NAFO Sci. Coun. Studies, 30: 51–55

Review of Russian Bottom Trawl Surveys in the NAFO Subareas 0, 2 and 3 for 1954–95

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Abstract

This paper provides data on trawl surveys carried out by the Polar Research Institute of Marine Fisheries and Oceanography (PINRO), Murmansk, USSR/Russia in the NAFO area during last 35 years. The years of investigations are divided into 3 periods, 1961–70, 1971–82 and 1983–95, during which changes in methods of the trawl surveys were done, as well, methodological changes were introduced when collecting biological data and calculations were performed for stocks assessment. A short description of the investigations is given in the paper and problems pertaining to the difficulties of conducting the trawl surveys, mainly during the recent years, are considered.

Key words: biological data, sampling, stock, surveys, trawl

Introduction

Retrospective review of Union of Soviet Socialist Republics (USSR) and the Russian Federation trawl surveys in the NAFO area was done at the Polar Research Institute of Marine Fisheries and Oceanography (PINRO) to maintain the long-time series of observations made during trawl surveys, and consider further the use of the data to give allowance for the changes introduced into the methods of sampling and processing of biological data. Over the 35-year period, changes were done depending on the required task, particularly when progressing from quantitative assessment of young fish only, to estimation of commercial fish total stock, as well as when changes were made to the type of vessel or trawl gear and haul duration, and methods for calculating abundance and biomass indices.

In this review, the historic records of research surveys are considered. Based on the methods of collecting data, the years of investigations were divided into 3 periods; 1961–70, 1971–82 and 1983–95. A short description of these periods are given, as well as contents of the investigations carried out.

Materials and Methods

Types of investigations

The first survey observations carried out by PINRO in the ICNAF area refer to 1954. In the period 1954–60, new fisheries areas were explored and most attention was given to obtaining and accumulating biological data from fish-searching vessels. During December 1961 to January 1962, the regular observations of the stock status of commercial fishes were initiated, and this represented the first trawl survey. Despite changes in programs for research during subsequent years, stock assessment of commercial fishes and the prediction of their expected catches remained to be the main aim of all further surveys .

Monitoring of the status of stocks was undertaken based on comprehensive studies of the ecosystem. Environmental conditions of fish dwelling areas and formation of fish aggregations were studied, i.e. bottom topography, bottom composition, ice coverage and meteorological conditions. Direction and velocity of ocean currents were studied and temperature, salinity and chemical composition of water from surface to bottom were recorded by standard depths at each trawling point and along oceanographic sections crossing the shelf and slopes in all areas from the North Labrador to St. Pierre Bank.

To characterize food supply and feeding migrations of fish, the species composition of the benthos was determined from catches taken by a bottom trawl. Zooplankton samples were collected at the bottom trawling depth as well as by sampling the pelagic waters. Analysis for stomach contents of different fish species was done from each catch to study the differences in feeding conditions depending on depth and the prevailing water masses. To study the daily rhythm of feeding, the intensity of feeding and the vertical migrations of fish, daily observations were carried out over feeding concentrations, with hauls at the same position within specific time intervals.

Feeding, spawning and wintering migrations of fish were also studied from the results of tagging and recoveries. Location of spawning grounds was interpreted depending on state of gonads in fish caught in the trawls and on the quantity of eggs and larvae in ichthyoplankton samples taken at different sections on the shelf. Data on quantity of eggs and larvae were also used to estimate preliminary values for recruitment.

During a number of cruises, studies were undertaken to determine population structure based on parasitological and morphometric analyses, as well as on observations over distribution and direction of fish migrations.

To characterize stock status the data were gathered on quantity of fish in catches, their length, age, weight, sex composition, maturity, fatness and condition factor.

Besides, the studies on the status of stocks, an extensive program for research surveys included studies on bottom fishing trawl selectivity, technological investigations and searching of new methods for processing marine products. In 1985, an attempt was undertaken to assess stocks applying television and underwater camera. However, no special success was attained due to some technical problems.

Methods for trawl surveys

1961–70 surveys. The trawl surveys carried out during the entire study period of 35 years are given in Table 1. During 1961–70 the surveys were carried out by side trawlers. Bottom trawls, with trawl wings at a distance of 10–12 m and a mouth opening height of 1.6–1.8 m, and with a 9 m fine-meshed insertion (8–10 mm mesh bar) at the codend, were used as survey fishing gear. Speed of trawling was 3.2 knots, with a duration of 1 hr. The number of trawl stations was planned from the cruise duration. During the first years, when the methods of trawl surveys were being developed, hauls were done over a vast area extending from Labrador to Nova Scotia. Thus, the number of hauls in each ICNAF Division during one survey was small. Position of trawl stations was taken at random, the points of the most successful hauls were annually tested.

In 1967, to cover the area more completely, the grid of trawl stations was expanded and number of areas surveyed was limited to the individual ICNAF Div. 3K, 3L, 3N, 3O and 3P. By the end of the period (1967–70), about 300 hauls were performed during a cruise, and the trawl station positions became relatively constant and an attempt was made to occupy the same stations every year.

The 1961–70 surveys aimed at estimating the size at recruitment of some key species. The method of quantitative assessment was conducted for young cod and haddock to 35 cm and *S. marinus* to 15 cm length. Until 1967 surveys were carried out in the autumn–winter period. Since 1968, when the season of observations was shifted to spring–summer, cod and haddock at lengths to 40 cm and redfish to 20 cm long had begun to be referred to as young fish. Larger fish were measured without determining their total number in catches. Age samples of young fish were taken from different catches in order to represent specimens from all size groups. Samples of adult fish were usually taken from concentrations, from representative size-classes, 300 specimens from each area. Strength of the year-classes was determined by indices of relative abundance/number of young fish from each previous year-class, using mean catch per trawling hour.

1971–82 surveys. Since 1970 in Div. 3K and since 1971 in all Subareas, the surveys have been carried out by stern trawlers, most frequently by MB-1202 *Persey-III*. Since this time and during all subsequent surveys, a trawl with a distance between wings of 14.3 m and opening height of 4 m has been used. Length of small-meshed insertion in a codend was equal to 19 m, with a mesh bar of 10–12 mm. Speed of trawling was 3.5 knots for a 1 hr duration. To maintain the long-term series of observations and to obtain comparable data, 141 hauls were performed by BRT-96 *Rossiya* and BMRT-1202 *Persey-III* in parallel courses at the same cod aggregations in 1970. Comparison of catches taken by different-type vessels and different trawls has shown the catches by BMRT *Persey-III* to be, on the average, by 1.4 times higher than those taken by BRT *Rossiya*.

Hauls, as in the previous period, were planned to be at stations with preset positions. However, the position of trawl stations varied somewhat during the surveys depending on the preset depth, bottom topography, bottom conditions and on other specific reasons applied to the survey.

After 1971 the surveys were designed to become "total", i.e. all the fish caught of any species and of all length groups were quantitatively assessed. For quantitative estimation of specimens the same method was used as in the surveys of the previous period, i.e. measurements were taken such that single specimen average calculations were possible or, in case of large catches, length/weight keys were developed by sampling age data. These keys were supplemented, refined and corrected during subsequent surveys.

TABLE 1. Information regarding trawl surveys conducted in 1961–95.

Year	Period	NAFO Area	Vessel	Cruise No.	Number of valid hauls
1961–62	Dec–Mar	2J, 3KLMNOP, 4VWX, 5Z	BRT-95 *Pobeda*	1	181
1962–63	Dec–Jan	2GHJ, 3KLMNOP	BRT-95 *Pobeda*	4	180
1964	Jan–Mar	2J, 3KLMNOP	BRT-95 *Pobeda*	1	148
1964–65	Dec–Feb	3KLMNOP	BRT-97 *Sevastopol*	22	153
1965–66	Dec–Feb	2GHJ, 3KLMNOP	BRT-97 *Sevastopol*	24	118
1967	Jan–May	2J, 3KLMNOP	BRT-99 *Novorossijsk* BRT-97 *Sevastopol*	21 26	182
1968	Apr–Jun	3KLMNOP	BRT-96 *Rossiya*	10	222
1969	Apr–Jul	2J, 3LMNOP	BRT-96 *Rossiya*	11	276
1970	Mar, May–Aug	3K 3LMNOP	BMRT-1202 *Persey-III* BRT-96 *Rossiya*	4 13	 299
1971–72	May–Aug Apr–Jul	3KLMNOP 3KLMNOP	BMRT-1202 *Persey-III* – " –	6 8	240 241
1973	Jun–Aug	3KLMNOP	– " –	11	291
1974	Jun–Aug	3KLMNOP	– " –	12	266
1975	Jun–Sep	3KLMNOP	– " –	14	295
1976	Mar–Jun	3KLMNOP	– " –	15	294
1977	Apr–Jul	3KLMNO	– " –	18	227
1978	May–Jul	2J, 3KLMNO	– " –	20	262
1979	Mar–Jun	3KLMNO	BMRT-2645 *Suloy*	2	309
1980	Apr–Jul	2J, 3KLMNO	BMRT-0422 *Kononov*	2	334
1980–81	Dec–Jan Jun–Jul Dec	OB, 3K 2J, 3KLMNO OB	– " – – " – BMRT-1202 *Persey-III*	3 4 26	69 232 11
1982	Apr–Jul Jul	2J, 3KLMNO 3K	BMRT-2645 *Suloy* – " –	2 2	324 53
1982–83	Nov–Jan 	OB, 3K – " –	– " – – " –	26 –"–	51 67
1983	May–Jul Jul Nov–Dec	3KLMNO 3K OB, 2GH	BMRT-2645 *Suloy* – " – – " –	27 –"– 29	464 94 125
1984	Mar–Jul Jul Sep Nov–Dec	3KLMNO 3K OB, 2G OB, 2GHJ	– " – – " – – " – BMRT-0023 *Kuropatkin*	30 30 31 6	514 113 105 96
1985	Mar–Jun Jun Nov–Dec	3KLMNO 3K OB, 2GH	PST-1363 *Genichesk* – " – BMRT-422 *Kononov*	2 –"– 33	447 53 83
1986	Apr–Jul Oct	3KLMNO OB, 2GHJ, 3K	– " – PST-1330 *Klintsi*	34 23	540 125
1987	Mar–Jul Sept–Nov	3KLMNO OB, 1BCD, 2GH	BMRT-1202 *Persey-III* PST-1366 *Shaitanov*	37 8	530 195
1988	Mar–Jul Aug–Dec	3KLMNO 1BCD, OB, 2GH, 3K	BMRT-1202 *Persey-III* PST-1366 *Shaitanov*	40 12	524 260
1989	Mar–Aug Aug–Dec	3KLMNO 1BCD,OB, 2G, 3K	BMRT-1202 *Persey-III* PST-1366 *Shaitanov*	43 17	589 161
1990	Mar–Aug Aug–Dec	3KLMNO 1BCD, OB, 2G, 3K	BMRT-1202 *Persey-III* PST-1366 *Shaitanov*	48 23	512 184
1991	Mar–Jul	3LMNO	PST-1362 *Vilnyus*	35	368
1991–92	Aug–Jan Apr Oct–Dec	OB, 2GHJ, 3KLM 3M OB, 2GHJ, 3KLM	PST-1366 *Shaitanov* PST-1366 *Shaitanov* PST-1366 *Shaitanov*	25 27 28	285 53 147

TABLE 1. (Continued). Information regarding trawl surveys conducted in 1961–95.

Year	Period	NAFO Area	Vessel	Cruise No.	Number of valid hauls
1993	Apr–Jul	3LMNO	PST-1362 *Vilnyus*	43	300
1994	Jun–Jul	3L	PST-1362 *Vilnyus*	48	85
1995	May	3M	STM-0708 *Olenica*	6	58

When stock assessments were carried out, mean quantity and mean weight of fish in catch per trawling hr were assumed to be the indices of abundance and biomass. These indices were determined for each species and area by dividing the total number and weight of fish caught into the number of hauls including the empty ones.

Besides the spring-summer surveys in Subarea 3, after December 1980, autumn–winter trawl surveys were conducted both in Subarea 3 and Subareas 0, 1, and 2, to assess stocks of Greenland halibut, to collect data on rock grenadier and to determine percent ratio of these fishes at different depths.

1983–95 surveys. Since 1983 trawl surveys and stock assessment have been carried out according to Canadian methods (Doubleday, 1981). It allowed Russia to obtain data comparable with results from the analogous surveys performed by other countries. As in the previous years, until 1990 BMRT-type vessels were used in the surveys, however, in 1985 the survey was carried out by PST-type vessel (smaller tonnage class), which since 1991 have been completely replaced by large freezer trawlers. For sampling hauls, the same trawl was used as in the previous years. Speed of trawling was constant at 3.5 knots. Duration of hauls was 1 hr in 1983, but since 1984, in order to increase their number, a 30-minute haul duration has been used. During a cruise in Div. 3KLMNO from 450 to 550 hauls were performed. Position of trawl stations was determined at random depending on the preset depth, bad rocky bottom conditions, different sub- and underwater obstacles and making allowance for fishing boundary zones. Three additional hauls were planned for each stratum depending on its area.

Since 1984 quantitative assessment has been done only for main commercial fish species, viz haddock, cod, redfish and four flatfish species.

In 1985, age samples were collected using the Canadian methods. To analyze fish age, 15–20 specimens per length group were taken from different catches. If the fish were measured by sex, then 20 males and 20 females per length group were taken for age analysis. The indices for relative abundance and biomass were calculated as follows. Mean number and weight of fish in the catch from the area fished by trawl per time unit (1 hr or 30 min) were determined by a number of hauls in each stratum. Further calculation was done using the formula:

$$N = \frac{Sn}{s}$$

where N is abundance (or biomass) of fish in the stratum preset;
S is stratum area,
s is fished area, and
n is mean number (or weight) of fish in catch per time unit.

The fished area was determined as a product of distance covered by the vessel with a trawl per 1 hr (or 30 min) and distance between trawl wings. With the speed of 3.5 knots the vessel with a trawl covered 3.5 naut. miles per 1 hr and 1.75 miles per 30 min. In this case, distance between trawl wings was 14.3 m. The area fished by trawl during the 1 hr trawling was equal to 0.027 naut. miles^2 and to 0.0135 naut. miles^2 during 30 min haul. Trawl efficiency coefficient was conventionally assumed to be 1.

The indices of relative abundance and biomass of fish calculated for each stratum were summarized by area on the whole.

In 1985, on the Flemish Cap, and during subsequent years in all areas of Subarea 3, the trawl survey has been followed by a hydroacoustic survey, that allowed to assess abundance and biomass of fish in layers inaccessible to fishing by a bottom trawl. The abundance and biomass indices obtained based on the bottom trawl survey and acoustic survey were summarized, and more accurate estimates of stocks and approximate their values to absolute numbers were produced.

Results

As a result of the long-term investigations, a large body of information characterizing the life cycles of demersal commercial fish, conditions of formation of their aggregations and fishery, was accumulated. A large database was also developed on commercially important fish species, containing information on the number, weight, length, age and sex compositions, maturity and feeding. Based on these data the estimates for abundance and biomass of demersal fish were calculated, and the conclusions about the stock level were taken into account when estimating TAC for the commerical species. Results from analysis for biological and statistical data were presented to the ICNAF/NAFO Scientific Council Meeting (see *ICNAF Redbook* series to 1979 and *NAFO Scientific Council Reports* since then) as summary and scientific research documents (see Scientific Council Research Documents and Summary Documents indexes published as SCS Doc. series) and papers published in the *Journal of Northwest Atlantic Fishery Science* and *NAFO Scientific Council Studies*, and in PINRO literature.

Conclusion

At present, when fisheries within NAFO Regulatory Areas are carried out on demersal fish according to quotas or under designated restrictions on some species or areas, monitoring the stock status based on trawl surveys has a high level of importance. This importance has recently increased as certain fisheries are restricted by moratoria.

Until recent times the main advantage of trawl surveys conducted by PINRO in the NAFO area was their regularity, long-term series of observations and diversity of the information collected. However, during the recent 5 years a general economic crisis in Russia has affected an opportunity of PINRO to conduct regular observations. Difficulties include changes of vessel types and periods of surveys, sometimes surveys were not conducted or were restricted to one Subarea. Similarly, oceanographic observations were excluded from surveys and no complete biological data on all fish species, excepting cod, redfish and halibut, were obtained.

Under such conditions a continuation of conducting investigations properly is possible only in collaboration with the NAFO member-countries. A recent example is the co-operation between Russia and Norway during surveys conducted in the Barents Sea. According to this agreement each country simultaneously executes a part of a total survey along definite sections of the shelf. Such cooperation allows more hauls to be performed and further the collection of data, while analyses are stronger when data are pooled. In case of joint surveys in the NAFO area it is necessary, as a preliminary step, to calibrate sampling trawls jointly and to clarify methods for sampling data. The joint efforts undertaken by several countries would allow each of them to reduce fundings for such kind of investigations.

References

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