A REVIEW OF WHITING RESEARCH

By

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Whiting Research was initiated at the Woods Hole Biological Laboratory of the Bureau of Commercial Fisheries in 1955 at the request of the ASMFC, and through the support of funds made available by the Saltonstall-Kennedy Act of 1954. The problems faced at that time were the problems presented by any intensive marine fishery. Questions asked were: How extensive are the whiting populations? How much exploitation can they stand? Are we exploiting them wisely today? If management is necessary, what measures should be taken?

Six years is not sufficient time in which to collect the necessary biostatistics to answer these questions, especially when some of the necessary biological parameters are unknown at the start. However, much progress has been made. Distributional surveys have been conducted, divisions of stock investigated, growth rates and mortality rates have been studied, food habits have been looked into and mesh selection experiments conducted.

There are two species of whiting along our coast, Merluccius bilinearis (Silver Hake) which supports the present fishery, and M. albidus, a deepwater species which is not now exploited.

The silver hake occurs along the continental shelf from the Gulf of St. Lawrence, southward approximately to Cape Hatteras, N. C. Reports of its occurrence as far south as Florida are probably incorrect and refer to another species. The important commercial fishing grounds for silver hake are along the New England coast and offshore on Georges Bank. Smaller quantities are landed from the middle atlantic Coast (Fritz 1960).

The silver hake undergoes an inshore-offshore seasonal migration. They appear inshore in the early spring and remain all summer in depths less than 50 fathoms. During this period they are common along the coast of the Gulf of Maine and on Georges Bank. Bureau surveys indicate that they are in many places the most abundant groundfish in the spring and summer. During the late fall the species disappears from inshore waters. The wintering grounds of the silver hake have long been a matter of conjecture, but Bureau groundfish surveys show that they are in depths greater than 100 fathoms. Here they find water temperatures close to 50° F (Fritz and Callahan, 1960). Whether the fall migration is related to temperature or whether other ecological factors such as availability of food or association with other species of fish is important is not now known.

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Studies of stock differentiation have been completed. In these studies samples of hake from many areas in the Gulf of Maine, Rhode Island, New York and New Jersey were examined for vertebral number, relative head length, relative length of pelvic fin and ventral fin, and eye diameter. Differences in vertebral number were not statistically significant, but the other measurements indicated that we are concerned with two groups of silver hake along our coast. One of them occupies the Gulf of Maine, while the other occurs south of Cape Cod (Conover, Fritz, Veiera, 1961).

Tagging experiments have been conducted to test the conclusions arrived at from the morphometric studies. Pilot experiments have not yet indicated the feasibility of a large scale tagging operation, but some returns are available. These returns do not show any mixing of the two groups defined by the morphometric studies (Fritz 1959).

Silver hake mature at two or three years of age. Spawning activity coincides with the annual migration into shoal water in the late spring and early summer depending upon location, normally proceeding from south to north. After the eggs are released and fertilized, they drift with the ocean currents. Kuntz and Radcliff (1918) have described the development of the egg and larva, but there is still no information on that part of the life cycle between the larva and the young fish that has taken up its life on the bottom.

However, Bureau surveys have contributed much information on the distribution of young-of-the-year (age group 0) after they reach the bottom. High concentrations were found in September in such places as the basin of the Gulf of Maine, in East Channel between Georges Bank and Browns Bank, in the area south of Block Island and in Block Island Canyon (Anonymous 1956). Winter surveys revealed the interesting fact that the young-of-the-year do not make the deep water winter migration, but remain in deep holes inshore in very cold water. Thus winter finds the new year class distributed over a large area of inshore waters although clearly separated from the older generations.

The silver hake has long been known as a voracious predator pursuing and devouring large numbers of herring and other fish. Recent studies by Jensen and Fritz (1960) and by Schaefer (1960) have shown that invertebrates may also make up a large part of the hakes diet, especially of the smaller sizes. Hake under 30 cm. in length preferred shrimp; medium sized fish (31-45 cm.) ate both shrimp and fish; while the larger hake ate mostly fish of various species. These recent studies corroborated the earlier observations that the larger hake are very voracious and may eat fish half their own length. These studies also corroborated the cannibalistic habits of the silver hake.

An important aspect of the Whiting program has been an intensive attack on the problem of age determination. Scales so far have not yielded to this attack and have been set aside for the present. Otoliths are much better. By the use of otoliths and length frequencies a growth rate has been established. However, it is not sufficiently precise for some population dynamics work.

Growth of male and female silver hake is similar for the first three years after which the females grow faster than the males (Fritz (1957) Rept. 1957, page 52). Males generally do not grow larger than 37 centimeters in length, with weight of 1/2 pound, while females grow twice that size reaching a weight of approximately 5 pounds. Schaefer (1960) obtained similar results from growth studies conducted in the middle Atlantic area. Age composition studies indicate that the bulk of the commercial landings are composed of three and four year old fish, but with the present mesh size used, much younger fish are taken.

One of the important aspects of the whiting research program is a statistical system which has been set up to record the relative abundance of the species on the basis of commercial catches. Such information has now been collected since 1956. These data will be used for general abundance indices, for estimating mortality rates, and for determining the effect of fishing on the stocks. Analyses to date show that abundance in general varies on the different fishing grounds, the highest being on Georges Bank.

From year to year there has been a variation in abundance in the different areas, but it has varied from area to area so that it is too early to determine whether there has been any overall general trend in whiting abundance. In general it can be said that no definite effect of fishing can be seen in these studies so far.

Although we do not yet have sufficient biological information to determine the maximum sustained yield for the whiting populations, management of this fishery is being forced on us by the involvement of this species in other fisheries such as the haddock. In some areas substantial amounts of haddock are taken by whiting fishermen so that we are confronted with the problem of regulating a mixed fishery.

Haddock fishermen in ICNAF Subarea 5 are required to use a minimum mesh size of 4-1/2 inches in the codends of trawl nets. A whiting net must have a much smaller size to retain marketable fish. A possible solution of this problem through the use of a special net was suggested by Robert Livingstone of the Woods Hole Laboratory. This net would take advantage of the differential behavior of haddock and whiting.

Previous experiments using an underwater television camera to observe the behavior of various species of fish in otter trawls had indicated that haddock and silver hake react differently to their containment within the net and that this differential behavior might be utilized in developing special types of net which would allow the escape of small, undersized haddock while at the same time retaining most of the silver hake of marketable size. To test this idea a large number of experiments were conducted on a special cruise of the Delaware last summer.

In some of these, a "window" was constructed in the upper part of the codend of the net. This window was in some cases simply a large hole. In other cases, it was a large area covered with a very large mesh rather than the small mesh of which the rest of the net was constructed. The window, in turn, was covered with a special small mesh codend to

recover any fish that passed through the window. In some experiments a deflector consisting of large mesh netting was hung from the upper part of the net and extended halfway to the bottom of the net.

The results of the experiments substantiated the theory that different species come into the net at different levels and have different reaction patterns in attempting to escape. Haddock, cod, and sea herring tend to come in high in the net and were deflected through the window in substantial percentages. Other species, such as the silver hake tend to come into the net low down and were not deflected through the window in such high percentages.

Another experiment in which the codend was divided horizontally by a sheet of netting showed, in general, the same difference in behavior pattern of the different species of groundfish. Although the experiments corroborated previous ideas as to the differential behavior of different species, it was not possible in this series of experiments to develop any net which might, in a practical way, allow most of the small haddock to escape while retaining most of the marketable silver hake.

Although these initial experiments do not rule out the eventual development of a satisfactory "window net", we must look to other ways of managing the mixed fishery for the present. In any case we must have information on the sizes of whiting released through various sizes of mesh. A number of mesh selection experiments have been conducted at various times by the Woods Hole Laboratory.

Mesh selection experiments using double manila demonstrated that a satisfactory separation of large and small silver hake is possible, the data showing reasonably sharp selection characteristics for the species. A 3-1/2 inch mesh for example, has a 50 percent retention point at 22.5 cm., and 25 and 75 percent retention points at about 18 and 27 cm., respectively. (See Table 1).

Future Research

Although the present age-growth data are comparable with that obtained for other species of *Merluccius* in other parts of the world, the techniques for aging should be improved and refined. Structures other than scales and otoliths might be used.

Details of migrations should be worked out. A knowledge of the environmental factors which are related to these movements would be useful in predicting year to year variations.

The relation of spawning success to year class strength and surveys of young fish would be helpful in predicting future abundance. Concentrated work must be done on mortality rates in order to compute yield isopleths for management recommendations.

Table 1.--Silver hake selection - Delaware cruise 61-12
double manila

Length (cm.)	Percentage retained in cod end		
	2-7/8" (2 tows)	3" (13 tows)	3-1/2" (19 tows)
10			
11		36	
12		37	8
13	61	41	10
14	57	34	11
15	65	38	15
16	73	38	17
17	70	48	20
18	77	58	24
19	82	59	38
20	69	63	36
21	83	80	42
22	100	89	47
23		82	56
24		84	56
25		88	67
26		91	72
27		95	76
28		98	81
29		99	77
30		99	85
31		100	83
32			91
33			94
34			96
35			98
36			99
37			99
38			99
39			100
40			

The appearance of a large fleet of foreign vessels on our whiting grounds sounds a new note of urgency to whiting research. We must obtain the information required to assess the effects of this increased effort.

Lastly, the biology of *M. albidus* must not be neglected. The population structure of this species must be determined before exploitation. The assessment of effect of fishing is a comparatively easy task when pre-exploitation data are available.

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