

ANNUAL MEETING - JUNE, 1963Serial No. 1125  
(D.a.62)Document No. 54USSR Research Report, 1962Soviet Fishery Investigations in  
the ICNAF Area in 1962by A.S. Noskov, G.P. Zakharov,  
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In 1962 fishery investigations in the Northwest Atlantic were carried out mainly by exploratory and partly by fishing vessels under the leadership of the Polar and Atlantic Institutes of Marine Fisheries and Oceanography. Altogether 25 of such exploratory and research cruises were made during the year. The R/V "Akademik Knipovich" and SRT-R 9048 each made two cruises in the ICNAF area. Oceanographic observations were also carried out on board the r/v "Topseda" during her two hydrological surveys in the areas of Greenland Labrador and Newfoundland (1st in June-July, 2nd in August-September).

In the course of the above investigations distribution and feeding of fish, specific and size-age compositions of catches were studied. Spawning grounds and seasons were determined as well as the conditions necessary for the formation of commercially important fish concentrations. Zoo- and ichthyoplankton were studied. One of the cruises was entirely devoted to the estimation of the young commercial fish in the area of Labrador and Newfoundland. Vertical distribution of redfish was studied in the Labrador area. In some areas with greater depths (over 1000 metres) between Greenland and Iceland investigations were aimed at detecting the midwater concentrations of redfish.

SUBAREA I

In spring and autumn 1962 oceanographic observations in Subarea I were carried out by vessels "Topseda", "Novorossisk" and "Pobeda". The preliminary analysis of the collected data has revealed that the cold waters of the polar origin were extended over much greater space in the areas of Eastern, Southern and Western Greenland in 1962 in comparison with the preceding year. This may probably be related to the slackening of the Irminger component of the West-Greenland Current. In September 1962 the mean temperatures of the 0-200 m layer on the sections intersecting the main fishery banks of Western Greenland (Fyllas, Fiskenas and others) were from 0.5° to 1.0° lower than in 1961.

Investigations in the waters of West Greenland were carried out in April-June and August-September.

In spring no commercial concentrations of cod were observed in Subarea I F. Small catches of mainly immature cod were composed of 42-86 cm fish. The mature specimens were in the post-spawning maturation stage. In August-September catches were largely composed of young immature cod (mode 60-65 cm). In August-September the near-bottom temperatures in the places of cod concentrations varied from 2.5° to 3.7°C.

In late April on the western slope of Frederikshob bank (I E) catches were made of both redfish and large-size spawning cod (mode 74-80 cm) at the depths 370-600 m. However, the catches of cod did not exceed 0.6-0.8 tons per one hour of trawling. During the same period small catches of immature cod (mode 45-50 cm) were taken in shallow waters in Subarea I E. The cod were rather sluggishly feeding on planktonic and benthic invertebrates (Fig. 1). The predominance of 5-9 year-olds on the diagram of age composition of cod in Subarea I E results from the fact that sampling was done from the catches taken at greater depths.

During the repeated surveys in Subarea I E in June the catches of cod in some cases amounted to 1.0-1.5 tons per one hour of trawling. The catches were chiefly composed of large-size (mode 74-86 cm) post-spawning cod sluggishly feeding at that time on Euphausiacea. Feeding conditions in summer are usually not favourable for cod in the area and do not stimulate the formation of dense concentrations of fish.

In the end of April-the beginning of May spawning cod occurred also on the western slope of Danas bank (I D) at the depths 370-470 m with specimens of 74-80 cm prevailing in catches. In this area catches varied in size from 0.5 to 0.8 tons per one hour of trawling. More than half of the fish were in the post-spawning stage. Catches decreased with the depth, while the spawning cod gained in number. Only individual specimens of small-sized cod occurred in the shallow waters of the banks Danas and Fiskenas. In April-early May the near-bottom temperatures in these shallow-waters were negative. Towards the end of May the near-bottom temperature in the shallows of Danas bank has risen to 1.5°C. During this period good catches (up to 3 tons per one hour of trawling) of small and medium size cod (mode 47-53 cm) of 1958 year-class were taken in this area (Fig. 1, diagram for 28-30th May). Cod were intensively feeding on Euphausiacea and sand lance.

In the beginning of May, cod, mainly immature, were detected on Fyllas bank at the depth 225-250 m. The bulk of catches was made of 59-71 cm fish of the 1957 year-class. Among the mature fish prevailed male specimens with gonads in the liberation stage. In the second half of May the catches on Fyllas bank taken at the depths from 100 to 150 m were mainly composed of 74-83 cm cod of the 1953 year-class. The cod was feeding on sand lance and Euphausiacea.

In Subarea I C no dense concentrations of cod were observed in May. Only in some instances the catches reached one ton per hour of trawling. Catches contained both immature and mature post-spawning cod. Specimens of 62-65 and 77-80 cm prevailed in catches. The fish fed on Euphausiacea, Pandalidae and benthic invertebrates.

In mid-May catches of cod in the southern part of Store Hellefiske bank (I B) did not exceed 0.5 tons per one hour of trawling. The catches were mainly composed of immature cod of the 1957 year-class (mode 51-56 cm). Fish of 1958-1959 year-classes constituted an insignificant part in catches. The cod's main food organisms were Euphausiacea, Pandalidae, and Amphipoda.

Redfish (Sebastes marinus marinus) occurred in spring everywhere along the West Greenland shelf area. In southern subareas from Cape Farwell to 64° N redfish were caught at the depths 350-500 m. Further northward on the western slope of Lille-Hellefiske bank redfish were caught at the depths 220-270 metres. No stable concentrations of redfish were registered at that time. On the western slope of Frederikshob bank occasional catches yielded up to 3 tons per one hour of trawling (mode 40 cm, male and female). Much bigger redfish (mode 57-60 cm) were caught on the southern slope of Danas bank. Commercial catches of redfish were taken on the eastern slope of

Banan bank and on the western slopes of the banks Lille-Hellefiske and Helder. Catches reached 5.0-7.0 tons per one hour of trawling and consisted of fish mostly of 39-43 cm long.

On the eastern slope of Banan bank a few scores of small sized redfish (6-16 cm) were caught in the trawl provided with a small-meshed cover. The number of small-sized redfish on the western slope of this bank was insignificant.

In all subareas of West Greenland the ratio of males and females was close to 1:1. As in the preceding year, the major part of redfish were immature specimens. Only a few females had the gonads with developing embryos. The number of mature males was bigger than that of mature females.

## SUBAREA II

Throughout the year the research and exploratory fishing vessels of the Polar and Atlantic Institutes carried out standard hydrological sections and bottom temperature and salinity measurements in places of intensive fishing operations in areas 1 and 2. In the Newfoundland area waters of the polar origin in the first half of 1962 occupied less space than usual. The mean temperatures in layer 0-50 m, section 3 A (eastern slope of the Grand Bank) were higher than in moderately warm 1960, their values being close to the temperatures of the warm year of 1958. The results of estimations on other sections (6 A and others) provide further evidence in support of these observations. Towards the end of August the onflow of cold Labrador waters has somewhat intensified. In the end of 1962 the sea off Labrador coast was colder than in the end of 1961.

These changes have left the near-bottom layers of the sea (below 200 m) almost unaffected. The analysis of the long-term hydrological changes in subareas 2 and 3 has revealed that in most cases the temperature and salinity in the near-bottom layers undergo very little variations.

In 1962 the research work in the Labrador area covered more northward areas right up to the waters flowing round the Baffin Land where investigations were made in September on board a scouting trawler. The area from 69°N to the northern edge of Labrador was covered by instrumental investigations and experimental trawlings. No commercial concentrations of redfish or cod were discovered.

In all places with low near-bottom temperatures occurred the blue-back halibut (Reinhardtius hippoglossoides) with 50 to 70 cm specimens prevailing. Most specimens were immature, only some individuals displayed the post-spawning stage. The halibut was intensively feeding on Boreogadus saida and other boreal species.

Redfish (S. marinus mentella) began to show up in the area from 66°40'N at the depths 400-500 meters and in waters with negative near-bottom temperatures (-1.3°C) south of 64°45'N where they were greatly affected by a warm branch of the West Greenland Current, attracting the growing number of redfish. The maximum catches of redfish of 0.3-0.5 tons per hour of trawling were registered in 61°30'N at the depth 480-520 m when the near-bottom temperature was 3.2°C. With the decrease of depth the redfish decreased both numerically and in size: in the 400-500 layer the length range was 17-49 cm, the mode being 24-32 cm; in the 300-400 m layer the size range was 9-27 cm and the mode 12-19 cm. The majority of redfish taken by trawl were immature specimens. Their food consisted of planktonic crustaceans and the young cod and halibut.

Labrador: Between 59° and 58°N dense shoals of post-spawning cod were observed in the middle of April at the depth 400-500 m. The catches amounted to 4.0-6.0 tons per one hour of trawling. Cod of 53-68 cm at the age of 7-10 years prevailed in catches (Fig. 3, 4). In September-October cod were very dispersed in this area. The catches did not exceed several hundred kilograms per one hour of trawling. During this period fish were smaller than in spring (mode 47-53 cm at the age 5-6 years).

In May dense shoals of cod were encountered in the central part of Labrador (2H). The catches were dominated by fish of 56-62 cm long at the age 9-12 years (Figs. 3 and 4). In autumn the catches of cod in this subarea were insignificant because the fish kept in small shoals. Dominating was 6-8 year-old fish.

The basic area of cod fishery in 1962, as in the past years, was Southern Labrador (2 J). In April-May both pre-spawning and post-spawning cod were successfully fished for on the banks Hamilton and Sundal. Immature cod concentrations occurred on the shallower depths. In April the catches were dominated by fish of 43-62 cm, in May - by those of 53-62 cm. (Fig. 3). The proportion of fish of different ages varied in relation to the place and time of fishing. Most important in catches were cod of 1955-1957 year-classes (Fig. 4).

As in the other areas, no large commercial concentrations were observed in Subarea 2 J in autumn.

In Subarea 2 J stable diurnal vertical migrations of cod were registered in spring. During the light time of the day the fish kept in the water column sinking to the near-bottom layers at night. These migrations greatly influenced the productivity of fisheries, i.e. in the day-time catches were smaller than at night. The migrations were evidently caused by peculiar trends of feeding: the cod fed on planktonic organisms in the day-time and on benthic forms in the night time.

Fishing for redfish (S. marinus mentella) in Subarea 2 J was conducted in January-May. Here the pre-spawning and spawning concentrations of redfish were represented mainly by males of 34-38 cm and females of 43-48 cm. (Fig. 5).

In Subarea 2 H commercially-important catches of redfish were obtained in April-May. The prevailing sizes were 30-40 cm. In the second half of the year fishing operations in the Labrador area were mainly conducted by exploratory vessels. In November commercial concentrations of redfish were discovered on the north-east slope of Hamilton bank. Dominating lengths of females and males were 32 cm and 35 cm correspondingly (Fig. 5).

### SUBAREA III

On the northern Newfoundland bank (3 K) the cod fisheries proceeded during winter and spring. In winter catches were dominated by 53-65 cm fish, in spring - 41-56 cm. Most important in catches was cod at the age of 4-8 years of 1954-58 year-classes (Fig. 3-4).

On the northern slope of the Grand Newfoundland Bank (3 L) the commercial fishing fleet operated mainly in winter. In the other seasons of the year cod served as by-catch in the redfish fisheries. The prevailing sizes of cod in catches taken by a research vessel were 44-53 cm in April and December and 32-35 cm in March. The age varied from 3 to 9 years (Figs. 3-4).

On the Flemish Cape bank (3 M) cod formed dense and stable

concentrations in winter in the southeastern part of the bank, and in spring - on the spawning grounds on the southwestern slope of the bank at the depths exceeding 300 m. In 1962 the commercial fishing fleet exploited the pre-spawning concentrations in December. The catches were mainly composed of 45-62 cm fish at the age of 5, 6, 8 and 9 years (Figs. 3-4). Fish caught by a research vessel in March in shallow waters (less than 200 m) had the age 2-4 years.

During the spawning period immature cod was dispersed over the whole space of the bank, whereas on the spawning grounds prevailed the fish with gonads in higher stages of development. There were more males than females among the mature fish. The spawning season continued from the end of February till early April, reaching the peak in the middle of March. The first fish to spawn were those of older age: on the 3rd of March the spawning grounds were dominated by cod at the age of 8-9 years and on the 19th March - by 5-6 year-olds.

Second spawners dominated during the initial period of spawning. Recruits (mature fish with no spawning marks on otoliths) constituted 32.7% on March 3 but by March 19 the number of recruits grew to 49.9%.

In 1962 the catches on Flemish Cape bank were dominated by cod of the rich 1957 year-class. The linear rate of growth of cod on Flemish Cape bank is higher than in subareas 2 J and 3 K, and lower than in 3 L, 3 N, 3 O, 3 P.

On the southwestern slope of the Grand Newfoundland Bank cod fishing was conducted from February till July and in December; on the banks Green and St. Pierre - in February; on the southeastern slope of the Grand Bank - in April. The size and age composition of cod in these subareas is shown on Figs. 3 and 4.

The catches of redfish (*S. marinus mentella*) in 1962 were considerably lower than in the previous years. Lack of stable concentrations did not facilitate the shifting of fishing effort on redfish. In subareas 3 K and 3 L redfish were caught in the first half of the year during the period of formation of pre-spawning and spawning concentrations. Prior to liberation of larvae the females concentrated on the northeastern slope of the Grand Newfoundland Bank in the places of intrusion of warm waters of the Atlantic Current. Redfish concentrations kept at the depths 300-400 m where the near-bottom temperatures were 3.0-3.9°C. The prevailing sizes for males were 35-36 cm, for females 43-45 cm (Fig. 6). Before the extrusion of larvae the females departed to the depths of 500-600 m where the near-bottom temperature reached 4-6°C. Mass liberation of larvae was observed within 3-4 days after which the redfish dispersed. Males constituted from 25 to 50 per cent in catches of pre-spawning redfish concentrations. With the departure of females to the depths in the areas of pre-spawning concentrations their number in the catches decreased resulting in general decline of the catch. Mainly females were caught in the places of liberation of larvae.

Apart from the other reasons, the decline in the catch of redfish on Flemish Cape bank was influenced by the reduced fishing time and effort and by the decrease of catches per one hour of trawling. In summer 1962 the catches of redfish per one hour of trawling by SRT and SRT-R vessels constituted 0.30-0.45 tons, and in 1960-61 they amounted to 0.55-0.60 tons.

In summer, concentrations of redfish were observed on the northwestern and northeastern slopes of the Flemish Cape bank at the depths 300-400 m. The prevailing lengths of males were 31-33 cm, females - 34-35 cm (Fig. 5). The sex ratio was 1:1. 25 per cent of fish were immature. The redfish were intensively feeding on

Amphipoda, Pandalidae, caplin, and lantern anchovy. Golden redfish (S. marinus marinus) constituted a considerable part in catches taken on the northern slope of the Flemish Cape bank.

Early and late in the year the commercial fishing fleet carried out redfish fishing on the southern slope of Flemish Cape. In the second half of the year the bank was regularly visited by exploratory vessels. In autumn the basic sizes of redfish were 33-35 cm for males and 35-38 cm for females.

The exploratory fishing vessels operated on the southeastern slope of the Grand Newfoundland Bank (3 N), sometimes obtaining very good catches of redfish. In Subarea 3 O the catches were dominated by redfish males of 26-27 cm and females of 27-29 cm. There were up to 50% immature specimens. The larvae were extruded in June at the depths 160-220 m. During the day-time the redfish kept at the bottom and at night ascended to the middle layers. The feeding was done at the expense of Euphausiacea.

Concentrations of haddock (Melanogrammus aeglefinus) were discovered in February on the southwest slope of the Grand Newfoundland Bank (3 O). The fish kept in the zone of intrusion of the warm Atlantic Current waters at the depths 100-390 m (Fig. 7) where the near-bottom temperature was 4.5°-9.0°C. The expeditional vessel SRT-R 9048 had the maximum catch of 1.2 tons per one hour of trawling at the depth 150-200 m (near-bottom temperatures being 5-7°C). The prevailing sizes of haddock were 38-42 cm (Fig. 8). At smaller depths the fish was smaller in size than at greater depths.

In spring and summer the haddock fisheries on the southwest and southeast slopes of the Grand Newfoundland Bank were considerably less extensive than during the same seasons in 1960 and 1961. No haddock concentrations were found in its usual habitats. The absence of haddock in spring-summer period is explained by the unfavourable hydrological conditions in 1962. Normally in May-June the spawning concentrations of haddock were observed on the southwest slope of the Grand Newfoundland Bank up to the depths 40-100 m (near-bottom temperatures 4-8°C). In July-August haddock used to feed in the southeastern part of the Grand Bank at the depth 40-50 m (near-bottom temperatures 4-5°C).

From May till August 1962 the near-bottom temperatures along the whole southwest slope of the Grand Newfoundland Bank up to the 300 m depth never rose above 4°C. On the southeast slope of the Grand Bank the near-bottom temperatures were also low up to the second half of August (2°C in May and 3-4°C in June).

In the end of August the near-bottom temperature in the southeast part of the Grand Newfoundland Bank has somewhat increased and exceeded 4°C. At that time haddock approached the shallow waters in this area and intensively fed on caplin's eggs and Amphipoda (Fig. 9). The haddock catches of a research vessel (trawl mesh 36 mm) were dominated by fish of 40-44 cm and 24-26 cm.

The catches were mainly composed of haddock specimens of 1955 year-class (27.7% in February and 28.2% in August). The haddock of 1956 year-class consisted in February 26.1% and in August 12.4%; the 1957 year-class haddock yielded 30.4% in February and 23.1% in August; the 1958 year-class yielded 6.6% in February and 11.6% in August. The year-classes of 1959 and 1960 numerically were very poor, but the year-class of 1961 was more abundant (16.0% in August).

The haddock of 20-28 cm long (about 40%) of the 1961 year-class were also present in considerable numbers on the St. Pierre bank. So, the year 1961 was apparently favourable for the survival

of the young haddock in this area.

#### SUBAREA IV

In 1962 regular fishing for silver hake (Merluccius bilinearis) was carried out in the shelf area of Nova Scotia. In July-September the silver hake catches from pre-spawning and spawning concentrations southwest of Sable Island (4 W) were composed of specimens from 20 to 45 cm (mode 27-28 cm). In December dense fishable concentrations of hake were exploited westward of Sable Island. These concentrations consisted mainly of immature fish with 24-26 cm long specimens prevailing (see Fig. 10).

In April herring were successfully caught by drift nets on Banquereau bank. In the beginning of the month herring chiefly concentrated in the southeast of the bank; by the end of the month they departed to the north and northwest. The depths in the area of fishery varied from 70 to 300 m. The surface temperature in July was 0.5-0.7°C, and in the end of April 0.9-1.2°C. In the day-time herring stayed in the deeper layers coming closer to the surface in the evening. The length of herring in catches varied from 22 to 36 cm with specimens of 25-27 cm (41%) and 32-35 cm (21%) prevailing.

#### SUBAREA V

Four research cruises were made in the Georges Bank area (5 Z) in the period from March till December, during which along with fish-scouting operations observations were conducted on the hydrological conditions, distribution of herring and silver hake, and on the state of the numerical strength of the latter.

In Subareas 4 and 5 the Atlantic and Polar Institutes carried out oceanographic research from April till November 1962 on the Georges Bank and in the south of Nova Scotian shelf. The section along 65°W was worked in June 1960, 1961 and 1962. The mean temperature of this section in 1962 was by 0.17° higher than in 1961, and by 0.92° than in 1960. This suggests the lasting rise in water temperature in the area in question.

In July took place a redistribution of water masses in connection with tide variations, the water temperature on the 50 m layer changing by 5.4° within the period of six hours.

#### Observations on the Seasonal Development of Plankton on the Georges Bank in 1962

In 1962 plankton were sampled on Georges Bank during exploratory cruises from February till August. Sampling was done by a Judey net of No. 38 webbing.

In February plankton were sampled on the northern and southwestern slopes of the bank. Diatom and peredinea bloom was observed in both areas. Specific composition at that time was very poor. In the northern part the biomass reached the value of 800-1000 mg/m<sup>3</sup>, whereas in the southwest it was 180-400 mg/m<sup>3</sup>. First spawning of Calanus finmarchicus began in the end of February. Warm water forms of plankton occurred on the southwest slopes. Limacina retroverea, Metridia lucens. In March rather poor blooms of diatoms were observed on the southern and southwest edges of the bank. Calanus finmarchicus continued to spawn. Biomass was 100-150 mg/m<sup>3</sup>, with higher values on some of the stations at the expense of phytoplankton. The qualitative composition is mainly characterized by the boreal



forms.

In May biomass in the northern part of the bank reached the value of 500-800 mg/m<sup>3</sup>; in the northwest it was 100-150 mg/m<sup>3</sup>, and in the southeast 20-40 mg/m<sup>3</sup>. C. finmarchicus occurred everywhere.

In June zooplankton biomass sharply increased to the value of 500-1000 mg/m<sup>3</sup> on all slopes of the bank with the exception of the southern part, where it did not exceed 100-150 mg/m<sup>3</sup>. The qualitative composition has markedly enlarged.

In July mass development of diatoms is observed, especially in the northern and southeastern parts. Mass development of the young C. finmarchicus and Euphausiacea takes place at the same time. In comparison with June biomass is decreasing and becomes more evenly distributed. The northern slopes were dominated by C. finmarchicus and the young Euphausiacea, the central part by small Calanoida forms, and the southern part by such warm water planktonic forms as Metridia longa, Limacina retroverea, etc.

#### Silver hake (Merluccius bilinearis)

In 1962 considerable concentrations of silver hake were observed on Georges Bank which were successfully exploited by large fish-freezing trawlers from April till October.

The body length of silver hake varied from 22 to 66 cm. The catches consisted mainly of 28-32 cm specimens of 160-200 grams. Males were smaller than females. Thus, the average length of males was 30.1 cm and that of females 33.2 cm. The rich generation of 1958 formed the overwhelming part in catches, yielding on the average 94.1%. Silver hake males attain the stage of first maturity when they reach the length of 24 cm; females first mature when they reach 31 cm. At the length of 31 cm all females and males become mature. Main concentrations of silver hake were observed on the southeast slopes of Georges Bank. That was a dense spawning shoal. The hake kept at the depths 50-150 m in the water front zone within the range of near-bottom temperatures 7-11° (see Fig. 11). The spawning season continued from July to September, the peak falling on the second half of July. On the southeast slopes the feeding of hake proceeded very inactively.

As to the northwest slopes, the herring in catches was accompanied by considerable quantities of hake, mainly feeding with only a small part in the stage of spawning; in July-August hake kept in the water front zone at the depths 40-110 m where the near-bottom temperatures ranged from 5.0 to 11.5°. Hake was rather intensively feeding on the northwest slopes. The main items of the food diet were invertebrates, mainly Euphausiacea and prawns. Specimens of more than 35 cm were feeding chiefly on fish: small silver hake, young haddock and red hake.

There are certain differences both in the biology and with regard to systematic characteristics of the silver hake of Georges Bank and the Sable Island area: spawning on Georges Bank took place mainly in July, whereas in the area of Sable Island it was in September; the average number of vertebrae on Georges Bank was from 54.76 to 56.88 and that of the Sable Island area 55.00. So, these areas seem to be inhabited by presumably independent local stocks.

As regards the prospects of hake fisheries on the Georges Bank in 1963, it may be supposed with reasonable safety that it will also be successful because the bulk of catches will be composed of the abundant year-class of 1958.



### Herring (*Clupea harengus*)

During the period of 1959-61 the Atlantic and Polar Institutes of Marine Fisheries and Oceanography have undertaken a few research cruises in the shallow waters of Nova Scotia and Georges Bank for the purpose of oceanological and ichthyological studies. As a result, concentrations of herring were discovered on the Georges Bank. Most stable and dense concentrations were observed from May to October. Herring fisheries commenced from May 1961 and were successfully maintained through 1962. In 1961 the catches of herring on Georges Bank reached the amount of 67,584 tons. 36,567 of these were taken by large fish-freezing trawlers of the BMRT type and 31,017 by middle fishing trawlers (SRT and SRT-R) using drift nets. In 1962 the herring catch grew to 151,144 tons of which 44,549 tons were taken by BMRT, while SRT and SRT-R took 88,197 tons by means of drift nets and 18,398 by trawls.

In 1961-62 regular research cruises were undertaken during which observations were made on the biology and stock conditions. The main results of these observations are briefly summarized below.

#### Size and Age Composition of Herring Catches

Herring which are caught on the Georges Bank form a discrete population spawning on the bank itself. The adult herring remain on the bank almost the year round, immature specimens being occasionally encountered in small numbers in the western and northern parts of the bank. The young herring dwell in the coastal areas of the Maine Gulf where they are an object of local fishery. In samples taken on Georges Bank, both from commercial and experimental catches, herring were represented by specimens having the body length from 18 to 32 cm. The minimum age of herring in catches (the age determinations were based on scale readings) was 2 years, the maximum age was 9 years (see Fig. 12). The bulk of the catch was composed of fish of the 1956 year-class whose share in 1961 catch was about 54.4%, and in the catch of 1962 - 49%. This generation in comparison with the others may be considered as an abundant one, followed, as regards the numerical strength, by the 1955 year-class. The 1955 year-class contribution was 20.3% in 1961 and 23.5% in 1962. The 1953 and 1954 year-classes were not important in catches: in 1961 they yielded 6.6% and in 1962 - 4.6% of the total catch. The year-class of 1957 was also numerically weak: in 1961 catch it constituted 14% and in the catch of 1962 - 16.3%. Still younger herring were observed only in insignificant numbers; e.g. the 1958 generation averaged 4.4% in the 1961 catch and 7.1% in the catch of 1962.

The predominance of the successive year-classes of 1956 and 1957 in catches also resulted in one modal group continually dominating in the size composition of catches.

As seen from Fig. 12, in May 1961 mode corresponded to the body length of 25 cm (the body length in this case is estimated in accordance with Smith, i.e. the length is measured from the top of the snout to the middle of the caudal fin), shifting to the right side with the growing age of herring. In August 1961 the size of the modal group was 26 cm. No marked changes in the size composition were observed in the fall, winter and spring up to next June. This is explained by the fact that herring's growth is retarded during this period. By July 1962, following the intensive growth in May-June, mode fell on 27 cm.

Simultaneously, with the shifting of the peak of the size composition curve, a decrease in the number of specimens of less than 24 cm was noted during 1961-1962.

Proceeding from the results of the above observations on the size and age composition, the following conclusions can be drawn:

1. The Georges Bank is inhabited mainly by adult herring.
2. In 1961-1962 the herring stock was dominated by relatively good generation of 1956. Out of all other year-classes only those of 1955 and 1957 were of commercial value.
3. Herring older than 9 years did not occur in catches. This is attributed to a high rate of natural mortality at the time when they reach this age.
4. The stocks in 1961 and 1962 were mainly composed of one and the same generations of 1955, 1956 and 1957. Because of the reduced numerical strength, resulting from both natural and fishing mortality, the size of the stock of herring has decreased in 1962 and is bound to decrease even further in future, which should adversely effect, first of all, the productivity of herring fishery.

Thus, a considerable decline in herring catches per drift net was observed already in 1962. As evident from the data presented on Table I, the average monthly catch per one net varied from 90 kg to 550 kg in 1961, and from 12 to 192 kg in 1962. It must be noted that in 1962 more fishing vessels were engaged in fishing operations in the area, so the more limited regions of fishing for herring concentrations have to a certain extent contributed to the decline of catch per one net.

Nevertheless, the catch per one net in November 1962 with the number of vessels reduced by several times in comparison with 1961, was three times lower than in 1961, which is but another evidence of declining stocks.

#### Distribution of Herring on Georges Bank

Distribution of herring on Georges Bank, as based on the results of observations obtained by exploratory vessels, as well as on the data on distribution of the commercial fishing fleet during the period of 1961-62, seems to assume the following pattern:

In late autumn, winter and in early spring, when the numerical strength of food zooplankton on the bank is low, herring are sporadically observed on the northwest slopes of the bank and in adjacent areas of Maine Gulf.

During this period herring settle in small separate groups over considerable water space, though these groups are, as a rule, observed for a short time only. Fishing operations in this period are generally inefficient, exception being January 1962 when herring were successfully taken by big fish-freezing trawlers; however, no commercial concentrations were observed in the corresponding period of 1963.

Stable concentrations of herring on Georges Bank begin to appear in April-May with the development of zooplankton. From this period and till October inclusive the herring remain in the area of slope in the northern, northwestern, eastern and southeastern parts of the bank, and sometimes on the bank itself (see Fig. 13). Such distribution of herring in the area is explained by the intermingling of cold waters from Nova Scotia shelf and from Maine Gulf with warm

waters of Gulf Stream flowing round the southeastern part of the bank, which results in the higher productivity of zooplankton. Distribution of zoo- and phytoplankton biomass in late June-early July 1962, i.e. during intensive feeding of herring, is outlined on Fig. 14.

During May-June the feeding herring recurrently moved from one area to another. This led to the correspondent movements of the fishing fleet. Thus, on the northern slopes of the bank, where herring concentrations were almost continually present from May to October, the number of days spent on active fishing operations during this period in 1962 has amounted to 90%. On the southern and southeastern parts of the bank the fishing fleet conducted operations in May and June. In July-August herring formed the pre-spawning concentrations on the northern slopes and remained there till spawning terminated in October. In October separate shoals of post-spawning herring departed along the slope to the eastern part of the bank, and from there proceeded first to the north, then to the northwest into Maine Gulf.

### Feeding

The feeding of herring was very sluggish in March-April, both in 1961 and in 1962. According to the data collected by Ju. K. Benko and A.P. Wilson, over 50% of analysed herring had empty stomachs. Stomachs of those who were feeding contained such items as Euphausiacea, C. finmarchicus, phytoplankton, and young sand eels.

During this period herring normally remain in the near-bottom layers in the day-time, and rise to the surface at night.

It must be noted, however, that in certain areas where concentrations of food organisms could be observed, herring were intensively feeding during this period as well; e.g. in April 1962 herring were actively feeding on the spawning concentration of Euphausiacea in the southeastern part of the bank where they remained at the surface for 24 hours round.

In May a sharp increase of the numerical strength and biomass of C. finmarchicus was observed almost everywhere, the biomass reaching the maximum value in June. Thus, in the middle of June 1962 the value of biomass on the northern slopes of the bank was 500-1000 mg/m<sup>3</sup> and 100-150 mg/m<sup>3</sup> on the southern slopes. May-June is the period when the feeding of herring reaches its highest point. It was during this period when a relatively fast growth and accumulation of fat were observed. According to the unpublished data collected by senior scientist of the Atlantic Institute, Dr. Rulev, the fat content increases from 3% in May to 14% in June. By the end of June, when the numerical strength of C. finmarchicus has markedly decreased, feeding of herring became less intensive. In July-August the main item of the herring's diet was Euphausiacea. Since that period herring all the time remained at the bottom, whereas in May and June they mainly kept in the water thickness during the day-time, ascending to the very surface at night. For this reason the drift net fishing is most efficient from April till July and trawl fishing - from August till October.

The fat ratio achieves maximum value (16%) in July and declines in August because this period is characterized by intensive development of gonads. During the spawning season in September-October the amount of fat drops to 4.5% decreasing still further during the winter season. In April the percentage of fat was as low as 1.4%.

### Spawning

Herring of Georges Bank in mass reach the maturity stage at the age of 4 years, and since the majority of herring (over 80%) in 1961-1962 were of 4 years old or older, the main mass of herring was composed of mature specimens. As seen from the data on Fig. 15 in spring 1961 the main mass of herring had the sexual glands in the maturation stage and only a small part of herring remained immature.

Intensive development of sexual glands was taking place in June-July, and in the end of August part of the specimens had their gonads in the stage of maturation. Spawning at its height was observed in the first half of September and continued through the end of October. Spawning of herring in the northern part of the bank took place at the depth from 50 to 150 m. In 1962 the development of gonads followed the same course as in 1961. Spawning took place in the same area, however its peak was observed somewhat later - in the middle of September.

Table I attached, page 13.

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TABLE I

SUMMARY OF THE RESULTS OF DRIFT NET HERRING FISHERY IN 1961-62

Year	Fishing Effort	Months											
		Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1961	Number of days of fishing	-	-	-	-	37	45	212	97	-	1126	2829	337
	Number of nets	-	-	-	-	2233	1722	3273	2019	-	58620	124568	26391
	Average catch per net in kg	-	-	-	-	90	370	550	500	-	130	120	170
	Catch in tons	-	-	-	-	201	638	1800	1002	-	7522	15318	4536
1962	Number of days of fishing	-	4	127	1456	2787	3036	3242	2663	1440	1169	690	177
	Number of nets	-	1025	36219	83922	191133	205669	160325	85844	33389	51297	62677	20031
	Average catch per net in kg	-	12	21	62	83	102	110	68	192	54	35	36
	Catch in tons	-	12.5	755.6	5157.0	15981.8	19997.6	17580.4	5873.7	6419.3	2783.0	2170.9	714.9