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AN ABRIDGED ACCOUNT OF PREDATOR-PREY
INTERACTIONS FOR SOME NORTHWEST ATLANTIC
SPECIES OF FISH AND SQUID

by

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INTRODUCTION

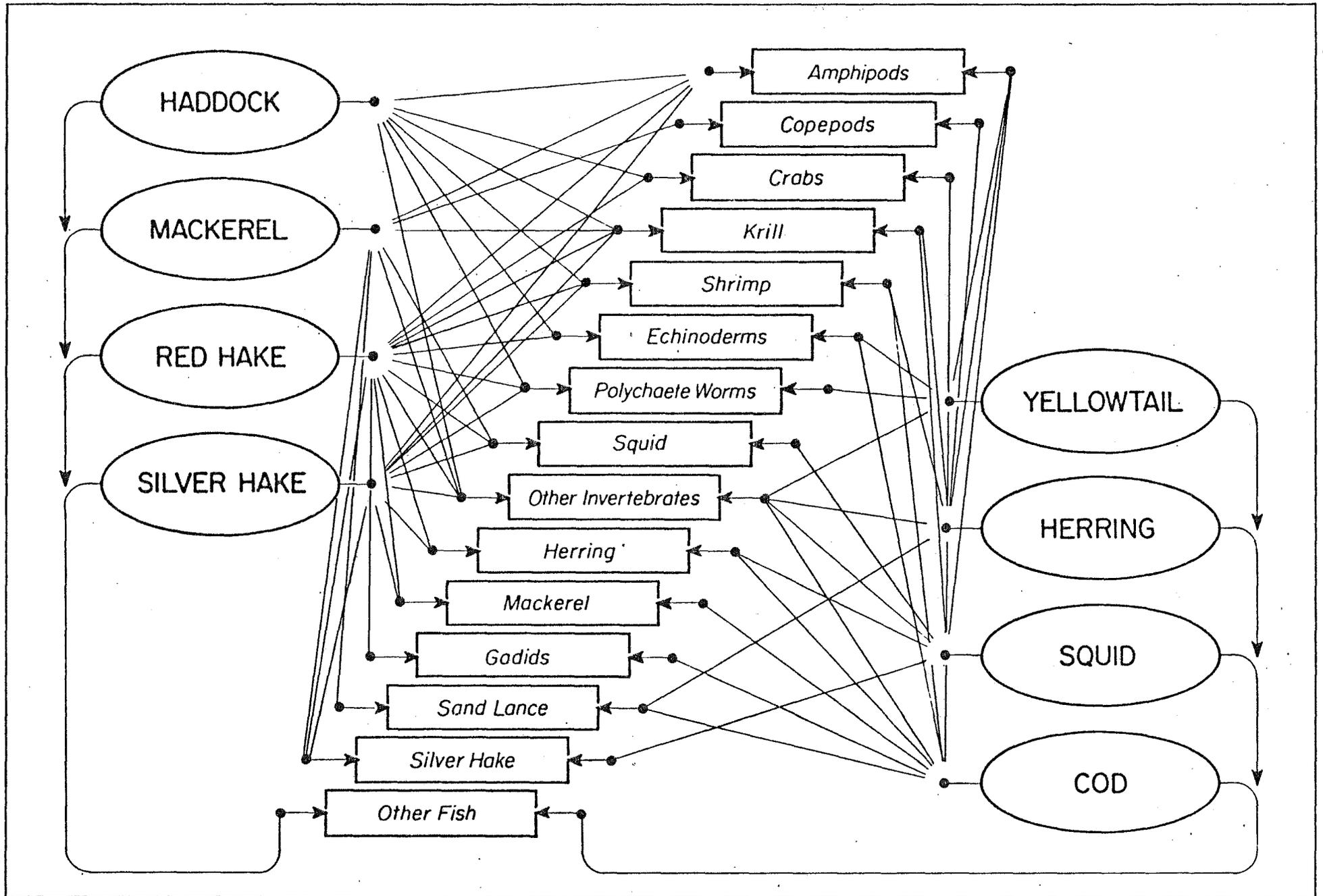
A quantitative evaluation of the interaction between marine animals is essential for establishing meaningful management programs for the various fish stocks. However, predator-prey interactions are not adequately documented and are unlikely to be understood in the near future because of the overall complexity of the marine environment. This report only considers the food habits of seven commercially important fish and two squid species and attempts to present a simplified version of the known interaction between these predators and their prey.

The data on the predators of the fish and squid was compiled either from food habits studies conducted by the Northeast Fisheries Center or from a review of the available food habits literature. It is presented as a qualitative guide to the known predators of each fish species. It should not be considered as complete because detailed studies on the food habits of many of the larger fish predators have not been conducted in the Northwest Atlantic.

The data on the prey of each fish is a summary of more detailed food habits studies which have been presented in a series of laboratory reports (Bowman 1975, 1977; Maurer and Bowman 1975; Bowman et al. 1976; and Langton and Bowman 1977). Here, only the major prey groups are listed and the percentage that each group contributes to the total diet indicated in the text.

In the diagrams accompanying the text the relative importance of both predators and prey for each fish and squid species has been indicated by the boldness of the arrows.

Figure 1 is a simplified presentation of the predator-prey interactions for only nine commercially important species of fish and squid. It is presented as an example of the complexity of the known interactions between these animals and their prey. The two squid species, Loligo and Illex, have been grouped together under the single heading - squid. In the diagram, the predator names have been enclosed in ovals while the prey groups have been placed in boxes. The food habits of each predator may be determined by following the arrows from the predator to the various prey groups. The dietary overlap of any two predators may be qualitatively evaluated by comparing the number of prey groups they share in common. A complete picture of the competition between predators must also take into consideration such factors as the life stage of the fish, the spatial and temporal overlap of both predators and prey together with seasonal differences in the activity and dietary requirements of the animals.

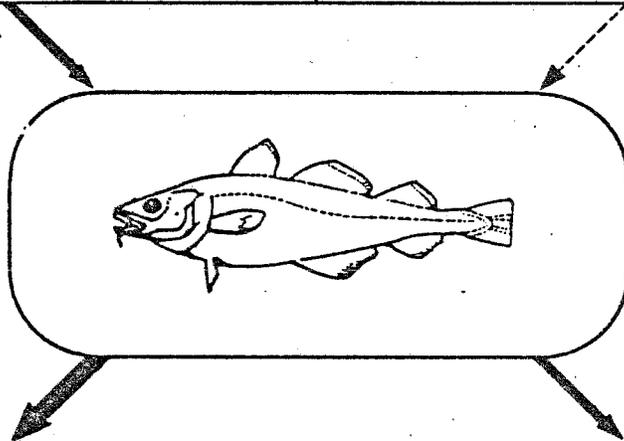


ATLANTIC COD (Figure 2)

Predators - The only predator of adult cod was cod itself. Most cod were larger and more active than many fishes where food habits have been studied. Cod, apparently, are not preyed upon by the small and medium sized fish and the food habits of the possible larger predators such as sharks, porpoises and whales are not known in the study area. Smaller, juvenile cod, were probably eaten in substantial quantities by other groundfish, however, identifying gadids to the species level from partially digested remains is difficult. It is, therefore, likely that smaller cod were simply identified to the family level (Gadidae).

Prey - Over 88% of the prey of Atlantic cod is either fish (68%) or crustaceans (20%). The major single fish species identified in the stomachs examined was the herring, Clupea harengus (15%). Other fish such as the gadids (4%), mackerel (3%), flatfish (2%), and unidentified fishes (18%) make up the majority of remaining fish consumed. The crustacean prey was comprised of a variety of different groups with the crab, (Cancer), (5%) and pandalid shrimp (3%) being the largest individual contributors.

PREDATORS OF ADULT ATLANTIC COD	
<i>Atlantic Cod</i>	<i>at least 9 other possible Cod predators</i>



PREY OF ADULT ATLANTIC COD	
<i>Fish</i> - <i>Herring</i> - <i>Gadids</i> - <i>Mackerel</i> - <i>Flatfish</i>	<i>Crustaceans</i> - <i>Crabs</i> - <i>Shrimp</i>

ADULT ATLANTIC COD

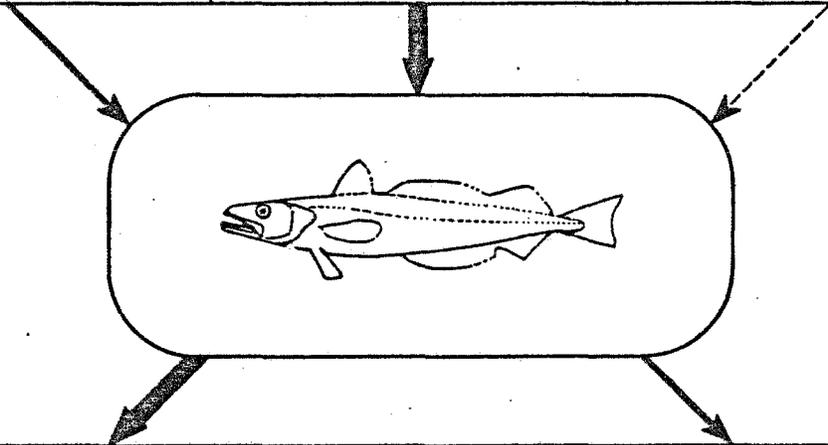
SILVER HAKE (Figure 3)

Predators - Silver hake was preyed upon by a number of different fish.

The fourspot flounder and the American shad were major predators while other fish such as spotted and white hake, mackerel, pollock, goosefish and bluefish have also been identified as predators of silver hake. Cannibalism was also evident and was more significant than for most of the other species of fish examined.

Prey - The diet of silver hake, like Atlantic Cod, consisted primarily of fish (70%) and crustaceans (26%). Mackerel (19%) and herring (10%) were the most important fish species preyed upon although gadids (6%) and other unidentified fish (29%) also contributed significantly to the diet. Krill (13%) and pandalid shrimp (5%) were the major groups of crustaceans consumed.

PREDATORS OF ADULT SILVER HAKE		
<i>White Hake</i> <i>Silver Hake</i> <i>Atlantic Mackerel</i> <i>Pollock</i> <i>Goosefish</i> <i>Bluefish</i> <i>Spotted Hake</i>	<i>American Shad</i> <i>Fourspot Flounder</i>	<i>at least 7 other possible Silver Hake predators</i>



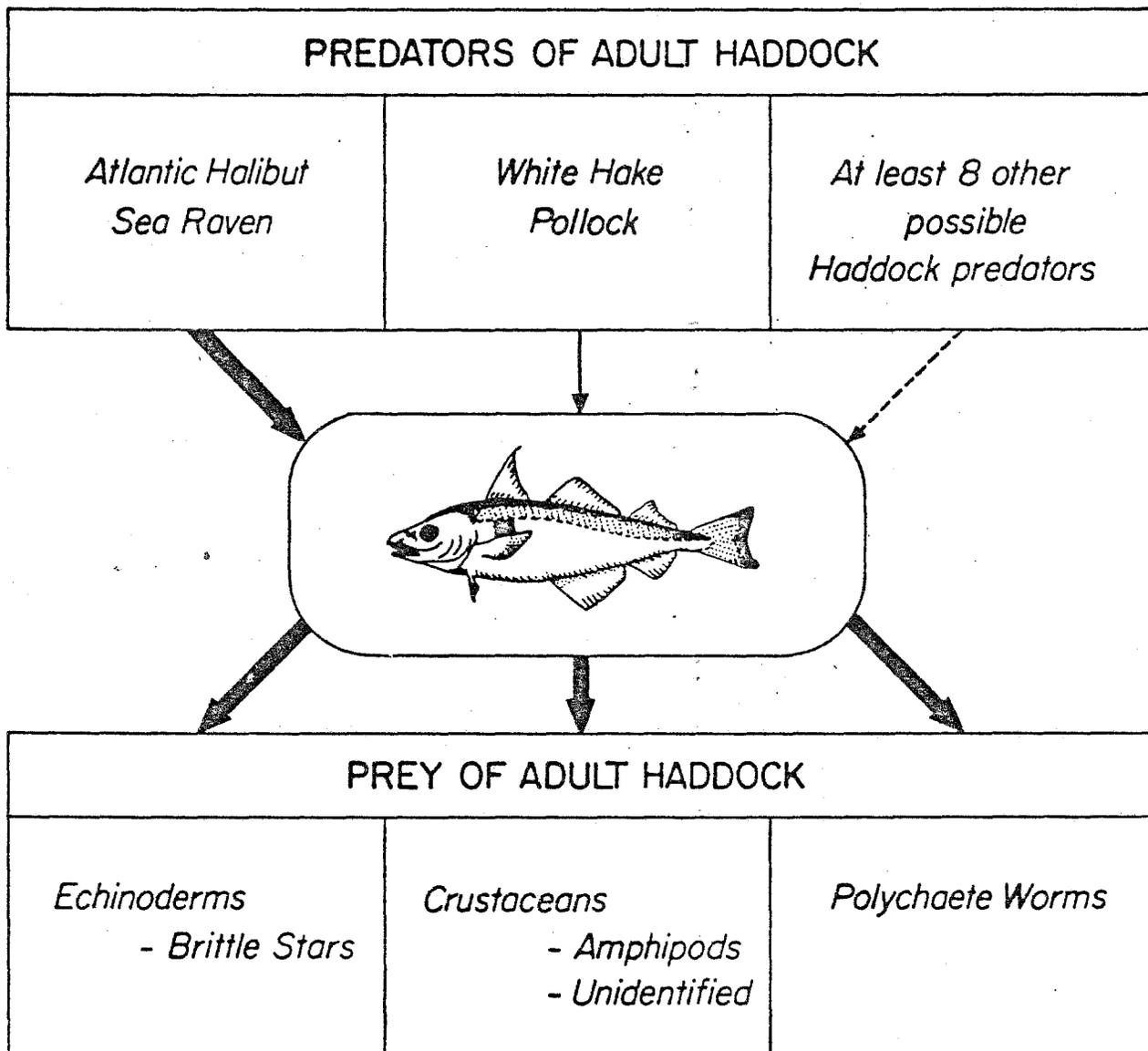
PREY OF ADULT SILVER HAKE	
<i>Fish</i> <ul style="list-style-type: none"> - <i>Herring</i> - <i>Mackerel</i> - <i>Gadids</i> - <i>Unidentified</i> 	<i>Crustaceans</i> <ul style="list-style-type: none"> - <i>Shrimp</i> - <i>Krill</i>

ADULT SILVER HAKE

HADDOCK (Figure 4)

Predators - The haddock is preyed on by the Atlantic halibut, sea raven, and less heavily by the white hake and pollock. At least eight other fish are known to eat gadids which probably include some juvenile haddock that could not be identified to the species level because they were partially digested when the stomach contents of the predators was examined.

Prey - The major prey groups of the haddock are echinoderms (37%), particularly brittle stars (27%), a variety of crustaceans (18%) and polychaete worms (16%). Molluscs (4%) are a minor prey group and fish usually comprise slightly less than 2% of the diet.



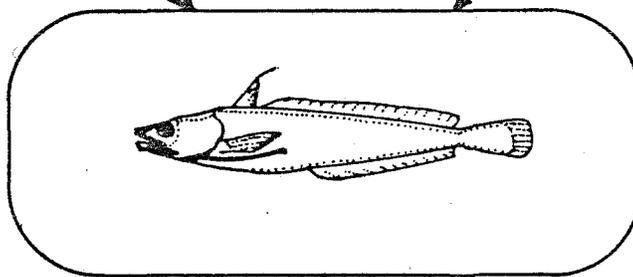
ADULT HADDOCK

RED HAKE (Figure 5)

Predators - Goosefish, red hake itself, and potentially at least eight other species of fish prey on red hake. These eight other species of fish are known to prey on gadids but the particular species of gadid could not be identified from the partially digested fish found in the predators stomach.

Prey - Red hake prey heavily on a variety of Crustacea (52%); the largest single contributors are pandalid shrimp (12%), the crab, Munida, (10%) and amphipods (7%). Fish (29%) are the next most important group but most of the fish remains could not be identified (24%). The fish that could be identified were herring, silver hake, red hake, mackerel, wrymouth, and some flatfish species.

PREDATORS OF ADULT RED HAKE	
<i>Goosefish</i> <i>Red Hake</i>	<i>At least 8 other possible Red Hake predators</i>



PREY OF ADULT RED HAKE	
<i>Fish</i>	<i>Crustaceans</i>
- <i>Herring</i>	- <i>Amphipods</i>
- <i>Gadids</i>	- <i>Crabs</i>
- <i>Mackerel</i>	- <i>Shrimp</i>

ADULT RED HAKE

GADIDAE (Figure 6)

Predators - If the Gadidae are considered as a single group, they have a large number of predators. The major predators are offshore hake, Atlantic angel shark, goosefish, dusky shark, Atlantic halibut, American shad, fourspot flounder, and the sea raven. The Gadidae themselves, such as Atlantic cod, silver, white and spotted hake and pollock are cannibalistic and also feed on each other. Other fish such as the spiny dogfish, Atlantic mackerel and bluefish are also known to be predators of the Gadidae.

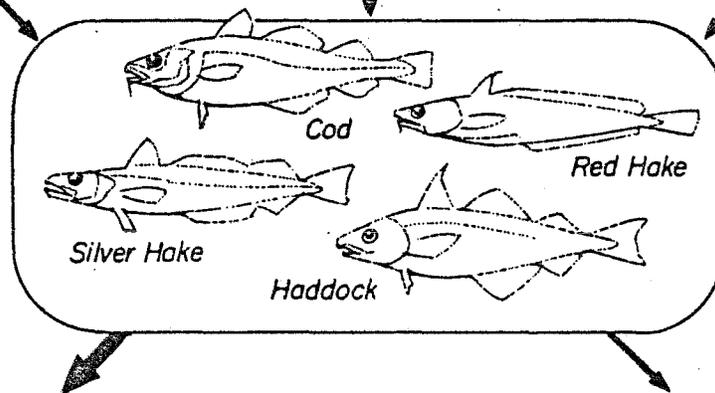
Prey - Fish, especially herring, mackerel and other gadids together with Crustacea are the major prey groups, whereas polychaete worms and echinoderms are particularly important as part of the diet of the haddock.

PREDATORS OF ADULT GADIDS

Atlantic Cod
Silver Hake
White Hake
Spiny Dogfish

Offshore Hake
Atlantic Angel Shark
Goosefish
Dusky Shark
Atlantic Halibut
American Shad
Fourspot Flounder
Sea Raven

Pollock
Atlantic Mackerel
Bluefish
Spotted Hake



PREY OF ADULT GADIDS

Fish

- *Herring*
- *Mackerel*
- *Gadids*
- *Unidentified*

Crustaceans

- *Crabs*
- *Shrimp*
- *Krill*
- *Amphipods*

Polychaete Worms

Echinoderms

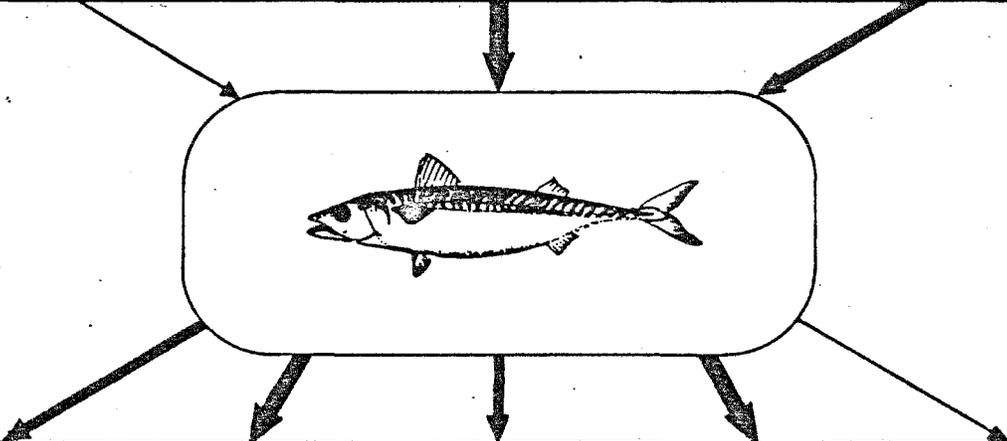
ADULT GADIDS

MACKEREL (Figure 7)

Predators - Mackerel have been identified in the stomach of a number of different fishes. They are preyed heavily on by spiny dogfish, silver hake, white hake, weakfish, goosefish, and Atlantic cod. They also comprise part of the diet of swordfish, red hake, Atlantic bonito, bluefin tuna, blue shark, porbeagle, sea lamprey, shortfin mako and thresher sharks.

Prey - Mackerel prey most heavily on crustaceans (44%) such as copepods (28%), krill (12%), and shrimp (3%). They also feed on squid (29%), and less intensively on fish (4%) and ascidians (5%).

PREDATORS OF ADULT MACKEREL		
<i>Red Hake</i> <i>Atlantic Bonito</i> <i>Bluefin Tuna</i> <i>Blue Shark</i> <i>Porbeagle</i> <i>Sea Lamprey</i> <i>Shortfin Mako</i> <i>Thresher Shark</i>	<i>Spiny Dogfish</i> <i>Silver Hake</i> <i>White Hake</i> <i>Weakfish</i>	<i>Goosefish</i> <i>Cod</i> <i>Swordfish</i>



PREY OF ADULT MACKEREL				
<i>Fish</i> - <i>Silver Hake</i> - <i>Sand Lance</i>	<i>Squid</i>	<i>Ascidians</i>	<i>Crustaceans</i> - <i>Copepods</i> - <i>Krill</i> - <i>Shrimp</i>	<i>Chaetognaths</i> <i>Echinoderms</i>

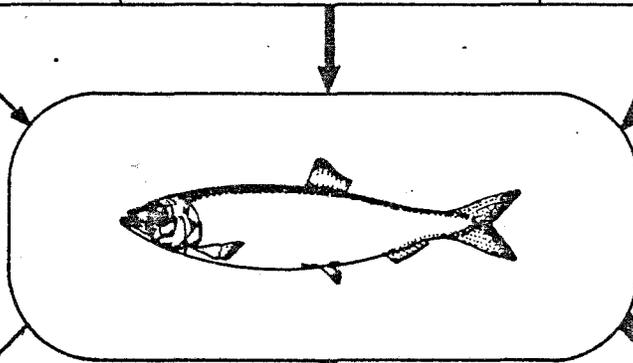
ADULT MACKEREL

HERRING (Figure 8)

Predators - Herring are preyed upon heavily by the Atlantic cod, spiny dogfish, and silver hake. Other predators are the pollock, red hake, goosefish, Atlantic salmon, bluefin tuna, haddock, hickory shad, porbeagle, swordfish, clearnose skate, blue shark, and thresher shark.

Prey - The Atlantic herring is known to prey on crustaceans (55%), the most important groups being krill (36%) and copepods (8%). They also prey heavily on planktonic arrowworms (32%) and to a lesser extent on molluscs (4%), and fish (1%).

PREDATORS OF ADULT HERRING		
<i>Red Hake</i> <i>Goosefish</i> <i>Atlantic Salmon</i> <i>Bluefin Tuna</i> <i>Haddock</i> <i>Hickory Shad</i> <i>Porbeagle</i> <i>Swordfish</i> <i>Clearnose Skate</i> <i>Blue Shark</i> <i>Thresher Shark</i>	<i>Pollock</i>	<i>Atlantic Cod</i> <i>Spiny Dogfish</i> <i>Silver Hake</i>



PREY OF ADULT HERRING		
<i>Fish</i> - <i>Sand Lance</i> - <i>Herring</i>	<i>Crustaceans</i> - <i>Krill</i> - <i>Copepods</i>	<i>Chaetognaths</i> <i>Mollusca</i>

ADULT HERRING

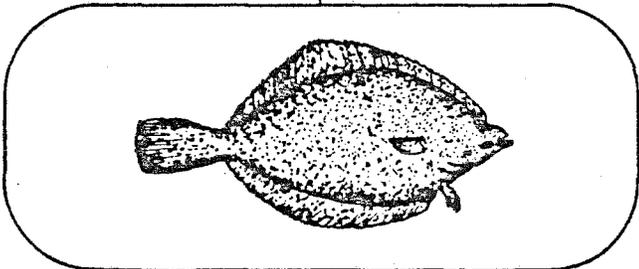
YELLOWTAIL FLOUNDER (Figure 9)

Predators - Yellowtail are known to be preyed on by spiny dogfish, Atlantic cod, spotted hake and longhorn sculpin.

Prey - Yellowtail prey most heavily on polychaete worms (42%) and crustaceans (37%), particularly amphipods (31%). Minor elements in their diet are molluscs, echinoderms, ascidians, and fish.

PREDATORS OF ADULT YELLOWTAIL

Spiny Dogfish
Atlantic Cod
Spotted Hake
Longhorn Sculpin



PREY OF ADULT YELLOWTAIL

Crustaceans
- *Amphipods*

Polychaete Worms

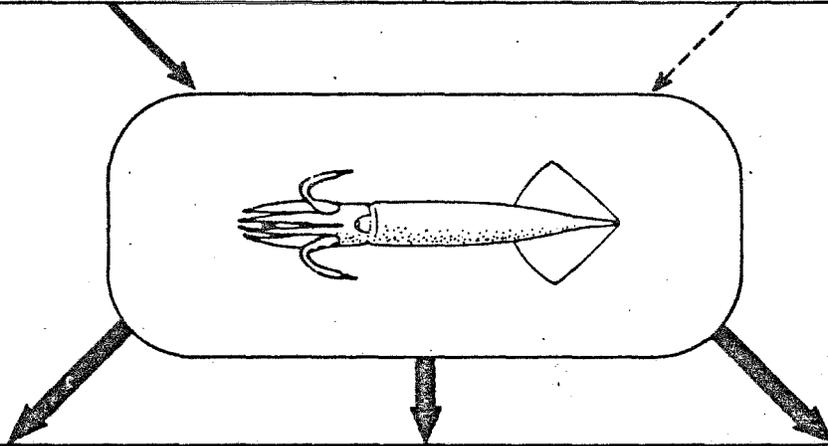
ADULT YELLOWTAIL

SHORTFIN SQUID (ILLEX) (Figure 10)

Predators - Known predators of the shortfin squid are the fourspot flounder, goosefish and swordfish. Illex is probably eaten by a substantially greater number of fish, however, partially digested animals are often difficult to identify and are simply recorded as squid remains, with no reference to the species. There are at least 47 other species of fish that are known to eat "squid".

Prey - Food habits of squid are difficult to quantify because the squid do not swallow their prey whole. Nevertheless, they are known to prey on other squid, fish, and crustaceans such as krill.

PREDATORS OF SHORTFIN SQUID (<i>Illex</i>)	
<i>Fourspot Flounder</i> <i>Goosefish</i> <i>Swordfish</i>	<i>at least 47 other possible Squid predators</i>



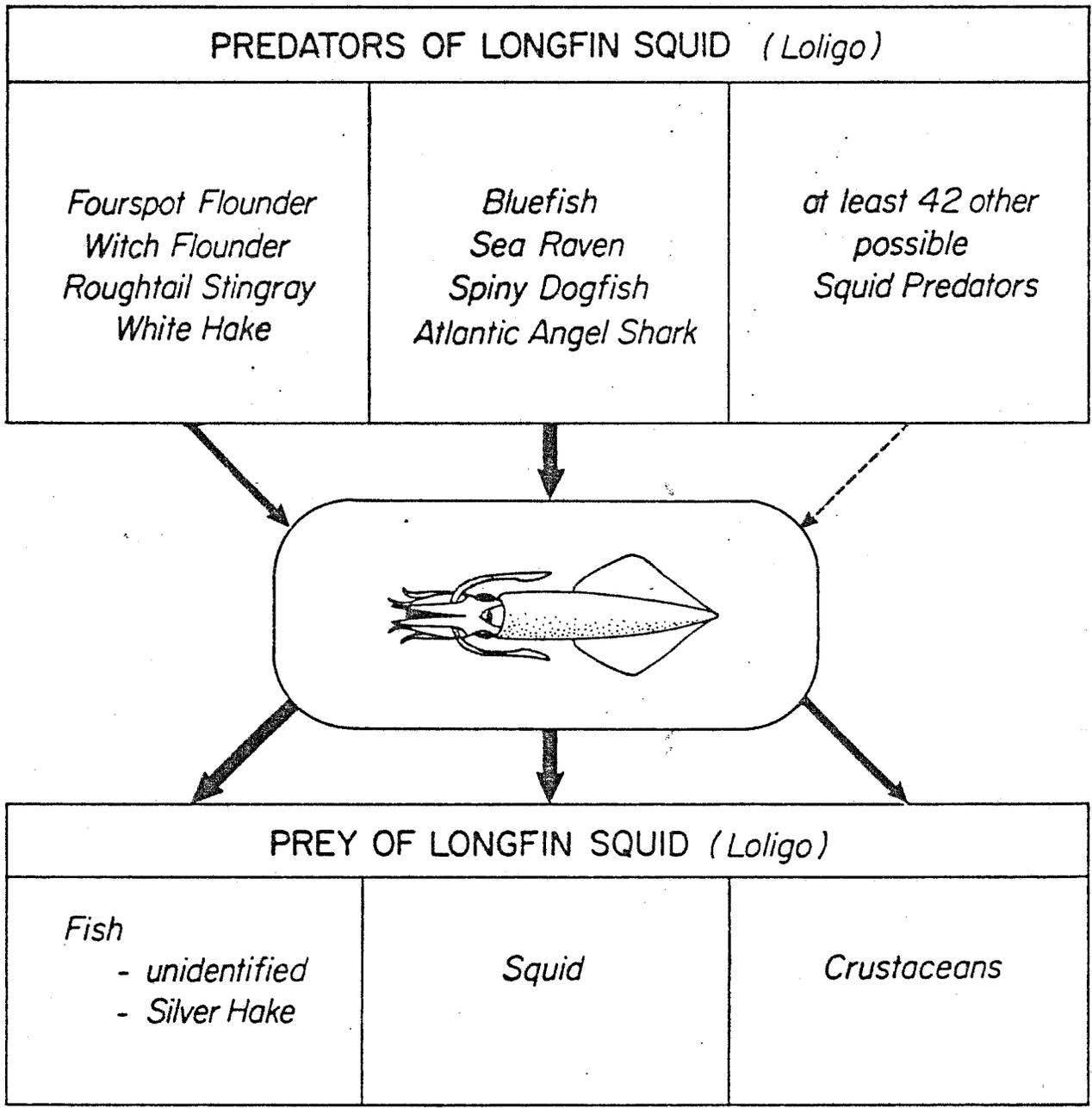
PREY OF SHORTFIN SQUID (<i>Illex</i>)		
<i>Fish</i> - unidentified	<i>Squid</i>	<i>Crustaceans</i> - <i>Krill</i>

ADULT SHORTFIN SQUID (*Illex*)

LONGFIN SQUID (LOLIGO) (Figure 11)

Predators - Bluefish, sea ravens, spiny dogfish and the Atlantic angel shark are known to be major predators of the longfin squid. The fourspot flounder, witch flounder, rougtail stingray and white hake are also known to prey on Loligo. In many cases, squid remains in the stomach of fish are only identified as "squid" with no reference to the species. It is likely that some of these animals are the longfin squid and there are at least 42 other species of "squid" eating fish in addition to those identified above.

Prey - The longfin squid is known to feed on fish, possibly silver hake, mackerel, herring and menhaden, among others, and also on squid and crustaceans. However, as with the shortfin squid, it is difficult to identify the species of fish eaten or to quantify the diet because squid do not swallow their prey whole.



ADULT LONGFIN SQUID (*Loligo*)

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