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PART I - AtlantNIRO Studies in NAFO Subarea 4 in 1993  
PART II - PINRO Research in the NAFO Area in 1993

PART I - AtlantNIRO Studies in NAFO Subarea 4 in 1993

by

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A. State of Fishery

According to the provisional data Russian silver hake catch on the Scotian Shelf (4VWX) amounted to 8,000 t. That means 46% reduction as compared to the previous year. The volume of the fishing effort decreased twice and CPUE remained at the same level as compared to the 1992 estimates (Table 1). The fishery situation in the area was unstable as previously. Catches varied sharply. To the south of SMGL concentrations of pollock were abundant. Accessibility of hake to the fishery was explained both by the peculiarities of its distribution and behaviour and other species by-catch. Oceanographic factors, possibly, played a decisive part. During the first two ten-day periods of May the conditions were especially unfavourable. During the third ten-day period the situation improved noticeably and remained at that level in June and during the first ten-day period of July. Due to the sharp decline of catches in the middle of the month the fleet left the Scotian Shelf. Rather dense concentrations of silver hake having been found, an attempt to resume the fishery was made in the middle of August. However, the fishery was stopped on August 20 in accordance with the decision of the Canadian authorities. The fleet left the Scotian Shelf once and for all.

The bulk of the 1994 fishery stock will consist of the comparatively strong 1992 year-class and weak 1991 and 1990 year-classes. As compared to 1993 a slight biomass increase will apparently take place. In case of favourable environmental conditions this fact may result in increase of CPUE as compared with two previous years.

B. Special Research  
Environmental studies

In 1993 the Russian vessels did not conduct environmental

studies within the Scotian Shelf. As previously, data on the sea surface temperature for some quadrants in the Northwest Atlantic were analysed. Comparison of monthly means for SST anomalies observed in 1993 on the one hand and 1991 and 1992 on the other hand showed a considerable increase in surface temperature within the Scotian Shelf and to the south of it in the slope waters. As during the two previous years a noticeable prevalence of negative anomalies could be observed within the Grand Banks of Newfoundland. In 1993 SST positive anomalies prevailed in the Labrador Sea to the north of the Grand Banks. A considerable temperature increase in this area also took place as compared to 1991 and 1992. It is clearly seen in the centre of the quadrant with the coordinates of 50-55°N and 45-50°W.

The study of the statistical relationship between monthly mean values of CPUE registered in June and hydrological factors was continued. Some equations of multiple regression with coefficients of about 0.70 were selected from 34 variants of calculation. They may be recommended to be checked using independent data. SST monthly means, their derivatives and indices for location of surface water boundaries were used as predictors.

Variations in abundance of year-classes for some commercial species from the Northwest Atlantic were studied in connection with the annual variability of the hydrological condition between 1977 and 1991. Direct and inverse relations between them were found, developmental trends for these processes were revealed and some ideas concerning abundance variations within the next years were suggested. The results of this study are presented in detail in a separate report.

#### Biological studies

In October-November 1993 a joint Russian-Canada survey on juvenile silver hake was conducted on board the Canadian vessel. The provisional abundance estimate for 0-group allows to characterize the 1993 year-class as a comparatively strong one. Possibly, this fact results from the noticeable warming-up observed in the Scotian Shelf area in 1993.

Samples were taken from the commercial catches in May, June and during the first half of July. Totally the volume of data collected in 1993 has increased as compared to that of 1992. About 31,300 specimens were measured, and 823 pairs of otoliths were taken for age determination.

Specimens of 26-33 cm long constituted the bulk of the 1993 commercial catches (Table 2). The share of the specimens of 22 cm long and less (mainly fish aged 1) increased as compared to those of the three previous years. As usual fish aged 2-4 prevailed in the catches (Table 3). However, this year share of fish aged 1 increased as well and this fact is in close agreement with data of length-frequency measurements. The 1993 maturity rate was noticeably higher as compared to that of the previous year and corresponded to that of 1989 (Table 4).

Miscellaneous studies

Variability of some indices was analysed characterizing the dynamics of silver hake fishery and size of stocks within the Scotian Shelf prior and after 200-mile zone had been introduced. Such indices as total catch, CPUE, biomass and abundance estimates by SPA and silver hake abundance and biomass in the Canadian July survey catches were taken for the analysis. In the process of studies considerable differences in variability of the indices between two periods were found. Variation coefficients (CV) in the majority of cases used to be higher until 1977. However, as far as variability of biomass and abundance estimates are concerned considerable discrepancies were found only in those cases where an adaptive framework was used to tune SPA (after 1977).

At the same time no differences were found between CV estimates which were obtained using ad hoc methods for both periods. According to the Canadian July surveys conducted between 1977 and 1992 variability of abundance and biomass indices turned out to be high and approximated to that of observed till 1977. An attempt was made to reveal main directions of abundance regulation (fishery management) for some fishing objects from the Northwest Atlantic (subareas 2-4) grouped by the geographical principle with due regard for the 200-mile economic zone.

The following population groups have been singled out:

1. those inhabiting the northern edge of the species area and the 200-mile zone;
2. those inhabiting the central part of the species area and the 200-mile zone;
3. partly or wholly inhabiting NAFO Regulation Area.

The results obtained allowed to suggest the following. Abundance of the first population group is mainly influenced by the oceanographic factors. The environmental conditions being unfavorable for juvenile hake survival, even complete ban of fishery won't bring positive results. However, when the first post-depression period strong year-class appears the drastic measures should be taken to protect it from the premature catch. Dynamics of the stock size for the second population group enables to suggest that for some populations maintaining the optimum fishing mortality level is the principal method to regulate abundance. As far as the third population group is concerned, it is exposed to danger due to the overfishing. Thus, strict observance of the fishery regulations is the first necessary condition to regulate the abundance of this population group successfully.

Detailed results of the studies mentioned in the present report are contained in separate scientific documents.

Table 1

Soviet and Russian Silver Hake Catches per Vessel-Day (t)  
by Year and Month

Year	Month				Mean Catch per Fishery Season
	April	May	June	July	
1977	32.7	25.0	39.5	35.4	31.3
1978	20.3	16.8	17.1	26.9	23.5
1979	21.8	25.9	25.8	36.5	27.4
1980	22.8	20.6	21.0	23.6	20.9
1981	14.1	17.9	22.9	20.6	26.6
1982	49.7	37.9	37.4	31.9	37.2
1983	37.8	33.9	21.3	14.3	30.5
1984	44.8	34.3	35.8	43.1	38.4
1985	41.9	42.2	33.2	40.5	38.9
1986	-	50.2	42.0	42.4	44.3
1987	49.2	37.0	34.6	12.3	32.6
1988	43.8	40.4	33.5	15.3	36.8
1989	44.0	44.0	34.7	31.0	40.7
1990	36.1	24.1	24.6	33.0	24.5
1991	31.8	25.7	23.8	23.7	26.4
1992*	24.2	15.1	14.9	-	18.2
1993*	-	14.6	22.6	18.2	18.2

\* Russian catches

Table 2

Length Composition of Silver Hake in the Soviet and Russian Commercial Catches (%)

Length, cm	Year				
	1989	1990	1991	1992*	1993*
15	0.2	+	+	0.1	+
16	0.4	0.1	+	0.1	+
17	0.5	0.2	+	0.2	0.1
18	0.5	0.4	0.4	0.3	0.2
19	0.4	0.4	0.2	0.1	0.3
20	0.5	0.3	0.2	0.1	1.0
21	1.3	0.2	0.1	+	1.3
22	1.7	0.3	+	0.2	1.4
23	1.7	1.4	0.1	0.6	1.2
24	1.6	4.7	0.8	1.4	1.6
25	3.0	10.8	2.9	5.0	2.7
26	4.8	14.8	7.0	8.0	5.2
27	5.2	15.0	12.3	11.3	9.6
28	7.3	12.6	16.2	14.6	14.3
29	11.6	11.4	16.7	12.8	15.6
30	15.2	9.8	15.4	17.2	14.7
31	15.0	7.6	12.2	11.4	11.7
32	12.2	4.9	7.8	8.5	8.0
33	7.5	2.5	3.9	4.2	4.9
34	4.0	1.2	2.0	1.6	2.8
35	2.2	0.6	1.0	1.7	1.7
36	1.2	0.4	0.4	0.4	0.9
37	0.8	0.2	0.2	0.1	0.5
38	0.4	0.1	0.1	0.1	0.2
39	0.3	0.1	0.1	+	0.1
40	0.2	+	+	-	+
41	0.1	+	+	+	+
42	0.1	+	+	+	+
43	0.1	+	+	+	-
44	+	+	+	+	+
45	+	+	-	-	-
46	1	+	-	-	-
47	+	+	-	-	-
48	1	+	-	-	-
49	+	-	-	-	-
50	+	-	-	-	-
51	+	-	-	-	-
Mean length, cm	29.6	27.7	29.1	29.0	29.1
Mean weight, kg	0.188	0.141	0.187	0.189	0.175

\* Russian catches

Table 3  
Age Composition of Silver Hake in the Soviet and  
Russian Commercial Catches(%)

Age (yr)	Year				
	1989	1990	1991	1992*	1993*
1	5.0	2.3	1.0	1.2	3.8
2	31.7	51.4	23.1	35.1	24.7
3	38.1	32.4	43.6	41.7	40.3
4	20.2	11.6	26.6	17.7	25.3
5	4.1	1.8	5.1	4.1	4.9
6	0.8	0.5	0.5	0.2	1.0
7	0.1	+	0.1	+	+
8	+	+	+	-	-
9	+	-	-	-	-
Mean age	2.9	2.6	3.1	2.9	3.0

\* Russian Catches

Table 4  
Mean Stages of Gonad Maturity\* for Silver Hake by  
Year and Month

Year	May		June		July	
	Males	Females	Males	Females	Males	Females
1989	4.1	3.2	4.6	4.3	4.7	4.6
1990	3.5	3.4	4.0	3.6	4.3	4.3
1991	3.5	3.3	4.1	3.7	-	-
1992	3.3	3.1	3.8	3.2	-	-
1993	3.9	3.3	4.6	4.2	4.8	4.6

\* Mean stages were only calculated for mature specimens  
starting with the third stage

PART II - PINRO Research in the NAFO Area in 1993

by

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Subareas 0 and 1

A. Fisheries status

Greenland halibut. In July 1993 Russian ships commenced the licensed fishery on Greenland halibut in Div.OB. The operations were done by 6 ships of the PST-, 3 BMRT- and 3 STM-types. In the first half of the month the ships were in search of halibut aggregations at 550-1100m depths along 61°40' - 65°55'N. Daily catch made up on the average 4.8-5.2 t.

In August Greenland halibut commercial aggregations were distributed at 550-1100m depths from 61°42' to 62°55'N between 63°40' and 64°10'N. Daily catch was on the average 4.9-5.1 t. Daily catch by some other vessels reached 11 t. By-catch of grenadier and other fish constituted below 10%. Rough weather conditions prevented from operating.

In September the fishing was continued in the same positions and depths as in previous cruises. by 1 of the BMRT-, 3-6 PST- and 1-3 STM-types ships. Daily catch by the ships was on the average 4.9-6.5 t. No fishery was conducted by Russian ships in SA 1.

B. No special surveys for studying fish and their inhabitation were carried out in 1993.

Subareas 2 and 3

A. Fisheries status

Greenland halibut. No fishery on halibut was practically conducted off Labrador (2G, 2H, 2I). simultaneously the vessels were searching for fish in the main commercial area of the Baffin Land.

B. Special investigations. In 1993 no trawl survey for Greenland halibut stocks assessment was conducted in SA 0 and 2 and no biological information was obtained.

Roundnose grenadier. No directed fishing for grenadier was carried out. It occurred in small numbers as by-catch in the Greenland halibut and redfish fisheries.

Redfish. In 1993 Russian fishing ships fished for redfish aggregations from April to October outside the fishing zone of Canada and within it on the Flemish Cap Bank and off the southern and southwestern Newfoundland. Some Russian fishing vessels have started to fish redfish on the Flemish Cap southern and southwestern slopes since 8 April. During the whole month the catches were low (from 0.5 to 10 t per 2-3.5 hr of trawling) because of unfavourable hydrometeorological conditions. 1-6 Russian vessels operated on the bank during May. Redfish catches varied from 5-8 to 20-25 t per 2-3 hr of trawling.

Since June the main group of the vessels has mainly operated on the southern Grand Newfoundland Bank where the redfish catches varied from 2 to 10 t per 2-3 hr with a daily catch being 20-50 t. Fishing efficiency was high during summer and reduced only by September, just after the fishery has ceased. In September-October 1 BMRTPT-type vessel was fishing on the southwestern Flemish Cap Bank slope. Daily catches did not exceed 17 t.

Capelin. Since 1991 the capelin stock from the Northwest Atlantic has been at a low level. Considering this, no fishery on capelin was conducted by Russia in 1993.

Cod. In 1993, as in previous years, no directed fishery on cod was carried out by Russian fleet. Cod were caught only as by-catch when fishing redfish on the Grand Newfoundland southern slopes. According to the data from fishing vessels cod by-catch in this area in June was registered as 0.6% and 0.2% (other species).

Other species. No directed fishery for other species was carried out, small by-catches of wolffish, cod, skate, flatfishes, roughhead and roundnose grenadier occurred in Greenland halibut and redfish catches. Provisional catch of commercial species is given in Table 1.

### Subarea 3

#### B. Special studies

##### 1. Studying of environmental conditions

###### a) Oceanographic observations

Oceanographic works were performed by RV "Vilnyus" over the Grand Bank (Divs. 3LNO) from 28 April to 25 June and on the Flemish Cap Bank (Div. 3M) from 26 June to 7 July. 169 and 28 trawl oceanographic stations with temperature and salinity measurements along standard depths were occupied respectively in those areas.

By results from the observations over the Grand Bank the peculiarities of near-bottom temperature and salinity distribution were evaluated, as well as their deviations from the norm and trends toward variations in the characteristics given. These estimates were obtained by interpolating the measured values in points of a regular 0.5° grid, by methods of calculations for temperature and salinity values averaged by areas, as well as by the long-term data presented in the papers (Borovkov and Tevs, 1988; Borovkov and Tevs, 1992).

Analysis for the data showed that in April-June 1993 thermohaline conditions of a near-bottom layer were determined by a distribution of winter origin waters with negative temperatures and lower salinity over the northern and central Grand Bank, as well as by transformed slope waters with a higher content of heat and salts, which occupied the bank southern periphery (Fig. 1). In accord with the estimates for anomalies (Fig. 2) a deficiency of heat and salts was predominant in the area of cold sub-surface waters, whereas the temperatures and salinity of transformed slope waters were considerably higher than the norm. Nature of the anomalies fields reflects, on the one hand, an extension of the area, increase in depth of distribution and accentuation of properties of cold sub-surface waters, what probably results from a severe winter in the area of these waters formation and activating of their advection southward. On the other hand, availability of essential positive temperature and salinity anomalies in the bank southern periphery indicate the more intensive, than usually, intrusion of slope waters into this area in spring-summer period.

This combination of anomalies stipulated an intensification of contrasts in a climatic near-bottom frontal zone, localised in the Grand Bank southern periphery.

Specific character of regional processes, which conditioned inhomogeneity of fields of the near-bottom temperature and salinity anomalies in spring-summer 1993, affected the spatial peculiarities of year-to-year variations in characteristics. As can be seen in Fig. 3 these peculiarities are expressed by a differentiation of velocity of heating



and rise in salinity between the surveys in 1991 and 1993, which was higher in the southern part of the shelf (Divs.3NO), compared to the northern one (Div.3L).

Integral indices for thermohaline conditions (Fig.3) characterize the situation in 1993 as a stage of completing the next period of salts deficiency, which has commenced at the border of 80-90's, and continuation of a phase of reduction in heating deficiency, initiated after an extreme cooling in 1990.

## 2. Biological studies

In 1993, as in previous years, priority was given to evaluation of the status of commercial stocks through trawl and hydroacoustic surveys. However, no trawl survey for halibut stocks was conducted off the Baffin Land and Labrador because of financial difficulties. Table 2 shows survey details, time and amounts of material collected.

Redfish (3M). Trawl-acoustic survey to study distribution and biology of redfish (and other species) on the Flemish Cap Bank was carried out by RV "Vilnyus" (1362) in June-July 1993. The densest redfish concentrations were found at 200-700m depths on the southeastern and northwestern slopes of the bank. Redfish at age 3-24 from 9 to 49cm long occurred in catches. Large specimens of redfish above 25cm long were mainly fished at the depths below 500m. At these depths the catches were minor, with maximum being 130 kg. Small specimens of redfish (below 15cm long) were mainly distributed at 250-350m depths.

By results from the trawl survey in 1993 the biomass of redfish was estimated at 147.1 thou.t, which was 1.5 times higher compared to 1991 and 1992.

Redfish (3LN). Divs.3LN was covered incompletely because of some restrictions for survey from Canadian side. Redfish occurred in catches from 184 to 728m depths, with the highest catches being at 550-750m depths. Redfish of 9-48cm long with two modal groups (22 and 26cm) were found in catches by a bottom trawl.

Redfish biomass calculated by data from the trawl-acoustic survey in 1993 made up 64.3 thou.t. Redfish abundance and biomass from these divisions occurred to be lower than in 1991, however, higher for 1989-1990. This allows to expect an increase in redfish stock in the nearest years (mainly due to a recruitment of the 1988 rich yearclass to redfish stock).

Cod (3M). No essential cod aggregations were found during trawl-acoustic survey on the Flemish Cap in June-July. Cod distribution over the whole bank was homogeneous, except for the eastern slope, where the catches were higher compared to other ones. Cod at age 2-4 of 24-47cm long occurred in catches. Immature specimens constituted the bulk of catches. By the data from the 1993 trawl survey the cod stock on the Flemish Cap increased by 2.2 - in abundance and by 1.4 times in biomass compared to 1991, however, it is still at a low level compared to 1983-1989.

Cod (3LNO). Trawl survey on the Grand Newfoundland Bank southern slopes was conducted in April-May 1993. Cod were mainly distributed along the continental slope. Maximum catches (3-7 t) were taken from 155 to 395m depths on the southern (Div.3N) and southwestern (Div.3O) slopes. Cod of 18-92cm long occurred in catches, with specimens of 30-44cm long from the 1989-1990 yearclasses predominating.

Div.3L was not surveyed completely since a part of this division (10 strata) was closed by Canada for investigations. Cod aggregations here were scattered and distributed in near-bottom layers. Cod of 15-104cm long with a dominating length 30-35cm (at age 3-4) were found in catches.

No trawl-acoustic survey was conducted in Div.3K.

The trend toward a restoration of cod stocks became visible in Divs.3NO. By results from the trawl survey for 1993 the abundance (113.7 mill.indiv.) was higher compared to 1991 and biomass (105.8 thou.t) - somewhat lower. By the data from the 1993 trawl-acoustic survey the abundance of cod, compared to 1991, increased by 4.8 times and biomass has remained at the same level.

Capelin (3LNO). Acoustic survey for capelin was conducted by RV "Vilnyus" (MG-1362) only in Divs.3LNO from 8 to 25 June 1993. The stock was estimated at 315 thou.t. which was higher than in 1991 (118 thou.t). No survey was carried out in 1992. In 1993 very large quantities of larvae and young capelin were caught during the survey, especially in the northwestern part of Div.3O and in the southwestern part of Div.3N. Lots of young capelin about 7cm long were found in bottom trawl meshing when no recordings were available, i.e. fish were distributed near the bottom and were not recorded by echo-sounding. Besides, large specimens of capelin frequently and in large quantities occurred in trawl meshing when conducting trawl survey on bottom fishes. All this indicate a restoration of capelin stocks.

American plaice (3M). By results from the Russian surveys a reduction in American plaice stocks has been noted on the Flemish Cap Bank, being continued since 1988. In 1992 this stock occurred to be the lowest for the period 1985-1993 (biomass - 1.0 thou.t. abundance - 1.5 mill.indiv.). Data obtained in the trawl-acoustic survey for 1993 show a minor rise in stock compared to 1992. The abundance and biomass constituted 3.6 mill.indiv. and 2.7 thou.t., respectively.

Witch (3LNO). By results from the trawl-acoustic survey in 1993 the witch stock remains at a low level. The abundance and biomass made up 5.3 mill.indiv. and 2.8 thou.t., respectively.

#### REFERENCES

- BOROVKOV, V.A. and I.I. TEVS. MS 1988. Temperature of Bottom Waters over the Newfoundland Shelf in Spring-Summer 1972-86. NAFO SCR Doc.88/97. Ser.No.N1554. 16 p.
- BOROVKOV, V.A. and I.I. TEVS. MS 1992. Oceanographic Conditions in Subareas 0, 2 and 3 in 1991. NAFO SCR Doc.92/21. Ser.No.N2068. 14 p.

TABLE 1. Russian catches in Subareas 0, 1, 2, 3 and 4 in 1991-1993. Preliminary data under slash indicate joint venture catches, as received from Canada and Greenland (tons).

Species	NAFO Area	1991	1992	1993
Cod	2	-	-	
	2+3K	4	-	
	3O	67	51/-	
	3M	1	1/-	
	4X	191	1/-	
Haddock	4X	195	1/-	
	3O	2	-	
S. mentella	2+3K	-	6/-	
	3L	3345	571/-	
	3O	4278	5845/-	
	3M	8878	2937/-	
	4X	263	12/-	
Roundnose grenadier	0+1	74	75/75	
	2+3	67	30/30	
American plaice	2+3K	-	4/-	
	3M	3	-	
	3O	30	30/-	
	4X	65	1/-	
Witch flounder	2+3K	2	-	
	3O	-	-	
	4	9	4/-	
Greenland halibut	0+1	1576	7175/7175	
	2+3K	2833	304/-	
Capelin	2+3K	429	-	
	3O	-	-	
Silver hake	4X	49376	2016/-	
	3O	-	-	
Saithe	4X	1204	117/-	
Yellowtail flounder	3O	-	-	
Herring	4	932	277/-	
Mackerel	3+4	1182	1937/-	
Argentine	4X	43	-	
Squid ( <i>Illex</i> )	3+4	560	44/44	
Others		2374	235/-	
TOTAL		78203	21674/7324	

TABLE 2. Inventory of biological surveys.

SA	Div.	Month <sup>1</sup>	Survey type <sup>2</sup>	Objectives	No. of tows
3	3L	5-6	S	Groundfish, temperature, salinity	74
	3M	4-7	S	Groundfish, temperature, salinity	69
	3N	5	S	Groundfish, temperature, salinity	80
	3O	5	S	Groundfish, temperature, salinity	78
	3LNO	6	O	Capelin, temperature, salinity	15

<sup>1</sup> Use number from 1 to 12 for months.

<sup>2</sup> Insert S for stratified-random and O for other surveys.

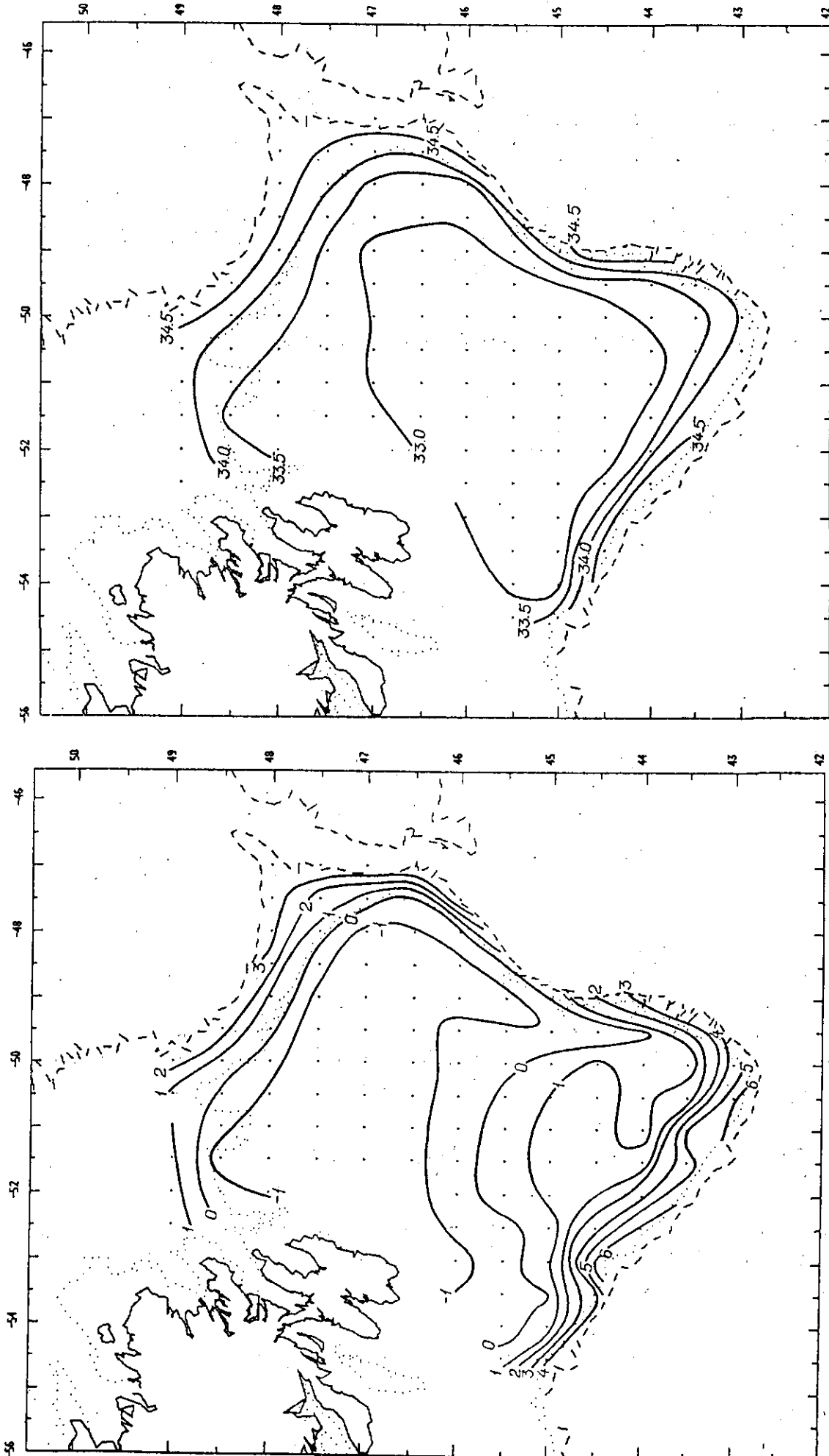


Fig. 1. Distribution of bottom temperature (left) and salinity (right) on the Newfoundland Shelf from RV "Vilnius" survey data for 28 April-25 June 1993

200 m isobath: - dotted line

1000 m - - dashed line

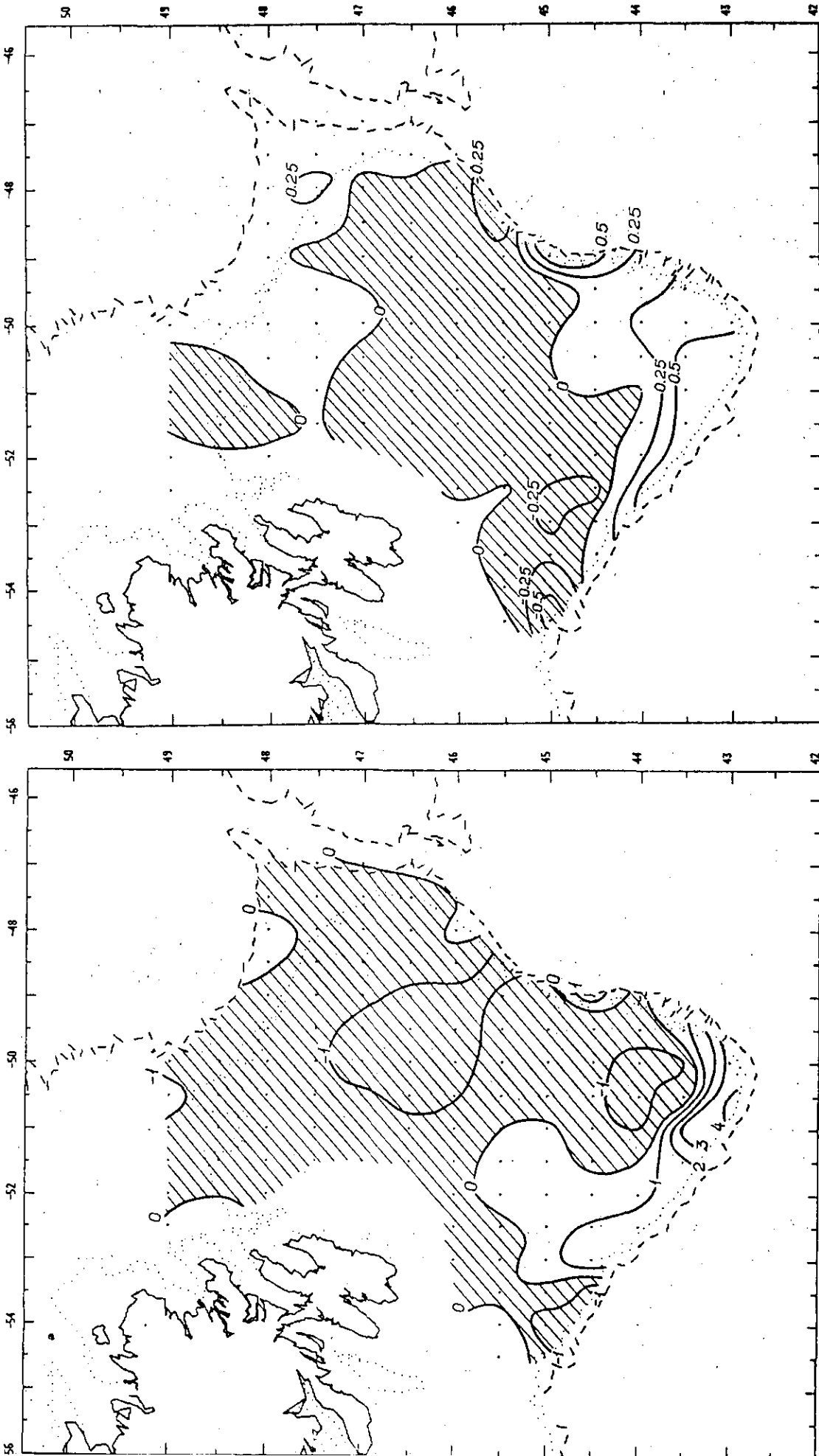


Fig.2. Anomalies of bottom temperature (left) and salinity (right) on the Newfoundland Shelf in spring-summer 1993. Negative anomalies are shaded. For the rest of parameters see Fig.1 legend.

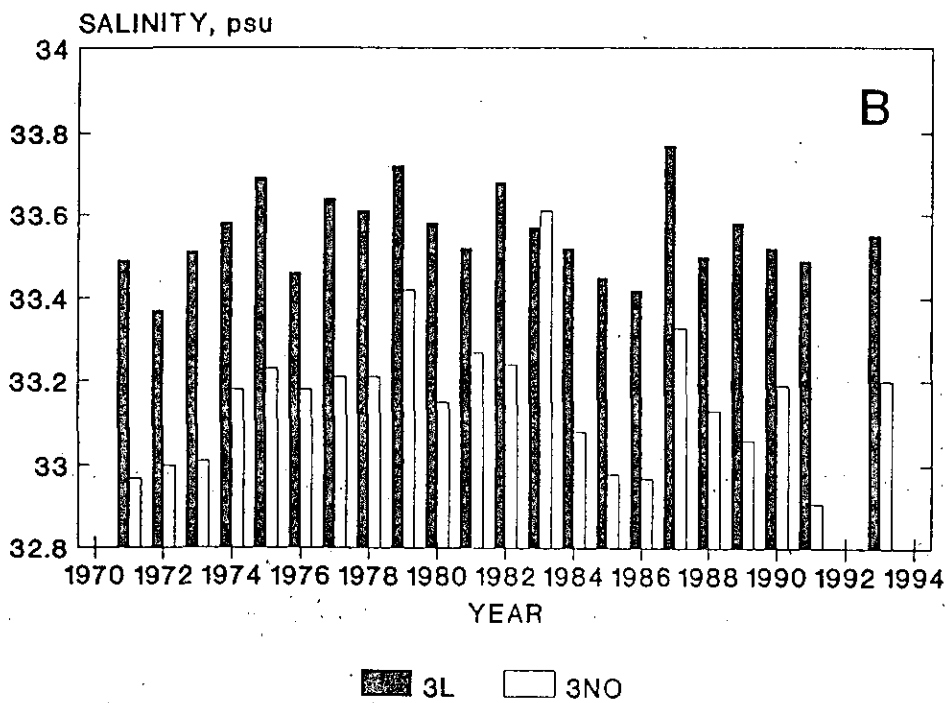
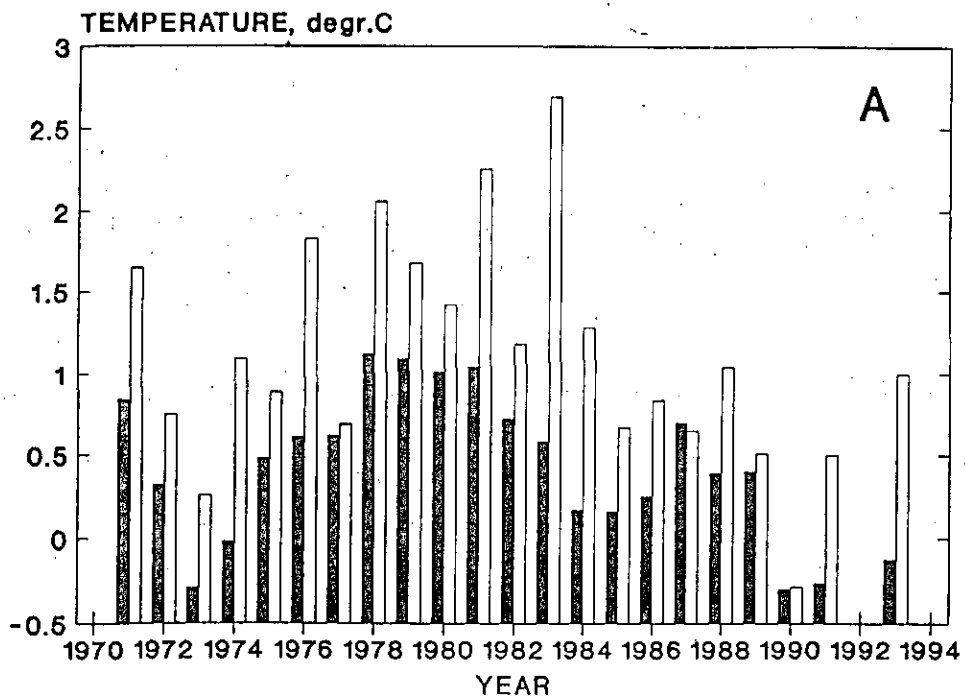


Fig 3. Long-term variations of spring-summer bottom temperature (A) and salinity (B) on the Newfoundland Shelf in Divs. 3L and 3NO.