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# USSR Research Report for 1988

## SECTION I

## PRINRO Investigations in NAFO Convention Area in 1988

by

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## Subareas 0 and 1

### A. Fishery status

In October - December 1988 USSR fishing vessels set about trawl fishery for Greenland halibut on the continental slope in Div. 0B more than once. However, the fishery stopped quickly due to poor yields.

Total Soviet catch of Greenland halibut and roundnose grenadier in SA 0+1 was 53 t and 120 t respectively (Table 1).

### B. Special investigations

#### 1. Environmental investigations

In October 1988 RV "Kapitan Shaitanov" took standard deepwater measurements of water temperatures and salinities in Davis Strait south of 66°20'N at 24 points on transects 34-A, Cumberland, Fyllas Banke, and at 52 random points (Table 2).

The observations conducted show that in October 1988 heat content of waters in Davis Strait was higher compared to the same period of the previous year. The strongest deviations occurred in the southern Davis Strait where the average temperature in the upper 200-m layer exceeded the previous year level by 0.4 - 0.6°C.

Ice conditions in the strait were close to the long-term average ( SCR Doc. 89/Borovkov, Tevs).

#### 2. Biological investigations

Greenland halibut. Greenland halibut stock in SA 0+1 was estimated, like in previous years, through trawl survey. During the survey a standard bottom sampling trawl with small-mesh linear in the codend was towed for one hour at the speed of 3.0 knots. Positions of trawlings were determined by the

random station method, and subsequently were corrected according to bottom type, depth, wind direction etc. From 3 to 28 October 113 accident-free hauls were made at depths of 200 - 1250 m.

Greenland halibut catches occurred practically over the entire survey area except the stratum No.21 (Tables 3,4). Examination of the catches shows that Greenland halibut had a scattered distribution over a vast area without any concentrations. The catches taken from 200-300 m on the shelf in Div. 0B did not exceed 40 kg and consisted of young fish of 6-25 cm long; those taken from 350-600 m comprised immature fish of 33-40 cm in length. Peak halibut catches were obtained from depths of 750-1250 m (Tables 3,4). Males of 28-84 cm long and females of 24-104 cm with modal size of 48-49 cm in both sexes occurred in catches. The biomass of Greenland halibut in the survey region in SA 0+I in the zone accessible for bottom trawl fishing was estimated to be 101,800 t including 54,600 t in Div.0B (Tables 3,4).

Compared to historical results from trawl surveys the actual estimates of abundance and biomass indices for Greenland halibut are lowest for the period since 1980 (SCR Doc. 88/41). The continuing increase in heat content of waters in this region, which we reported earlier (SCR Doc. 87/15, SCR Doc. 87/93), accounts for the scattered distribution of Greenland halibut, decrease in accessibility of halibut stocks for bottom trawl sampling, and therefore, trawl fishing.

Roundnose grenadier. Biological materials were collected during the trawl survey in SA 0 (14-28 October 1988), and in SA I (3-13 October). Catches in SA I did not exceed 500 kg per hour trawling. In SA 0 roundnose grenadier catches were 50-200 kg, and only once there was a 1200 kg catch (near the boundary of Div. 2G). These maximum catches were taken while trawling at depths greater than 1000 m. At depths of less than 1000 m roundnose grenadier occurred only as by-catch to Greenland halibut. From 1000 m and deeper roundnose grenadier accounted for more than 50% by weight in catches. In 1988, like in earlier years, an increase in average size of grenadier males and females occurring in catches was observed with increasing depth of fishing. In SA 0, for instance, the average lengths of fish in catches from 1000 - 1100 m and 1201 - 1300 m were 54.5 cm and 58.5 cm, respectively. There was no significant difference between the roundnose grenadier average lengths in SA 0 and I. The average length of grenadier in all surveyed zones including SA 2 and Div.3K was 55.2 cm, and the average age - 9.2 years. The detailed information on roundnose grenadier may be found in the paper by P.I. Savvatimsky to NAFO Scientific Council Meeting (SCR Doc. 89/Savvatimsky).

## Subareas 2,3

### A. Fishery status

Greenland halibut. According to preliminary data the Soviet catch of Greenland halibut was 1,053 t in 1988 versus 4,092 t in 1987. Halibut-directed fishery took place from late November through December at depths of 500 - 1300 m. (mainly 900 - 1100 m) in the Central Labrador (Div. 2H) with efficiency of about 0.5 t/hour trawling. Elevated heat content of the shelf waters accounted for the large and fairly even distribution of halibut and low density of concentrations. Stormy weather interfered with the fishery, so there was a high breakdown rate of fishing gears.

Roundnose grenadier. In 1988 the Soviet fishery had a low efficiency due to deepwater distribution of roundnose grenadier. A few BMRT-type vessels operated in July - November in Div. 3K at depths of 900 - 1350 m ( mainly 1100-1200m) to have roundnose grenadier average catch of 12.1 t per boat/day. Other vessels had a markedly lower catch due to technical reasons limiting the feasibility of deepwater fishery. However, it should be noted that according to the results from trawl surveys carried out annually in the Labrador waters relative amount of roundnose grenadier in catches from 1000 - 1200m did not exceed 15-20% in the 1980-1985 period, and by 1987 - 1988 it had grown to 50-60% (SCR Doc. 88/IX/100). This might be caused by gradual movement of grenadier concentrations from deep layers upwards.

Redfish. In 1988 Soviet vessels fished for redfish outside 200-mile Fishing Zone of Canada, principally in January-April on Flemish Cap (Div. 3M) and the slopes of Grand Bank (Div. 3LNO), in July - September and partly in October - December in 3LNO, as well as inside the fishing zone of Canada in SA 2+3K in September - November.

According to preliminary data total Soviet catch was 31,252 t which is 17,794 t less than in 1987 (Table 1). Production of the fishery was close to that in 1987 almost in all the areas except for SA 2+3K where fishing conditions were unstable and catch per haul ranged from 1 to 18 t, mostly 1-3 t.

Capelin. Soviet vessels fished for capelin from 14 May to 3 June in Div. 3NO, and from 5 September to 18 November in Div. 2J+3K. Total capelin catch was 4,736 t and 16,825 t, respectively. According to preliminary data production of the fishery per boat/day was 35.8 t in May, and 45.5 t in June.

In the spring-summer period the catches in 3NO comprised mostly mature fish of 14 - 16 cm long, and in September-November individuals of 10 - 20 cm in length occurred in 2J

and 3K (about 80% of the catch were fish of 12-16 cm long weighing 14-19 g).

Other fishes. Catch of other fishes in SA 2 and 3 was determined by their occurrence as by-catch in directed fishery for redfish, halibut, roundnose grenadier, and capelin (Table 1).

B. Special investigations

1. Environmental investigations

a) Oceanographic observations in SA 2

Oceanographic observations were performed in September - November on board the RVs "Kapitan Shaitanov" and "Vilnius". Water temperatures and salinities were measured at standard depths of 88 random stations and 17 stations along the transects 8-A and 38-A. Vertical temperature profiles were derived from 39 bathythermograph sets.

In the autumn 1988 there occurred a heavy increase in water temperature in the upper 50 m layer, and larger-than-usual spread of relatively cold waters eastwards off the continental slope. Examination of historical fluctuations in water temperatures in this area discovered the following peculiarities. After the strong cooling of waters in 1982-84, which turned out to be unique within the 25-year period of observations, the average temperature of the Labrador Current waters became close to normal in 1985-86, then the slight cooling in 1986-87 was followed again by a warming trend in water temperatures (SCR Doc. 89/Borovkov, Tevs).

b) Oceanographic observations in SA 3

The observations were made in March-June on board the RV "Persey-III" and in September-December on the RVs "Kapitan Shaitanov" and "Vilnius". Table 2 presents the information on the works including the list of standard hydrographic transects done.

The average water temperature in the near-bottom layer in the northern Newfoundland Shelf (Div. 3KL) was somewhat lower compared to the previous year. On southern Grand Bank (Div. 3NO) the average temperature of the near-bottom waters was a little higher than in the previous year and slightly below the normal.

Relative excess of heat was noted in the northeastern part and on the eastern slope of Grand Bank as well as around St. Pierre and Green Banks.

2. Biological surveys

Like in previous years, in 1988 a special emphasis was made on estimation of commercial stocks by way of sampling trawl and acoustic surveys. Brief information on these works is given in Table 5. Bottom fish stocks were estimated through the trawl survey using NAFO stratified random scheme. In order to estimate abundance and biomass of fishes

distributed pelagically outside the zone of bottom trawl fishing, the trawl survey in SA 3 was performed together with the acoustic one.

Roundnose grenadier (2+3K)

In 2GH trawl survey took place from 18 September to 1 October, and from 28 October to 8 November 1988. In 3K two bottom trawling series were carried out from 13 to 16 September, and from 11 to 12 November at different depths on the continental slope in order to derive the vertical distribution of Greenland halibut and roundnose grenadier and their ratio in catches. The percentage of roundnose grenadier in catches was about the same as in 1987, but higher than that in 1983-1986. Within the survey period grenadier catches did not exceed 130 kg in 3K, and 520 kg per trawling hour with bottom sampling trawl in 2GH. Peak catches of roundnose grenadier were obtained when trawling at depths greater than 1000m. Grenadier - halibut ratio in catches varied by trawling depth and area. In 2GH roundnose grenadier were more than 50% by weight in catches beginning from the depth of 1000m, and in 3K - from the depth of 1100m. The length of roundnose grenadier in catches was increasing with depth of fishing. For instance, in 2G the average length of grenadier in catches taken from 900-1000m was 51.0 cm, and 55.0 cm in those from 1200-1300 m. No trawlings were made at depths greater than 1300m. For all the trawlings the average length of grenadier in catches was 47.2 cm in 2GH, and 42.7 cm in 3K. The survey results indicate that roundnose grenadier concentrations in 1988, like in previous years, occurred in very deep waters and were ill-accessible for estimation with bottom sampling trawl.

Greenland halibut (2GH, 3K)

Trawl survey for halibut stocks in the Northern and Central Labrador (Div. 2GH) was carried out onboard RV "Kapitan Shaitanov" from 18 September to 1 October, and from 28 October to 8 November. In 3K it was conducted from 23 April to 6 May, and from 28 to 30 May 1988 onboard RV "Persey-III".

Greenland halibut occurred in catches evenly throughout the entire area without making any concentrations. The average catches per trawling hour in strata at depths of 200-400 m on the Northern and Central Labrador shelf were 1 to 30 kg, and consisted mainly of young fish of 15-30 cm long. Peak catches of Greenland halibut (0.2 t) were taken from 1000-1250 m. Total abundance of Greenland halibut in 2GH was $16.4 \times 10^6$ fish, and the biomass amounted to 13,700 t (Table 6). Compared to historical data from trawl

surveys the indices of Greenland halibut abundance and biomass in 1988 were the lowest for the 1983-1988 period (SCR Doc. 88/41).

In 3K a higher, as compared with previous years, density of 19-59 cm halibut ($\bar{M}$ = 34.7 cm) concentrations was observed in a deepwater trench (strata 627 and 622) during the survey. Despite the fact that in 1988 the survey did not cover depths greater than 1000m, the abundance and biomass indices derived exceeded the long-term averages (Table 7).

Age composition of halibut catches (Table 8) shows that there is a good recruitment from strong 1982-1986 year-classes among which the 1985 one is particularly marked (males and females at age 3).

Redfish (3M). In 1988 the commercial part of the redfish population on Flemish Cap comprised mainly fish of 22-27 cm in length at age 7-9 from the 1979-1981 year-classes. The trawl survey results supported the findings of 1987 pointing to a good recruitment from strong 1985-1986 year-classes (recruits at age 2-3) which will be the base for the fishery in 1992-1993. The percentage of fish at age 10 remained at the 1987 level (20%). The trawl survey results showed that the redfish abundance and biomass indices had gone down (Tables 9,10). This appears to be due to the fact that the major part of the fish ( about 90%) was distributed pelagically and, therefore, turned out inaccessible for bottom trawl sampling. According to the trawl-acoustic survey data the total redfish biomass on Flemish Cap was 457,600 t. Stock estimates from the redfish survey in 3M are compatible with those obtained using the VPA methodology (SCR Doc. 89/Vaskov et al.).

Redfish (3LNO): Fish ranged from 8 to 45 cm in length at age 1 to 22 occurred in sampling trawl catches on Grand Bank. Fish of 21-28 cm long at age 6 to 9 from the 1979-1982 year-classes prevailed in catches. Data on the redfish abundance and biomass in this region obtained from the 1988 trawl-acoustic survey reveal an increase in the fish stock and a good recruitment from the 1985-1986 year-classes. The total redfish biomass estimated on the basis of the trawl-acoustic survey in 3LNO was about 400,000 t in 1988, and the VPA methodology yielded the value of 351,300 t in 3LN (SCR Doc. 89/Vaskov et al.).

Redfish (3K). According to the trawl-acoustic survey data the redfish biomass in 3K in 1988 was 212,800 t, and abundance - 593 X $10^6$ fish (Table 11). These values are below the long-term averages derived by using only the 1983-1986 trawl survey data (320,000 - 370,000 t). Probably, the 1987-1988 survey data do not reflect the actual stock status in 3K because there is no intensive fishery in the region in question.

Cod (3M). Cod stock was assessed using the data from the June 1988 trawl survey, and those from the acoustic one which was conducted parallel to the trawl survey along the cruise line (Table 11). The survey showed that during this period the major part of the stock (82% of abundance and 77% of biomass) was in the pelagic layer and, therefore, inaccessible for bottom trawl sampling (SCR Doc. 89/Bulatova et al.).

Young cod of 20-35 cm in length at age 2-3 were predominant in sampling trawl catches. A poor recruitment from the 1987 year-class was registered. Generally, the Flemish Cap cod stock still remains in a depressive state. For recovery and preservation of the spawning part of the stock the cod-directed fishery should be further prohibited.

Cod (3NO). According to the trawl-acoustic survey the Grand Bank cod stock in 1988 was below the 1987 level (Table 11). In 3N 18-32 cm cod prevailed in catches, in 3O predominant length range was 24-35 cm. A poor recruitment to the cod stock from the 1985 and 1986 year-classes is expected. Therefore, the poor recruitment together with low abundance of the 1983,1984 year-classes seem to lead to a certain decrease in the 3NO cod stock (SCR Doc. 89/Bulatova et al.).

Cod (3KL). In 1988 the cod abundance and biomass indices derived from the trawl and trawl-acoustic surveys were higher than in 1987. Fish of 30-35 cm and 48-62 cm in length at age 5 and 5-7 belonging to the 1985, 1981-1983 year-classes prevailed in catches. The surveys conducted reveal a relatively high and stable cod stock of the Labrador population during the 1984-1988 period which is above the long-term average level for the 1977-1988 period (SCR Doc. 89/Bulatova et al.).

Haddock (3NO). The main haddock concentrations were found along the southwestern slope of Grand Bank at depths of 150-235 m. Fish ranged in length from 22 to 89 cm occurred in catches with predominance of 44-51 cm individuals (Table 12). Due to the ban imposed on the haddock-directed fishery a gradual stock recovery is observed on Grand Bank. The trawl survey data estimate the biomass of haddock in 3O at 230,200 t, and taking into account the abundance of fish distributed pelagically, the total biomass amounts to 669,300 t. For the first time in 1988 the average weight of one haddock in sampling trawl catches amounted to 1 kg.

American plaice (3K,3LNO,3M). According to the trawl survey data the American plaice stocks in 3K were relatively stable during the four previous years; a drop was noticed on the Grand Newfoundland Bank (3LNO) (Tables 9,10). Fish ranged in length from 6 to 70 cm occurred in catches with

individuals of 26-34 cm being predominant. The biomass of American plaice on Flemish Cap was 6,500 t, the abundance - $10X10^6$ fish which is also below the previous years level. Fish ranged in length from 32 to 38 cm were predominant in catches.

Yellowtail flounder (3NO). During the two previous years fish of 35-42 cm long prevailed in catches with sampling trawls. For the six previous years abundance and biomass indices were the highest in 1983 and 1984 (abundance - 257 X $10^6$ and 261 X $10^6$ fish, biomass - 113,000 t and 97,000 t, respectively). By 1988 the abundance had gradually declined to 45.4 X $10^6$ fish, and the biomass - to 20,800 t (Tables 9,10).

Witch flounder (3KLNO). The results of the 1983-1988 trawl surveys indicate a decrease in the witch flounder stocks in 3KL and their stability in 3NO (Tables 9,10). The detailed information on witch flounder stock dynamics may be found in a paper by S.A. Kuzmin (SCR Doc. 89/Kuzmin).

Capelin (2J+3K and 3LNO). In 1988 there were acoustic surveys for capelin stocks in the spring-summer period in 3LNO and in the autumn in 2J+3K, as well as a trawl survey to derive abundance indices of capelin pre-recruits in 3KLNO.

In the spring-summer period the acoustic survey in 3LNO was performed onboard the RV "Persey-III". The survey results are scrutinized in a paper (SCR Doc. 89/Petrov, Chechenin). The total capelin biomass in 3LNO was 3,950,000 t, and the abundance - 332.4 X $10^9$ fish. The 1986 strong year-class prevailed in catches by numbers of fish while the 1985 year-class was predominant by biomass.

The acoustic survey carried out in 2J+3K onboard MG-1362 "Vilnius" in November 1988 estimated the biomass of feeding concentrations at 61.0 X $10^9$ fish.

More than four-time decrease in the stock in the autumn period in 2J+3K was sure to be determined by both natural postspawning mortality of mature fish, and underestimation of capelin concentrations distributed in the territorial waters of Canada. The largest concentrations of capelin covering the area of more than 130 miles in extension were situated more westerly than usual near the territorial waters. This allows the assumption that a great part of the capelin stock was inaccessible for the acoustic survey.

As a result of the ichthyoplankton survey for capelin pre-recruits conducted in 3KLNO from 21 November to 9 December 1988 on MG-1366 "Kapitan Shaitanov" it was established that the 1988 year-class may be regarded as a year-class with elevated abundance since it exceeds by far the strong 1986 and 1987 year-classes in both the numbers of larvae captured, and the area of thier distribution. Thus, in 1990-

1991 a good recruitment from the strong 1986-1988 year-classes to the capelin stock is expected.

Table 1. Soviet catch in SA 0, 2,3,4 in 1986-88, t.

| Fishes | NAFO SA, Div. | 1986 | 1987 | 1988* |
|---|---|---|---|---|
| Cod | 2GH | - | 4 | - |
| | 2J+3KL | 146 | 87 | 11 |
| | 3NO | 1181 | 764 | 2590 |
| | 3M | 1231 | 706 | 34 |
| | 4VWX | 28 | 25 | 106 |
| Haddock | 4VWX | 322 | 207 | 385 |
| | 3NO | - | 6 | - |
| Deepwater redfish | 2+3K | 3528 | 3229 | 821 |
| | 3LN | 10885 | 18851 | 11723 |
| | 30 | 6099 | 7089 | 5207 |
| | 3M | 15045 | 19875 | 13501 |
| | 4VWX | 9 | 92 | 68 |
| Roundnose grenadier | 0+1 | 1 | - | 120 |
| | 2+3 | 2801 | 2725 | 1890 |
| American plaice | 2+3K | 39 | 77 | 14 |
| | 3M | 962 | 501 | 228 |
| | 3LNO | 188 | 46 | 64 |
| | 4VWX | 6 | 14 | - |
| Witch flounder | 2J+3KL | 21 | 725 | 4 |
| | 3NO | 1724 | 1425 | 1005 |
| | 4W | - | 41 | - |
| Greenland halibut | 0+1 | 32 | - | 53 |
| | 2+3KL | 770 | 4092 | 1053 |
| Capelin | 2J+3K | 16757 | 31131 | 16825 |
| | 3LNO | - | 36 | 4736 |
| Silver hake | 4VWX | 66571 | 41329 | 64685 |
| | 3NO | 67 | - | - |
| Pollock | 4VWX | 564 | 314 | 1054 |
| Yellowtail flounder | 3LNO | - | - | - |
| Herring | 4VW | 508 | 38 | 920 |
| Mackerel | 3+4 | 689 | 49 | 654 |
| Argentine | 4VWX | 108 | 25 | 315 |
| Squid Illex | 3+4 | 39 | 345 | 352 |
| Others | | 17360 | 16464 | 128 |
| Total | | 147681 | 150312 | 128546 |

* - Preliminary data

Table 2. Inventory of oceanographic observations made by PINRO in NAFO SA in 1988

| Ship's name | NAFO SAs | NAFO standard section | | | | Other stations | | | | | | Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Date span | Name | Parameters | Tot. Stns | Seasons JFM | AMJ | JAS | OND | Parameters | Tot Stn. | STD Bottle |
| Kapitan Shaitanov | 0 | 12-14 Oct | Cumberland | T,S | 8 | | | | 18 | T,S | 18 | Bottle |
| | 0 | 26-27 Oct | 34-A | T,S | 7 | | | | 1 | T | 1 | MBT |
| | 1 | 14-15 Oct | Fylla-Bank | T,S | 9 | | | | 32 | T,S | 32 | Bottle |
| | 1 | | | | | | | | 1 | T | 1 | MBT |
| | 2 | 18-19 Sept | 38-A | T,S | 6 | | | 19 | 19 | T,S | 38 | Bottle |
| | 2 | | | | | | | 4 | 7 | T | 11 | MBT |
| Vilnius | 2 | 25-27 Oct | 8-A | T,S | 11 | | | 16 | 34 | T,S | 50 | Bottle |
| | 2 | | | | | | | 28 | | T | 28 | MBT |
| Persey-III | 3 | | | | | 119 | 322 | | | T,S | 441 | Bottle |
| | 3 | | | | | | 3 | | | T | 3 | MBT |
| Vilnius | 3 | 5-6 Sept | Flemish Cap | T,S | 6 | | | 21 | 74 | T,S | 95 | Bottle |
| | 3 | 12-13 Oct | Flemish Cap | T,S | 6 | | | 25 | | T | 25 | MBT |
| | 3 | 25-26 Nov | Flemish Cap | T,S | 6 | | | | | | | |
| | 3 | 5-6 Dec | Flemish Cap | T,S | 6 | | | | | | | |
| Kapitan Shaitanov | 3 | | | | | | | 27 | 43 | T,S | 70 | Bottle |
| | 3 | | | | | | | 3 | 6 | T | 9 | MBT |

Table 3. Results of the 1988 trawl survey for the Greenland halibut stock state in Divs 1BCD

| Stratum | Depth, m | Nos of haulings | Mean catch per hour hauling | | Abundance, individuals ('000) | Biomass, tons |
|---|---|---|---|---|---|---|
| | | | indiv. | kg | | |
| 11 | 501-750 | 3 | 40.3 | 40.10 | 2976.2 | 2962 |
| 12 | 751-1000 | 3 | 63.3 | 77.80 | 3713.6 | 4564 |
| 13 | 1001-1250 | 3 | 69.7 | 91.80 | 3097.8 | 4080 |
| 16 | 1001-1250 | 4 | 71.0 | 107.90 | 5548.5 | 8432 |
| 17 | 751-1000 | 5 | 269.0 | 323.20 | 16877.3 | 20278 |
| 18 | 501-750 | 4 | 5.8 | 5.30 | 140.1 | 128 |
| 19 | 401-500 | 3 | 0.7 | 0.40 | 3.5 | 2 |
| 20 | 301-400 | 3 | 1.0 | 0.40 | 15.1 | 6 |
| 21 | 201-300 | 3 | 0 | 0 | 0 | 0 |
| 26 | 501-750 | 5 | 52.6 | 48.70 | 6910.1 | 6398 |
| 27 | 401-500 | 3 | 6.0 | 3.60 | 66.2 | 36 |
| 28 | 301-400 | 3 | 14.0 | 4.90 | 134.3 | 47 |
| 29 | 201-300 | 3 | 0.7 | 0.25 | 4.4 | 2 |
| 33 | 501-750 | 3 | 58.7 | 31.20 | 413.1 | 220 |
| 34 | 401-500 | 3 | 24.3 | 6.20 | 76.5 | 20 |
| Total | 201-1250 | 51 | 45.1 | 49.5 | 39976.7 | 47175 |

Table 4. Results of the trawl survey for the Greenland halibut stock state in Div. 0B in October 1988

| Stra-tum | Depth, m | Nos of haulings | Mean catch per hour hauling | | Abundance, individuals ('000) | Biomass, tons |
|---|---|---|---|---|---|---|
| | | | individ. | kg | | |
| 1 | 201-300 | 3 | 64.0 | 0.9 | 5585 | 81 |
| 2 | 301-400 | 3 | 89.7 | 18.8 | 6124 | 1281 |
| 3 | 401-500 | 4 | 20.8 | 17.9 | 2010 | 1733 |
| 4 | 501-750 | 5 | 51.4 | 55.7 | 8892 | 9633 |
| 5 | 751-1000 | 7 | 121.7 | 147.1 | 9332 | 11274 |
| 6 | 1001-1250 | 5 | 99.4 | 156.6 | 7271 | 11454 |
| 8 | 201-300 | 3 | 1.3 | 0.1 | 175 | 13 |
| 9 | 301-400 | 4 | 51.3 | 8.3 | 7627 | 1240 |
| 10 | 401-500 | 4 | 23.3 | 11.1 | 1348 | 643 |
| 11 | 501-750 | 5 | 59.6 | 59.9 | 5101 | 5124 |
| 12 | 751-1000 | 3 | 116.3 | 133.8 | 4063 | 4672 |
| 13 | 1001-1250 | 3 | 146.7 | 176.8 | 1863 | 2246 |
| 22 | 201-300 | 3 | 1.0 | 0.5 | 82 | 41 |
| 23 | 301-400 | 3 | 128.7 | 12.3 | 4456 | 427 |
| 24 | 401-500 | 3 | 22.0 | 5.2 | 1181 | 280 |
| 25 | 501-750 | 4 | 79.0 | 56.2 | 6232 | 4432 |
| Total | 201-1250 | 62 | 67.3 | 53.8 | 71342 | 54574 |

Table 5.

Inventory of biological surveys, 1988

| Sub-area | Division(s) | Month(s)[1] | Type of survey[2] | Nature of survey | No. of sets |
|---|---|---|---|---|---|
| 0 | B | 10 | S | Trawl: G.halibut, grenadier | 62 |
| 1 | BCD | 10 | S | " " " | 51 |
| 2 | G | 9-11 | S | " " " | 83 |
| | H | 9 | S | " " " | 36 |
| 3 | K | 9, 11 | S | " " " | 28 |
| 3 | N | 3-4 | S | Trawl and acoustic: groundfish | 79 |
| | O | 3-4 | S | " " " | 88 |
| | L | 4 | S | " " " | 126 |
| | K | 4-5 | S | " " " | 107 |
| | M | 6 | S | " " " | 124 |
| 3 | LO | 4-6 | O | Acoustic: capelin | 28 |
| 2+3 | J+K | 10-11 | O | " " | 15 |
| 2+3 | J+KLMN | 9-11 | O | Acoustic: Myctophidae | 77 |

[1] Use number from 1 to 12 for months.

[2] Insert S for stratified-random and O for other surveys.

Table 6. Results of the trawl survey for the Greenland halibut stock state in Divs 2GH in October - November 1988

| Stratum | Depth, m | Nos of haulings | Mean catch per hour hauling | | Abundance, individuals ('000) | Biomass, tons |
|---|---|---|---|---|---|---|
| 909 | < 200 | 3 | 19.0 | 1.0 | 1951 | 103 |
| 910 | < 200 | 3 | 7.3 | 0.8 | 635 | 70 |
| 925 | < 200 | 3 | 3.7 | 1.3 | 245 | 86 |
| 901 | 201-300 | 4 | 31.5 | 3.6 | 1415 | 162 |
| 908 | 201-300 | 3 | 20.7 | 3.6 | 448 | 78 |
| 911 | 201-300 | 3 | 22.7 | 6.5 | 582 | 167 |
| 924 | 201-300 | 3 | 20.0 | 2.3 | 560 | 64 |
| 926 | 201-300 | 3 | 39.0 | 11.3 | 625 | 181 |
| 902 | 301-400 | 3 | 11.7 | 13.8 | 52 | 61 |
| 912 | 301-400 | 3 | 32.0 | 29.7 | 86 | 80 |
| 923 | 301-400 | 3 | 18.7 | 5.3 | 129 | 36 |
| 927 | 301-400 | 3 | 28.7 | 17.3 | 884 | 533 |
| 903 | 401-500 | 3 | 8.0 | 7.9 | 24 | 23 |
| 913 | 401-500 | 3 | 36.7 | 27.7 | 84 | 64 |
| 922 | 401-500 | 3 | 4.3 | 3.9 | 30 | 27 |
| 928 | 401-500 | 3 | 13.7 | 15.2 | 397 | 441 |
| 904 | 501-750 | 3 | 23.3 | 26.4 | 132 | 150 |
| 914 | 501-750 | 3 | 13.7 | 13.6 | 57 | 57 |
| 921 | 501-750 | 4 | 52.8 | 58.3 | 278 | 307 |
| 929 | 501-750 | 4 | 16.5 | 22.0 | 771 | 1027 |
| 905 | 751-1000 | 3 | 52.3 | 55.1 | 318 | 335 |
| 915 | 751-1000 | 3 | 97.0 | 116.5 | 345 | 414 |
| 920 | 751-1000 | 4 | 118.8 | 138.8 | 757 | 884 |
| 906 | 1001-1250 | 3 | 127.0 | 218.5 | 1077 | 1853 |
| 916 | 1001-1250 | 3 | 87.7 | 137.0 | 474 | 741 |
| 919 | 1001-1250 | 4 | 98.5 | 154.9 | 1153 | 1813 |
| 933 | 401-500 | 3 | 54.7 | 44.0 | 101 | 81 |
| 942 | 401-500 | 3 | 15.7 | 13.0 | 32 | 26 |
| 960 | 401-500 | 3 | 29.7 | 26.5 | 118 | 105 |
| 934 | 501-750 | 3 | 64.7 | 70.7 | 187 | 204 |
| 941 | 501-750 | 3 | 22.7 | 23.5 | 75 | 77 |
| 961 | 501-750 | 3 | 39.7 | 40.0 | 310 | 313 |
| 935 | 751-1000 | 3 | 93.7 | 108.8 | 333 | 387 |
| 940 | 751-1000 | 3 | 42.0 | 56.8 | 151 | 204 |
| 962 | 751-1000 | 3 | 112.7 | 147.5 | 1010 | 1322 |
| 936 | 1001-1250 | 3 | 21.0 | 61.6 | 61 | 178 |
| 939 | 1001-1250 | 3 | 53.7 | 113.4 | 259 | 546 |
| 963 | 1001-1250 | 3 | 21.7 | 46.5 | 213 | 456 |
| Total | < 200-1250 | 119 | 41.5 | 48.5 | 16359 | 13656 |

Table 7. Abundance and biomass of the Greenland halibut in Div. 3K in 1981-1988 (from trawl surveys data)

| Year, month | Area investigated sq.miles | Number of haulings | Abundance, individuals ('000) | Biomass, t ('000) |
|---|---|---|---|---|
| 1981, January | 9479 | 34 | 57.1 | 62.3 |
| 1981, July | 20755 | 48 | 110.2 | 62.5 |
| 1982, July | 23030 | 53 | 154.9 | 98.4 |
| 1983, January | 19954 | 67 | 120.2 | 96.7 |
| 1983, July | 27926 | 94 | 587.8 | 122.6 |
| 1984, July | 31185 | 113 | 288.6 | 216.7 |
| 1985, June | 19012 | 53 | 127.1 | 72.9 |
| 1986, June | 31185 | 122 | 266.4 | 174.8 |
| 1987, May-June | 28470 | 108 | 129.7 | 66.9 |
| 1988, April-May | 28470 | 107 | 303.1 | 112.3 |

Table 8. Age composition of the Greenland halibut in Div. 3K in 1984 - 1988 (from trawl surveys data), (per thousand)

| Age, years | Males | | | | | Females | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1984 | 1985 | 1986 | 1987 | 1988 | 1984 | 1985 | 1986 | 1987 | 1988 |
| I | - | - | 2 | 4 | 21 | - | - | 3 | - | 32 |
| 2 | 2 | 17 | 38 | 85 | 124 | 5 | 53 | 61 | 102 | 123 |
| 3 | 55 | 74 | 97 | 177 | 325 | 61 | 101 | 114 | 158 | 263 |
| 4 | 139 | 220 | 150 | 109 | 147 | 119 | 184 | 138 | 116 | 156 |
| 5 | 214 | 289 | 236 | 147 | 191 | 196 | 230 | 213 | 121 | 183 |
| 6 | 239 | 221 | 258 | 245 | 122 | 227 | 195 | 237 | 199 | 144 |
| 7 | 220 | 118 | 156 | 186 | 41 | 200 | 128 | 141 | 202 | 59 |
| 8 | 107 | 44 | 45 | 26 | 21 | 100 | 60 | 50 | 47 | 27 |
| 9 | 23 | 14 | 15 | 17 | 5 | 44 | 30 | 21 | 25 | 8 |
| 10 | 1 | 2 | 3 | 3 | 2 | 21 | 13 | 10 | 9 | 3 |
| 11 | - | 1 | - | 2 | - | 7 | 3 | 3 | 8 | 1 |
| 12 | - | - | - | + | - | 7 | 2 | 3 | 5 | 1 |
| 13 | - | - | - | - | - | 5 | 1 | 3 | 4 | 1 |
| 14 | - | - | - | - | - | 3 | + | 1 | 1 | - |
| 15 | - | - | - | - | - | 2 | + | 1 | - | - |
| 16 | - | - | - | - | - | 2 | - | 1 | 1 | - |
| 17 | - | - | - | - | - | + | - | + | 2 | - |
| 18 | - | - | - | - | - | + | - | + | - | - |
| 19 | - | - | - | - | - | - | - | - | - | - |
| 20 | - | - | - | - | - | - | - | - | - | - |
| No. of individ. | 2436 | 1334 | 7006 | 3311 | 4424 | 5609 | 2626 | 8165 | 4030 | 4983 |
| Mean age | 5.84 | 5.24 | 5.32 | 5.05 | 4.04 | 6.16 | 5.32 | 5.34 | 5.31 | 4.23 |

Table 9.

Biomass of demersal fishes in NAFO Subarea 3 in 1983-1988 (from trawl surveys data) ('000 tons)

| Species | Division | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|
| Cod | 3K | 56.9 | 355.3 | 243.6 | 271.3 | 130.5 | 331.2 |
| | 3L | 202.3 | 383.3 | 177.1 | 437.2 | 131.9 | 159.4 |
| | 3NO | 182.8 | 266.8 | 457.7 | 425.4 | 289.8 | 110.2 |
| | 3M | 23.0 | 31.1 | 28.1 | 26.1 | 12.3 | 7.7 |
| Haddock | 3NO | 19.3 | 229.8 | 85.2 | 37.1 | 27.1 | 230.2 |
| Redfish | 3K | 376.6 | 319.8 | 356.9 | 372.8 | 69.5 | 13.8 |
| | 3LN | 125.0 | 199.4 | 85.9 | 46.8 | 60.8 | 40.0 |
| | 30 | 127.4 | 108.7 | 129.0 | 109.4 | 19.2 | 34.5 |
| | 3M | 154.9 | 132.3 | 51.9 | 309.5 | 106.4 | 47.0 |
| American plaice | 3K | 64.5 | 52.7 | 17.9 | 18.9 | 18.4 | 13.9 |
| | 3LNO | 533.8 | 642.1 | 325.6 | 348.6 | 225.8 | 160.4 |
| | 3M | 8.9 | 7.5 | 7.8 | 20.2 | 9.3 | 6.5 |
| Yellowtail flounder | 3NO | 113.3 | 96.9 | 84.5 | 39.5 | 26.5 | 20.8 |
| Witch flounder | 3K | 6.2 | 13.0 | 19.8 | 14.5 | 5.0 | 3.1 |
| | 3LN | 2.0 | 9.3 | 12.2 | 6.2 | 4.7 | 1.9 |
| | 30 | 1.3 | 2.5 | 3.4 | 5.9 | 3.9 | 6.8 |

Table 10. Abundance of demersal fishes in NAFO Subarea 3 in 1983-1988 (from trawl surveys data) (indiv. x $10^6$)

| Species | Division | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|
| Cod | 3K | 35.3 | 295.9 | 286.0 | 270.4 | 132.9 | 306.2 |
| | 3L | 121.5 | 311.9 | 180.7 | 297.0 | 73.4 | 89.4 |
| | 3NO | 137.3 | 259.3 | 520.7 | 269.8 | 54.2 | 55.4 |
| | 3M | 65.4 | 60.5 | 37.1 | 37.2 | 36.8 | 26.7 |
| Haddock | 3NO | 77.9 | 440.8 | 152.5 | 49.3 | 39.7 | 197.7 |
| Redfish | 3K | 964.3 | 749.1 | 810.3 | 816.1 | 154.6 | 44.1 |
| | 3LN | 428.9 | 720.3 | 245.1 | 133.4 | 182.1 | 167.3 |
| | 30 | 1187.8 | 763.8 | 1232.4 | 750.7 | 99.4 | 348.8 |
| | 3M | 644.0 | 376.7 | 177.3 | 1200.2 | 463.2 | 183.1 |
| American plaice | 3K | 144.7 | 93.3 | 48.8 | 48.3 | 44.4 | 56.9 |
| | 3LNO | 1440.2 | 1295.6 | 693.8 | 826.8 | 604.3 | 458.6 |
| | 3M | 20.4 | 26.5 | 15.8 | 33.4 | 16.5 | 10.0 |
| Yellowtail flounder | 3NO | 257.4 | 261.0 | 194.0 | 89.6 | 64.8 | 45.4 |
| Witch flounder | 3K | 8.5 | 16.2 | 28.4 | 22.1 | 8.3 | 5.5 |
| | 3LN | 2.4 | 12,6 | 15.3 | 7.5 | 6.3 | 3.0 |
| | 30 | 2.8 | 4.3 | 6.6 | 11.8 | 6.0 | 10.3 |

Table 11. Results of the 1988 trawl-acoustic survey for demersal fishes in NAFO Subarea 3

| Species | Division | Trawl survey | | Acoustic survey | | Trawl and acoustic surveys summarized | | Portion of fish in pelagic waters | |
|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | Biomass | Abundance | Biomass | Abundance | Biomass | Abundance | Biomass |
| Cod | 3K | 306.2 | 331.2 | 228.8 | 143.3 | 535.0 | 474.5 | 43 | 30 |
| | 3L | 89.4 | 159.4 | 194.9 | 223.8 | 284.3 | 383.2 | 68 | 58 |
| | 3NO | 55.4 | 110.2 | 135.2 | 149.8 | 190.6 | 260.0 | 71 | 58 |
| | 3M | 26.7 | 7.7 | 123.8 | 26.5 | 150.5 | 34.2 | 82 | 77 |
| Haddock | 3NO | 197.7 | 230.2 | 428.2 | 439.1 | 625.9 | 669.3 | 68 | 66 |
| Redfish | 3K | 44.1 | 13.8 | 548.9 | 199.0 | 593.0 | 212.8 | 92 | 93 |
| | 3LN | 167.3 | 40.0 | 867.8 | 156.5 | 1035.1 | 196.5 | 84 | 80 |
| | 3O | 348.8 | 34.5 | 1576.1 | 170.0 | 1924.9 | 204.5 | 82 | 83 |
| | 3M | 183.1 | 47.0 | 1660.0 | 410.6 | 1843.1 | 457.6 | 90 | 90 |

Table 12. Length composition of haddock in Div. 3O in 1987 and 1988 (per thousand)

| Length, cm | 1987 | 1988 |
|---|---|---|
| 14-15 | 10 | - |
| 16-17 | 44 | + |
| 18-19 | 51 | - |
| 20-21 | 8 | + |
| 22-23 | - | 10 |
| 24-25 | + | 19 |
| 26-27 | 4 | 29 |
| 28-29 | 1 | 22 |
| 30-31 | 1 | 8 |
| 32-33 | 1 | 2 |
| 34-35 | 6 | 4 |
| 36-37 | 26 | 3 |
| 38-39 | 72 | 5 |
| 40-41 | 118 | 27 |
| 42-43 | 122 | 72 |
| 44-45 | 131 | 121 |
| 46-47 | 109 | 138 |
| 48-49 | 83 | 142 |
| 50-51 | 64 | 115 |
| 52-53 | 43 | 82 |
| 54-55 | 33 | 76 |
| 56-57 | 19 | 40 |
| 58-59 | 18 | 26 |
| 60-61 | 11 | 21 |
| 62-63 | 7 | 14 |
| 64-65 | 6 | 7 |
| 66-67 | 5 | 5 |
| 68-69 | 3 | 3 |
| 70-71 | 1 | 2 |
| 72-73 | 2 | 2 |
| 74-75 | + | 1 |
| 76-77 | + | 1 |
| 78-79 | + | 1 |
| 80-81 | - | 1 |
| 82-83 | - | - |
| 84-85 | + | - |
| 86-87 | - | + |
| 88-89 | + | 1 |
| 90-91 | 1 | - |
| 92-93 | - | + |
| 96-97 | + | - |
| No. of fish measured (per thou) | 1000 | 1000 |
| Number of individuals | 2804 | 3044 |
| Mean length, cm | 42.64 | 47.04 |

SECTION II

Report of Soviet Investigations in NAFO Subarea 4 in 1988

by

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## A. STATE OF FISHERY

For the first time after introduction of the 200-mile zone in 1977 the Soviet silver hake fishery began on April 1. By that time, dense aggregations had already formed on the shelf slope. The fishing conditions were most favourable in April-May when, according to preliminary data, the catches per day of fishing exceeded 40 tons. In the end of June, the hake aggregations began to disperse and migrate to the north. Early in June (a month earlier than in the previous year), the catches of hake per unit effort sharply reduced and the fleet displaced to another area. The Soviet catch of the silver hake totaled to 64.7 thous. tons in the fishing season of 1988. Basically, the quota (57 thous. tons) was taken in June. However the extra quota was not fulfilled completely.

In the catches, the silver hake was mainly represented by the specimens 26-33 cm in length. The mean length was 29.4 cm, the mean weight - 0.190 kg, both values being higher than in the previous year (table 1). The number of the fish 24-27 cm in length markedly decreased in the catches compared with 1987. The smaller specimens were very few. The age composition was characterized by an obvious predominance of two or three year old fish belonging to strong 1985-1986 year classes (table 2). As it was expected, judging by the size composition, the number of the one year old fish appeared to be insignificant.

## B. SPECIAL INVESTIGATIONS

In October-November, a trawling survey of 0-group silver hake was made according to the joint USSR-Canada program by the SRTM-K "Saulkrasty". A total of 111 trawling stations was occupied

and temperature measurements were taken at each. A hydrological transect was made along the shelf slope from 64°00' to 61°40''W. 14 trawling and hydrographic stations were made to study the vertical distribution of the young hake.

According to the preliminary data, the 1988 year class abundance is estimated at the 1986 level (table 3).

In 1988, the environmental studies on the Scotian Shelf were carried out within the framework of the USSR-Canada program for the study of the adult silver hake distribution relative to environmental factors. The studies were based on a number of hypotheses suggested by the Soviet and Canadian scientists. To verify some of them, the observations were made and materials collected during the cruise of the Soviet ship SRTM-K 8108 "Strelnya" in June-August. The objectives of the cruise consisted in carrying out ecological surveys of varying scales over the shelf area. Two surveys covered the shelf slope between 58° and 64°30'W, eight surveys were made within the limited shelf parts (25 x 25 miles) and involved the "patch" study and the survey of the shelf area between 58°30' and 65°30'W. In addition, two reconnaissance surveys were made in the areas of the Emerald Deep and Western Bank. The surveys involved meteorological, oceanographic and hydrological observations, zooplankton and adult silver hake sampling.

To verify a hypothesis suggesting a dependence of the silver hake distribution on oceanographic conditions, the distributions of the silver hake and the fields of the near-bottom water temperature were compared. The largest aggregations have been found to occur near the bottom at the temperatures ranging from 7° to 9°C in the areas with greater horizontal gradients along the boundary between the cold intermediate layer and warm slope waters.

The "patch" study appeared to be most successful as it permitted the observation of the change of situations in the

distribution of the hake and near-bottom temperature during a relatively short time interval. As an example, three successive situations on the slope part which changed one another over the July 27 to August 10 period, 1988, are depicted in fig. 1. The following peculiarities are of interest in the figure: the "patch" of the silver hake was formed in the area with a greater water temperature gradient ; then the area of the relatively cold water of the intermediate layer reduced which is evident from the configuration of the 5°C isotherm, the temperature gradient weakened and the density of the hake "patch" decreased.

The "patches" of large concentration of the hake to the north of the slope result from the fishing in the spawning ground. No trawlings were made in that site during the first survey. Similar situations were also recorded in two other locations on the slope. In the future, the distribution of the plankton food in those locations will be studied and the comparison made between the plankton food distribution, the hake "patches" and near-bottom temperatures. As a preliminary, it can be concluded that the above-mentioned peculiarities of the temperature field may serve as indicators of larger or smaller concentrations of the silver hake. There exist no direct relationship between these peculiarities and the formation of the silver hake "patches"; the former are rather the result of the dynamic processes occurring over the slope and seem to promote the formation of food patches where the hake concentrates. The results of a more complete analysis of the materials will be included in a special report.

The ecological studies carried out by the SRTM-K 8108 "Strelnya" in June-August 1988 are the first stage in the implementation of the USSR-Canada program of the study of the silver hake distribution on the Scotian Shelf. At the subsequent stage, the research activities will be focused on field observations ("patch" studies) with a greater range of physical and biological factors.

Table 1 Size composition of silver hake in Soviet commercial catches by year, %

| Length, cm | Year | | | | |
|---|---|---|---|---|---|
| | 1984 | 1985 | 1986 | 1987 | 1988 |
| 1 | 2 | 3 | 4 | 5 | 6 |
| 12 | - | - | + | - | - |
| 13 | - | - | + | + | - |
| 14 | - | + | + | + | - |
| 15 | - | + | + | + | - |
| 16 | + | + | 0.3 | 0.1 | - |
| 17 | + | 0.1 | 0.6 | 0.3 | + |
| 18 | 0.3 | 0.2 | 1.1 | 0.3 | + |
| 19 | 0.6 | 0.4 | 1.2 | 0.3 | + |
| 20 | 1.1 | 0.7 | 1.6 | 0.2 | + |
| 21 | 1.5 | 0.8 | 1.4 | 0.1 | + |
| 22 | 1.6 | 1.0 | 1.0 | 0.2 | + |
| 23 | 1.3 | 1.1 | 0.8 | 1.2 | 0.1 |
| 24 | 1.0 | 1.2 | 0.6 | 5.5 | 0.5 |
| 25 | 0.7 | 1.8 | 0.8 | 12.2 | 1.8 |
| 26 | 0.6 | 4.2 | 2.0 | 15.2 | 4.9 |
| 27 | 1.9 | 8.8 | 4.5 | 13.2 | 10.9 |
| 28 | 5.1 | 11.4 | 8.2 | 9.0 | 17.5 |
| 29 | 10.0 | 11.0 | 13.1 | 7.2 | 19.8 |
| 30 | 16.2 | 11.3 | 16.9 | 7.3 | 16.2 |
| 31 | 16.3 | 11.2 | 14.8 | 6.9 | 11.8 |
| 32 | 14.0 | 9.8 | 12.8 | 6.7 | 7.0 |
| 33 | 9.2 | 8.3 | 8.7 | 4.9 | 4.0 |
| 34 | 6.3 | 5.9 | 4.5 | 3.4 | 2.7 |
| 35 | 4.4 | 4.0 | 2.4 | 2.2 | 1.3 |
| 36 | 2.8 | 2.5 | 1.4 | 1.3 | 0.7 |
| 37 | 2.1 | 1.5 | 0.6 | 0.8 | 0.3 |
| 38 | 1.3 | 0.9 | 0.4 | 0.5 | 0.1 |
| 39 | 0.6 | 0.7 | 0.2 | 0.3 | 0.1 |
| 40 | 0.5 | 0.4 | 0.1 | 0.2 | + |
| 41 | 0.3 | 0.3 | + | 0.1 | + |
| 42 | 0.2 | 0.2 | + | 0.1 | + |
| 43 | 0.1 | 0.1 | + | + | + |
| 44 | + | 0.1 | + | + | + |
| 45 | + | 0.1 | + | + | - |
| 46 | + | + | + | + | - |
| 47 | + | + | + | - | - |
| 48 | + | + | + | - | - |
| 49 | + | + | + | - | - |
| 50 | - | - | + | - | - |
| 51 | - | + | + | - | - |
| 52 | - | + | - | - | - |
| **Mean length** | 30.8 | 30.1 | 29.8 | 28.4 | 29.4 |
| **Mean weight, kg** | 0.197 | 0.198 | 0.189 | 0.161 | 0.190 |

Table 2 Age composition of silver hake in Soviet commercial catches by year, %

| Age | Year | | | | |
|---|---|---|---|---|---|
| | 1984 | 1985 | 1986 | 1987 | 1988 |
| 1 | 5.0 | 5.4 | 7.4 | 1.6 | + |
| 2 | 10.1 | 33.7 | 12.9 | 59.3 | 42.4 |
| 3 | 38.6 | 29.9 | 45.1 | 21.0 | 41.3 |
| 4 | 33.1 | 21.8 | 28.8 | 14.5 | 13.8 |
| 5 | 10.5 | 7.7 | 5.3 | 2.8 | 2.4 |
| 6 | 2.0 | 1.2 | 0.4 | 0.6 | 0.1 |
| 7 | 0.6 | 0.3 | 0.1 | 0.2 | + |
| 8 | 0.1 | + | + | - | + |
| 9 | + | + | + | - | - |
| 10 | - | - | + | - | - |
| Mean age | 3.4 | 3.0 | 3.1 | 2.6 | 2.8 |

Table 3 Indices of 0-group silver hake abundance in 1981-1988

| Index | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
| Abundance, sp. x $10^7$ | 110 | 2 | 34 | 11 | 62 | 32 | 20 | 32 |

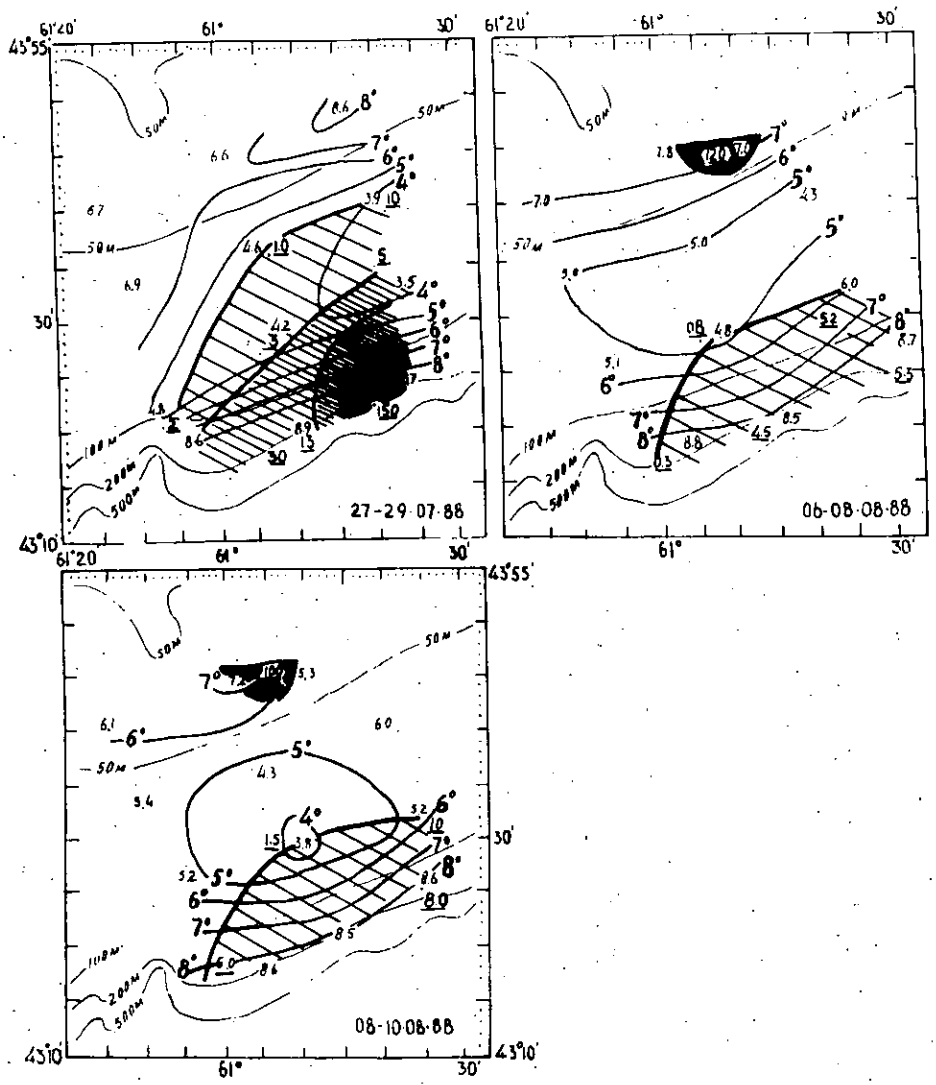


**Fig.1.** Changes in distribution of scientific silver hake catch values (kg) and near-bottom water temperature (°C) in the operational area 3. Catch sizes are subdivided into 4 cathegories: 0-10, 11-50, 51-100 and 100 kg ; catch values are underlined.