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Results of Soviet Observations on the Distribution of Silver Hake in the Areas of  
Georges Bank (5Z) and Nova Scotia (4W) in 1962-63

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Silver hake (Merluccius bilinearis Mitchill) is common off the eastern coast of North America from the Bell Isle Strait to the Bahama Islands ( H.B. Bigelow and W.O. Schroeder, 1953 ; A.V. Taning, 1958 ).

Concentrations of silver hake may be encountered at the depths ranging from 20 m to 550 m both in midwater and near the bottom. As indicated by Bigelow, silver hake prefers deep waters in winter and migrates to shallower waters in springtime where it stays through summer during pre-spawning and spawning seasons.

Soviet observations on the distribution of silver hake in the areas of Nova Scotia and Georges Bank were started simultaneously with the development of Soviet trawl fishing for silver hake there. The first results of these observations were reported in an ICNAF contribution on the Soviet fishery research in 1962 ( A.S. Noskov, G.A. Zakharov and I.N. Sidorenko, 1963 ).

Both commercial fishery statistical data and the information obtained during the cruises of research scouting vessels were used for the assessment of silver hake distribution in divisions 5 Z and 4 W.

Results of observations in Subarea 5 Z

In the Georges Bank area concentrations of silver hake began to be fished by Soviet trawlers first in April 1962 in the southeast part of the bank. The catches were then composed of first-time spawners of 4-year-old silver hake specimens of 29 cm to 33 cm long ( Fig. 1 ).

The densest concentrations of silver hake were found at the depths 85- 200 m along the slope of Georges Bank in the frontal zone separating waters of the Atlantic origin from those of Labrador at near bottom water temperatures 10-12°C. After the termination of mass spawning in the second part of July concentrations of silver hake in this area were found to have dispersed.

This area was repeatedly surveyed by scouting vessels during the period from September 1962 through April 1963, however no silver hake was observed in the southeast part of the bank to the depth 200m.

In 1963 concentrations of silver hake were found in the southeast part of Georges Bank in the second part of May and, as in 1962, they were observed there till the second part of July after which the silver hake left the area.

Fig. 2 shows the gonad development pattern of male and female silver hake in 1963. As seen from the figure, male spawners appeared in catches two months before female spawners. Post- spawners were first sighted in June and already in July they composed over 30% of the shoal.

The size- age composition of silver hake catches in the southeast part of Georges Bank was similar to that of 1962. As before, the catches were mainly composed of first-time spawners of 4- year- old silver hake of 29-33 cm long ( Fig.1 ).

Both in 1962 and in 1963 concentrations of silver hake preferred to be in the frontal zone that separates the warm waters of Atlantic origin from the waters of Labrador origin supplied from northwest. Especially dense concentrations of silver hake were registered in the areas where near bottom water temperatures were 10°- 12°C ( Fig.3, (1-5) ).

Displacement of the near bottom water layer with temperatures 10°-12°C resulted in corresponding, changes in the location of silver hake concentrations. This, according to

the observations by A.A. Sarnits ( AtlantNIRO ) winds and tides have caused certain changes in the frontal partition of waters and in the position of the water layer with temperature  $10^{\circ}$ - $12^{\circ}$ C which in turn has made the silver hake to change location.

In the northwest slope of Georges Bank concentrations of silver hake were observed at the depths from 40 m to 110 m both in summer 1962 and in summer 1963 ; however silver hake kept more dispersed, so that catches there were lower than in the southeast part of the bank.

The frontal zone of this area is known to have an abundant development of zooplankton in summer, especially such forms as Euphausiidae and Gammaridae that serve as objects of intensive feeding of hake, herring and the young of other species of fish. Unlike the immature hake, large post-spawning specimens fed on their own young and on the young herring and other fishes in the area.

Such concentrations were observed in the frontal zone with water temperature at the bottom from  $6^{\circ}$ C to  $11^{\circ}$ C ( Fig. 3  $\rightarrow$  (6) ).

In autumn 1963 a concentration of young ( 20-26 cm) silver hake was sighted in the area of Main Gulf north of Georges Bank at the depths 240- 280 m.

The size composition of silver hake, the ratio of immature specimens, and the size of the catch per unit of effort are given in Fig. 1.

Pre-spawning and spawning concentrations of silver hake in the southeast part of Georges Bank remained near the bottom during daytime. At night the fish somewhat raised above the bottom which influenced the size of the catch. In the northern part of Georges Bank a correlation was established between the diurnal vertical migrations and food habits of silver hake. According to the observations by L.N. Domanevski ( AtlantNIRO, 1963 ) two peaks of the most intensive feeding

of silver hake were registered in August 1962 : one during the nighttime ( 0-2 hours ) and another at midday ( at noon). It was noted that while at night bottom food grew in importance ( Gammaridae ), in the daytime the silver hake fed mainly on Euphausiidae. When feeding on Gammaridae the silver hake kept closer to the bottom yielding greater trawl catches.

Results of observations in division 4 W

Concentrations of silver hake were first found in this division in spring 1962 in the zone of continental slope south of Sable Island.

However observations on the distribution and fishing of silver hake in the area were of incidental character,

In August- September 1962 spawning of silver hake was observed by research scouting vessels in the area of Sable Island.

A dense concentration of young silver hake was observed in November 1962 in the gut area northwest of Sable Island at the depth 140-160 m. It was composed of 25-29 cm long pre-spawning specimens that were seen here till February 1963.

Hydrological observations showed that during winter season the gut area northwest of Sable Island was penetrated from southwest by an inflow of near bottom warm water passing between Emerald and Sambro banks at the depth 100-150 m. Silver hake was observed there in the frontal zone on the border of this warm water at the bottom and cold waters of Labrador origin. Horizontal temperature gradient in the near bottom layers were not too great and ranged from 6.6° C to 1.6° C ( per 10 miles distance. The most abundant concentrations of silver hake were found in the zones where the temperature near the bottom was 5.5° C to 7.8° C. Distribution of hake concentrations was found to vary in correspondence with the changes in the location of warm water inflow.

In spring 1963 - from the latter half of February to April - concentrations of pre-spawning silver hake as they become mature, began to migrate along with warm water inflow and appeared in April on the continental slope southwest of Sable Island ( Fig. 4 ).

Silver hake was observed there in warm waters of Atlantic origin along the slope and below the layer of cold Labrador waters at temperatures near bottom  $7^{\circ}$ -  $10^{\circ}$  C,

In April 1963 large size silver hake specimens of older age, especially females, were observed to approach the continental slope along with pre-spawning hake.

Thus, in April a concentration of silver hake was fished in the slope area somewhat westerly of Sable Island. This shoal was formed by 86 % of females and the size of specimens varied from 25 cm to 49 cm ( mode 35-37 cm). Shoals of young and older generations were found to partially mix, though in May some size division took place : while in the eastern part of the area large-size specimens dominated in catches, in the western part catches were mainly composed of smaller size fish ( Fig 4 ),

No observations were conducted in the area in summer 1963, but in August- September spawning concentrations of silver hake were encountered in the shallow waters off Sable Island at temperatures near bottom  $9$ - $12^{\circ}$  C. The catches in this area were dominated by large ( 34-35 cm ) female specimens and easterly, over the slopes of the Gully Deep - by 26- 29 cm male specimens.

No sizable concentrations of mature post-spawning silver hake were discovered in division 4 W in winter.

1. As a result of the analysis of operations of research, scouting and fishing vessels in the areas of Georges Bank ( 5 Z ) and Nova Scotian shelf ( 4 W ) main grounds and

periods of feeding concentrations of young hake ( recruits) and spawning concentrations of silver hake were established and their seasonal migration routes were charted.

2. Concentrations of pre-spawning silver hake each year approach the southeast slope of Georges Bank in April- May. These shoals are mainly composed of first- time spawners of 4-year- old fishes body length 29-33 cm; they prefer the depths 85- 200 m with temperatures near bottom  $10-12^{\circ}\text{C}$  along the bank slope in the frontal zone dividing the waters of Atlantic and Labrador origin.

3. Feeding concentrations of silver hake are formed in summer on the northwest slope of Georges Bank influenced by food-abundant Labrador and coastal waters at the depth 40 m to 110 m and at near bottom temperatures  $6^{\circ}-11^{\circ}\text{C}$ .

4. In the area of deep water gut northwest of Sable Island concentrations of young silver hake ( recruits ) are formed during the autumn- winter period; they will spawn for the first time in the year to come. The food- abundant frontal zones that divide the warm deep water inflow near the bottom and water masses of Labrador origin serve as a hydrological indicator of the location of young silver hake. Shoals of silver hake normally prefer the depths of 150 m to 170 m at near bottom temperatures  $5.5^{\circ}\text{C}$  to  $7.8^{\circ}\text{C}$ . Concentrations of silver hake there are mainly formed of 3-year- old fishes of 25 cm to 29 cm long.

5. During the spring season, as silver hake becomes mature, it follows the warm water inflow into the area of continental slope and intermingles with the shoals of repeatedly spawning specimens which are dominated by females. The frontal zone with near bottom water temperature  $7^{\circ}-10^{\circ}\text{C}$ , which is usually limited to the depths 170-250 m of the continental slope, serves as a hydrological indicator of silver hake's habitat during the said period.

6. Mass spawning of silver hake in division 4 W occurs in August- September in the shallow waters near Sable Island which are by then warmed up to  $9^{\circ}-12^{\circ}\text{C}$  at the bottom.

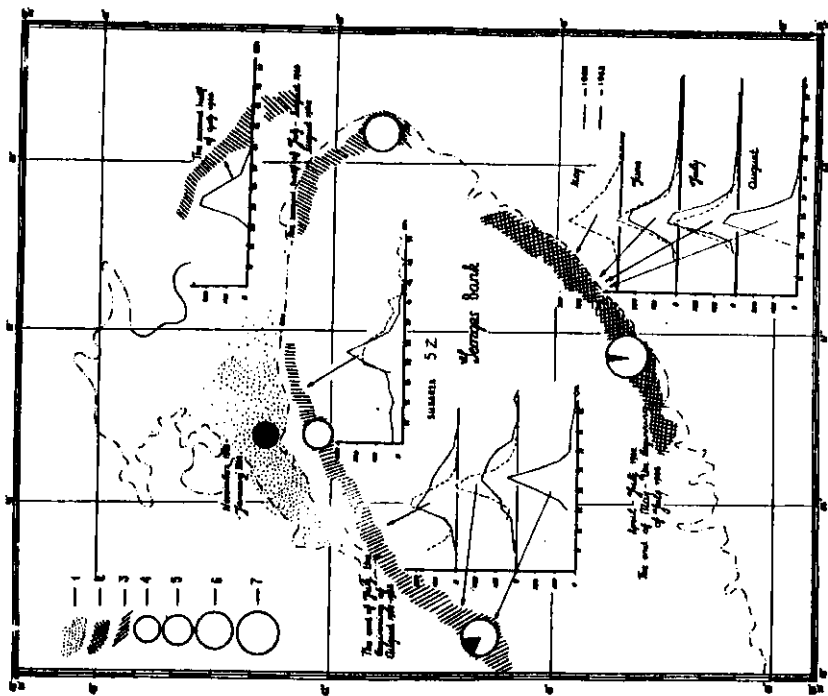


Fig. 1. Distribution of silver hake concentrations in the area of Georges Bank ( 5 Z ) in 1962-63.

Conventional symbols :

- 1 - Concentrations of young silver hake ( recruits)
- 2 - Spawning concentrations of silver hake
- 3 - Feeding concentrations
- 4 - Average catch of less than 2 tons of silver hake per hour of trawling by big refrigerator trawlers
- 5 - Average catch of 2 to 3 tons per hour
- 6 - Average catch of 3 to 4 tons per hour
- 7 - Average catch of more than 4 tons per hour.

The black section inside the circle indicates the proportion of immature silver hake in the catch.

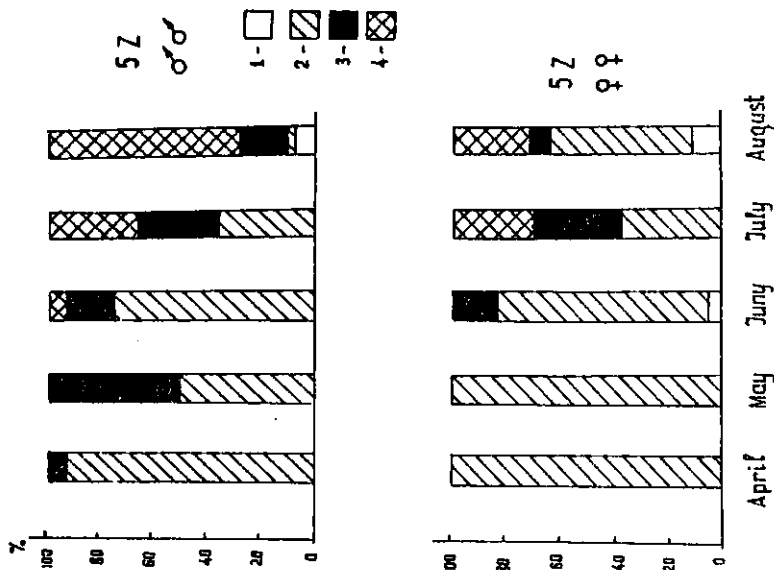


Fig. 2. Pattern of gonad development of male and female silver hake by months in 1963. Subarea 5 Z, Georges Bank.

Conventional symbols :

- 1 - immature silver hake
- 2 - pre-spawning silver hake
- 3 - silver hake spawners
- 4 - post-spawning silver hake

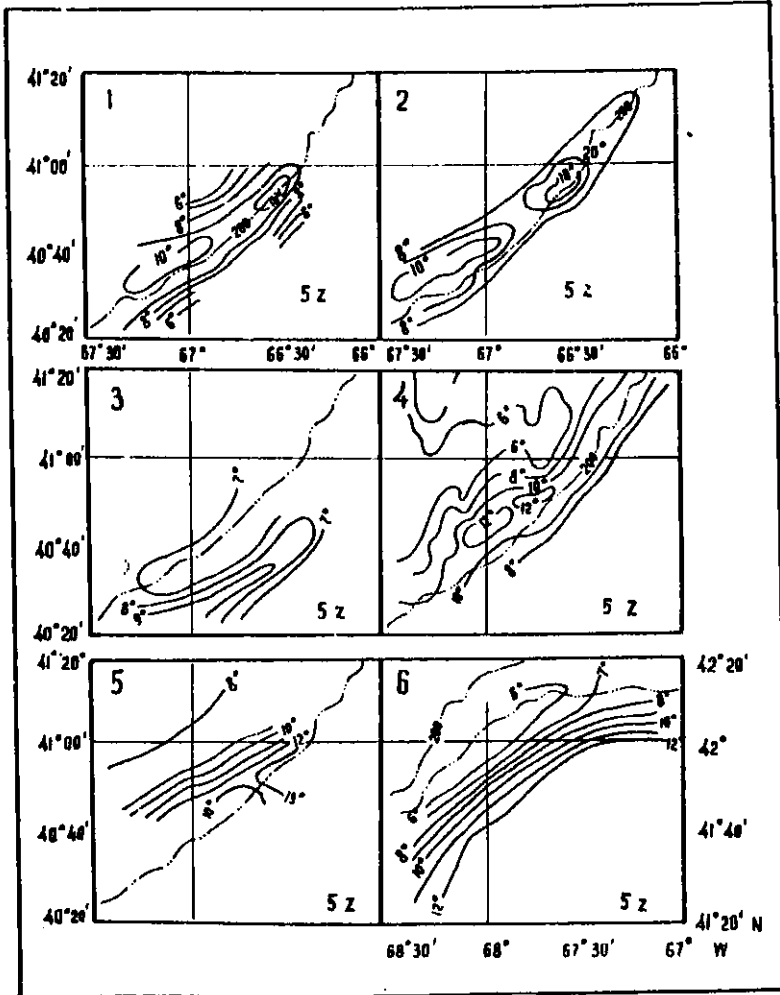


Fig. 3. Water temperature ( C° ) distribution near bottom on the silver hake spawning ground in the southeast part of Georges Bank ( 1 - 5 ) and in the area of feeding concentrations ( 6 ) in 1962-63.

Conventional symbols :

- |                 |   |               |
|-----------------|---|---------------|
| 1 - June 1962   | - | 2 - July 1962 |
| 3 - August 1962 |   | 4 - May 1963  |
| 5 - July 1963   |   | 6 - July 1962 |

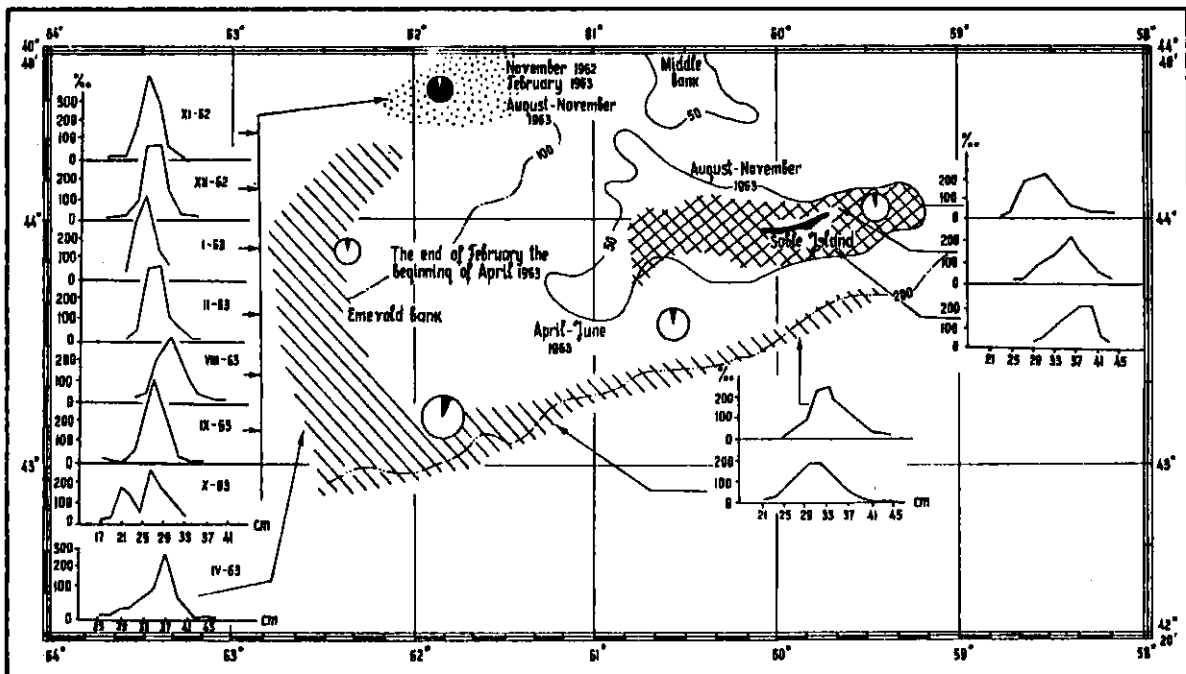


Fig. 4. Distribution of silver hake concentrations in the area of Sable Island ( 4 W ) in 1962- 63.

Conventional symbols : same as for Fig. 1.