantity in the stomachs of fish from Southern New England ($F = 6.862$ exceeds $F_{.05,1,21} = 4.32$). The adjusted mean stomach content weights of the small (4-15 cm FL) silver hake from each area were Middle Atlantic 0.149 g, Southern New England 0.198 g, and Georges Bank 0.214 g.

Yearly and seasonal differences - The percentages of various prey categories between years, seasons, and geographic areas indicate the stomach contents are quite variable (Table 9). For example, in the Middle Atlantic the Crustacea portion of the diet of silver hake varies from 3.1% (spring, 1973) to 70.0% (fall, 1976). Similar variability can be seen in the percentages listed for most of the prey categories. Only one prey, the American sand lance (*Ammodytes americanus*), was noted as being rather unique in the diet of silver hake. American sand lance was only found in the stomachs of silver hake collected in the spring during 1975 and 1976. The largest percentage weights of American sand lance within a particular area are from samples collected during the spring of 1976 (in all three areas). Another observation is that fish sampled in the spring tended to be larger (see mean lengths at bottom of Table 9) than those collected in the autumn.

The adjusted stomach content data for large and small silver hake from all areas and years combined indicate that approximately twice as much food is found in the stomachs during spring than in autumn. The adjusted mean stomach content weights are presented in Table 10 for each season, year, and geographic area. In almost every year, in all areas, the stomachs of similar size fish contain larger quantities of food in the spring than in the fall (two exceptions are fish collected on Georges Bank in 1973 and 1974; large and small fish, respectively).

Maturity stage verus diet - Information on maturity was gathered in conjunction with food data for 759 adult silver hake (Table 11). Gonads were classified as: 1) resting - gonad small in size and relatively

transluscent, 2) developing - gonad enlarged and either cream (males) or yellow-orange (females) colored, 3) ripe - gonad fills most of gut cavity, reproductive material either runs freely from an incision in the gonad or is extruded with pressure on the abdomen of the fish, 4) spent - gonad is flaccid, hemorrhaging is often evident.

No particular prey type was found in the stomachs of fish identified as being in a specific maturity stage; all mature silver hake eat mostly fish. The stomachs of spawning (ripe) silver hake contained an average of about 9 times less food than the stomachs of fish otherwise classified (Table 11). During the pre- and post-spawning periods the stomachs contained the largest quantities of food (1.004 g and 1.292 g, respectively).

Influence of depth - Analysis of samples from different bottom water depths (range from 27 to 365 m) revealed that the food composition, quantity of food, and average length of fish varied with depth (Table 12). The majority (69.4%) of silver hake were caught at depths between 38 and 110 m.

Considering only the depth ranges where more than 50 fish were sampled (i.e., 0-220 m, and representing 95.6% of all silver hake collected) the mean Fl of fish tends to increase with an increase in depth. Also, the percentage weight of euphausiids and squid in the stomachs tends to increase at deeper bottom depths, while the percentage weight of fish in the diet shows a corresponding decrease. The adjusted mean stomach content data for both small and large fish are given in Table 13. The data are from only those depth ranges from which more than 20 fish (within a size group and depth category) were collected. The adjusted stomach content weight of small silver hake steadily decreased from the 0-37 m depth range (0.252 g)

to the 111-146 m depth range (0.116 g). The quantity of food found in the stomachs of the large fish was variable; steadily decreasing between the 0-37 m and 74-110 m depth range; increasing at the 111-146 m range. From the 111-146 m to the 257-293 m depth range the values again decreased (Table 13). Overall, the trend was for fish sampled at deeper depths to have less food, on the average, in their stomachs.

Influence of temperature - Silver hake were taken from bottom water temperatures ranging from 1° to 16°C. The composition and quantity of food in silver hake stomachs varied according to temperature. Fish was a major prey at all temperatures, but made up the largest percentage weight of the diet (about 90%) at temperatures between 6° and 10°C (Table 14). The percentage weight of *Loligo* increased with a rise in water temperature (e.g., 3.6% at 7°C to 84.6% at 15°C). Decapods and euphausiids made up a large part (over 24%) of the food at temperatures from 1° to 5°C; decreased in importance at temperatures from 6° to 9°C (to about 5%); and then increased in importance again at temperatures from 10° to 16°C (average of about 10%). The adjusted mean stomach content weight (data for temperatures for which 20 or more fish, within a size group and temperature, were analyzed) of both large and small silver hake (Table 15) was greatest at low temperatures (4°-7°C), least at intermediate temperatures (8°-12°C), and between the values noted for low and intermediate temperatures, at the highest temperatures (14°-15°C).

DISCUSSION

The diet of silver hake consists almost exclusively of a combination of fish, crustaceans, and squid. The relative importance of each particular

prey group as a food of silver hake is, for the most part, dependent on the size of the predator and/or the availability of the prey (Bigelow and Schroeder 1953; Jensen and Fritz 1960; Fritz 1962; Dexter 1969; Vinogradov 1972).

The composition of the diet of male and female silver hake is known to differ (Vinogradov 1972; Bowman 1975). The present investigation confirms earlier reports that females feed predominantly on fish and that males eat mostly crustaceans. In addition, the stomachs of females contained larger quantities of food than the amounts found in the stomachs of males of similar size. Since the rate of growth in fishes is directly related to their dietary intake it came as no surprise to learn that females grow faster than males (Schaefer 1960).

Bowman and Bowman (1980) showed that silver hake caught during late September (early autumn) on Georges Bank in 1978 fed more intensively at night than during daylight. The findings of the present study (for the same size fish collected in autumn) are similar to those reported earlier, but also indicate that an additional feeding period may occur around noon during the springtime. No such a pattern of feeding has been noted for adult silver hake in the past.

Differences in the composition and/or quantity of food in the stomachs of silver hake collected within various geographic areas have been observed previously by Schaefer (1960), Vinogradov (1972), and Langton and Bowman (1980). In this study two items are particularly noteworthy concerning the diet of silver hake gathered from different geographic areas. The first is the large quantity of food in the stomachs of silver hake from

the Middle Atlantic (on the average 2-3 times more than the quantities in the stomachs of Southern New England and Georges Bank fish). The second is the high percentage weight (20.8%) of silver hake in the diet of silver hake caught in the Middle Atlantic. Of interest is that Langton and Bowman (1980) also found that silver hake caught in the Middle Atlantic area, during the period 1969-1972, were more cannibalistic than fish examined from other areas of the Northwest Atlantic.

Vinogradov (1972) concluded that the differences he observed in the feeding of silver hake in the Northwest Atlantic (in 1965-1967) were "due to variations from area to area in the species composition of the fish food and the rate of feeding". Vinogradov's mention of "the rate of feeding" referred to the variation in feeding intensity of silver hake throughout the year. He found silver hake feed most intensively in the spring-summer and autumn periods. During the summer (when silver hake spawn) and winter he noted that the feeding rate diminishes. The data presented here, alone or in conjunction with other published and unpublished data, tends to corroborate Vinogradov's conclusions. Silver hake caught in the spring had twice as much food in their stomachs as those caught in fall (data in this paper for 24-35 cm FL fish, 1.282 g-spring; 0.591 g-fall). The stomachs of spawning silver hake contained small quantities of food (0.122 g) compared to fish with developing (1.004 g) or spent (1.292 g) gonads (present data). Fish >20 cm FL collected during late summer-early autumn on Georges Bank in 1978 had small quantities of food (mean stomach content weight of 0.193 g) in their stomachs (Bowman and Bowman 1980). The stomach contents of silver hake collected on Georges Bank during the winter (December-January) of

1976-1977 were analyzed by Bowman and Langton (1978) and the mean stomach content weight of fish 20 cm FL and larger was 0.4 g. The stomachs of silver hake (all larger than 29 cm FL) collected in February (late winter) of 1977 on Georges Bank, by American and Polish scientists aboard the Polish research vessel WIECZNO (conducting research in conjunction with the Woods Hole Laboratory), contained an average of 0.103 grams of food (unpublished data-available from the author). The pattern of feeding intensity for silver hake throughout the year, based on the above information, is intensive feeding in the spring and early summer; curtailment of feeding in summer and early autumn (during spawning); resumption of feeding in the autumn, but to a lesser degree than in the spring; and finally a reduction in feeding throughout the winter. Somewhat similar feeding patterns have been established for other species of marine fish (Tyler 1971).

Grosslein et al. (1980) reported an increase in bottom trawl survey catches of American sand lance in 1976 in the Northwest Atlantic. The population upsurge of American sand lance, and the high percentage weights of American sand lance found in silver hake stomachs during 1976, is an indication of silver hake's opportunistic predatory behavior. Availability of prey is likely one of the most important factors in determining what types and how much food silver hake eat.

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Table 1. Number of silver hake stomachs examined from each geographic area by year and season.

Year	Season	Number examined		
		Middle Atlantic	Southern New England	Georges Bank
1973	Spring	39	105	48
	Fall	144	129	191
1974	Spring	189	93	103
	Fall	54	117	157
1975	Spring	68	100	92
	Fall	91	120	146
1976	Spring	111	125	63
	Fall	93	129	115
Totals		789	918	915

Table 2. Dietary composition of 2622 silver hake caught in the Northwest Atlantic during the years 1973-1976. (+ indicates <0.1%.)

Prey	Percentage weight		
POLYCHAETA	0.1		
CRUSTACEA	10.2		
Amphipoda		1.3	
Ampeliscidae			1.0
Oedicerotidae			0.1
Hyperiidae			0.1
Other Amphipoda			0.1
Decapoda		3.9	
Crangonidae			1.4
Pandalidae			2.0
Pasiphaeidae			0.1
Other Decapoda			0.4
Euphausiacea		4.0	
Mysidacea		0.7	
Cumacea		+	
Copepoda		+	
Other Crustacea		0.3	
CEPHALOPODA	9.2		
Loligo			7.6
Other Cephalopoda			1.6
PISCES	80.0		
Scomberesox saurus			1.5
Clupeidae			2.7
Merluccius bilinearis			9.2
Phycis chesteri			0.2
Ammodytes americanus			1.8
Scomber scombrus			7.5
Stenotomus chrysops			1.6
Peprilus triacanthus			3.5
Other Pisces			52.0
MISCELLANEOUS	0.5		
No. of stomachs examined		2622	
No. of empty stomachs		803	
Mean stom. cont. wt. (g)		1.477	
Mean fish FL (cm)		20.3	

Table 3. Percentage composition (by weight) of the diet of silver hake versus fish length for silver hake collected in the Northwest Atlantic from 1973 through 1976. (+ indicates <0.1%.)

Prey	Length category (cm) 1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	>50
POLYCHAETA	-	0.4	0.5	-	0.1	0.3	0.2	+	0.1	-	-
CRUSTACEA	89.7	80.3	81.6	77.3	28.0	55.5	21.3	2.3	0.5	0.2	0.2
Amphipoda	58.7	18.9	6.1	1.2	1.7	1.3	0.7	+	+	-	+
Ampeliscidae	11.0	4.9	0.1	0.5	0.6	0.5	0.2	+	-	-	+
Oedicerotidae	3.1	3.4	4.1	0.1	+	0.2	0.1	+	-	-	-
Hyperiidae	42.1	6.2	0.3	0.4	0.6	0.4	0.3	-	-	-	-
Other Amphipoda	2.5	4.4	1.6	0.2	0.5	0.2	0.1	+	+	-	-
Decapoda	11.8	23.9	31.1	7.0	16.2	20.0	10.5	1.6	0.3	0.1	0.1
Crangonidae	7.7	16.0	18.7	3.7	4.3	6.1	4.3	0.3	0.1	-	+
Pandalidae	-	1.7	5.3	2.1	10.7	12.0	4.3	1.2	0.2	-	0.1
Pasiphaeidae	-	-	-	-	-	-	0.8	-	-	-	-
Other Decapoda	4.1	6.2	7.1	1.2	1.2	1.9	1.1	0.1	-	0.1	-
Euphausiacea	1.9	5.7	23.7	64.4	7.8	26.4	8.8	0.6	0.2	0.1	-
Mysidacea	4.2	22.1	12.8	3.9	0.2	6.7	0.6	+	+	-	0.1
Cumacea	0.8	1.1	0.2	+	0.2	+	+	-	-	-	-
Copepoda	1.7	+	+	-	+	-	-	-	-	-	-
Other Crustacea	10.6	8.6	7.7	0.8	1.9	1.1	0.7	0.1	+	+	+
CEPHALOPODA	-	-	-	-	17.8	3.4	14.9	14.3	0.1	12.0	-
Loligo	-	-	-	-	15.3	-	13.5	10.0	-	12.0	-
Other Cephalopoda	-	-	-	-	2.5	3.4	1.4	4.3	0.1	+	-
PISCES	4.8	13.9	14.0	19.9	52.8	38.7	62.4	83.4	98.9	87.8	99.8
Scomberesox saurus	-	-	-	-	-	-	-	5.6	-	-	-
Clupeidae	-	-	-	-	-	-	3.5	3.5	8.0	-	-
Merluccius bilinearis	-	2.0	4.0	-	22.1	5.0	6.9	24.2	5.9	-	-
Phycis chesteri	-	-	-	-	-	-	1.2	-	-	-	-
Ammodytes americanus	-	6.3	2.0	-	-	+	3.1	0.4	7.7	-	-
Scomber scombrus	-	-	-	-	-	-	7.8	8.8	6.1	6.8	15.5
Stenotomus chrysops	-	-	-	-	-	-	-	-	10.5	-	-
Peprilus triacanthus	-	-	-	-	-	-	2.7	3.4	-	-	20.6
Other Pisces	4.8	5.6	8.0	19.9	30.7	33.7	37.2	37.5	60.7	81.0	63.7
MISCELLANEOUS	5.5	5.4	3.9	2.8	1.3	2.1	1.2	+	0.4	+	-
No. of stomachs examined	344	603	216	86	243	444	428	147	61	28	22
No. of empty stomachs	60	75	38	26	108	192	189	63	29	11	12
Mean stom. cont. wt.(g)	0.066	0.025	0.104	0.370	0.452	0.545	1.440	7.278	10.321	32.081	20.262
Mean fish FL (cm)	4.5	7.7	12.5	18.0	23.5	28.2	32.6	37.7	42.8	47.9	54.4

Table 4. Stomach contents of male and female silver hake collected in the Northwest Atlantic during 1973-1976. Data are expressed as a percentage weight. (+ indicates <0.1%.)

Prey	Male		Female	
POLYCHAETA	0.2		+	
CRUSTACEA	35.0		4.5	
Amphipoda		0.6		0.2
Ampeliscidae		0.2		0.1
Oedicerotidae		0.1		+
Hyperiidae		0.2		0.1
Other Amphipoda		0.1		+
Decapoda		11.9		2.3
Crangonidae		5.1		0.6
Pandalidae		5.5		1.5
Pasiphaeidae		-		+
Other Decapoda		1.3		0.2
Euphausiacea	18.8		1.7	
Mysidacea	2.7		0.2	
Cumacea	+		+	
Copepoda	+		-	
Other Crustacea	1.0		0.1	
CEPHALOPODA	4.3		10.4	
Loligo		3.4		8.6
Other Cephalopoda		0.9		1.8
PISCES	59.1		84.6	
Scomberesox saurus		-		1.8
Clupeidae		-		3.2
Merluccius bilinearis		22.6		7.6
Phycis chesteri		-		0.2
Ammodytes americanus		1.4		2.0
Scomber scombrus		3.8		8.4
Stenotomus chrysops		-		1.9
Peprilus triacanthus		3.3		3.7
Other Pisces		28.0		55.8
MISCELLANEOUS	1.4		0.5	
No. examined	613		842	
No. of empty stomachs	252		354	
Mean stom. cont. wt.(g)	0.853		4.204	
Mean fish FL (cm)	28.4		32.1	
Length range (cm)	6-59		7-64	

Table 5. Composition of the diet, of male silver hake, in terms of percentage weight versus fish length. (+ indicates <0.1%.)

Prey	Length group (cm) 5-10	11-15	16-20	21-25	26-30	31-35	36-40	>41
POLYCHAETA	-	-	-	0.3	+	0.3	-	-
CRUSTACEA	19.2	64.1	97.2	29.3	73.1	32.7	3.8	1.9
Amphipoda	-	-	2.7	1.4	1.0	0.2	0.1	+
Ampeliscidae	-	-	1.9	0.6	0.4	+	0.1	+
Oedicerotidae	-	-	-	-	0.1	0.1	+	-
Hyperiidae	-	-	0.8	0.6	0.4	0.1	-	-
Other Amphipoda	-	-	+	0.2	0.1	+	+	-
Decapoda	0.3	1.9	1.1	10.7	19.1	15.0	2.6	1.5
Crangonidae	-	1.9	0.6	1.5	7.4	7.7	0.9	0.1
Pandalidae	-	-	-	8.3	9.8	5.7	1.7	-
Pasiphaeidae	-	-	-	-	-	-	-	-
Other Decapoda	0.3	-	0.5	0.9	1.9	1.6	-	1.4
Euphausiacea	-	50.3	92.7	14.2	41.4	15.9	+	-
Mysidacea	11.3	11.9	-	-	10.4	0.8	0.2	0.4
Cumacea	-	-	-	0.4	+	+	-	-
Copepoda	-	-	-	+	-	-	-	-
Other Crustacea	7.6	-	0.7	2.6	1.2	0.8	0.9	-
CEPHALOPODA	-	-	-	4.4	0.2	8.3	2.5	-
Loligo	-	-	-	-	-	8.1	-	-
Other Cephalopoda	-	-	-	4.4	0.2	0.2	2.5	-
PISCES	71.4	21.6	+	64.1	23.6	57.2	93.7	98.1
Scomberesox saurus	-	-	-	-	-	-	-	-
Clupeidae	-	-	-	-	-	-	-	-
Merluccius bilinearis	-	-	-	10.0	5.0	7.7	70.0	66.2
Phycis chesteri	-	-	-	-	-	-	-	-
Ammodytes americanus	50.8	21.6	-	-	-	3.1	-	-
Scomber scombrus	-	-	-	-	-	9.2	-	-
Stenotomus chrysops	-	-	-	-	-	-	-	-
Peprilus triacanthus	-	-	-	-	-	8.0	-	-
Other Pisces	20.6	+	+	54.1	18.6	29.2	23.7	31.9
MISCELLANEOUS	9.4	14.3	2.8	1.9	3.1	1.5	-	-
No. examined	12	5	20	119	248	178	21*	8*
No. empty	4	0	4	50	109	73	9	3
Mean stom. cont. wt. (g)	0.030	0.435	0.414	0.400	0.456	1.215	3.565	7.282
Mean fish FL (cm)	8.4	13.4	19.1	23.7	28.5	32.2	37.1	50.9

Table 6. Composition of the diet of female silver hake, in terms of percentage weight, versus fish length. (+ indicates <0.1%.)

Prey	Length group (cm) 5-10	11-15	16-20	21-25	26-30	31-35	36-40	>41
POLYCHAETA	-	-	-	-	0.4	0.1	+	+
CRUSTACEA	8.7	100.0	75.2	27.9	39.9	13.0	2.0	0.2
Amphipoda	0.3	-	0.3	1.8	1.3	0.8	+	+
Ampeliscidae	-	-	-	0.7	0.5	0.2	+	-
Oedicerotidae	-	-	-	+	0.3	+	+	-
Hyperiidae	0.3	-	0.1	0.5	0.3	0.4	-	-
Other Amphipoda	-	-	0.2	0.6	0.2	0.2	+	+
Decapoda	-	95.4	7.2	21.1	20.3	5.9	1.4	0.1
Crangonidae	-	95.4	1.8	6.6	5.1	1.9	0.2	+
Pandalidae	-	-	4.7	12.9	13.3	3.1	1.1	0.1
Pasiphaeidae	-	-	-	-	-	+	-	-
Other Decapoda	-	-	0.7	1.6	1.9	0.9	0.1	-
Euphausiacea	7.5	4.0	66.8	3.3	13.5	5.2	0.6	0.1
Mysidacea	0.9	-	-	0.3	3.8	0.5	+	+
Cumacea	-	-	-	0.1	+	+	-	-
Copepoda	-	-	-	-	-	-	-	-
Other Crustacea	-	0.6	0.9	1.3	1.0	0.6	+	+
CEPHALOPODA	-	-	-	28.4	6.1	18.7	15.1	5.9
Loligo	-	-	-	27.2	-	16.6	10.7	5.8
Other Cephalopoda	-	-	-	1.2	6.1	2.1	4.4	0.1
PISCES	81.9	-	22.0	42.9	51.8	66.7	82.7	93.6
Scomberesox saurus	-	-	-	-	-	-	6.1	-
Clupeidae	-	-	-	-	-	5.4	3.8	2.8
Merluccius bilinearis	-	-	-	31.9	5.0	6.6	20.8	-
Phycis chesteri	-	-	-	-	-	-	-	-
Ammodytes americanus	81.9	-	-	-	0.1	3.2	0.5	2.7
Scomber scombrus	-	-	-	-	-	7.3	9.5	9.3
Stenotomus chrysops	-	-	-	-	1.6	-	-	3.7
Peprilus triacanthus	-	-	-	-	-	-	3.6	5.0
Other Pisces	-	-	22.0	11.0	45.1	44.2	38.4	70.1
MISCELLANEOUS	9.4	-	2.8	0.8	1.8	1.5	0.2	0.3
No. examined	9	3	22	113	202	259	126	103
No. empty	2	0	3	45	83	120	54	47
Mean stom. cont. wt.(g)	0.099	0.152	0.670	0.571	0.673	1.597	8.185	17.826
Mean fish FL (cm)	8.0	12.0	18.5	23.4	28.0	32.9	37.7	46.0

Table 7. Prey in the stomachs of silver hake collected during each hour over a 24-hour period. Data are expressed as a percentage weight and a "+" indicates <0.1%.

Prey	Hour 01	02	03	04	05	06	07
POLYCHAETA	0.1	-	-	-	-	+	-
CRUSTACEA	28.0	2.8	14.0	64.6	5.2	10.2	2.2
Amphipoda	3.8	0.3	0.3	2.0	0.1	0.3	0.1
Ampeliscidae	0.8	0.1	0.1	0.9	-	0.1	+
Oedicerotidae	1.4	+	+	0.5	-	+	+
Hyperiidae	0.8	0.1	0.2	0.4	+	0.1	-
Other Amphipoda	0.8	0.1	+	0.2	0.1	0.1	0.1
Decapoda	18.1	1.3	12.1	9.1	4.4	1.9	1.0
Crangonidae	7.4	0.6	2.5	2.8	0.5	0.4	0.9
Pandalidae	9.6	0.6	9.5	5.3	2.9	1.0	0.1
Pasiphaeidae	-	-	-	-	-	-	-
Other Decapoda	1.1	0.1	0.1	1.0	1.0	0.5	-
Euphausiacea	0.4	0.9	0.9	52.1	0.5	7.7	0.2
Mysidacea	4.0	0.2	0.4	0.3	-	+	0.7
Cumacea	0.1	+	+	+	-	+	-
Copepoda	-	+	-	+	-	-	-
Other Crustacea	1.6	0.1	0.3	1.1	0.2	0.3	0.2
CEPHALOPODA	3.4	2.5	-	-	89.6	2.4	-
Loligo	-	2.4	-	-	89.3	-	-
Other Cephalopoda	3.4	0.1	-	-	0.3	2.4	-
PISCES	66.1	94.7	86.0	34.5	5.0	87.3	97.7
Scomberesox saurus	-	-	-	-	-	-	-
Clupeidae	-	-	16.1	-	-	-	-
Merluccius bilinearis	10.4	16.2	-	-	-	43.0	-
Phycis chesteri	-	-	-	-	-	-	-
Ammodytes americanus	17.2	-	-	-	-	0.9	31.9
Scomber scombrus	-	14.0	26.0	-	-	-	-
Stenotomus chrysops	-	-	-	-	-	-	-
Peprilus triacanthus	-	-	37.8	-	-	-	-
Other Pisces	38.5	64.5	6.1	34.5	5.0	43.4	65.8
MISCELLANEOUS	2.4	+	+	0.9	0.2	0.1	0.1
No. examined	199	170	180	208	48	114	50
No. empty	37	43	27	31	26	40	23
Mean stom. cont. wt.	0.391	4.246	1.350	0.302	1.156	1.416	3.097
Mean fish FL (cm)	16.9	21.3	15.1	12.4	27.1	23.6	26.2
Length range (cm)	3-49	4-57	4-51	4-39	10-43	3-54	9-50

Table 7. (cont'd)

Prey	Hour 08	09	10	11	12	13	14
POLYCHAETA	0.7	0.3	0.1	-	+	-	-
CRUSTACEA	68.4	28.1	31.7	7.0	7.6	8.8	15.3
Amphipoda	6.3	1.7	+	0.1	0.2	+	+
Ampeliscidae	3.7	0.7	+	+	+	-	-
Oedicerotidae	0.1	-	+	-	0.1	-	-
Hyperiidae	2.0	0.3	-	0.1	+	+	+
Other Amphipoda	0.5	0.7	+	+	0.1	-	+
Decapoda	40.0	19.8	1.0	5.2	1.6	+	1.2
Crangonidae	7.6	2.5	0.7	1.3	1.0	+	0.3
Pandalidae	32.2	13.7	-	2.9	0.3	-	0.6
Pasiphaeidae	-	-	-	-	-	-	-
Other Decapoda	0.2	3.6	0.3	1.0	0.3	-	0.3
Euphausiacea	4.2	4.9	30.5	1.4	1.9	6.0	11.3
Mysidacea	7.8	0.2	-	0.1	3.5	2.5	2.6
Cumacea	+	0.1	-	0.1	-	-	-
Copepoda	-	-	-	+	-	-	-
Other Crustacea	10.1	1.4	0.2	0.1	0.4	0.3	0.2
CEPHALOPODA	3.8	-	30.0	-	-	7.6	-
Loligo	-	-	27.5	-	-	-	-
Other Cephalopoda	3.8	-	2.5	-	-	7.6	-
PISCES	25.0	71.0	37.6	92.9	91.0	78.7	84.5
Scomberesox saurus	-	-	-	-	-	-	-
Clupeidae	-	-	-	-	-	-	-
Merluccius bilinearis	2.3	-	-	63.4	-	0.6	-
Phycis chesteri	-	-	-	-	4.3	-	-
Ammodytes americanus	-	16.6	-	-	-	-	-
Scomber scombrus	-	-	-	-	84.8	-	-
Stenotomus chrysops	-	-	-	-	-	-	-
Peprilus triacanthus	-	-	23.8	-	-	-	-
Other Pisces	22.7	54.4	13.8	29.5	1.9	78.1	84.5
MISCELLANEOUS	2.1	0.6	0.6	0.1	1.4	4.9	0.2
No. examined	51	91	42	74	63	63	68
No. empty	9	44	19	28	24	40	40
Mean stom. cont. wt.	0.402	0.324	1.729	2.331	2.885	0.850	1.781
Mean fish FL (cm)	27.1	25.9	28.1	25.0	27.1	29.3	33.0
Length range (cm)	13-42	5-64	9-45	4-46	9-54	13-46	10-53

Table 7. (cont'd)

Prey	Hour 15	16	17	18	19	20
POLYCHAETA	0.1	-	0.4	-	0.2	0.3
CRUSTACEA	8.1	10.8	37.7	29.8	9.0	7.2
Amphipoda	+	+	0.3	0.4	0.3	0.8
Ampeliscidae	+	-	+	-	0.1	+
Oedicerotidae	-	-	-	+	-	0.2
Hyperiidae	+	+	+	0.4	0.2	0.4
Other Amphipoda	+	+	0.3	+	+	0.2
Decapoda	4.8	1.9	33.9	16.7	2.1	4.9
Crangonidae	0.8	0.3	19.5	9.1	0.5	2.4
Pandalidae	0.7	0.8	8.7	-	0.6	2.2
Pasiphaeidae	-	-	-	7.6	-	-
Other Decapoda	3.3	0.8	5.7	+	1.0	0.3
Euphausiacea	0.9	7.8	0.2	11.1	6.5	1.1
Mysidacea	-	1.0	0.7	+	+	-
Cumacea	-	+	-	-	+	0.1
Copepoda	-	-	-	+	-	+
Other Crustacea	2.4	0.1	2.6	1.6	0.1	0.3
CEPHALOPODA	-	5.6	39.0	2.5	30.8	0.8
Loligo	-	-	35.9	-	-	-
Other Cephalopoda	-	5.6	3.1	2.5	30.8	0.8
PISCES	89.9	82.8	20.7	62.7	59.6	88.8
Scomberesox saurus	-	-	-	-	-	-
Clupeidae	83.1	-	-	-	-	-
Merluccius bilinearis	1.3	-	-	8.2	0.2	-
Phycis chesteri	-	-	-	-	-	-
Ammodytes americanus	-	-	-	-	-	+
Scomber scombrus	-	-	-	-	-	-
Stenotomus chrysops	-	-	-	-	-	41.9
Peprilus triacanthus	-	-	-	-	-	-
Other Pisces	5.5	82.0	20.7	54.5	59.4	46.9
MISCELLANEOUS	1.9	0.8	2.2	5.0	0.4	2.9
No. examined	67	111	114	123	136	181
No. empty	37	31	49	33	55	54
Mean stom. cont. wt.	0.397	1.406	0.471	0.523	0.956	0.898
Mean fish FL (cm)	25.7	21.1	21.0	16.8	19.5	20.3
Length range (cm)	4-49	4-55	5-53	3-44	3-53	4-59

Table 7. (cont'd)

Prey	Hour 21	22	23	24
POLYCHAETA	-	0.4	0.4	+
CRUSTACEA	2.1	18.1	57.5	1.2
Amphipoda	+	0.7	3.5	+
Ampeliscidae	+	+	1.7	+
Oedicerotidae	+	0.1	+	+
Hyperiidae	+	0.5	0.9	+
Other Amphipoda	+	0.1	0.9	+
Decapoda	1.9	2.8	35.9	0.7
Crangonidae	0.7	1.5	7.4	0.2
Pandalidae	1.2	1.2	19.5	0.4
Pasiphaeidae	-	-	-	+
Other Decapoda	+	0.1	9.0	0.1
Euphausiacea	0.1	11.6	15.8	0.4
Mysidacea	+	2.8	+	0.1
Cumacea	+	+	0.1	+
Copepoda	+	+	+	-
Other Crustacea	0.1	0.2	2.2	+
CEPHALOPODA	0.2	-	-	36.2
Loligo	-	-	-	36.2
Other Cephalopoda	0.2	-	-	+
PISCES	97.7	81.1	38.3	62.5
Scomberesox saurus	-	-	-	10.5
Clupeidae	-	20.0	-	-
Merluccius bilinearis	-	28.3	-	0.9
Phycis chesteri	-	-	-	-
Ammodytes americanus	-	-	28.7	+
Scomber scombrus	-	-	-	-
Stenotomus chrysops	-	-	-	-
Peprilus triacanthus	-	-	-	6.3
Other Pisces	97.7	32.8	9.6	44.8
MISCELLANEOUS	+	0.4	3.8	0.1
No. examined	83	158	202	129
No. empty	18	43	58	20
Mean stom. cont. wt.	7.513	1.638	0.115	4.610
Mean fish FL (cm)	21.6	17.5	15.9	18.9
Length range (cm)	4-50	3-45	4-55	5-52

Table 8. Geographic breakdown of the prey found in the stomachs of silver hake caught in the Northwest Atlantic during the years 1973-1976. Data are expressed as a percentage weight. (+ indicates <0.1%.)

Prey	Middle Atlantic		Southern New England		Georges Bank	
POLYCHAETA	0.1		0.1		0.1	
CRUSTACEA	7.3		7.3		16.4	
Amphipoda		0.5		0.2		0.4
Ampeliscidae		0.1		0.1		0.1
Oedicerotidae		0.2		+		0.1
Hyperiidae		0.1		0.1		0.1
Other Amphipoda		0.1		+		0.1
Decapoda		4.9		2.6		6.5
Crangonidae		2.4		1.0		1.3
Pandalidae		1.8		1.2		4.4
Pasiphaeidae		0.4		-		+
Other Decapoda		0.3		0.4		0.8
Euphausiacea		1.2		3.4		7.9
Mysidacea		0.3		0.7		1.2
Cumacea		-		0.1		+
Copepoda		+		+		+
Other Crustacea		0.4		0.3		0.4
CEPHALOPODA	4.3		13.7		6.7	
Loligo		2.9		13.0		6.7
Other Cephalopoda		1.4		0.7		+
PISCES	87.5		78.4		76.4	
Scomberesox saurus		-		-		6.1
Clupeidae		3.2		1.3		5.0
Merluccius bilinearis		20.8		7.9		0.4
Phycis chesteri		-		-		0.8
Ammodytes americanus		1.7		0.4		4.8
Scomber scombrus		-		6.0		21.1
Stenotomus chrysops		-		4.1		-
Peprilus triacanthus		1.4		2.2		8.9
Other Pisces		60.4		56.5		29.3
MISCELLANEOUS	0.8		0.5		0.4	
No. of stomach examined	789		918		915	
No. of empty stomachs	180		357		268	
Mean stom. cont. wt.	1.544		1.815		1.080	
Mean fish FL (cm)	17.5		22.5		20.8	
Length range (cm)	3-57		3-59		3-64	

Table 9a. Annual and seasonal breakdown of the stomach contents for silver hake collected in the Middle Atlantic. Data are expressed as a percentage weight for fish collected during the spring and autumn of the years 1973-1976. (+ indicates present but <0.1%.)

Prey	MIDDLE ATLANTIC							
	1973		1974		1975		1976	
	S	F	S	F	S	F	S	F
POLYCHAETA	-	-	0.1	-	0.5	-	1.6	-
CRUSTACEA	3.1	4.2	9.6	6.5	24.7	4.7	34.0	70.0
Amphipoda	+	0.4	1.2	1.2	1.3	2.7	2.1	15.2
Ampeliscidae	-	0.2	+	0.7	-	0.3	0.6	1.3
Oedicerotidae	-	+	1.1	-	0.4	-	0.9	-
Hyperiidae	-	0.1	-	0.5	+	2.1	-	12.1
Other amphipoda	+	0.1	0.1	+	0.9	0.3	0.6	1.8
Decapoda	3.1	3.3	3.7	5.1	8.9	0.4	22.9	46.6
Crangonidae	1.4	0.5	2.0	4.4	5.9	0.3	11.1	25.8
Pandalidae	1.0	2.4	-	0.7	2.6	-	11.7	13.3
Pasiphaeidae	0.6	-	-	-	-	-	-	-
Other Decapoda	0.1	0.4	1.7	+	0.4	0.1	0.1	7.5
Euphausiacea	-	0.2	4.4	-	14.4	0.3	+	-
Mysidacea	-	+	-	-	-	-	5.4	-
Cumacea	-	+	+	+	0.1	-	+	-
Copepoda	-	-	+	+	-	+	-	-
Other Crustacea	+	0.3	0.3	0.2	+	1.3	3.6	8.2
CEPHALOPODA	-	14.9	9.7	-	25.2	-	6.3	-
Loligo	-	12.4	-	-	24.9	-	-	-
Other Cephalopoda	-	2.5	9.7	-	0.3	-	6.3	-
PISCES	96.5	80.9	79.5	93.0	46.6	93.7	54.8	5.2
Scomberesox saurus	-	-	-	-	-	-	-	-
Clupeidae	-	-	-	91.5	-	-	-	-
Merluccius bilinearis	23.3	49.0	-	-	4.0	-	-	-
Phycis chesteri	-	-	-	-	-	-	-	-
Ammodytes americanus	-	-	-	-	10.7	-	19.8	-
Scomber scombrus	-	-	-	-	-	-	-	-
Stenotomus chrysops	-	-	-	-	-	-	-	-
Peprilus triacanthus	-	-	-	-	24.4	-	-	-
Other Pisces	73.2	31.9	79.5	1.5	7.5	93.7	35.0	5.2
MISCELLANEOUS	0.4	+	1.1	0.5	3.0	1.6	3.3	24.8
No. examined	39	144	193	54	67	91	111	93
No. empty	11	52	26	10	7	23	22	29
Mean stom. cont. wt.(g)	19.960	0.982	0.466	0.793	1.057	0.243	0.606	0.075
Mean fish FL (cm)	33.9	18.0	14.1	12.9	19.8	13.5	21.7	16.9
Length range (cm)	20-53	4-45	3-46	4-37	5-44	3-40	8-57	3-35

Table 9b. Annual and seasonal breakdown of the stomach contents for silver hake collected in Southern New England. Data are expressed as a percentage weight for fish collected during the spring and autumn of the years 1973-1976. (+ indicates present but <0.1%.)

Prey	SOUTHERN NEW ENGLAND							
	1973		1974		1975		1976	
	S	F	S	F	S	F	S	F
POLYCHAETA	0.1	-	+	-	+	+	0.2	+
CRUSTACEA	2.8	12.5	3.3	46.1	7.9	17.0	19.8	2.2
Amphipoda	+	1.7	+	4.0	0.1	0.8	0.2	0.5
Ampeliscidae	-	1.6	+	1.5	0.1	0.2	+	+
Oedicerotidae	-	-	-	-	+	-	+	+
Hyperiidae	-	0.1	-	1.9	+	0.5	0.1	0.5
Other Amphipoda	+	+	+	0.6	+	0.1	0.1	+
Decapoda	1.8	8.4	0.1	13.7	6.9	9.7	5.5	1.2
Crangonidae	0.2	0.9	+	4.5	2.0	0.4	4.7	0.2
Pandalidae	0.9	7.3	-	7.0	1.8	9.1	0.8	1.0
Pasiphaeidae	-	-	-	-	-	-	-	-
Other Decapoda	0.7	0.2	0.1	2.2	3.1	0.2	-	+
Euphausiacea	0.5	0.9	3.2	23.5	0.8	4.9	9.9	+
Mysidacea	0.3	+	-	-	0.1	0.9	3.8	-
Cumacea	+	-	+	1.7	+	-	+	+
Copepoda	-	+	-	+	-	+	-	-
Other Crustacea	0.2	1.5	-	3.2	+	0.7	0.4	0.5
CEPHALOPODA	78.9	1.6	0.3	-	20.2	-	-	2.8
Loligo	78.2	-	-	-	20.2	-	-	-
Other Cephalopoda	0.7	1.6	0.3	-	-	-	-	2.8
PISCES	18.2	85.9	95.6	45.2	70.1	82.9	79.8	94.5
Scomberesox saurus	-	-	-	-	-	-	-	-
Clupeidae	-	-	-	-	-	31.8	-	-
Merluccius bilinearis	0.2	0.7	-	2.3	5.5	1.6	-	44.9
Phycis chesteri	-	-	-	-	-	-	-	-
Ammodytes americanus	-	-	-	-	1.6	-	1.8	-
Scomber scombrus	-	-	15.7	-	-	-	-	-
Stenotomus chrysops	-	-	-	-	-	-	-	24.7
Peprilus triacanthus	14.7	-	-	-	-	-	-	-
Other Pisces	3.3	85.2	79.9	42.9	63.0	49.5	78.0	24.9
MISCELLANEOUS	+	+	0.8	8.7	1.8	0.1	0.2	0.5
No. examined	105	119	93	117	100	120	125	140
No. empty	33	86	40	38	41	31	43	45
Mean stom. cont. wt.(g)	2.406	0.401	6.902	0.107	0.952	0.581	2.181	1.970
Mean fish Fl. (cm)	15.9	27.5	31.2	16.8	24.4	18.1	23.0	22.9
Length range (cm)	6-47	4-49	9-59	4-37	6-55	4-55	3-53	4-54

Table 9c. Annual and seasonal breakdown of the stomach contents for silver hake collected on Georges Bank. Data are expressed as a percentage weight for fish collected during the spring and autumn of the years 1973-1976. (+ indicates present but <0.1%.)

Prey	GEORGES BANK							
	1973		1974		1975		1976	
	S	F	S	F	S	F	S	F
POLYCHAETA	-	-	-	-	+	+	+	-
CRUSTACEA	70.8	15.0	41.8	18.2	10.9	5.9	18.7	6.0
Amphipoda	1.4	0.4	0.3	1.3	0.2	0.4	0.9	0.1
Ampeliscidae	0.1	0.3	+	0.7	-	0.2	-	0.1
Oedicerotidae	-	+	+	0.3	0.1	+	-	-
Hyperiidae	-	-	-	-	-	0.1	0.8	+
Other Amphipoda	1.3	0.1	0.3	0.3	0.1	0.1	0.1	+
Decapoda	60.7	13.9	2.5	12.6	1.0	3.2	2.8	4.5
Crangonidae	1.9	2.0	1.3	2.1	0.5	1.6	0.6	2.1
Pandalidae	44.5	11.6	-	8.3	-	1.1	2.0	2.2
Pasiphaeidae	-	-	0.1	-	-	-	-	-
Other Decapoda	14.3	0.3	1.1	2.2	0.5	0.5	0.2	0.2
Euphausiacea	2.3	0.2	31.2	2.6	9.4	0.5	14.8	+
Mysidacea	-	0.1	7.8	1.6	0.2	1.7	-	0.1
Cumacea	+	+	-	+	-	+	-	-
Copepoda	-	+	-	+	-	+	-	-
Other Crustacea	5.9	0.4	+	0.1	0.1	0.1	0.2	1.3
CEPHALOPODA	-	-	-	-	-	-	12.8	56.4
Loligo	-	-	-	-	-	-	12.8	56.2
Other Cephalopoda	-	-	-	-	-	-	-	0.2
PISCES	23.7	84.9	57.9	81.8	88.1	94.1	68.5	35.8
Scomberesox saurus	-	-	-	68.8	-	-	-	-
Clupeidae	-	-	-	-	-	39.2	-	-
Merluccius bilinearis	-	-	-	4.1	-	-	-	-
Phycis chesteri	-	-	-	-	3.2	-	-	-
Ammodytes americanus	-	-	-	-	-	-	31.6	-
Scomber scombrus	-	31.0	-	-	63.7	-	-	-
Stenotomus chrysops	-	-	-	-	-	-	-	-
Peprilus triacanthus	-	45.1	-	-	-	-	-	-
Other Pisces	23.7	8.8	57.9	8.9	21.2	54.9	36.9	35.8
MISCELLANEOUS	5.5	0.1	0.3	+	1.0	+	-	1.8
No. examined	48	198	103	157	92	146	63	115
No. empty	24	39	39	27	18	39	34	48
Mean stom. cont. wt. (g)	0.340	1.029	0.996	0.577	2.629	0.906	2.478	0.767
Mean fish FL (cm)	31.4	16.6	24.2	16.0	24.5	18.1	29.7	22.3
Length range (cm)	27-42	4-54	8-49	4-40	11-54	4-48	10-64	3-55

Table 10. Annual and seasonal breakdown of the adjusted mean stomach content weight data of large (24-35 cm FL) and small (4-15 cm FL) silver hake gathered from three geographical areas in the Northwest Atlantic during 1973-1976. (S = spring, F = autumn.)

	YEAR AND SEASON									
	1973		1974		1975		1976		Averages	
AREA	S	F	S	F	S	F	S	F	S	F
Middle Atlantic										
Large fish										
Adjusted weight(g)	5.545	1.081	0.995	0.325	2.203	0.912	0.936	0.149	2.420	0.617
Number in sample	26	68	44	9	26	29	38	43		
Small fish										
Adjusted weight(g)	-	0.108	0.180	0.096	0.148	0.142	0.207	0.155	0.178	0.131
Number in sample	-	61	136	33	31	45	47	42		
Southern New England										
Large fish										
Adjusted weight(g)	0.242	0.122	0.488	0.303	0.694	0.657	0.987	0.976	0.603	0.515
Number in sample	17	67	51	33	47	49	63	58		
Small fish										
Adjusted weight(g)	0.256	0.036	0.200	0.074	0.414	0.184	0.205	0.149	0.269	0.111
Number in sample	73	15	4	49	35	62	39	58		
Georges Bank										
Large fish										
Adjusted weight(g)	0.400	0.743	0.916	0.576	1.239	0.506	0.735	0.734	0.823	0.640
Number in sample	43	58	50	53	32	57	27	51		
Small fish										
Adjusted weight(g)	-	0.140	0.321	0.325	0.566	0.106	0.473	0.117	0.453	0.183
Number in sample	-	119	36	95	16	80	9	50		
Ave. large fish adj. wt.									1.282	0.591
Ave. small fish adj. wt.									0.300	0.142

Table 11. Relationship between the adjusted stomach content weight and maturity stage of silver hake. Fish were caught on spring and autumn bottom trawl survey cruises conducted in the Northwest Atlantic from 1973 to 1976.

Stomach content data	Maturity Stage			
	Resting	Developing	Ripe	Spent
Adjusted weight (g)	0.826	1.004	0.122	1.292
Number of fish examined	379	297	29	54
Mean fish FL (cm)	28.6	30.6	31.3	31.2
Length range (cm)	24-35	24-35	27-34	25-35

Table 12. Breakdown by depth range of the stomach contents of silver hake caught at bottom water depths ranging from 27 to 365 m. Data expressed as a percentage weight. (+ indicates present but <0.1%.)

Prey	Bottom depth range (m) 27-37	38-73	74-110	111-146	147-183	184-220	221-256
POLYCHAETA	0.4	+	+	-	-	0.1	-
CRUSTACEA	14.1	6.6	6.1	7.1	18.5	37.2	21.8
Amphipoda	0.5	0.4	0.5	0.2	0.1	0.3	0.2
Ampeliscidae	0.1	0.1	0.1	0.2	+	0.3	-
Oedicerotidae	0.3	+	0.1	-	-	-	-
Hyperiidae	+	0.2	0.2	+	0.1	-	0.1
Other Amphipoda	0.1	0.1	0.1	+	-	+	0.1
Decapoda	8.2	4.3	4.3	1.5	0.3	7.8	0.5
Crangonidae	5.2	1.4	0.9	0.2	+	0.3	+
Pandalidae	1.8	2.5	2.8	1.0	-	5.8	-
Pasiphaeidae	1.0	-	-	-	-	-	-
Other Decapoda	0.2	0.4	0.6	0.3	0.3	1.7	0.5
Euphausiacea	3.8	0.7	1.0	5.2	16.1	29.0	20.1
Mysidacea	0.8	0.9	0.1	+	1.8	-	-
Cumacea	+	+	+	-	-	-	-
Copepoda	+	+	+	+	-	-	-
Other Crustacea	0.8	0.3	0.2	0.2	0.2	0.1	1.0
CEPHALOPODA	0.4	2.4	9.4	-	54.0	53.6	-
Loligo	-	2.0	7.4	-	53.7	-	-
Other Cephalopoda	0.4	0.4	2.0	-	0.3	53.6	-
PISCES	83.4	90.5	83.8	92.9	27.2	8.2	77.5
Scomberesox saurus	-	3.6	-	-	-	-	-
Clupeidae	-	1.3	4.2	-	12.8	-	-
Merluccius bilinearis	23.8	15.4	+	-	-	-	-
Phycis chesteri	-	-	0.8	-	-	-	-
Ammodytes americanus	4.1	2.9	-	1.3	-	-	-
Scomber scombrus	-	5.8	23.4	-	-	-	-
Stenotomus chrysops	-	3.9	-	-	-	-	-
Peprilus triacanthus	-	1.0	9.9	-	9.2	-	-
Other Pisces	55.5	56.6	45.5	91.6	5.2	8.2	77.5
MISCELLANEOUS	1.7	0.5	0.7	+	0.3	0.9	0.7
No. examined	330	1136	752	172	120	93	50
No. empty	68	282	262	98	43	31	20
Mean stom. cont. wt. (g)	1.531	1.530	1.232	2.221	3.375	0.802	1.185
Mean fish FL (cm)	17.3	18.0	20.7	25.5	29.2	25.0	21.1
Length range (cm)	3-49	3-57	3-64	3-53	12-47	7-52	9-49

Table 12. (cont'd)

Prey	Bottom depth range (m) 257-293	294-329	330->365
POLYCHAETA	-	-	-
CRUSTACEA	8.3	4.3	34.0
Amphipoda	+	-	0.7
Ampeliscidae	-	-	-
Oedicerotidae	-	-	-
Hyperiidae	+	-	0.7
Other Amphipoda	+	-	-
Decapoda	0.6	-	10.7
Crangonidae	-	-	-
Pandalidae	-	-	-
Pasiphaeidae	0.1	-	-
Other Decapoda	0.5	-	10.7
Euphausiacea	5.9	3.5	22.6
Mysidacea	1.4	0.8	-
Cumacea	-	-	-
Copepoda	-	-	-
Other Crustacea	0.4	-	-
CEPHALOPODA	-	-	-
Loligo	-	-	-
Other Cephalopoda	-	-	-
PISCES	91.6	93.2	65.8
Scomberesox saurus	-	-	-
Clupeidae	-	-	-
Merluccius bilinearis	-	-	-
Phycis chesteri	-	-	-
Ammodytes americanus	-	-	-
Scomber scombrus	-	-	-
Stenotomus chrysops	-	-	-
Peprilus triacanthus	-	-	-
Other Pisces	91.6	93.2	65.8
MISCELLANEOUS	0.1	2.5	0.2
No. examined	45	9	15
No. empty	20	1	4
Mean stom. cont. wt. (g)	1.885	4.129	0.768
Mean fish FL (cm)	31.8	32.2	28.0
Length range (cm)	12-51	31-34	21-34

Table 13. Adjusted mean stomach content data for large (24-35 cm FL) and small (4-15 cm FL) silver hake sampled within each given bottom water depth range. All samples were obtained during bottom trawl survey cruises conducted in the Northwest Atlantic, 1973-1976.

Bottom depth range(m)	Large fish (24-35 cm FL)		Small fish (4-15 cm FL)	
	Adjusted weight (g)	Number of fish	Adjusted weight (g)	Number of fish
0-37	1.240	85	0.252	190
38-73	1.020	384	0.183	600
74-110	0.612	295	0.136	334
111-146	1.260	93	0.116	25
147-183	0.946	94	-	-
184-220	0.296	44	-	-
257-293	0.082	25	-	-

Table 14. Composition of the stomach contents of silver hake collected at each bottom water temperature ranging from 1° - 16°C. Data are given in terms of percentage weight. (+ indicates present but <0.1%.)

Prey	Bottom Water Temperature °C 1	3	4	5	6	7	8	9
POLYCHAETA	-	-	0.7	0.2	0.2	+	-	-
CRUSTACEA	58.1	31.0	25.1	24.8	3.8	5.6	4.0	5.9
Amphipoda	-	2.0	0.6	1.0	0.2	0.3	+	0.4
Ampeliscidae	-	-	-	0.1	+	+	+	0.1
Oedicerotidae	-	-	0.3	0.5	+	0.1	+	+
Hyperiidae	-	-	-	0.1	0.1	0.1	+	0.2
Other Amphipoda	-	2.0	0.3	0.3	0.1	0.1	+	0.1
Decapoda	-	6.6	21.8	5.2	3.2	2.4	3.2	2.1
Crangonidae	-	-	15.3	2.8	1.2	1.1	1.7	0.8
Pandalidae	-	-	6.4	1.7	1.6	1.2	0.3	0.8
Pasiphaeidae	-	-	-	-	-	-	1.1	-
Other Decapoda	-	6.6	0.1	0.7	0.4	0.1	0.1	0.5
Euphausiacea	-	-	1.4	17.5	+	0.9	0.6	1.6
Mysidacea	58.1	-	0.1	0.6	0.1	1.8	+	1.4
Cumacea	-	0.2	+	0.1	+	+	+	+
Copepoda	-	-	-	+	-	+	+	+
Other Crustacea	-	22.2	1.2	0.4	0.3	0.2	0.2	0.4
CEPHALOPODA	-	-	-	22.1	-	4.8	+	0.5
Loligo	-	-	-	-	-	3.6	-	-
Other Cephalopoda	-	-	-	22.1	-	1.2	+	0.5
PISCES	41.9	69.0	73.5	51.8	95.5	89.1	95.2	93.1
Scomberesox saurus	-	-	-	-	-	-	-	-
Clupeidae	-	-	-	-	-	-	11.5	-
Merluccius bilinearis	41.9	69.0	-	39.6	-	1.1	0.7	20.3
Phycis chesteri	-	-	-	-	-	1.6	-	-
Ammodytes americanus	-	-	59.9	4.2	0.2	2.7	-	-
Scomber scombrus	-	-	-	-	-	31.1	22.4	-
Stenotomus chrysops	-	-	-	-	-	-	-	19.9
Peprilus triacanthus	-	-	-	-	-	-	3.8	-
Other Pisces	-	-	13.6	8.0	95.3	52.6	56.8	52.9
MISCELLANEOUS	-	+	0.7	1.1	0.5	0.5	0.8	0.5
No. examined	10	9	68	220	209	155	131	212
No. empty	0	2	20	37	52	47	48	85
Mean stom. cont. wt. (g)	0.108	0.076	1.211	0.826	4.162	3.200	3.430	1.616
Mean fish FL (cm)	9.8	14.1	22.4	16.5	22.5	24.9	23.8	23.3
Length range (cm)	8-12	13-18	8-64	4-51	6-53	5-54	4-55	4-57

Table 14. (cont'd)

Prey	Bottom water temperature °C 10	11	12	13	14	15	16
POLYCHAETA	-	+	-	-	-	-	-
CRUSTACEA	7.3	22.9	14.0	9.0	9.6	7.3	0.9
Amphipoda	0.7	0.7	1.3	0.1	0.3	0.1	-
Ampeliscidae	0.2	0.5	0.3	+	0.2	+	-
Oedicerotidae	+	+	0.2	+	-	-	-
Hyperiidae	0.4	0.2	0.5	0.1	0.1	+	-
Other Amphipoda	0.1	+	0.3	+	+	0.1	-
Decapoda	4.8	1.5	9.1	5.9	4.0	4.1	-
Crangonidae	1.1	0.6	2.4	0.5	1.8	0.7	-
Pandalidae	2.3	0.4	6.0	5.1	2.0	2.8	-
Pasiphaeidae	-	-	-	-	-	-	-
Other Decapoda	1.4	0.5	0.7	0.3	0.2	0.6	-
Euphausiacea	1.3	18.3	1.7	2.9	4.1	-	0.9
Mysidacea	+	1.9	1.2	+	0.2	2.9	-
Cumacea	0.1	+	+	+	+	-	-
Copepoda	+	+	+	+	+	-	-
Other Crustacea	0.4	0.5	0.7	0.1	1.0	0.2	-
CEPHALOPODA	8.0	5.7	13.8	36.9	5.4	84.9	75.6
Loligo	7.9	5.5	12.8	35.8	-	84.6	-
Other Cephalopoda	0.1	0.2	1.0	1.1	5.4	0.3	75.6
PISCES	84.4	70.6	71.3	54.0	84.3	7.7	23.5
Scomberesox saurus	-	17.2	-	-	-	-	-
Clupeidae	16.1	-	-	4.0	-	-	-
Merluccius bilinearis	3.0	0.3	-	-	69.7	-	-
Phycis chesteri	-	-	-	-	-	-	-
Ammodytes americanus	-	1.3	-	-	-	-	-
Scomber scombrus	-	-	-	11.4	-	-	-
Stenotomus chrysops	-	-	-	-	-	-	-
Peprilus triacanthus	-	-	-	23.4	-	-	-
Other Pisces	65.3	51.8	71.3	15.2	14.6	7.7	23.5
MISCELLANEOUS	0.3	0.8	0.9	0.1	0.7	0.1	-
No. examined	214	411	409	247	159	75	12
No. empty	49	146	116	82	38	13	7
Mean stom. cont. wt. (g)	1.135	0.885	0.337	2.236	1.088	0.781	0.148
Mean fish FL (cm)	18.5	20.6	16.8	19.8	18.1	14.0	25.8
Length range (cm)	3-55	3-54	3-49	3-53	4-48	4-54	22-41

Table 15. Adjusted mean stomach content data for large (24-35 cm FL) and small (4-15 cm FL) silver hake sampled at each bottom water temperature from 4°-15°C. All samples were obtained during bottom trawl survey cruises conducted in the Northwest Atlantic, 1973-1976.

Bottom water temperature(°C)	Large fish (24-35 cm FL)		Small fish (4-15 cm FL)	
	Adjusted weight(g)	Number of fish	Adjusted weight(g)	Number of fish
4	1.297	20	0.317	28
5	1.352	48	0.250	137
6	1.198	89	0.313	82
7	1.686	80	0.271	47
8	0.756	49	0.157	49
9	0.225	105	0.156	68
10	0.846	63	0.136	93
11	0.448	173	0.135	156
12	0.869	136	0.131	224
13	1.094	100	0.109	108
14	0.725	63	0.202	84
15	-	-	0.250	56

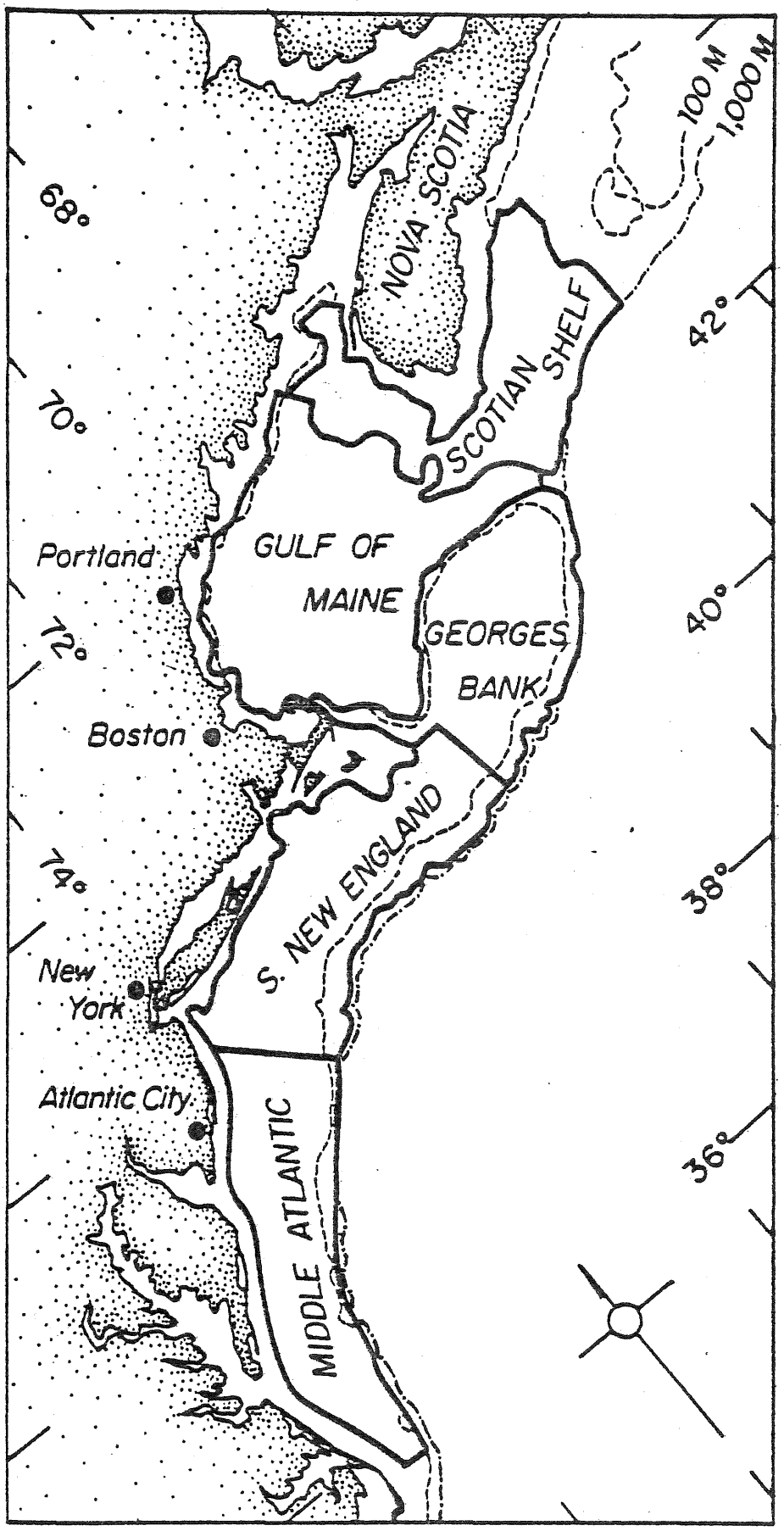

Figure 1. Offshore areas sampled for the bottom trawl survey conducted by the Northeast Fisheries Center between the years of 1973 and 1976, inclusive.

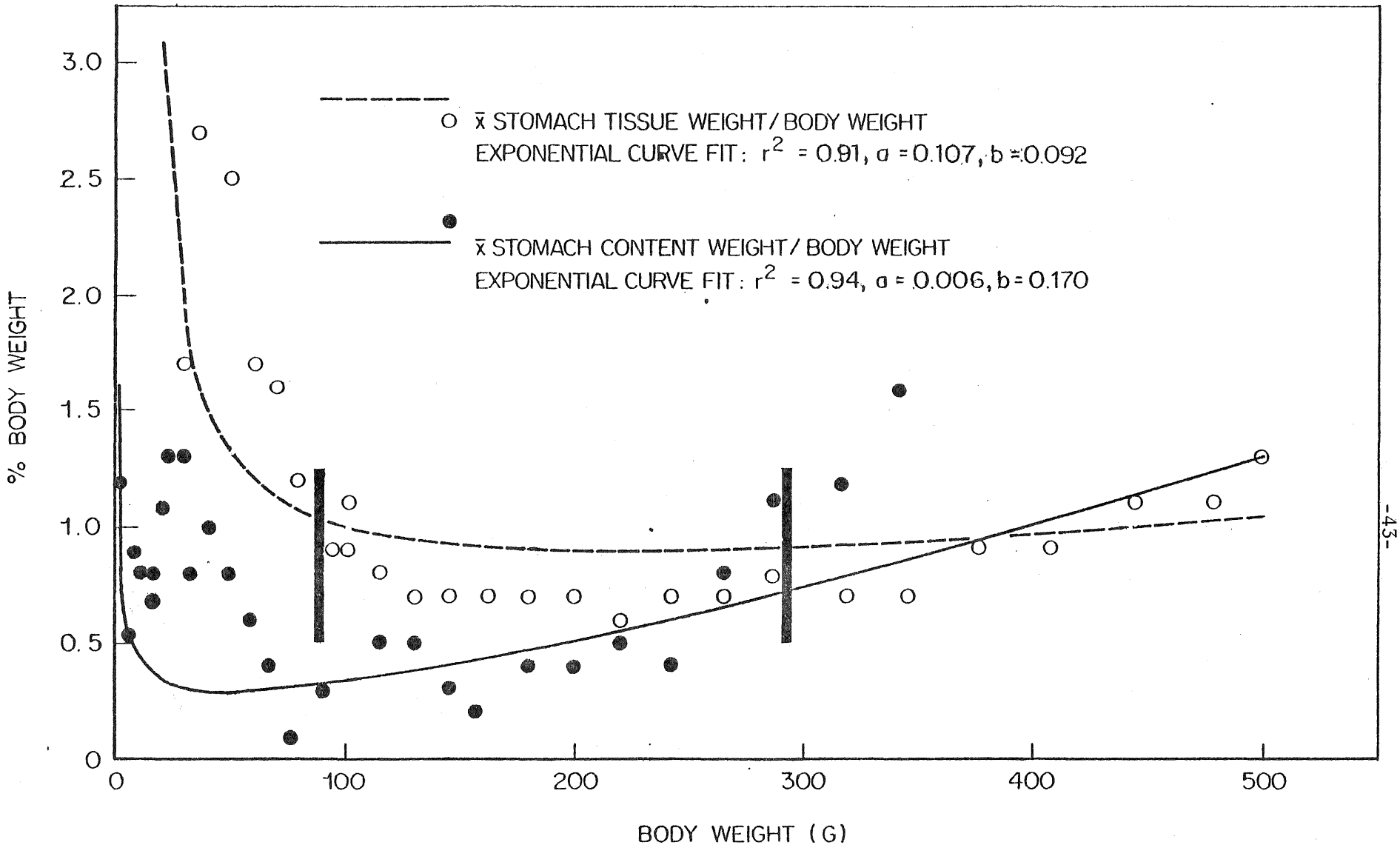

Figure 2. Percentage body weight made up by the stomach tissue weight and the stomach content weight of different size silver hake. Area enclosed by solid lines represents more than 80% (excluding juveniles) of the silver hake population (fish 2-7 years old), based on survey data. Stomach tissue weight/fish length and stomach content weight/fish length data were fit to an exponential curve (form $y=ae^{bx}$). The data are presented in terms of body weight for illustrative purposes.

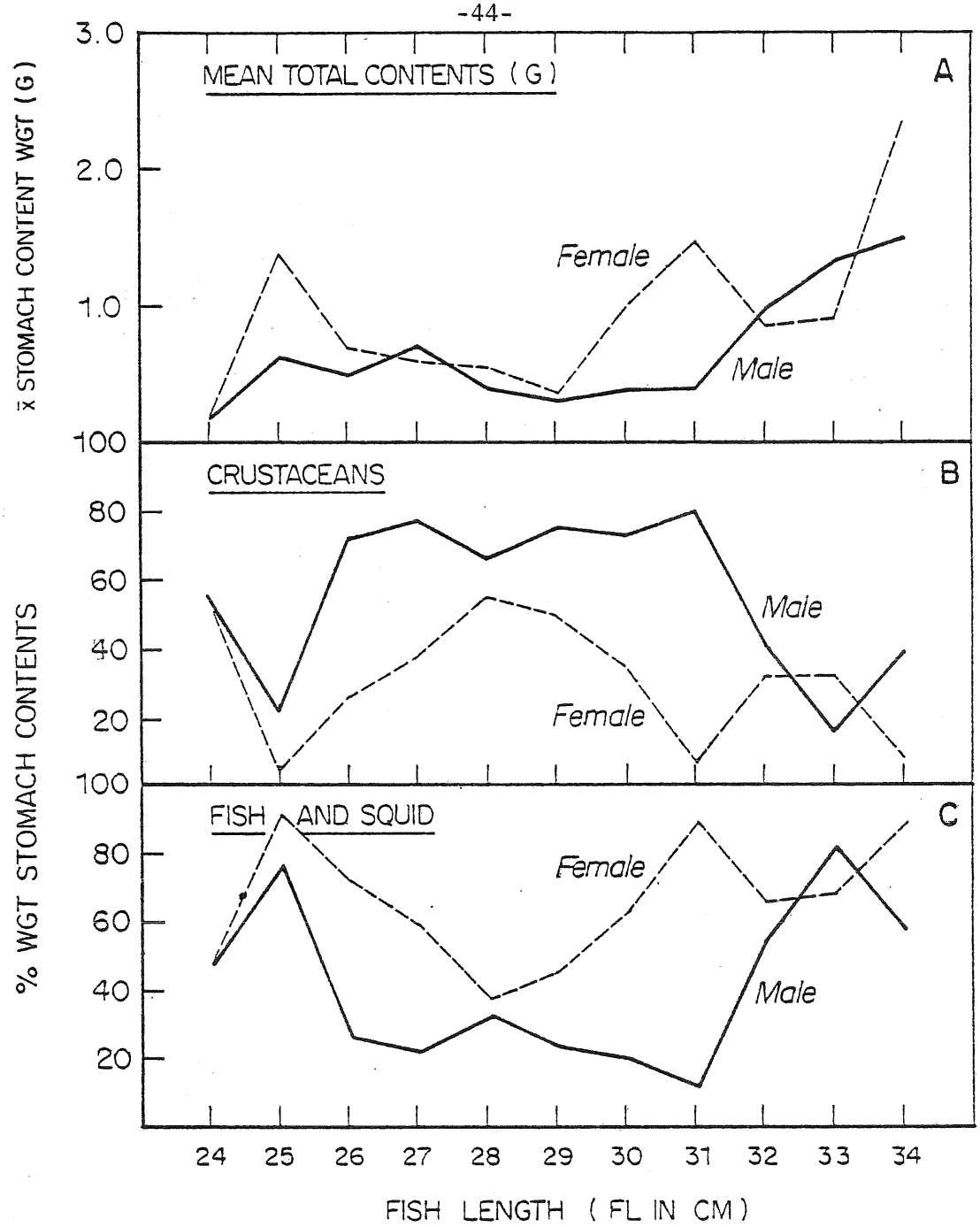

Figure 3a. Presentation of the mean stomach content weight of male and female silver hake versus fish length, 3b. Percentage of total stomach contents weight made up by crustaceans for male and female silver hake of lengths from 24-34 cm (FL), 3c. Percentage of total stomach contents weight made up by fish and squid (combined) for male and female silver hake of lengths from 24-34 cm (FL).

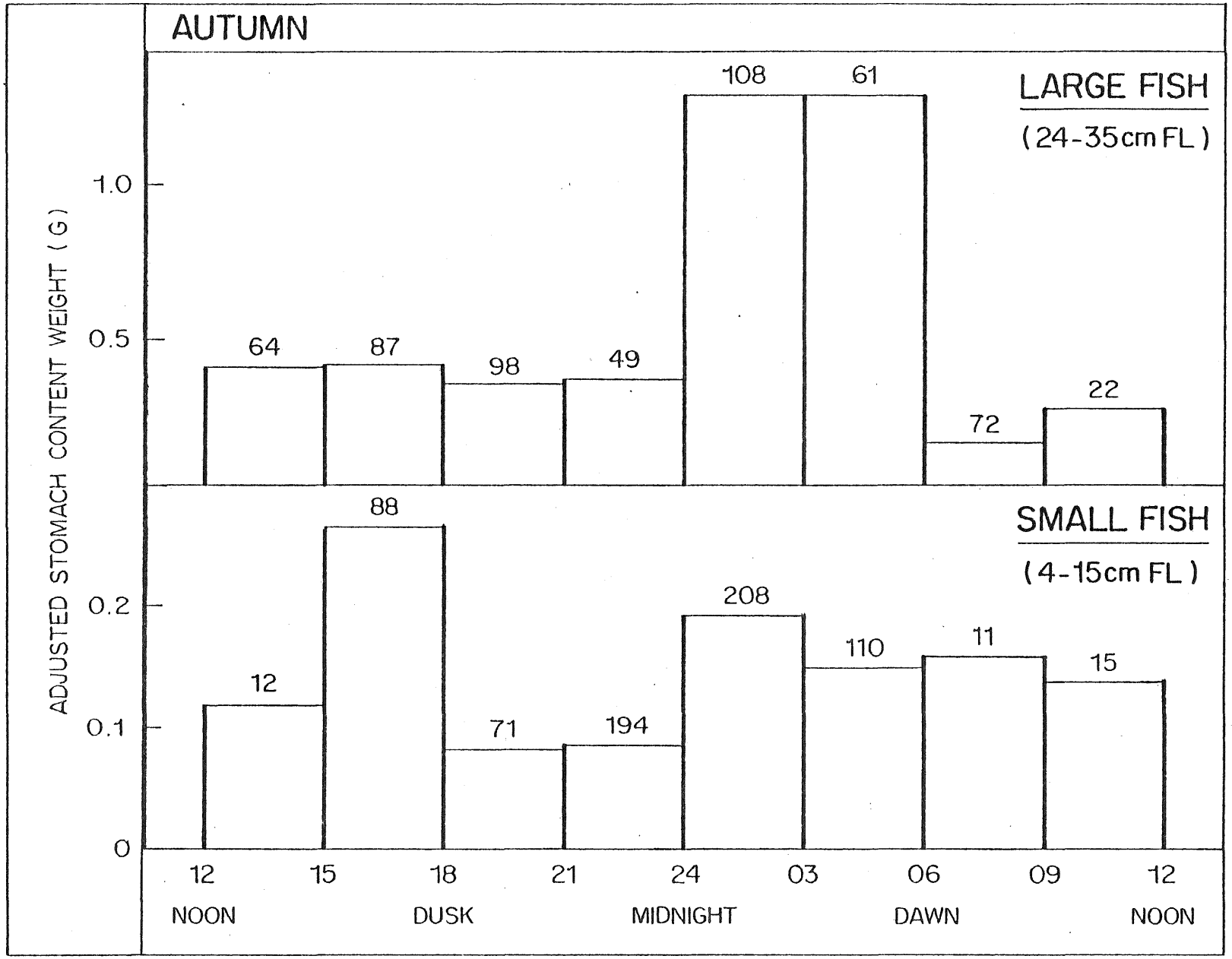

Figure 4. Adjusted mean stomach content weight of large (24-35 cm FL) and small (4-15 cm FL) silver hake collected in the autumn versus time of day. The number of fish sampled in each time period is given just above the histogram.

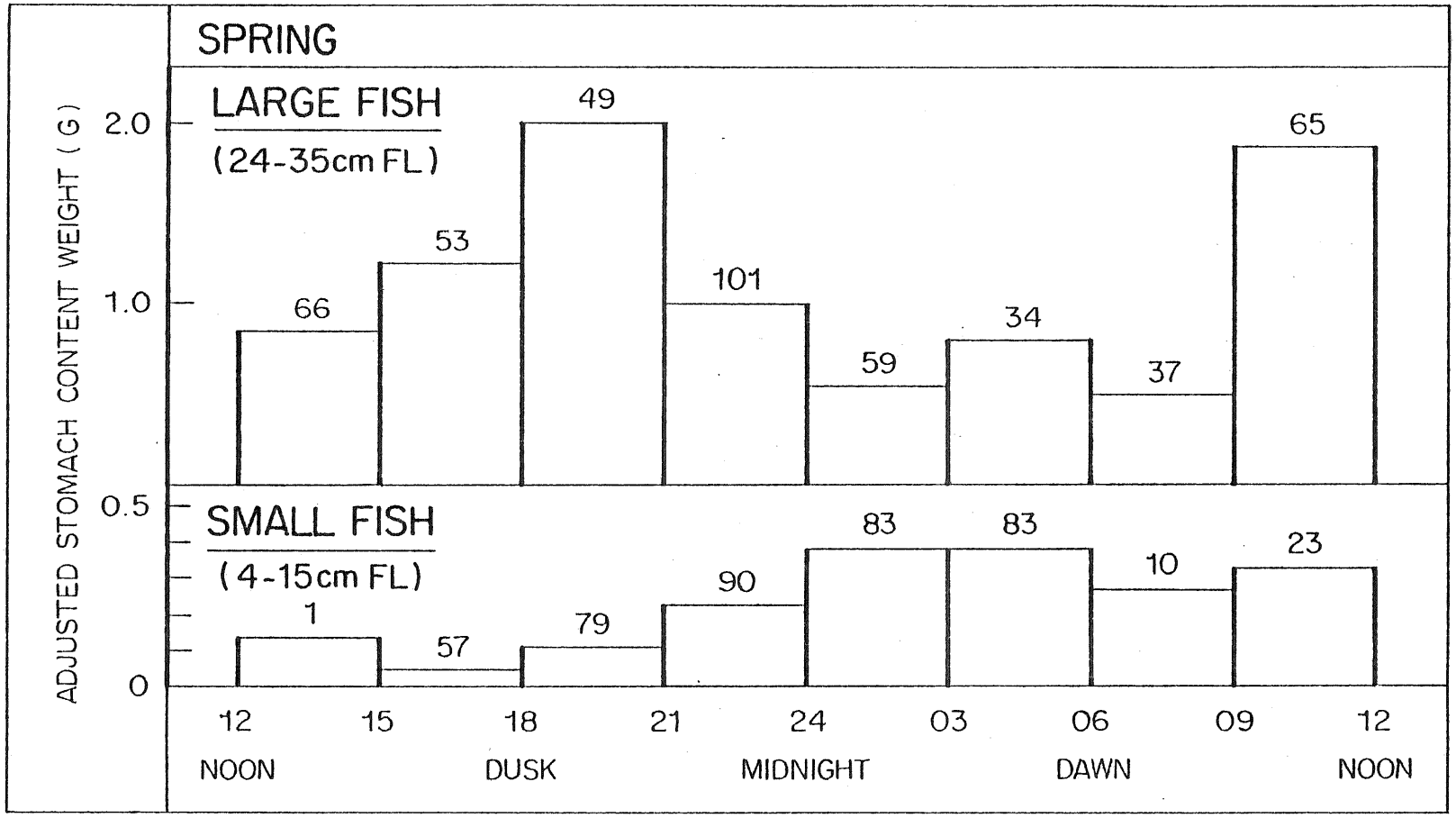

Figure 5. Adjusted mean stomach content weight of large (24-35 cm FL) and small (4-15 cm FL) silver hake collected in springtime versus time of day. The number of fish sampled in each time period is given just above the histogram.