THE BARENTS SEA CAPELIN AUTUMN INVESTIGATIONS 1972–2011

– a 40 years anniversary

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The Barents Sea capelin autumn investigations 1972–2011 *a 40 years anniversary*

When we set out for the capelin investigations in autumn of 2011, we may do so knowing that we are conducting the 40th in a row of such investigations. This fact makes this time series the longest series of acoustic stock size estimation of a particular stock in any part of the world. This fact also inspired the preparation of this memorial volume to mark the occasion and to celebrate this scientific milestone.

What caused the leaders and scientific staff at IMR in Bergen to plan and conduct the survey in 1972, which is today counted as the first survey in the series? The reasons are not obvious, but perhaps the underlying motives will be clearer by looking more closely at the history lying behind these surveys. The survey in 1972 was, in fact, not planned as a totally new undertaking, but was rather seen as a continuation of what had gradually developed during some years.
The development of this survey cannot be seen isolated from the development of various surveys during the last part of the 1960s and first part of the 1970s. In many ways, this was a golden age of scientific surveys carried out by IMR. There is a technological, an administrative and a scientific part of this development.

Disclaimer

Unfortunately, this volume was prepared during a few days in summer, and no attempt was made to include Russian colleagues in the work. That would have been appropriate, and would have made this memorial volume much more interesting.

Acknowledgements

Thanks to my colleagues Ingolf Røttingen, Bjarte Bogstad, and Sigurd Tjelmeland, who read and commented on this paper. Thanks also to Bente Røttingen and Ingolf Røttingen, who supplied some of the pictures.
If no other sources are mentioned, the author has taken the photographs.

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Figure 1:
The hero in our story – the capelin.


Foto: Ø Paulsen

The development that cleared the way for acoustic surveys

The acoustic technology progressed by leaps and bounds during this period. The scientist Oscar Sund used an echosounder to study spawning cod in Lofoten already in 1938 (Anon, 1959), and such equipment was gradually introduced in the fishing fleet after the end of World War II. This development was described in the introduction to an important contribution to the literature at that time (Midttun and Hoff, 1962): "Echo sounding is now widely used in fish detection and sounders are constructed especially for such purposes. In fishery research echo-surveys are regularly undertaken in order to study the distribution of fish. Today one is interested in knowledge of how far echo sounding can be used also as a method for estimating fish abundance. At the Institute of Marine Research, Bergen, new types of calibrated sounding equipment have recently been used, with which it was possible to measure the absolute values of echoes received." An instrument called "echo integrator" was developed by Ingvar Hoff at IMR, and is described in an appendix to Dragesund and Olsen (1965). However, Midttun and Nakken (1968) mention that attempts to use acoustic methods for abundance estimation were described by several authors prior to this; e.g. on cod by Midttun and Sætersdal (1957) and by Richardson et al. (1959) and on herring by Truskanov and Sherbino (1964). It will take too much time and space to go deeply into these first attempts of acoustic stock size estimation, here it suffice to say that at the beginning of the 1970s, this method had matured to a stage where it was possible to introduce it as a standard method during surveys for pelagic fish. This period also marked the coming of new vessels specially built for scientific surveying. "G.O. Sars" was built in 1970, and was the first scientific vessel equipped with calibrated echo sounders and echo integrators.

The Institute of Marine Research was also rapidly developing in those years, with large increases of the staff. An impressive amount of surveys were carried out annually; seemingly the ships were utilized more or less continuously throughout the year. This development was partly caused by the dramatic changes taking place in the Norwegian fisheries during this period. The huge stock of Norwegian spring spawning herring, that had been the main target for the large Norwegian pelagic fleet after World War II, suddenly disappeared during the 1960s. The fleet turned to the Barents Sea capelin stock and other pelagic stock, to compensate for the lack of herring. The reasons for the dramatic shifts in the stock sizes were poorly understood but probably, it was clear to all that an increased monitoring of the stocks was needed to understand their fluctuations. Surveys of the capelin were introduced both during winter, spring, summer and autumn, but it was soon realized that one had to concentrate on a few annual surveys. The autumn period was found to be the most promising for monitoring of the total stock, because the stock was spread out over the whole feeding area, it was mostly found in the water column, not to close to the sea bed or the surface, and horizontal migration was minimal. This facilitated the use of acoustics to study distribution and stock size.

The international 0-group surveys served as obstetric aid to the capelin surveys

The survey for 0-group fish, which started in 1965 as an international cooperation, may be seen as a predecessor for the autumn survey for capelin. In fact, the first attempt to map the distribution and stock size of capelin was made during an 0-group survey in 1970. Although the work was done on "G.O. Sars" during that survey, the results were not reported in the 0-group survey report, but in a special cruise report, covering only the acoustic work on adult capelin and polar cod (Blindheim et al., 1971). During the cruise, the newly constructed echo integrators were used, and the "echo abundance" of capelin and polar cod were shown on contour maps. The total distribution areas of capelin and polar cod were not covered, and no attempts were made to convert the echo abundance to fish numbers. The second attempt made during an 0-group survey was the year after, in 1971 (Dragesund and Nakken, 1972). After the 0-group survey was finished, "G.O. Sars" set out for a new survey, partly covering the same area, but extending the cruise lines northwards, to cover the adult part of the capelin stock more completely. As in 1970, no attempt was made to calculate a complete stock size estimate based on the "echo abundance" (but see below). In the brief cruise report; the results were summarized in contour maps. A discussion of behaviour of capelin was included; they observed both a dial vertical migration and a horizontal migration towards the northwest between the

two surveys of the stock. During these two years the acoustic work on capelin was limited to the vessel ”G.O. Sars”. This was the only vessel carrying echo integrators at that time, and consequently the only vessel where this kind of work could be done. There is no mentioning of cooperation with USSR, although the work was (partly) undertaken during the 0-group survey, where two PINRO ships and several PINRO scientists were taking part.

The capelin survey series was established in 1972

The year after, in 1972, acoustic work was carried out for the third year in a row, partly as a dedicated survey from 5-20 August, but the work was continued during the international 0-group survey from 26 August to 11 September. In the report covering the work on adult fish during these two periods (Gjøsæter et al., 1972), a stock size estimate of capelin is given for the first time. This year, both ”G.O. Sars” and ”Johan Hjort” took part in the acoustic investigations and both vessels carried echo integrators. On ”G.O. Sars” the integrators were coupled to a 38 KHz echosounder while at ”Johan Hjort”, the echo integrator was coupled to a 50KHz echosounder. The vessels were intercalibrated by sailing side-by-side over 25 nautical miles and the echo integrator outputs were compared. It is commented that “bad weather entailed a large spread in the results”. It is noted that the fish registrations were identified by pelagic trawl, demersal trawl, and a purse seine. As mentioned, a stock size estimate was given, but in addition, an estimate was also given for the previous year, 1971. The conversion factor used to convert echo abundance to fish abundance is not given in the report, but the estimate given for 1972 is 13.5 million tonnes and for 1971 10.1 million tonnes. However, these results were recalculated at a later stage, and cannot be directly compared to later results (Dommasnes and Røttingen, 1985; Gjøsæter et al., 1998b; Gjøsæter et al., 1998a). In (Gjøsæter et al., 1998b) it is stated: “When the acoustic method was first applied on capelin in the early 1970s, no target strength measurements were available for this species. A conversion factor between integrator output and number of fish was established by counting fish traces on the echograms (Midttun and Nakken, 1971). This gave rise to quite varying conversion factors during the early 1970s (Dommasnes and Røttingen, 1985). A part of this variation was probably due to variations in the performance of the acoustic systems. Gradually, estimates of capelin target strength and its dependence on length became available (Dommasnes and Røttingen, 1985), and estimates obtained in previous years were recalculated accordingly.”

From 1973 onwards, the capelin survey was no longer part of the 0-group surveys, but was carried out after that survey was ended, usually around mid September. The 1973 survey (Dommasnes et al., 1974) was carried out with the vessels ”G.O. Sars” and ”Johan Hjort”, partly in cooperation with ”Havdrøn” that was doing polar cod investigations in the southeastern Barents Sea. Also this year, the vessels were intercalibrated, and the results were given as a contour map of echo abundance. No stock size estimate was given in the report, but was calculated later, based on the data obtained during the survey.

The 1974 survey (Buzeta et al., 1975) was carried out with the vessels ”G.O. Sars” and ”Havdrøn”, both equipped with echo integrators. The survey lasted for 54 vessel-days and covered a substantial part of the central, northern and eastern Barents Sea. No absolute stock size estimate was given in the report, and it was noted that since the equipment was changing somewhat from year to year, the values for echo abundance given each year were not directly comparable.

Figure 2: From the early beginning oceanographic sampling has been part of the capelin surveys.

One could ask why 1972 was considered to be the first year in the series and not 1970 or 1971. This decision was in fact taken several years later, when Dommasnes and Røttingen (1985) summed up the investigations made so far. Their main argument for starting in 1972 was probably that during 1970 and 1971, the surveys were characterized by "trial and error" to such a degree that they could hardly be seen as belonging to a survey series based on standard methodology. Additionally, the equipment was unstable and the calibration methods not very developed during these first years.

The capelin survey gradually became a joint survey

In 1975, the survey was, for the first time, carried out jointly by Norway and USSR. Citing the survey report (Dommasnes et al., 1975): "The investigations were carried out in cooperation with Sovietrussian scientists from the Knipovich Polar Research Institute of Marine Fisheries and Oceanography in Murmansk. A.S. Galkin was the leader of the investigations from the Sovietrussian side. At the end of the cruise all information was exchanged. Sovietrussian scientists are processing the data separately and a comparison of the results will be made later". The Norwegian vessels "G.O. Sars" and "Johan Hjort" and the USSR vessel "Poisk" were involved in the survey. All three vessels carried echo integrators, and "Johan Hjort" and "Poisk" did intercalibration runs with "G.O. Sars". All values were recalculated to "G.O. Sars"-equivalent values before they were plotted on maps. This year, a total estimate is given in the report; 6.5 million tonnes.

The terms of cooperation were seemingly identical also in 1976, when it is stated in the report (Dommasnes and Røttingen, 1977) that "The investigations were carried out in cooperation with Sovietrussian scientists from the Knipovich Polar Research Institute of Marine Fisheries and Oceanography in Murmansk. V. N. Shleinik was head of the Sovietrussian scientists. During a meeting at sea in September all information was exchanged. The Sovietrussian scientists are processing the data separately." This year the research vessel "Odissey" was used by the USSR scientists, and also this year the vessels were intercalibrated during the survey.

The first scientific paper discussing the methods and the results from the first years of the capelin survey is an ICES paper from 1975 (Nakken and Dommasnes, 1975). Here, the methods used are thoroughly discussed and the results recalculated based on new calculations of the conversion factor between echo abundance and capelin abundance. However, the length-dependency factor applied in the conversion was one obtained for sprat (l-1.72) and was later changed to l-1.91 for capelin (Dommasnes and Røttingen, 1985).

The same year, a thesis was also submitted for the fulfillment of the degree Cand. real. (Røttingen, 1975) dealing with the problem of calculating stock numbers from the output of the echo integrator, and parts of this thesis was published the year after (Røttingen, 1976). From this it is clear that the methods applied at the surveys were by no means fully developed before they were applied. On the contrary, the work was more based on "trial and error" and all conclusions were tentative.

Figure 3:
In the northern areas, when the ships approach the ice border, this fellow is sometimes seen. Unknown photopgrapher.

Figure 4:
In the northern area, where the krill and other high-grade zooplankton are abundant, the large ripening capelin feed intensely during autumn and may attain a considerable size and fat content.

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Figure 5:
In the areas where the big schools of capelin are found, it is very common to meet with Humpback whales. Unknown photographer.

More integrated cooperation – cooperative surveys since 1975

While during the first years there was no mentioning of Norwegian-USSR cooperation during the capelin surveys, from 1975 USSR vessels and scientists were mentioned in the cruise reports. However, it is said explicitly that although the data were exchanged after the survey, all further analysis of the data were done separately. In 1975 it is stated "comparison of the results will be made later". It is not clear whether this was actually done. It is also unknown to the present author whether stock size estimates were actually computed on the USSR side, but it is reasonable to assume that such work was done. It seems reasonable to suggest 1975 to be the first year of a cooperative acoustic capelin autumn survey, although the cooperation in 1975, 1976 and 1977 was not as formalized as in the period to follow.

From 1978, this situation changed. From then on, the cooperation between Norway and USSR at the autumn capelin investigations was more formalized. This was due to the new international law of the seas (UNCLOS) which grated the coastal states ownership and responsibility for the fish stocks within the Exclusive Economic Zones. Norway and the Soviet Union implemented this law in 1977. The capelin thus became a joint Soviet-Norwegian stock. In a management context it now became necessary to agree on the size and allocation of the TAC for capelin. This came into force in 1978 when the Joint Soviet-Norwegian fisheries commission agreed on a TAC for capelin for the autumn 1978/winter 1979 of 1.8 million tonnes (in accordance with the recommendation from the scientists) and an allocation of 60% to Norway and 40% to the Soviet Union. The scientists followed up this new management regime with more formalized meetings arranged after the survey and exchange of personnel during the surveys. A result of this was that joint reports were prepared and that methods were more standardized among the vessels.

The 1978 report (Anon, 1978) is, for the first time, jointly worked out during a meeting, and is published as an appendix to the meeting protocol dealing with joint assessment of capelin. Even though the report title only mentions the two Norwegian vessels, and the results, strictly speaking, only incorporates these two vessels, the introduction states that the investigations were carried

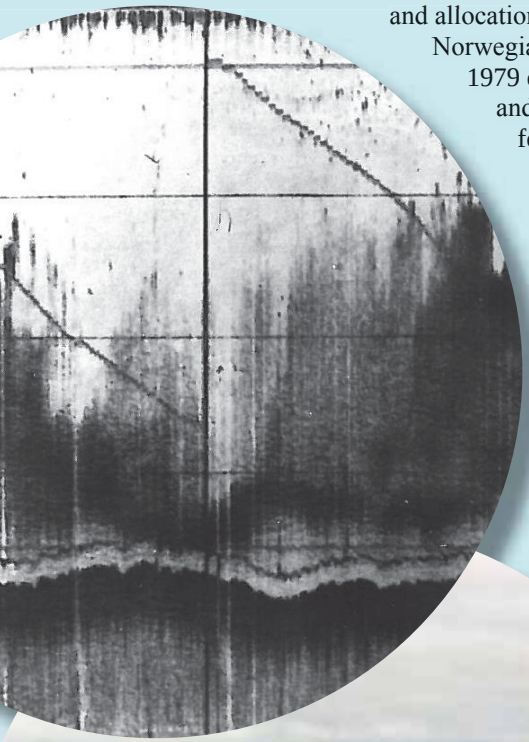

Figure 7:
Before the acoustic equipment on all vessels were calibrated by standard spheres, intercalibration runs between the participating vessels were crucial. Here, "G.O. Sars" and "PINRO" are sailing side by side during an intercalibration exercise.

Figure 8:
People were exchanged between the vessels to learn about the routines and the technical equipment used. This echogram was obtained on the vessel "Poisk" during a trawl station in 1978, when Ingolf Røttingen and Kaare Hansen stayed on board that vessel during the whole survey. Photographer Ingolf Røttingen.

Figure 6:
These pictures are not taken during an autumn capelin survey, but on a summer survey for capelin in 1976. Despite of this, it shows an interesting collection of people that played central roles during the early period of capelin surveys, like Johannes Hamre, Oddgeir Alvheim, Ingolf Røttingen, Bente Røttingen, Annlaug Nødtvedt, Gunnar Helle, Svein Lygren, Jan Erik Nygård. Photos were taken by Oddgeir Alvheim and unknown photographer(s).

out in cooperation with R/V ”Poisk”, where Ingolf Røttingen and Kaare Hansen were guests, and that Nikolay Ushakov was a guest on board ”G.O. Sars” for most of the cruise. This year also marked the beginning of a period of joint management of the capelin fisheries, see below.

The 1979 report (Mamylov and Dommasnes, 1979) has taken this a step further, when the Norwegian and the Russian vessels were all listed together and the intention clearly was to include all vessels data in the calculation. However, the report states that technical difficulties with the equipment at ”Poisk” made this difficult. The report in 1979 is signed by Viktor Mamylov and Are Dommasnes. Viktor Mamylov from PINRO worked on board “”G.O. Sars”” while the instrument technician Erling Molvær from IMR worked at ”Poisk”.

The mode of cooperation developed in 1978-1979 was continued in the following years. Intercalibrations between the vessels were carried out every year. For various reasons, like non-synoptic coverage, bad weather etc. the calculation of stock numbers was mainly based on the Norwegian vessels, while data from ”Poisk” or ”Persey III”, which mostly took part from PINRO, were used in some areas or some periods or just to check the validity of the results. Exchange of personnel, either during intercalibration or during the whole survey was common (Table 3).

Purpose of the survey

Was the technical accomplishment including the cooperation between the vessels always perfect? By no means! Now and again the echo sounders

Figure 9: It is a tedious process to sort the catch from the trawl stations. This picture was taken on board "G.O. Sars" in 2005, and shows from left Elena Eriksen, Jaime Alvarez, Bente Røttingen and Gjert Dingsør in activity.

Figure 10: The short time between the trawl stations forces the scientific crew to be ready for action any time... Jump into the work clothes and get into the lab!

and echo integrators failed in various ways, or the people operating them did not manage to get them work properly. Dispirited scientists often studied the results of intercalibrations and had to admit that yet another instrument comparison turned out to be a failure. Also the human part of the survey design and accomplishment was quite often put at test; for instance when one of the vessels, for unknown reasons, suddenly stopped following the arranged plan, stopped the survey before the arranged date, or did not follow the arranged methods in one or the other way. In some cases parts of the data had to be left out of the analyses because there were obvious problems with them, and in other cases bad data were probably included in the total material because there were no obvious problems with them… There is no reason to hide the problems that emerged now and then during the years. Said that, it should be emphasised that the problems were clearly more severe and more numerous during the first years. The technical installations have become much more stable and have performed much better during these 40 years. The collaboration between vessels and nations have matured and become better also. The responsible scientists involved, especially during the early period of the survey series, should be highly commended for their stamina and their ability not to resign either because of technical problems or human disagreements.

The ultimate goal of the survey has been, possibly with the exception of the first two or three years in the series, to obtain a quantitative measurement of the capelin stock size, or more precisely, the number of capelin distributed on age- and length-groups. But obviously, this goal must be seen in its context: The underlying purpose of the survey was to obtain a stock size estimate to be able to

Figure 11: Not only routine work has been conducted at the capelin surveys. In this case experiments with the "Bergen Acoustic Buoy" were made to investigate possible reactions of capelin to an approaching research vessel.

manage the capelin fishery in a rational way. The Norwegian-Russian Fisheries Commission from its foundation in 1976 undertook this task (Hønneland, 2006). But the basis for the scientific advice on management, either it came from a bilateral group of scientists or was developed under the auspices of the International Commission for the Exploration of the Seas (ICES), was always the stock size estimate obtained during the autumn capelin survey. The development of this advice cannot be covered in this short memorial volume, but the interesting history of its gradual evolution is explained in (Hamre, 1985; Tjelmeland, 1985; Gjøsæter, 1998; Gjøsæter et al., 2002; Gjøsæter et al., submitted). When Norway unilaterally limited its catch of capelin in winter 1974, this was based on the results of the acoustic surveys in 1972 and 1973 (Hamre, 1985). From 1979, a bilateral agreement with USSR/Russia about catch quota regulation has been in force. Unlike scientific advice in general, the capelin quota advice has mostly been well received by the managers, and with a few exceptions, the advice has been followed accurately. In 2011, the Norwegian part of the scientific team that has taken part in the development of the advice in later years, Sigurd Tjelmeland, Bjarte Bogstad, Bente Røttingen, Jaime Alvarez and Harald Gjøsæter, was awarded a prize for good management advice by the Institute of Marine Research.

Effort spent on the survey

During the first ten years the vesseldays (numbers of vessels multiplied with their numbers of days at sea) varied from 44 to 120, with an average of 75. From 2 to 4 (average 3) vessels participated. From 1986 to 1994 the survey aims were broadened; the survey was termed a multispecies survey, and the effort was increased. During this period the number of vessels was increased to 5-6 vessels (maximum 7) and the number of vesseldays was at average 148. From 1995 to 2002 the survey aims were again somewhat restricted, and the survey was termed an "acoustic survey for pelagic fish". Normally four vessels participated and the number of vesseldays was at average 83. From 2003 a new era started; the aims were considerably broadened and the survey called "ecosystem survey". The number of vessels participating again increased to five. The number of vesseldays was very high in 2004-2007 (more than 200, maximum 217) but in recent years the effort has been decreasing. The average for the period 2003-2010 is 171 vesseldays. When discussing the effort spent on the capelin investigation, it will not be correct simply

Figure 12: When all capelin data are transferred to the leading vessel, the stock size estimation programs are run. Here, Jostein Røttingen is mastering the computer.

Figure 13: while, Harald Gjøsæter, Bente Skjold, Bente Røttingen and Øyvind Tangen are sitting ringside following the process.

to compare the total number of vesseldays spent at the survey, since when the aims of the survey was broadened, a considerable part of the total time was spent on other work. Consequently, there has been a considerable decrease in the effort spent on capelin investigations in later years.

The vessels that took part

The vessel that holds the record for participation in the survey is the "old" "G.O. Sars". It was used from 1972, two years after it was built, until it was decommissioned in 2002, which is for 31 years. In most years this was considered the "leading vessel" since it was the technically best-equipped vessel and had meeting facilities where planning meetings before the surveys and sum-up meetings after the surveys could be held. From 2003 it was replaced with a new "G.O. Sars" that took part in the surveys all years except in 2004. The old "Johan Hjort" took part in 8 years from 1975-1982, when it was decommissioned. The new "Johan Hjort", built in 1990, have taken part in 20 years, while "Michael Sars" took part in 11 years. On the USSR (later Russian) side "Poisk", "Oddissey" and "Persey III" were used during the early period, replaced by "Vilnius", "Kokshaysk", "Professor Marti", "PINRO", "Atlantida", "AtlantNIRO", "Fridtjof Nansen", "Tsivilsk" and "Smolensk". "Fridtjof Nansen", with 12 surveys keeps the record on the USSR/Russian side.

The participating vessels and the effort put into the survey each year are shown in Table 1.

Figure 14:
One of the reasons why September is chosen as the time for the capelin survey is the nice weather often seen at this time of the year. This minimizes the loss of time due to bad weather, and facilitates high-quality acoustic data to be obtained.

Persons involved - the pioneers and those that stayed the course

Both G.O. Sars (Sars, 1879) and Johan Hjort (Hjort, 1914) include descriptions of the Barents Sea capelin stock, and on the USSR side R.S. Rass (Rass, 1933) contributed important knowledge in the early phase. From about 1960 the capelin investigations were intensified, probably brought about by the increased interest for capelin as a commercial resource (Gjøsæter, 1998). IMR introduced a survey program including one or more capelin surveys per year, in addition to the international 0-group survey that started in 1965. Central persons at IMR that lead these surveys were Steinar Olsen, Dag Møller, John Lahn-Johannesen, Anders Strøm, and Terje Monstad. Terje Monstad was a student at the University of Bergen, and in the period 1968-1970 he took his Cand.real. degree with the thesis "Alder, vekst og utbredelse av lodde (Mallotus villosus) i Barentshavet og ved kysten av Nord-Norge 1968-1970" ("Age, growth and geographical distribution of capelin (Mallotus villosus) in the Barents Sea and at the northern Norwegian coast in 1968-1970") (Monstad, 1971). On the USSR side V.S. Prokhorov was active in publishing results from capelin investigations. (Prokhorov, 1960; Prokhorov, 1967; Prokhorov, 1968).

Many persons were involved in the establishment of the capelin survey. As already mentioned, the survey emerged from the 0-group survey, and central person involved in that survey on the Norwegian side were also central to the start and early development of the autumn capelin survey. Among those should be mentioned Are Dommasnes, Terje Monstad, Ingolf Røttingen, Lars Midttun and Odd Nakken. The two last mentioned were heavily involved in the development towards the use of acoustic equipment in a quantitative way. The report from the 1972-survey, which we now consider the first survey in the series, was made by Jakob Gjøsæter, Lars Midttun, Terje Monstad, Odd Nakken, Odd Smedstad, Roald Sætre and Øyvind Ulltang – probably the complete scientific staff on board the two participating vessels. Such an impressive number of scientists involved in a survey stands out in contrast to the one, or maximum 2, scientists involved during acoustic surveys of today! In addition to those mentioned above, Johan Blindheim, Olav Dragesund, Are Dommasnes, Per Hognestad and Roald Sætre lead capelin surveys in this early period. In 1974 Johannes Hamres name appears for the first time on the cruise report. (More about him later.) In 1975 Ingolf Røttingen took part in the reporting. That year he finished a thesis contributing to the methodology of acoustic stock size estimation. He was also, together with instrument technician Kaare A. Hansen, among the first Norwegians to have a longer stay on board a USSR research vessel. In 1978 Harald Loeng appears among the authors of the cruise report, in 1980 Sigurd Tjelmeland appears for the first time, and in 1983 Harald

Figure 15:
Two of the Norwegian vessels that have taken part in capelin surveys for a number of years; the new "G.O. Sars" and "Johan Hjort". Unknown photographer.

Gjøsæter. From then on things stabilized, in the way that Johannes Hamre was normally the main responsible for the survey and cruise leader at "G.O. Sars", while Harald Gjøsæter was cruise leader on the second Norwegian vessel participating in the survey (normally "Michael Sars"). From about 1990 Gjøsæter assisted Hamre as main responsible on the Norwegian side, and from 1994 he took over Hamres position. The other Norwegian vessel was then lead by Sigurd Tjelmeland, Jan Henrik Nilsen or Jostein Røttingen. From 2003 the capelin investigations became a part of an "ecosystem survey", and several new persons were involved. However, during the period when the main capelin investigations were made, these same persons were normally in charge. Table 2 summarizes the leadership (as far as it is documented in the cruise reports) of the capelin survey. In some cases persons involved as "assistant cruise leader" or member of the meeting after the survey are also listed.

It is seen from table 2 that six persons have been involved in leadership of this survey during more than ten years out of the 40 years since it started. These are Ilya Dolgolenko, Harald Gjøsæter, Johannes Hamre, Dmitri Prozorkevich, Sigurd Tjelmeland and Nikolay Ushakov. Two persons participated 25 times or more, Harald Gjøsæter (26) and Nikolay Ushakov (25). From 1992 to 2008, with the exception of the year 2000, Ushakov stayed on board the leading Norwegian vessel during the survey, together with the Norwegian cruise leader conducting a joint leadership over the whole survey.

Exchange of personnel

During the late 1970s and early 1980s, it was quite normal to exchange people among the vessels, at least during intercalibrations or during the last days of the survey when all data was put together and the calculations were done. Such exchange was important during this early phase of the cooperation, to learn about the technical systems and procedures on each other's vessels. During the period after, exchange of people seemingly stopped, until the early 1990s, when one representative from PINRO was always on board the leading Norwegian vessel. This arrangement was made for two reasons. Since the survey was a joint survey, it was felt that one person from USSR/Russia and one from Norway should stay together on the leading vessel, to conduct a joint leadership over the survey. Second, this arrangement helped to avoid linguistic problems when communicating plans, data etc. among the vessels. It is stated several times in the reports that this arrangement facilitated the day-to-day planning and made the cooperation between vessels much more easy. Table 3 lists those exchanges that are reflected in the survey reports.

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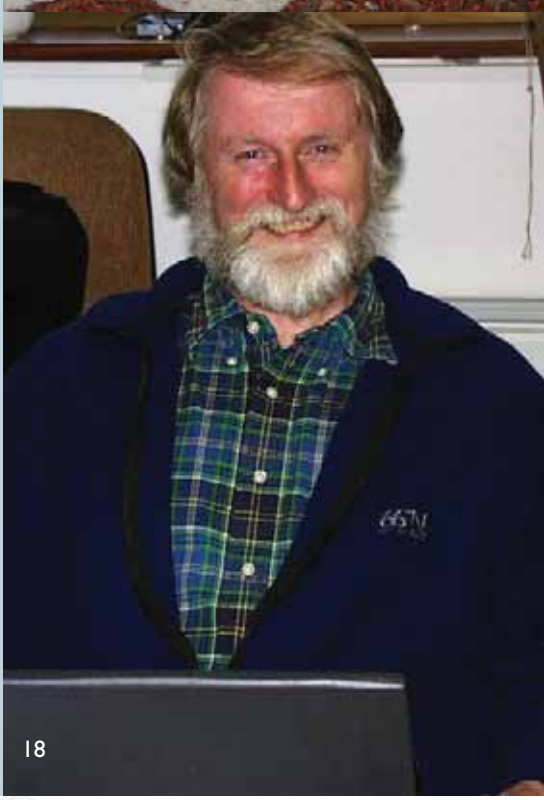

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Figure 16: Nikolay Gregorievich Ushakov is probably the person that has stayed the course longer than anyone else: for a number of years he was cruise leader on one of the USSR vessels, and from 1992 to 2008, except from one year, he stayed on board the leading Norwegian vessel during the capelin survey.

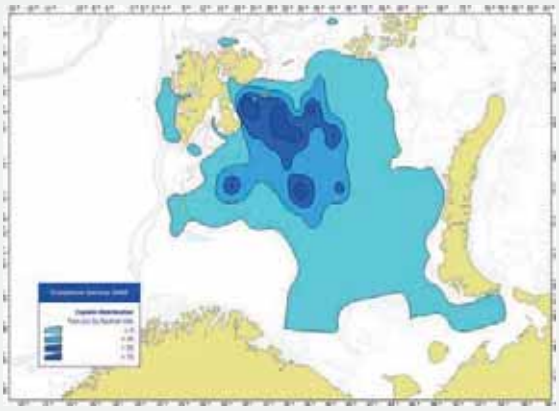
Figure 17: Two of the persons with many capelin surveys on their CV: Bente Røttingen and Nikolay G. Ushakov. Bente may be the one Norwegian with most capelin surveys; She started her career in 1975, and with the exception of two or three years, has attended all autumn capelin surveys since. And she continues to go…

Figure 18: Sigurd Tjelmeland, the main architect behind the capelin assessment software. He is also one of the main participants in the IMR-PINRO cooperation during a long period. He has also taken part in some capelin cruises and stayed for a whole cruise on board the Russian vessel "Fridtjof Nansen" in 1998.

Figure 19: When the capelin stock size estimate is ready, the next step is to run the assessment model. Bjarte Bogstad and Harald Gjøsæter in deep concentration: in a few moments the next year's quota advice will be evident. Unknown photopgrapher.

What has come out of it?

Certainly, there are many types of output from a survey series like this. What is considered most important will depend on who are asked. For the managers, the advice on management of the capelin fishery is obviously the most important outcome. Seen from a more academic side, the articles in academic journals, the progress in survey methodology, and the technical innovations in acoustic equipment that resulted from it will get a higher rating. For those that participated in the surveys, the social dimension (see below) should not be forgotten.



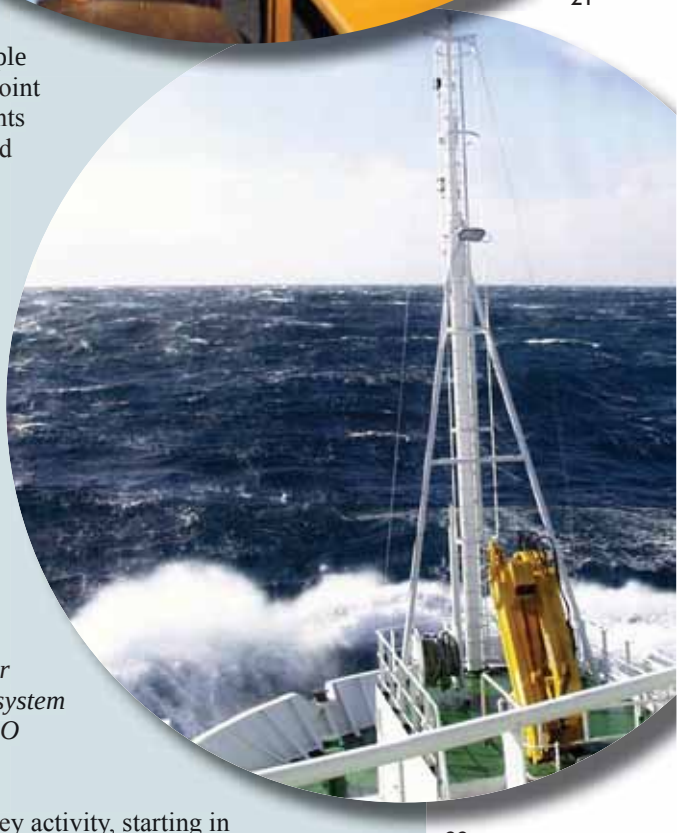
Several papers have been produced, where the material came from the autumn capelin surveys. Many of them ended up among the "grey literature", while others were published in international peer-reviewed journals. At least two doctoral theses are based solely or mainly on material from this survey series (Gjøsæter, 1999; Ushakov, 2000) while such material is included in several additional theses. Probably because this is a very long time series, and also because of the central position of the capelin stock in the Barents Sea ecosystem, the data from this survey series are included in several national and international scientific projects.

Figure 20:
The distribution of capelin (by age group) is illustrated in the cruise report by showing a density map (tonnes per square nautical mile). Figure made by Jaime Alvarez/Bente Røttingen.

21

The social dimension

There is no doubt that a close cooperation between two institutions, lasting for over 40 years and where people are doing joint research, has a social dimension in addition to the scientific one. In the capelin survey, the social dimension has always been very important. The reason is probably that the personnel involved were rather stable over the years, and colleagues gradually became friends. The meeting points between scientists at IMR and PINRO during the 1970s and 1980s were not so many as they are now, but people met during the annual March meeting, and before and after the joint surveys (the 0-group survey and the capelin survey) of the Barents Sea. During such meeting the 3-5 ships involved normally stayed side by side in harbours like Hammerfest. These meetings were always busy, since the tasks had to be done within short time frames. However, they were never too busy to allow for a party to be arranged, in many cases two: one at a Norwegian ship and the next day at a Russian ship. During such parties not only the meeting participants took part, normally the whole scientific crew and often the officers of the ship crew were also invited. After these surveys the participants often came back to the institutes bringing presents or greetings to people that did not participate that year. Quite many toasts were suggested to commemorate earlier participants that had retired or "veterans" that for various reasons no longer took part in the surveys. As an example of the feelings that existed among the participants, a statement in the report from the 2006 survey might be illustrative. On the frontispiece was stated:
This report is written in memory of our esteemed colleague V.S Mamylov from PINRO who passed away last year. Victor was for many years central to the development and execution of the ecosystem survey and his death is a big loss for PINRO and the IMR-PINRO cooperative investigations.



22

It should not be forgotten that the development of this joint survey activity, starting in the 1960s and with roots further back (Haug et al., 2009) and in many ways reached its summit in the joint capelin survey, came into being in a period with very poor conditions for cooperation between USSR and Norway. While the "cold war" was raging, scientists from PINRO and IMR found ways to conduct cooperative research in formal and informal ways because they saw that it was needed. But no doubt, they received a manifold return for their efforts, in form of exciting scientific merits and an excess of good social relations and friendship.

Figure 21: This picture depicts many persons central to the autumn capelin survey. From left: Nikolay Ushakov, Viktor Mamylov, Sigurd Tjelmeland, Harald Gjøsæter, Dimitri Prozorkevich, Bente Røttingen. The picture is taken in the conference room at "Johan Hjort" during a meeting after a capelin survey, probably in 1996 or 1997. Unknown photographer.

Figure 22: Even though the Barents Sea is often calm and nice during September, a storm or two are normally encountered during a cruise lasting three weeks or more. Here, "Johan Hjort" plunges its way through stormy seas. Photograph Jaime Alvarez.

Table 1: Vessel participation and survey effort.

Year	Vessels	No. of vessels	No. of vessel*days
1972	”G.O. Sars”, ”Johan Hjort”	2	72
1973	”G.O. Sars”, ”Johan Hjort”	2	44
1974	”G.O. Sars”, ”Havdrøn”	2	54
1975	”G.O. Sars”, ”Johan Hjort”, ”Poisk”	3	99
1976	”G.O. Sars”, ”Johan Hjort”, ”Odissey”	3	66
1977	”G.O. Sars”, ”Johan Hjort”, ”Odissey”	3	63
1978	”G.O. Sars”, ”Johan Hjort”, ”Poisk”	3	58
1979	”G.O. Sars”, ”Johan Hjort”, ”Poisk”	3	64
1980	”G.O. Sars”, ”Johan Hjort”, ”Poisk”	3	66
1981	”G.O. Sars”, ”Johan Hjort”, ”Persey III”	3	73
1982	”G.O. Sars”, ”Johan Hjort”, ”Persey III”, ”Poisk”	4	105
1983	”G.O. Sars”, ”Michael Sars”, ”Persey III”, ”Poisk”	4	85
1984	”G.O. Sars”, ”Michael Sars”, ”Persey III”, ”Kokshaysk”	4	77
1985	”G.O. Sars”, ”Michael Sars”, ”Vilnius”, ”Kokshaysk”	4	120
1986	”G.O. Sars”, ”Michael Sars”, Eldjarn, ”Vilnius”, ”Kokshaysk”	5	187*
1987	”G.O. Sars”, ”Michael Sars”, Eldjarn, ”Vilnius”, ”Artemida”, ”Persey III”, ”Professor Marty”	7	174*
1988	”G.O. Sars”, ”Michael Sars”, Eldjarn, ”Artemida”, ”Professor Marty”, ”PINRO”	6	201*
1989	”G.O. Sars”, ”Michael Sars”, Eldjarn, ”Professor Marty”, ”PINRO”, ”Persey III”	6	137*
1990	”G.O. Sars”, ”Michael Sars”, Eldjarn, ”Professor Marty”, ”PINRO”, ”Vilnius”	6	155*
1991	”G.O. Sars”, ”Michael Sars”, ”Johan Hjort” , ”Professor Marty”, ”PINRO”, ”Fridtjof Nansen”	6	120*
1992	”G.O. Sars”, ”Michael Sars”, ”Johan Hjort”, ”Professor Marty”, ”Fridtjof Nansen”	5	127*
1993	”G.O. Sars”, ”Johan Hjort”, ”Professor Marty”, ”Fridtjof Nansen”, ”PINRO”	5	115*
1994	”G.O. Sars”, ”Johan Hjort”, ”Professor Marty”, ”Fridtjof Nansen”, ”Atlantida”	5	112*
1995	”G.O. Sars”, ”Johan Hjort”, ”Professor Marty”, ”Fridtjof Nansen”	4	73
1996	”G.O. Sars”, ”Johan Hjort”, ”Atlantida”, ”Persey III”	4	57
1997	”G.O. Sars”, ”Johan Hjort”, ”Atlantida”	3	59
1998	”G.O. Sars”, ”Johan Hjort”, ”Atlantida”, ”Fridtjof Nansen”	4	88
1999	”G.O. Sars”, ”Johan Hjort”, ”AtlantNIRO”, ”Vega”	4	80
2000	”G.O. Sars”, ”Johan Hjort”, ”AtlantNIRO”, ”Fridtjof Nansen”	4	107
2001	”G.O. Sars”, ”Johan Hjort”, ”AtlantNIRO”, ”Fridtjof Nansen”	4	108
2002	”G.O. Sars”, ”Johan Hjort”, ”Michael Sars”, ”AtlantNIRO”, ”Fridtjof Nansen”	4	88
2003	”G.O. Sars” , ”Johan Hjort”, ”Jan Mayen”, ”Tsivilsk”, ”Smolensk”	5	163*
2004	”Johan Hjort”, ”Jan Mayen”, ”Smolensk”, ”Fridtjof Nansen”	4	217*
2005	”G.O. Sars”, ”Johan Hjort”, ”Jan Mayen”, ”Smolensk”, ”Fridtjof Nansen”	5	216*
2006	”G.O. Sars”, ”Johan Hjort”, ”Jan Mayen”, ”Smolensk”, ”Fridtjof Nansen”	5	208*
2007	”G.O. Sars”, ”Johan Hjort”, ”Jan Mayen”, ”Smolensk”, ”Vilnius”	5	207*
2008	”G.O. Sars”, ”Johan Hjort”, ”Jan Mayen”, Atlantic Star, ”Vilnius”	5	139*
2009	”G.O. Sars”, ”Johan Hjort”, ”Jan Mayen”, ”Vilnius”	4	116*
2010	”G.O. Sars”, ”Johan Hjort”, ”Jan Mayen”, ”Vilnius”, ”Fridtjof Nansen”	5	103*

[1] Total number of vessel*days, including time spent on other investigations.
[2] The “old” “Johan Hjort” was decommissioned in 1982. The new “Johan Hjort” was built in 1990.
[3] The ”old” 2G.O. Sars2 was replaced by a new G.O. Sars in 2003.

Table 2: People that have served as cruise leaders, or has participated in a leader team.

Person	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Alvarez, J.																				
Aschan, M.																				
Bakanev, V.S.																	1			
Blindheim, J.						1														
Borkin, I.																1		1		
Dolgolenko, I.																				
Dommasnes, A.		1	1	1	1		1	1									1			
Eriksen, E.																				
Fossum, P.																				
Galkin, A.S.				1									1							
Gjøsæter, H.												1	1	1	1		1	1	1	1
Gotovtsev, S.																				
Hamre, J.			1					1			1	1	1	1	1	1		1		1
Holst, J.																				
Hvingel, K.																				
Høines, Å.																				
Iversen, S.A.																				
Jørgensen, L.																				
Kaikov, V.													1							
Komlichenko, V.																		1		1
Korol, L.										1										
Krysov, A.I.														1						1
Loeng, H.						1	1		1								1		1	1
Mamylov, V.								1	1		1	1								
Mehl, S.															1	1	1	1		
Midttun, Lars	1										1	1		1	1		1			
Monstad, Terje	1					1	1													
Nakken, Odd	1	1	1	1					1											
Nedreaas, K.																				
Nilsen, J.H.						1														
Novoselov, S.Y.																1				
Olsen, E.																				
Ona, E.																	1			
Prozorkevich, D.																				
Røttingen, I.		1		1	1	1				1	1									
Røttingen, J.				1					1	1		1		1	1					
Shamrai, E.																				1
Shein, B.P.																				
Shevelev, N.S.																1	1	1	1	
Shleinik, V.N.					1															
Smedstad, Odd	1																			
Sunnanå, K.																			1	
Sætre, R.	1	1																		
Tjelmeland, S.									1	1	1	1		1					1	1
Toresen, R.												1		1	1	1				
Ushakov, N.G.								1			1	1		1	1	1	1	1	1	1
Vasiliev, A.																			1	
Wenneck, T. dL.																				
Zabavnikov, V.																				
Aanes, S.																				

Table 2 continued.

Person	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Sum
Alvarez, J.																1	1	1	1	4
Aschan, M.													1							1
Bakanev, V.S.																				1
Blindheim, J.																				1
Borkin, I.																				2
Dolgolenko, I.			1	1			1	1	1	1	1	1	1	1	1	1			1	13
Dommasnes, A.	1																			8
Eriksen, E.																		1		1
Fossum, P.													1		1					2
Galkin, A.S.																				2
Gjøsæter, H.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	26
Gotovtsev, S.			1																	1
Hamre, J.	1	1																		12
Holst, J.														1						1
Hvingel, K.															1					1
Høines, Å.															1					1
Iversen, S.A.	1																			1
Jørgensen, L.																	1			1
Kaikov, V.																				1
Komlichenko, V.																				2
Korol, L.																				1
Krysov, A.I.		1																		3
Loeng, H.	1																			7
Mamylov, V.																				4
Mehl, S.																1		1		6
Midttun, Lars																				6
Monstad, Terje																				3
Nakken, Odd																				5
Nedreaas, K.														1						1
Nilsen, J.H.						1	1	1			1									5
Novoselov, S.Y.																				1
Olsen, E.														1	1	1	1			4
Ona, E.																				1
Prozorkevich, D.				1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	15
Røttingen, I.																				6
Røttingen, J.									1	1									1	9
Shamrai, E.	1	1	1		1	1														6
Shein, B.P.		1																		1
Shevelev, N.S.																				4
Shleinik, V.N.																				1
Smedstad, Odd																				1
Sunnanå, K.													1							2
Sætre, R.																				2
Tjelmeland, S.		1	1	1	1															11
Toresen, R.																				4
Ushakov, N.G.	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1				25
Vasiliev, A.																				1
Wenneck, T. dL.													1		1	1	1	1	1	6
Zabavnikov, V.														1						1
Aanes, S.													1	1	1	1	1			5

Table 3

Year	Exchanged personnel
1978	N. Ushakov on ”G.O. Sars”, I. Røttingen and K. Hansen on ”Poisk”
1979	V. Mamylov on ”G.O. Sars”, E. Molvær on ”Poisk” (part time)
1980	V. Mamylov on ”G.O. Sars”, E. Molvær on ”Poisk” (part time)
1981	Leonid Korol on ”G.O. Sars” (part time), E. Molvær and A. Roald on ”Persey III” (part time)
1982	Leonid Korol on ”G.O. Sars” (part time), R. Pedersen and J. Røttingen on ”Persey III” (part time)
1983	S. Tjelmeland and H. Gjøsæter on ”Poisk” (part time)
1984–1991	No mentioning of exchanged personnel
1992–1999	Nikolay Ushakov on board ”G.O. Sars”
1998	Sigurd Tjelmeland on board ”Fridtjof Nansen”
2000	Alexander Krysov on board ”G.O. Sars”
2001–2003	Nikolay Ushakov on board ”G.O. Sars”
2004	Nikolay Ushakov on board ”Johan Hjort”
2005–2008	Nikolay Ushakov on board ”G.O. Sars”
2009–2010	Tatiana Prohkorova on board ”Johan Hjort”

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Figure 23:
Gold can be found both above and beneath the surface of the Barents Sea.

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