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A Brief Review of Investigations Conducted by PINRO in NAFO Subareas 0, 2 and 3

by

A. Vaskov, S. Lisovsky and S. Lobodenko

Polar Research Institute of Marine Fisheries and Oceanography
(PINRO), 6 Knipovich Street, Murmansk, Russia, e-mail: inter@pinro.ru

Abstract

The paper presents a brief review of investigations conducted by the Polar institute in NAFO Subareas 0, 2 and 3 in the recent forty years. The methods of carrying out trawl surveys and studying the environment and fishing gear selectivity are given and also the ways of their change and improvement are presented. The main goal of those researches was to study the status of fishery resources, the effect of environment on them and the influence of fishing gears on main commercial fish species.

Introduction

The first researches of PINRO in ICNAF/ NAFO Area date back to 1954. In 1954-1960, the new fishing areas were developed and, then, the main emphasis was placed on collecting and accumulating biological information received from the search vessels. In December 1961- January 1962, the regular observations over the commercial fish stock status were commenced by the first trawl survey. Despite the details of research programs varied in different years, the following surveys were aimed at estimating commercial fish stocks and forecasting their possible catch.

The stock status was checked based on complex ecosystem investigations. Actively studied were the conditions of living and forming fish concentrations: bottom topography, ground composition, ice and meteorological conditions. In the places of tows and hydrographic sections crossing shelf and slopes in all the divisions from the North Labrador to the Saint Pierre Bank, the current direction and velocity were studied, temperature, salinity and water chemical composition were determined from surface to bottom by standard horizons.

To characterize fish food supply, feeding conditions and migrations, benthos specific composition from catches by demersal trawl was analyzed, the zooplankton samples were collected at trawling horizon and in pelagial. The analysis of stomach content in different fish species from each catch allowed the differences in feeding conditions depending on depth and prevailing water mass to be revealed. To study daily rhythms of feeding and the intensity of feeding and vertical migrations of fish, the daily observations with tows at the similar positions in certain hourly intervals were made on feeding concentrations.

Feeding, spawning and wintering migrations of fish were investigated by the results of tagging and tagged fish recapture. The location of spawning grounds was determined by gonad status in caught fish and the amount of eggs and larvae in ichthyoplankton samples taken in different areas of the shelf. The data on the quantity of eggs and larvae were used to derive a preliminary value of stock recruitment.

In the number of cruises, the population investigations based on parasitologic and morphometric analyses, as well as on the observations over the distribution and direction of fish migration were carried out.

To characterize the status of stocks, the data on the number of fish in catches, their length-age, weight and sex composition and maturity, fatness and condition were collected.

Besides above-mentioned works, the wide program of research surveys included the study of fishing demersal trawl selectivity, technological investigations and search for new methods of processing marine products. In 1985, on the Flemish Cap Bank, there was a made attempt to estimate stocks using underwater television and video camera.

Material and Methods

A. Trawl surveys

The historical review of trawl surveys was presented at NAFO scientific session and published in journal “NAFO Scientific Council Studies” (Bulatova *et al.*, 1997). The data on trawl surveys conducted in the past 42 years are shown in Table 1.

In 1961-1970, the surveys were carried out by side trawlers. Used as fishing gear was a demersal trawl with 10-12 m horizontal and 1.6-1.8 m vertical opening by nets, a small-meshed insertion with the length of 9 m and 8-10 mm mesh knot-of-knot was sewed in to the codend of bag. The tow speed equaled to 3.2 knots, the duration – to one hour. A number of trawl stations was planned based on the total duration of cruise. In the first years, when methods of trawl surveys were at the stage of development, the tows were made in Subareas 6-11 and the number of them was not great. A position of trawl stations was determined arbitrarily, the places of more successful tows were annually checked.

In 1967, to cover the area more uniformly, the grid of trawl stations was continuously widened. In the area of Div. 3KLNO, in 1969-1970, to 300 tows per a cruise were made. The positions of trawl stations were becoming relatively constant and repeating themselves every year.

The main purpose of surveys in 1961-1970 was the estimation of recruitment size by method of quantitative assessment of juvenile cod and haddock with the length under 35 cm and redfish with that one of below 15 cm. Before 1967, the surveys were performed in autumn-spring. Since 1968, when the season of observations was changed and they started to be executed in spring-summer, cod and haddock below 40 cm in length and redfish under 20 cm became to be classified as juveniles. The larger fish were measured without estimating their total number in catches. The age samples of juveniles were collected from different trawls so that the individuals from every size group were represented. The samples of adult fish were usually taken from catches without selecting by size, in the number of 300 ind. in each area.

The strength of the next year-classes was determined by relative abundance indices – the amount of juveniles from each year-class in the average catch per an hour of towing.

Since 1970, in Div. 3K, and since 1971, in all the divisions, surveys were conducted by stern trawlers and more often by MB-1202 “Persey-III”. Since then, and during all the following surveys, the trawl with estimated 14.3 m horizontal and 4 m vertical opening by nets was used. The length of small-meshed insertion in the codend equaled to 19 m, with 10-12 mm knot-of-knot. The tow speed was 3.5 knots, the duration – one hour. In 1970, to keep the long-term data series and obtain the comparable data BRT-96 “Rossiya” and BMRT-1202 “Persey III” conducted 141 comparable trawlings on the similar concentrations of cod by parallel course. The comparison of catches by the two different vessels and trawls showed that the catches of BMRT “Persey-III” were, on the average, in 1.4 times higher than those ones of BRT “Rossiya”. Due to that, the data from the previous surveys were corrected by the following way.

As in the preceding period, the tows were planned to be made in the sites with the standard set coordinates, though during the surveys, the position of the trawl stations somewhat varied depending on the available given depth, bottom topography, ground conditions and other reasons.

Since 1971, the surveys became total: the caught fish of any species and all the size groups were assessed. For quantitative estimation of individuals used were the methods applied during the previous surveys: mass measurement, counting by the piece or, in the case of big catches, with using containers.

The weight was determined for main commercial fish species in catches. For this purpose, by the data of age samples worked out were the length-weight keys supplemented and corrected during the following surveys.

When estimating stocks the average number and weight of fish in a catch per a trawling hour were taken as an index of abundance and biomass. Those indices were determined for each species and area by dividing the total number and weight of fish caught into a number of tows also including the empty ones.

Since 1975, in Div. 2J, 3KLNO, to assess capelin abundance and biomass, conducting trawl-acoustic surveys was initiated. "Simrad" EK-38 echo sounders were used as echo integrating system. Tacks were made in latitudinal direction, from the coast of Canada to 280-300 m depth. The distance between tacks on dense concentrations of capelin was 10 miles, on the scattered ones – 30 miles. Parallel with the acoustic survey, the underwater photographing with the aid of "Triton" photo camera was applied.

From 1980, in Subarea 3, besides the spring-summer trawl surveys, they started to carry out the autumn-winter ones aimed at estimating halibut stocks, collecting data on roundnose grenadier and determining a percentage ratio of fish at different depth both there and in Subareas 0, 1, 2. Alongside with that, in autumn, on the Big Newfoundland Bank, a trawl survey for capelin pre-recruits was executed. It was conducted applying mid-water trawl with 3.5 mm mesh knot-of-knot. The hauls were made in 0-20 m, 20-40 m, 40-60 m layers with the duration of 10 min. When calculating the index of abundance the number of individuals per a mile of trawling was used as an indicator.

Since 1983, the trawl surveys and the stock assessment were initiated to be conducted by NAFO methods proposed by Canadian researchers (Doubleday, 1981), that allowed Russian specialists to obtain data comparable with the results from the similar surveys by the other countries. In the previous years, the surveys were conducted by the vessels of BMRT-type, since 1985 – by those ones of PST-type with less tonnage, then the large freezing trawlers were completely replaced. A trawl used for research tows was the same as in the previous years. A tow speed was constant and equaled to 3.5 knots. In 1983, the duration of tows was one hour, but since 1984 the half hour trawlings were initiated in order to increase their number. In Div. 3KLMNO, during the cruise, 450-550 hauls were conducted. The position of trawl stations was determined arbitrarily depending on the estimated depth, rough bottom, different above and underwater hindrances allowing for the boundary between fishery and buffer zones. Three and more tows were planned in each stratum depending on its area. While conducting trawl surveys, the acoustic one for main commercial fish species was also conducted.

From 1984, the main commercial fishes – haddock, cod, redfish and four Pleuronectidae species were only assessed.

Since 1985, on the Flemish Cap Bank, and, in the following years, in all the Divisions of Subarea 3, the trawl survey was accompanied by the hydroacoustic one that permitted the abundance and biomass of fish in the layers, which were inaccessible for fishing by demersal trawl, to be estimated. The indices of fish abundance and biomass derived based on demersal trawl and acoustic surveys were summed up, that made it possible to give more precise stock assessment and to approach their values to the absolute ones.

It should be noticed that arranging and conducting the cruises were connected with heavy financial expenses: the cost of expeditions fluctuated from 450 000 to 750 000 USD. In the course of time, the wide program of investigations carried out by PINRO in NAFO area was initiated to be shortened and became narrow-directed. In the recent decade, the changes in Russian economy had a negative effect on opportunities of the institute to conduct regular observations: different research vessels, different periods of their work and incomplete coverage – the Flemish Cap Bank only. However, despite this, Russia is very much interested in research on fishery resources in NAFO Convention areas.

B. Hydrographic investigations

The first hydrographic investigations of the Polar institute in NAFO (ICNAF) area date back to 1954, when the research vessel "Sevastopol" made 86 hydrographic stations on standard horizons. The works were made in Div. 3O, 3P.

Since 1958, complex hydrographic investigations were carried out on the Big Newfoundland Bank, the Flemish Cap Bank, in the areas of Labrador and Nova Scotia.

In 1960-1962, the researches in the area of Nova Scotia and the Georges Bank were, mainly, carried out by the search vessels. In 1960, at 450 stations, temperature, salinity, oxygen and biogenic elements were observed above the depth of 1 000 m.

While commencing the regular trawl surveys in 1961, they started to carry out the hydrographic investigations in the sites of tows and along the hydrographic sections crossing shelf and slopes in all the divisions from the North Labrador to the Saint .Pierre Bank. Current direction and velocity were studied, water temperature, salinity, chemical composition were measured from surface to bottom by standard horizons.

Since 1967, the hydrographic surveys covered Div. 3KLNOP. In 1967, the survey was carried out in autumn, and since 1968 - in spring-summer. 300-400 hydrographic stations were made in the period of survey. The works were aimed at studying the spatial and time variability of water temperature and salinity on the Newfoundland shelf.

From 1971, hydrographic investigations were regularly conducted in the areas of capelin spawning in the Newfoundland area.

In 1977-1982, PINRO executed a considerable number of works according to NAFO international project "Flemish Cap". Within the frames of the project, hydrographic investigations were performed in order to study variability of water condition dynamics and its biotic consequences (Kudlo *et al.*, 1984). The studied area represented the even grid of 42 hydrographic stations. The observations were also made on standard grid of trawl stations, as well as on standard hydrographic sections. In all, from December 1977 to April 1982, there were 26 hydrographic surveys conducted by vessels of PINRO on the Flemish Cap Bank.

The maximal number of hydrographic stations – over 4 000 - were made in 1981-1990, the last full-scale survey was carried out in the Northwest Atlantic in 1993. The survey was not completely performed in 1994.

Before 1994, the hydrographic surveys were executed using bathometers.

In 2001-2002, in the Northwest Atlantic the hydrographic surveys were renewed, but only conducted on the Flemish Cap Bank. They were performed applying FSI 3.0 STD-sondes.

C. Investigations of selectivity

With the appearance of large tonnage trawlers participating in fishery the necessity to prevent the trawl bags with great catches arose.

The first researches to evaluate the effect of the trawl bag upper panel covered by the additional strengthening net with the same mesh size as in the trawl bag on the trawl bag selectivity were conducted by BMRT "Kometa" when harvesting redfish in the area of Labrador and the Flemish Cap Bank in 1963.

The analysis of test results showed that strengthening net with such characteristics diminished the selectivity coefficient of standard bag by 7-8%.

In 1967, the selectivity of trawl bags with two types of strengthening nets on the upper panel of the trawl bag was investigated by BMRT "Vitebsk". The survey was executed when fishing cod in the area of Labrador. By the results of tests it was revealed that the strengthening net with the mesh size as in the standard codend reduced its selectivity by 15-20%, and the strengthening net with the mesh size of twice as large had no influence on its selectivity. Later, the cover of such type was approved to be used in NAFO Regulatory Area.

The investigations into selectivity of trawl bags with the mesh size of 100 and 120 mm while fishing redfish and Greenland halibut were commenced by BMRT "Suloy" in the area of Labrador and the Baffin Land in 1979. When testing used was a small-meshed cover of the ICES-type, where the upper panel of the trawl bag was covered by the small-meshed net, in which fish escaping through meshes concentrated.

In the fishery of redfish by the trawl bag with 120 mm mesh, the selectivity factor was 2.1, the range of selectivity – 13.0 cm. The trawl bag selectivity with 100 mm mesh was low. Fish retention from each size group exceeded 60%. Therefore, it was impossible to determine the parameters of selectivity.

Trawl bag selectivity with 120 mm mesh size in the fishery of Greenland halibut was assessed in the area of the Baffin Land. Only two series five valid tows each were made. Based on the results from them, in the trawl bag with such mesh fish retention was 93-95%.

In 1980, 1981, the researches to assess selectivity of trawl bags in demersal trawls with 117-135 mm mesh size were conducted for Greenland halibut, redfish, roundnose grenadier, witch flounder, cod by BMRT “Nikolay Kononov”. The works were executed in the Notre Dame Bay and in the Davis Strait. Selectivity was determined by the method of covering the trawl back with a small-meshed net.

In 1981, selectivity of demersal trawl bags with 125-145 mm mesh size for redfish, yellow-tail flounder, American plaice was investigated by PST “Menzelinsk” on the Flemish Cap Bank. During the cruise, the research on midwater trawl bags with applying the bag-shape cover was executed for redfish. The selectivity of mid-water trawl bags was essentially higher, than of the demersal ones with the same or greater mesh size.

The tests of the trawl bag selectivity in NAFO Regulation Area were renewed by BMRT “Vaigach” in 1994, when mid-water trawl selectivity for redfish was assessed. During the tests and later, the other vessels used completely enveloping bag-shape cover.

In 1996, a selectivity for Greenland halibut was investigated by STM “Ozernitsa” with applying the trawl bags equipped by selective grid with the lengthwise and cross bars. The sorting system was the same as used while fishing cod in the Barents Sea.

Owing to the necessity to specify technical measures of fishery regulation in NAFO Area, in 2001-2002, one cruise was conducted by STM “Mozdok” and the three ones – by SRTM “Remojfjord”. In the cruises, the selectivity of bottom trawl bags with 120-155 mm mesh size was tested for Greenland halibut, redfish, American plaice and roughhead grenadier.

Based on the results from the cruises, the reports were prepared and presented at the sessions of NAFO Scientific Council.

In the period of 1963-2002 there were 11 conducted cruises, during which the selectivity of trawl bags with different equipment and mesh size was studied for the main commercial fishes in NAFO Regulation Area.

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Table 1. Inventory of USSR/Russian trawl surveys conducted in 1961-2002.

Year	Period	NAFO Area	Vessel	Cruise No.	Number of valid hauls
1961-62	Dec-Mar	2J, 3KLMNOP 4VWX, 5Z	BRT-95 <i>Pobeda</i>	1	181
1962-63	Dec-Jan	2GHJ, 3KLMNOP	BRT-95 <i>Pobeda</i>	4	180
1964	Jan-Mar	2J, 3KLMNOP	BRT-95 <i>Pobeda</i>	1	148
1964-65	Dec-Feb	3KLMNOP	BRT-97 <i>Sevastopol</i>	22	153
1965-66	Dec-Feb	2GHJ, 3KLMNOP	BRT-97 <i>Sevastopol</i>	24	118
1967	Jan-May	2J, 3KLMNOP	BRT-99 <i>Novorossiysk</i>	21	182
			BRT-97 <i>Sevastopol</i>	26	195
1968	Apr-Jun	3KLMNOP	BRT-96 <i>Rossiia</i>	10	222
1969	Apr-Jul	2J, 3LMNOP	BRT-96 <i>Rossiia</i>	11	276
1970	Mar,	3K	BMRT-1202 <i>Persey-III</i>	4	157
	May-Aug	3LMNOP	BRT-96 <i>Rossiia</i>	13	299
1971-72	May-Aug	3KLMNOP	BMRT-1202 <i>Persey-III</i>	6	240
	Apr-Jul	3KLMNOP	BMRT-1202 <i>Persey-III</i>	8	241
1973	Jun-Aug	3KLMNOP	BMRT-1202 <i>Persey-III</i>	11	291
1974	Jun-Aug	3KLMNOP	BMRT-1202 <i>Persey-III</i>	12	266
1975	Jun-Sep	3KLMNOP	BMRT-1202 <i>Persey-III</i>	14	295
1976	Mar-Jun	3KLMNOP	BMRT-1202 <i>Persey-III</i>	15	294
1977	Apr-Jul	3KLMNO	BMRT-1202 <i>Persey-III</i>	18	227
1978	May-Jul	2J, 3KLMNO	BMRT-1202 <i>Persey-III</i>	20	262
1979	Mar-Jun	3KLMNO	BMRT-2645 <i>Suloy</i>	2	309
1980	Apr-Jul	2J, 3KLMNO	BMRT-0422 <i>N.Kononov</i>	2	334
1980-81	Dec-Jan	OB, 3K	BMRT-0422 <i>N.Kononov</i>	3	69
	Jun-Jul	2J, 3KLMNO	BMRT-0422 <i>N.Kononov</i>	4	232
	Dec	OB	BMRT-1202 <i>Persey-III</i>	26	11
1982	Apr-Jul	2J, 3KLMNO	BMRT-2645 <i>Suloy</i>	2	324
	Jul	3K	BMRT-2645 <i>Suloy</i>	2	53
1982-83	Nov-Jan	OB, 3K	BMRT-2645 <i>Suloy</i>	26	51
		OB, 3K	BMRT-2645 <i>Suloy</i>	_"	67
1983	May-Jul	3KLMNO	BMRT-2645 <i>Suloy</i>	27	464
	Jul	3K	BMRT-2645 <i>Suloy</i>	_"	94
	Nov-Dec	OB, 2GH	BMRT-2645 <i>Suloy</i>	29	125
1984	Mar-Jul	3KLMNO	BMRT-2645 <i>Suloy</i>	30	514
	Jul	3K	BMRT-2645 <i>Suloy</i>	30	113
	Sep	OB, 2G	BMRT-2645 <i>Suloy</i>	31	105
	Nov-Dec	OB, 2GHJ	BMRT-0023 <i>N.Kuropatkin</i>	6	96
1985	Mar-Jun	3KLMNO	PST-1363 <i>Genichesk</i>	2	447
	Jun	3K	PST-1363 <i>Genichesk</i>	-"	53
	Nov-Dec	OB, 2GH	BMRT-422 <i>N.Kononov</i>	33	83

Table 1. (continued)

1986	Apr-Jul	3KLMNO	BMRT-422 <i>N.Kononov</i>	34	540
	Oct	OB, 2GHJ, 3K	PST-1330 <i>Klintsi</i>	23	125
1987	Mar-Jul	3KLMNO	BMRT-1202 <i>Persey-III</i>	37	530
	Sept-Nov	OB, 1BCD, 2GH	PST-1366 <i>K.Shaitanov</i>	8	195
1988	Mar-Jul	3KLMNO	BMRT-1202 <i>Persey-III</i>	40	524
	Aug-Dec	1BCD, OB, 2GH, 3K	PST-1366 <i>K.Shaitanov</i>	12	260
1989	Mar-Aug	3KLMNO	BMRT-1202 <i>Persey-III</i>	43	589
	Aug-Dec	1BCD.OB, 2G, 3K	PST-1366 <i>K.Shaitanov</i>	17	161
1990	Mar-Aug	3KLMNO	BMRT-1202 <i>Persey-III</i>	48	512
	Aug-Dec	1BCD, OB, 2G, 3K	PST-1366 <i>K.Shaitanov</i>	23	184
1991	Mar-Jul	3LMNO	PST-1362 <i>Vilnyus</i>	35	368
1991-92	Aug-Jan	OB, 2GHJ, 3KLM	PST-1366 <i>K.Shaitanov</i>	25	285
	Apr	3M	PST-1366 <i>K.Shaitanov</i>	27	53
	Oct-Dec	OB, 2GHJ, 3KLM	PST-1366 <i>K.Shaitanov</i>	28	147
1993	Apr-Jul	3LMNO	PST-1362 <i>Vilnyus</i>	43	300
1994	Jun-Jul	3L	PST-1362 <i>Vilnyus</i>	48	85
1995	May	3M	STM-0708 <i>Olenica</i>	6	58
1995-96	Dec-Apr	3LM	STM-0707 <i>Ozernica</i>	2	163
1996	Apr-May	3M	STM-8339 <i>Olaine</i>	3	76
2000	Apr-May	3LM	STM-0703 <i>Onezhsky</i>	2	41
2001	May-Jun	3M	PST-1360 <i>Mozdok</i>	1	90
2002	May-Jun	3M	STM-1466 <i>Remoyfjord</i>	4	94