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SURVEY REPORT

FROM THE JOINT NORWEGIAN/RUSSIAN ECOSYSTEM SURVEY IN THE BARENTS SEA

AUGUST – OCTOBER 2004

Volume 1

Preface

The 2nd joint ecosystem survey was carried out during the period 1st of August to 4th of October 2004. This survey encompasses various surveys that previously have been carried out jointly or at national basis. Joint investigations include the 0-group survey, the acoustic survey for pelagic fish (previously known as the capelin survey), and the investigations on young Greenland Halibut north and east of Spitsbergen. Oceanographic investigations have always formed a part of these surveys, and studies on plankton have been included for many years. In recent years, observations of sea mammals, seabirds, bottom fishes, and benthos have been included. Consequently, from 2003, these surveys were called “ecosystem surveys”.

The present report from the survey will cover many but not all the aspects of the survey. Main focus is on the hydrographical conditions of the Barents Sea, the results from the 0-group investigations and from the acoustic investigation on pelagic fish (capelin, young herring and polar cod). Materials on sea mammals and seabird observations are also presented in volume 1 of the report. Results from the investigations on plankton, bottom fishes and benthos will only be briefly mentioned, since the reporting of these investigations will have to await further working up of material in the laboratories. Those investigations will be included in volume 2. The 1st volume of the report was made during a meeting between scientists participating in the survey, in Kirkenes 5-8th October.

A list of the scientific members on all vessels is given in Appendix I. Four research vessels participated:

Vessel	Institute	Cruise leader	Date
"Johan Hjort"	IMR	S. Aanes	01.08 – 12.08
		A. Dommasnes	13.08 – 20.08
		P. Fossum	20.08 – 09.09
		H. Gjøsæter	10.09 – 04.10
”Jan-Mayen”	IMR	M. Aschan	04.08 – 12.08
		K. Sunnanå	12.08 – 22.08
		T. de Lange Wenneck	10.09 – 01.10
“Smolensk”	PINRO	D. Prozorkevich	06.08 – 02.10
”F. Nansen”	PINRO	I. Dolgolenko	07.08 – 02.10

Synopsis

The main aim of the ecosystem survey was to map the distribution and abundance of the young and adult stages of several demersal and pelagic fish species, and in addition to this gather information about hydrographical features, zooplankton, benthos, seabirds and sea mammals.

The water temperature in all observed areas was significantly higher (+1.0 ^{0}C) than in the same period in 2003.

The yearclasses of haddock, herring, saithe and eastern polar cod are all rich. The yearclasses of cod and Greenland halibut are above the long term mean while the capelin yearclass is near the average level. Yearclasses of redfish and others species where estimated to be poor.

The total capelin stock was estimated to be 0.6 million tonnes, which is 18% larger than last years estimate. About 0.3 million tonnes were assumed to be maturing.

The polar cod stock was estimated to be 1.1 million tonnes, which is close to the estimate in 1999-2002 and 4 times higher than last year.

Norwegian Spring Spawning Herring of the 2003, 2002, and 2001 yearclasses were found in a large part of the surveyed area. The biomass of this stock was estimated to be 3.3 million tonnes, of which the 2002 year class formed a major component (about 85% by weight).

Blue whiting of age groups 1 to 7 were observed in the southwestern parts of the surveyed area, and the biomass of this stock component was estimated to be 1.4 million tonnes.

1 Methods

1.1 Hydrography

The hydrographical investigations consisted of measurements of temperature and salinity in depth profiles along sections and distributed over the total investigated area. All vessels used CTD-probes.

1.2 0-group investigations

The geographical distribution of 0-group fishes was estimated with a small mesh mid-water trawl (“Harstadtrål”). All vessels, which participated in the survey in 2004, used this type of mid-water trawl recommended in 1980 (Anon. 1983). The standard procedure consisted of tows at 3 depths, each of 0.5 nautical miles, with the headline of the trawl located at 0, 20 and 40 m. Additional tows at 60 and 80 m, also of 0.5 nm distance, were made when the 0-group fish layer was recorded deeper than 60 m or 80 m on the echo-sounder. Trawling procedure was standardised in accordance with the recommendations made in 1980. A smaller sized pelagic trawl were used during the first 20 years of the 0-group investigations. After 1985 the present gear has been used regularly. In the mid 1990s, Nakken and Raknes (1996) recalculated the indices from the first 20 years. Their new indices are based upon an estimate of how many 0- group cod and haddock that would have been caught if the new equipment had been used during the whole period from 1965. The indices of cod and haddock recalculated by Nakken and Raknes (1996) have been incorporated in the 0-group reports since 2001. Prozorkevich (2001) calculated abundance indices for 0-group herring since 1993.

A new type of 0-group indices (Dingsør and Prozorkevich, in prep) calculated from the actual catches will be presented in the next version of this report (Vol II). This new method allows for confidence limits to be calculated, and makes better use of the total data than the indices used hitherto have made. When indices for the whole period have been recalculated, and the results have been carefully scrutinized and compared to previous methods, this method is meant to replace the methods used up to now after a short period of overlap between the two methods.

Most of the stations were this year taken 30-40 nautical miles apart according to the bottom trawl stations. Area based abundance indices (ABI) were estimated by using the computer program Map Viewer. Mean values of abundance indices were calculated both for the period 1985-2004 and for the whole period 1965–2004. Another set of logarithmic transformed abundance indices are given for 0-group herring, cod and haddock, calculated according to Randa (1984). These are based on the logaritmic number of fish caught during a standard trawl haul of one nautical mile. When the logramitmic index is calculated the Barents Sea is divided in 18 subareas. The present year subarea 18 was undersampled. Therefore this area was reduced from 7800 to 2000 nm^2 for a better desciption of the present data.

Data for 0-group cod from the last survey with "Johan Hjort" show a tendency of migration towards the bottom. These data were therefore deleted before the final calculations of the indicies were carried out.

1.3 Acoustic survey for pelagic fish

A team consisting of N.G. Ushakov (PINRO) together with P. Fossum and then H. Gjøsæter (IMR) on board "Johan Hjort" conducted a joint leadership over the investigations, undertaking a day-to-day planning of survey grid.

Data on cruise tracks, hydrography, trawl catches, integrator values etc. were exchanged by use of e-mail, and these data were used during the day-to-day planning of the survey.

The survey area was chosen based on general knowledge of the distribution of the target species, and on information about fish distribution from the first parts of the ecosystem survey. "Johan Hjort" was not granted permission to work in parts of Russian EEZ. This is a step backwards from the situation in recent years, when the Norwegian vessels at least partly have been able to work in Russian EEZ. Nevertheless a good coverage of the total capelin distribution area was obtained.

The main distribution area of capelin was surveyed with course lines 15 nautical miles apart, while most other areas were surveyed with course lines 30-40 nautical miles apart. "Smolensk" and "F. Nansen" surveyed the eastern and central parts of the Barents Sea whereas "Johan Hjort" and "Jan Mayen" surveyed the western, northwestern and central parts. Altogether, about 19000 nautical miles of survey tracks were made. This represents a 10% increase from 2003.

"Johan Hjort" worked with EK-500, while "Jan Mayen" and the Russian vessels used EK-60 echo sounders. The Norwegian vessels had BEI, while the Russian vessels used FAMAS post-processing system. Also "J. Hjort" and "Jan Mayen" was equipped with transducers on adjustable keels that can be lowered in rough weather to avoid the damping effect of bubbles. Echo intensities per nautical mile were integrated continuously, and mean values per 5 nautical miles were recorded for mapping and further calculations. The echograms, with their corresponding s_A-values, were scrutinised every day. Contributions from the seabed, false echoes, and noise were deleted.

The corrected values for integrated echo intensity were allocated to species according to the trace pattern of the echograms and the composition of the trawl catches. Data from pelagic trawl hauls and bottom trawl hauls considered representative for the pelagic component of the stocks, which is measured acoustically, were included in the stock abundance calculations.

The echo sounders were watched continuously, and trawling was carried out whenever the recordings changed their characteristics and/or the need for biological data made it necessary. Trawling was thus carried out both for identification purposes and to obtain biological observations, i.e., length, weight, maturity stage, stomach data, and age.

In total, the Norwegian vessels carried out 519 trawl hauls and the Russian vessels carried out 481 trawl hauls, so in total 1000 hauls were made during the survey. The vessels gave the s_A-values in absolute terms based on sphere calibrations, that is, as scattering cross section in m^2 per square nautical mile. The acoustic equipment of the vessels was calibrated by standard spheres (see Appendix II).

1.3.1 Area coverage

As in last year the vessel time allocated to the survey is difficult to compare to that previous years, since new investigations have been added to the survey. The weather conditions were favourable during most parts of the survey, and consequently, an almost total coverage of the Barents Sea by a dense survey grid was achieved. The survey design used in recent years, running east-west courses starting in the south, in 2002 was abandoned in favour of starting in the north. Since the northern limit of the capelin distribution seems to be more variable than the southern limit, starting the survey in the north ensures that enough time can be allocated to the most important parts of the survey area. In 2003, the survey was once more started in the south, because the vessel “Jan Mayen” covered the areas north and east of Spitsbergen and located the northern limit of the capelin distribution before “Johan Hjort” started its capelin survey. In 2004 this was not the case, and the coverage of capelin in the central areas was started in the north.

1.3.2 Computations of stock sizes

The computations of number of individuals and biomass per length-and age group of the pelagic fish stocks were made using the stock size estimation program “BEAM” built on SAS GIS and developed at IMR. A strata system, dividing the Barents Sea in squares of 1º (latitude) x 2º (longitude), was used as basis for the calculation.

The mean s_A-value in each basic square was converted to fish area density ρ_A using the relation

$$\rho_A = \frac{s_A}{\bar{\sigma}}$$

and number of fish was found by multiplying with the area of the square. Numbers were converted to biomass by multiplying with observed mean fish weight in each length group.

The target strength relation for *capelin* is given by:

$$TS = 10 \cdot \log(\frac{\sigma}{4\pi}) = 19.1 \cdot \log L - 74.0$$

corresponding to a σ -value of $5.00 \cdot 10^{-7} \cdot L^{1.91}$

The target strength relation for *polar cod* and *blue whiting* is given by:

$$TS = 10 \cdot \log(\frac{\sigma}{4\pi}) = 21.8 \cdot \log L - 72.7$$

corresponding to a σ -value of $6.7 \cdot 10^{-7} \cdot L^{2.18}$

The target strength relation for *herring* is given by:

$$TS = 10 \cdot \log(\frac{\sigma}{4\pi}) = 20.0 \cdot \log L - 71.9$$

corresponding to a σ -value of $8.1 \cdot 10^{-7} \cdot L^{2.00}$

1.3.3 Sampling of fish

	Norwegian vessels	Russian vessels	Sum
Capelin			
No of samples	246	396	642
Nos. length measured	7692	17412	25104
Nos. aged	1851	2082	3933
Polar cod			
No of samples	272	393	665
Nos. length measured	9378	42855	52233
Nos. aged	1061	2062	3123
Herring			
No of samples	192	58	250
Nos. length measured	11846	2082	13928
Nos. aged	1113	297	1410
Blue Whiting			
No of samples	133	24	157
Nos. length measured	6171	829	7000
Nos. aged	356	-	356
Cod			
No of samples	446	324	770
Nos. length measured	16935	18233	35168
Nos. aged	-	36	36
Haddock			
No of samples	324	113	437
Nos. length measured	12601	6857	19458
Nos. aged	-	23	23
Redfish			
No of samples	71	75	146
Nos. length measured	210	1304	1514
Nos. aged	-	-	
Saithe			
No of samples	119	119	238
Nos. length measured	1400	3151	4551
Nos. aged	-	-	-
Greenland halibut			
No of samples	377	157	534
Nos. length measured	7068	7414	14482
Nos. aged	-	41	41

Length measurements include 0-group samples. Demersal fishes will be aged after the survey.

1.4 Bottom trawl survey

Bottom fish were identified in the acoustic registrations along all cruise tracks, with division of s_A-values by species. Bottom trawl hauls were executed every 35-40 miles. All participating vessels used a Campelen trawl. Primary results on cod, haddock, saith, shrimp and king crab are briefly presented in this volume. After age readings and analyses in laboratories, the main results on bottom fishes will be presented in the 2nd volume of the survey report.

1.5 Plankton investigations

Plankton sampling on the Norwegian vessels was carried out by WP-2 plankton nets with 0,25m^2 opening and 180 µm mesh size. Two hauls were made at each station, one was taken from the bottom to the surface and the other one from 100 m to the surface. Additional sampling was carried out daily by Mocness multinet planktonsampler.

The sampling on the Russian vessels was carried out by Juday-nets with 0,1 m^2 opening and 375 µm mesh size in depth intervals, 50-0, 100-50, 200-100 and bottom- 200m. Additional sampling was carried out by WP-2 and OPC on “F. Nansen”.

On board the samples were splitt, one part was fixated in formalin for systematic analysis the other one was fractioned in size categories. These size fractioned sampled was weighed after drying at 70°C for 24 hours. Large organisms like medusa, krill, shrimp and fish larvae were treated separately. Length of these specimens was measured before weighing. Final plankton results will be presented in 2nd volume of the survey report.

1.6 Sea mammals and birds investigations

Sea mammals were counted and specified at all vessels. On the vessels “J. Hjort” and “F. Nansen” seabirds were also identified and counted. Distribution charts of sea birds and sea mammals will be presented in this report. Final results will be presented in 2nd volume of the survey report.

1.7 Benthos observations

On the Norwegian vessel “Jan Mayen” benthos was sampled at each bottom trawl station. On “Johan Hjort” benthos was sampled during the period 20.08-10.09, on the rest of the “Johan Hjort” cruise benthos was not sampled due to lack of time and experienced taxonomist.

On the Russian vessels benthos were collected by bottom grab sampler and by a special trawl, “Sigsbi”. Additional samples from separate bottom trawl stations were taken when new kinds of benthos were found. All benthos organisms were identified to species or nearest family, counted and weighted and sub samples were fixed for further analyses Some preliminary results will be presented here.

2 Results and discussion

Survey routes with trawl stations; hydrographical stations, plankton stations and benthos sampling stations are shown in Fig. 2.1, 2.2 and 2.3 respectively.

2.1 Hydrographical conditions

Figs 2.1.1-2.1.6 show the temperature and salinity conditions along the hydrographical sections: Kola meridian, Cape Kanin – North, and Bear Island – West. The mean temperatures in main parts of these sections are presented in Table 2.1.1. During the survey this year, the standard section Bear Island – North Cape was not taken. Horizontal distribution of temperature and salinity are shown for 0, 50, 100, 200 m and near the bottom in Figs 2.1.7-2.1.16.

The current year seems to be a year with strong influx of warm water into the Barents Sea. The surface water temperatures were higher than the long term mean by 0.8-1.5°C on average, in the eastern part of sea. In the southern, central and western areas, the temperatures were 2.0-2.5°C higher than normal. Maximum positive anomalies (3.0-3.5°C) were observed in the southwestern part of the Barents Sea. In the bottom layer, positive anomalies of water temperature were found practically in all observed areas.

The waters of the Bear Island-West Section had the highest positive temperature anomalies in the 0-50 m layer. The water temperature of West and Middle Branches of the Norwegian Current was at average 1.8°C above the long-term mean in the 0-50 m layer and 1.1°C above the long-term mean in the 0-200 m layer.

In the Kola section the water temperatures in the 0-50 m and 0-200 m layers exceeded the long-term mean with 1.2 and 0.7°C in the Murmansk Coastal Current, 1.8 and 0.9°C in the Murmansk Current, and 2.0 and 1.1°C for the Central Branch of the North Cape Current. The waters of the Northern Branch of the North Cape Current were 1.7 and 1.1°C warmer than normal in the same layers.

The water of the Kanin Current in the Kanin section had positive temperature anomalies in the 0-50 m (+0.8°C) and 0-200 m (+0.7°C) layers. The water temperature of the Novaya Zemlya Current in the 0-200 m layer was also higher than the long-term mean (at average by 0.9°C).

A comparison between the results from 2004 and 2003 shows that the surface waters were warmer in the eastern part of the survey area in 2004 than in the same period in 2003 (on average 0.5-1.5°C). In the western, central and southern parts, the surface waters were warmer by 2°C and more. Below 50-meter layers and at the bottom, water temperature was lower than in 2003 in the eastern and a southeastern parts of the sea, but in other part of the Barents Sea the water temperature was higher than in 2003.

As a whole the thermal conditions in the Barents Sea during autumn 2004 corresponded to a level of abnormal warm years, such as 1989-1990, 1992 and 2002.

2.2 Distribution and abundance of 0-group fish and *Gonatus fabricii*

The distribution of various species of 0-group fish are shown in Figs 2.2.1 – 2.2.12. Abundance indices are shown in tables 2.2.1 and 2.2.2. Trawl stations with and without catch are indicated on the distribution charts as filled and open symbols respectively. The density grading is based on catches, measured in number of fish per 1.0 nautical mile trawling. Double shading indicates dense concentrations. The criteria for discriminating between dense and scattered concentrations are the same as used in earlier reports (Anon. 1980). Length frequency distributions of the main species are given in Table 2.2.3.

2.2.1 Herring

The total distribution area differed little compared to previous years. West of Spitsbergen only scattered distributions were observed. In the central part a large area with dense concentrations of herring were found. This year class can be characterised as rich and according to the logaritmic index this is the richest yearclass since 1983.

2.2.2 Capelin

West of Spitsbergen and in the most northern and eastern areas there were only scattered distributions of 0-group capelin. Dense concentrations were only located in some small areas in the SE of the Barents Sea, in the central part and close to Bear Island. According to the area index the year class seems to be somewhat weaker than average.

2.2.3 Cod

West of Spitsbergen there were only found scattered concentrations of 0-group cod. However, a large area with dense concentration of 0-group cod was found in the cental part of the Barents Sea. According to the indices the yearclass can be characterised as above average.

2.2.4 Haddock

Both the total distribution and the area of dense concentrations indicate a rich yearclass. The distribution is similar to last year, but the area with dense concentration of 0-group haddock is larger. Both the area index and the logaritmic index shows that the 2004 year class is the strongest since the start of these investigations forty year ago.

2.2.5 Polar cod

The abundance of the western component was lower than last year. The yearclass is also lower than the long term average and can be characterised as weak. The eastern component has the same density distribution as in 2002. According to the area index the yearclass of the eastern component is rich and near twice as large as the long term average.

2.2.6 Saithe

Like in 2002 saithe were distributed over the whole observed area except west of Spitsbergen. In most of the distribution area 0-group saithe were found in scattered concentrations. Some areas of dense concentrations were found in the southeatern part and close to bear Island. The area index was calculated to 286. Indices are not previous calculated for this species, but the yearclass seem to be rich, perhaps the richest observed in the Barents Sea since the start of these investigations.

2.2.7 Redfish

West off Spitsbergen redfish was observed in concentrations near the same level as last year. Another small area with high density was located near Bear Island. Except from this the redfish seem to be almost nonexistent in the Barents Sea. The yearclass can be characterised as very weak.

2.2.8 Greenland halibut

Scattered concentrations were mainly found west off Spitsbergen. The total distribution area was somewhat smaller than in 2002 but larger than average. The area index was higher than last year and at the same level as during the period 2000-2002.

2.2.9 Long rough dab

No areas with dense concentrations were found. Scattered densities were also found in smaller areas than previous years. The 2004 year class seems to be very weak.

2.2.10 Catfish

Catfish were only found in scattered concentrations around Spitsbergen and in the south-eastern part of the Barents Sea. No index is calculated for this species.

2.2.11 Sandeel

During the survey dense concentration was only found at one station close to the Norwegian coast. In the south-eastern part of the Barents Sea areas with scattered registrations had decreased 2-3 times compared to 2003. In the central part of the Barents Sea areas with scattered concentrations were of the same size as in 2003. No index is calculated for this species.

2.2.12 Gonatus

In the western parts of the investigated area 0-group *Gonatus fabricii* were found in two areas, one west of Spitsbergen and in another in the western part of the Barents Sea. Some scattered concentrations were also found in the central areas as far as 30°E. No index is calculated for this species.

2.3 Distribution and abundance of pelagic fish

2.3.1 Capelin

2.3.1.1 Distribution

The geographical density distribution of the total stock and each age group are shown in Figs. 2.3.1 to 2.3.5. The northern boundary of the main distribution area was located at least 30 nautical miles northwards compared to that found in 2003, extending north to 78°30’N east of Spitsbergen. However, in two areas more isolated concentrations were found further north; up to 81°30’between 30°E and 34°E, and to 80°30’N between 12°E and 18°E. The extension in the east west direction was equal to that found last year, from the Bear Island. in the west to Novaya Zemlya in the east. The main concentration was found between 76° and 77°30’N and from 26° to 33°E (Figure 2.3.5). Young capelin were found mainly in schools near the bottom at daytime and as a scattered layer during night. Typical echograms showing this change from day to night are shown in Figure 2.3.6 and 2.3.7. In two isolated areas larger capelin were found, where flocks of humpback whales were feeding on the capelin schools found near the sea floor. Figure 2.3.8 shows a whale that dives down to the capelin at about 180m depth.

2.3.1.2 Abundance estimate and size by age

A detailed stock size estimate is given in Table 2.3.1, and the time series of abundance estimates is summarized in Table 2.3.2. The main results of the abundance estimation in 2004 are summarised in the text table below. The 2003 estimate is shown on a shaded background for comparison. Age- and length distribution for the capelin stock in the subareas used for stock size estimation and for the total area are given in Figs. 2.3.9 and 2.3.10, respectively.

Year class		Age	Number (10^9)		Mean weight (g)		Biomass (10^3 t)	
2003	2002	1	51.2	82.4	3.8	2.4	195.3	200.8
2002	2001	2	24.8	9.6	11.9	10.2	293.9	97.4
2001	2000	3	5.6	11.0	21.5	18.4	121.4	201.6
2000	1999	4	0.7	1.4	24.2	23.5	17.4	33.0
Total stock in:								
2004	2003	1-4	82.3	104.4	7.6	5.1	628.0	532.8
Based on TS value: 19.1 log L – 74.0, corresponding to $\sigma = 5.0 \cdot 10^7 \cdot L^{1.91}$								

Details of the 2004 estimate are shown in Table 2.3.1 and the estimates by age group of the capelin stock 1 years old and older from 1973-2004 are shown in Table 2.3.2

The total stock is estimated at about 0.6 million tonnes, about 15% larger than the stock estimated last year. About 47% (290 thousand tonnes) of this stock is above 14 cm and considered to be maturing. The 2003 year class (1-group) consists, according to this estimate, of about 51 billion individuals. This estimate is about 36% lower than that obtained for the 1-group last year. The mean weight is estimated at 3.8 g, which is considerably higher than that measured last year, and 0.2 g above the long-term average. The biomass of the 2003 year class is about 0.2 million tonnes. It should be kept in mind that, given the limitations of the acoustic method concerning mixed concentrations of small capelin and 0-group fish and near-surface distribution, the 1-group estimate might be more uncertain than that for older capelin.

The estimated number of fish in the 2002 year class (2-group) is about 25 billion, more than twice the size of the 2001 year class measured last year. The mean weight at this age is 11.9 g (10.2 g in 2003), and consequently the biomass of the two years old fish is about 0.3 million tonnes. The mean weight is higher than in recent years and is 1.9 g above the long-term average (Table 2.3.2).

The 2001 year class is estimated at about 6 billion individuals with mean weight 21.5 g, giving a biomass of about 0.1 million tonnes. The mean weight is lower than that for the years 1996-2001, but is 3.0 g above the long-term average. The 2000 year class (now 4 years old) is estimated at 0.7 billion individuals. With a mean weight of 24.2 g this age group makes up only about 20 thousand tonnes. A few capelin older than four years were found.

Since 2003 the joint Russian-Norwegian 0-group and pelagic fish surveys became a part of an ecosystem survey. In addition to pelagic trawl stations several bottom trawl stations were included. It allows us to investigate to what extent the biomass of capelin is underestimated due to that specially older fish are distributed close to the bottom and could not be seen by echosounder (Figure 2.3.11).The biomass of this part of the stock is this year estimated by a swept area method to be in the size region of 24-41 thou. t. dependent on some parameters used in calculations. The distribution of this part of the stock by age and length group is shown in Table 2.3.3. There are some methodological problems to be solved before these estimates could be taken into consideration. Furthermore, in order to keep capelin index time series consistent and as the biological reference points used in management of this stock were settled based on data without this component of the stock in consideration, it was decided to continue using the old methodology for capelin stock assessment based on acoustic and pelagic trawl data only. A parallel and new time series of capelin assessment including the component of the stock distributed near the bottom was started in this year.

2.3.1.3 Mortality

Table 2.3.4 shows the number of fish in the various year classes, and their "survey mortality" from age one to two. As there has been no fishing on these age groups, the figures for total mortality constitute natural mortality only, and probably reflect quite well the predation on capelin. As can be seen from the table, the mortality was high prior to 1988, but then a substantial decrease occurred in 1988-89. This coincided with a considerable increase in the stock size caused by the rich 1989 year class. From 1990, the mortality again increased, up to 85% in 1992-93. This increase is in accordance with the observation of an increasing stock of cod, which were preying on a rapidly decreasing stock of capelin. The mortalities calculated for the period 1996-2002 varied between 20 and 52% and indicate a somewhat lower level of mortality. In 2003 a considerable increased natural mortality was observed, at the level (around 85%) observed in 1985-86 and in 1992-93 and this high level was continued from 2003 to 2004. The results of the calculation for the year classes 1988, 1992, and 1994 show, however, that either the one-group are underestimated or the two-group is overestimated these years. Knowing that the measurement of the 1-group is more uncertain than the older age groups due to limitations in the acoustic method, the first mentioned possibility is the most probable.

2.3.2 Polar cod

Compared to recent years, the polar cod distribution was almost completely covered. In some areas, particularly in the northern, a definite boundary of the polar cod distribution area was not found. During the trawl survey for Greenland halibut in the areas north and east of Spitsbergen, considerable amounts of polar cod was caught in bottom trawl in the studied areas. This situation is common during the autumn, when the polar cod stock is widely distributed in the northern part of the Barents Sea.

2.3.2.1 Distribution

The densest registrations of polar cod were found in a crescent-formed area between 72ºN, 40ºE, and 78ºN, 27ºE, with a centre of gravity at about 77ºN, 53ºE. This species had a wide distribution, mainly to the east of 30ºE. To the west and south of Spitsbergen local concentrations were registered.

2.3.2.2 Abundance estimation

The stock abundance estimate by age, number, and weight was calculated using the same computer program as for capelin. The geographical density distribution of polar cod by age is shown in Figs. 2.3.12-2.3.16. Age- and length distribution for the polar cod stock in the subareas used for stock size estimation and for the total area are given in Figs. 2.3.17 and 2.3.18, respectively.

A detailed estimate is given in Table 2.3.5, and the time series of abundance estimates is summarized in Table 2.3.6. The main results of the abundance estimation in 2004 are summarised in the text table below. The 2003 estimate is shown on a shaded background for comparison.

Year class		Age	Number (10^9)		Mean weight (g)		Biomass (10^3 t)	
2003	2002	1	99.4	15.4	6.3	7.4	627.1	114.1
2002	2201	2	22.8	2.1	17.8	18.4	404.9	37.9
2001	2000	3	2.6	2.0	31.3	31.3	82.2	63.9
2000	1999	4	0.4	1.5	55.3	40.6	24.6	64.4
Total stock in								
2004	2003	1-4	12.5	21.1	9.1	13.3	1143.8	280.2
Based on TS value: 21,8.1 log L – 72.7, corresponding to $\sigma = 6.7 \cdot 10^7 \cdot L^{2.18}$								

The 2003 year class (the one-year-olds) is almost 6 times larger than the abundance of the one- group measured last year, but their mean weight is 1.1 gram lower. The biomass is, therefore, 6 times as high as that of the one-year-olds measured last year. The abundance of the 2002 year class (the two-year-olds) is 22.8 billions that is almost 10 times large than the two-group found last year but with some lower mean weight. The biomass has, therefore, increased 10 times compared to the 2000 year class estimated last year. The three-years-old fish (2001 year class) is about 0.6 billions larger than the three-group estimated last year and has the same mean weight. Consequently, the biomass of this age group has increased with about 28% compared to that for the corresponding age group during the 2003 survey. The four-year-olds (2000 year class) are scarcely found and even less than in last year. The total stock, estimated at 1.1 million tonnes, is at the same level as in 1999 and 4 times larger than the biomass estimated last year. The reason for the dramatic increase in biomass for polar cod might be that the area of distribution was much better covered this year compared to last year.

2.3.2.3 Mortality

Table 2.3.7 shows the "survey-mortality rates" of polar cod of the year classes 1984 to 2003. The mortality estimates are unstable during the whole period. Although unstable mortalities may indicate errors in the stock size estimation from year to year, the impression remains that there is a considerable total mortality on young polar cod. Prior to 1993, these mortality estimates represent natural mortality only, as practically no fishing took place. In the period 1993 to 1997 the Russian fleet landed between 5 000 and 50 000 tonnes of polar cod, in 1998 the catch was negligible. In 1999 the catch was about 20 000 tonnes, in 2000 - 35 000 tonnes, in 2001 - 41 200 tonnes, in 2002 - 37 500 tonnes and in 2003 - 39 300 tonnes. Since there has been a minimum landing size of 15 cm (from 1998, 13 cm) in that fishery, a considerable amount of this could consist of two- and even one-year-olds, and this may explain some, but only a small part of the high total mortality. From 2003 to 2004 there are negative survey mortalities both for age groups 1-2 and for 2-3, confirming the impression expressed in the 2003 report that that years estimate for various reasons was an underestimate.

2.3.3 Herring

The youngest age groups (age 0 to 3) of the Norwegian spring spawning herring stock are found in the Barents Sea at irregular intervals. It is difficult to assess the stock size during autumn, due to various reasons. The age groups 1-3 are found mixed with 0-group herring and other 0-group fish, and these age groups are difficult to catch in the sampling trawl used during this survey. Besides, the herring schools are partly found near the surface, above the range of the echo sounders. The stock size estimates of herring are therefore considered less reliable than those for capelin and polar cod.

2.3.3.1 Distribution

The distribution of young herring is shown in Figure 2.3.19 – 2.3.22. The distribution area of juvenile herring was covered fairly well. In September juvenile herring were distributed over a large area between 16° and 48°E and up to 74°N. Some aggregations were also found along the branch of the Novaya Zemlya current as far east as Novaya Zemlya. Aggregations with highest density were recorded in the southern part of the sea between 26° and 40°E. The distribution area of herring in 2004 resembles that of the past few years.

2.3.3.2 Abundance estimation

The estimated number and biomass of herring per age- and length group is given in Table 2.3.8. The main results of the abundance estimation in 2004 are summarised in the text table below. The 2003 estimate is shown on a shaded background for comparison.

Year class		**Age**	**Number (10^9)**		**Mean weight (g)**		**Biomass (10^3 t)**	
2003	2002	1	12.3	99.8	28.5	31.0	406.4	3,090.9
2002	2001	2	36.5	4.3	74.7	50.8	2,725.3	220.1
2001	2000	3	0.9	2.5	118.3	131.5	106.6	325.5
Total stock in:								
2004	2003	1-3	51.7	106.6	62.9	34.0	3,251.9	3,636.4
Based on TS value: 20.0 log L – 71.9, corresponding to $\sigma = 8.1 \cdot 10^{-7} \cdot L^{2.00}$								

Total abundance was estimated at 52 x 10^9 fish and biomass at 3.3 x 10^6 t. The majority of fish (about 70% by number) was from the 2002 year class. According to these results, the 2000 year class has left the Barents Sea, the 2001 year class has had a natural mortality M=1.6, and the 2002 year class an M=1.0. Although the abundance of herring is less than half that measured last year, the biomass is 90% of the estimate obtained in 2003, because the mean weight of the two-year-olds, constituting the bulk of the stock, is much higher in 2004.

2.3.4 Blue whiting

In the southwestern part of the Barents Sea blue whiting were observed. In recent years, the blue whiting have seemingly expanded its distribution area towards northeast, partly entering the Barents Sea. A quantitative estimation of this species has normally not been attempted during this survey, since only a small part of the total distribution area of this species is covered. Nevertheless, this species is now a major component of the Barents Sea ecosystem, and consequently, it was decided to make a stock size estimate of the covered part of the stock during the current survey. The target strength used for blue whiting is uncertain, and the estimate should to a lesser extent than the other estimates be considered as a relative quantity only.

2.3.4.1 Distribution

The distribution of blue whiting (all age groups) is shown in Figure 2.3.23. The distribution area stretches from the western border of the covered area east to a line between North Cape and Spitsbergen. In addition, lower concentrations were detected along the coast of Finnmark east to Vardø.

2.3.4.2 Abundance estimation

The estimated number and biomass of blue whiting per age- and length group is given in Table 2.3.9. Total abundance was estimated at 17 x 10^9 fish and biomass at 1.4 x 10^6 t. The most numerous age groups were the 1-, 2-, and 4-year-olds.

2. 4 Demersal fish

Figures 2.4.1.-2.4.8. show distribution of demersal fish, shrimp and crab (*Paralithodes camtchatica*).

2.4.1. Cod

The total distribution area of cod in the Barents Sea was covered. At this time of the year, towards the end of the feeding period, the distribution of the cod is wide. Cod reach the limits of its natural habitat and single fishes were caught as far north as 81°30' N.

Two main concentrations were found; along the slope of Goose Bank and Murman Shallow and in the northern area between Hope Island and Kong Karls Land.

2.4.2. Haddock

The haddock distribution was covered quite well by the survey. Haddock were distributed in the warm water masses and along the coast of Norway and Russia between 17-45°E and to a lesser degree around Spitsbergen. Dense concentrations were found between 38-45°E along Murman Coast, but only a few fish has been registered to the east of 45°E.

2.4.3. Saithe

Saithe were scatterly distributed in small amounts along the coastal areas of Norway and Russia between 15-40° E . Main densities were observed north of Lofoten Islands. Single catches were observed until 78° N. It is obvious that the main part of this stock was not covered by the survey, because it is distributed in fjords, inlets and coastal waters south of 70° N.

2.4.4. Long rough dab(LRD)

The distribution of LRD was wider than the distribution of other species. It was practically found in all areas, and it's catches were quite significant in most cases. Catches of LRD were taken as far east as 65° E and north as 81° 40 N.

2.4.5. Redfish (*Sebastes mentella*)

Redfish were only distributed in the western path of survey area. Most dense concentrations were located along the shelf slope from the Norwegian coast to South Cap. In all other areas redfish was only found in scattered densities.

2.4.6. Greenland halibut

Mainly young age groups of Greenland halibut were observed because the adult part of the stock was distributed outside of the survey area. Main concentrations were located in the deeper part of the Spitsbergen slope. Small concentrations were also registered south-east of a line drawn between Bear Island and Hopen Island.

2.4.7. Shrimp (*Pandalus borealis*)

The shrimp was distributed practically all over the observed areas. The main concentrations of smaller shrimp were found between 71-76° N and 25-50° E. The larger size shrimp were mainly distributed around Spitsbergen.

2.4.8. Crab (*Paralithodes camtchatica*)

The crab distribution area was quite small and located between 35-43° E. However the catches in this area were very high and as usual mixed with haddock.

2.4 Zooplankton

The distribution of zooplankton is shown in Figure 2.5.1. In this volume only the data sampled on the Norwegian ships is presented. The figure shows the total biomass of zooplankton found below one square meter of the surface. The highest values were found west and Northeast of Spitsbergen. A minimum was found in the cold water masses East of Spitsbergen. Relative homogenious and intermediate values was found in the central part of the sea.

2.5 Sea mammals and birds

Visual observations of marine mammals and sea birds were made by observers on the RV "Johan Hjort", and RV "F. Nansen" during the whole cruise of both vessels. In addition an aerial survey of marine mammals was conducted to complement the vessel surveys. A total of 3362 marine mammals were observed (figure 2.6.1), but 2000 of these were a large group of beluga whales observed during the aerial survey.

Table. Marine mammals observed during the 2004 ecosystem survey in the Barents Sea by observers on-board the RVs "J. Hjort", "F.Nansen" and "Smolensk" and from the aerial survey.

Species	Number observed
Beluga	2012
Dolphin spp.	490
White-beaked dolphin	337
Seal spp.	163
Minke whale	162
Humpback whale	93
Killer whale	40
Large whale	26
Pilot whale	13
Harbour porpoise	9
Sperm whale	9
Fin whale	8

Excluding the large group of belugas, dolphins were the most commonly observed species. Of the observed dolphins 337 were identified as white-beaked dolphins, while 490 were not possible to identify. However, it is probable that the majority of the unidentified dolphins also were white-beaked dolphins. The majority of the observations of dolphins were made in the central and western part of the survey area. Few dolphins were seen in the southeast region close to the Kola Peninsula, or north of 78°N.

Minke whales were the most commonly observed baleen whale, and the 4th most common species overall (if the dolphins are combined into one group). Like the dolphins most observations of minke whales were made in the central and western part of the survey area, with a high density of observations east of Hopen Island.

Seals were the second most common marine mammal group observed. Most of the seals observed were harp seals, but all seals have been grouped together in the table. Seals were mostly observed in the northern area, NW of Novaja Zemlya and around Edge Island (Spitsbergen).

Of the larger marine mammals, humpback whales were most common, with the majority of observations northeast of Hopen Island. Fin whales were also observed, but in relatively low numbers, but a total of 26 unidentified large whales were observed, and it is probable that some of these also were fin whales.

2.7 Benthos investigations

PINRO has over many years sampled the benthic fauna in the Barents Sea, but this has not been done on previous Norwegian cruises. Given the increased focus on the health of the whole ecosystem, and the ecosystem aspect of the survey, a pilot scheme for sampling benthic macro-fauna from bottom-trawl catches was carried out on the RV “Johan Hjort” from 20. August to 10. September. This was in addition to the regular sampling of benthos carried out by the RV “F.Nansen” using grab and Sigsby trawl, and by RV “Smolensk” using bottom trawl and grab, from 7 August to 30 September.

2.7.1. Benthos samples taken from bottom trawl

Benthos samples were taken from the bottom-trawl catches after the fish had been sorted out of the catch. A subsample of ~3 kg was taken out and sorted to species level if possible. For each species group the number and total weight was recorded, except for some colonial organism like *Poriphera* and certain species of *Polychaeta* where only weight was recorded. Species that were unidentifiable were tagged and frozen at –23ºC for later identification on shore. For each station the relative contribution by weight and numbers for each species was calculated.

A total of 87 species groups were found, although 37 of these were not identified to species level. Preliminary results show that in terms of numbers the clam *Astarte crenata* was the most abundant, followed by species of brittle stars and sea-anemones. The full results from the benthos investigations will be presented in Volume 2 of the survey report pending a full identification of all species, and a comparison of the bottom-trawl data with the grab data.

Table 2.1.1. The mean temperature[1)] in the main parts of standard hydrographical sections in the Barents Sea and adjacent waters in August-September 1965-2004

Year	Section[2)] and layer (depth in metres)						
	1	2	3	4	5	6	7
	0-50	50-200	0-200	0-bot.	0-bot.	0-200	0-200
1965	6.7	3.9	4.6	4.6	3.7	5.1	-
1966	6.7	2.6	3.6	1.9	2.2	5.5	3.6
1967	7.5	4.0	4.9	6.1	3.4	5.6	4.2
1968	6.4	3.7	4.4	4.7	2.8	5.4	4.0
1969	6.7	3.1	4.0	2.6	2.0	6.0	4.2
1970	7.8	3.7	4.7	4.0	3.3	6.1	-
1971	7.1	3.2	4.2	4.0	3.2	5.7	4.2
1972	8.7	4.0	5.2	5.1	4.1	6.3	3.9
1973	7.7	4.5	5.3	5.7	4.2	5.9	5.0
1974	8.1	3.9	4.9	4.6	3.5	6.1	4.9
1975	7.0	4.6	5.2	5.6	3.6	5.7	4.9
1976	8.1	4.0	5.0	4.9	4.4	5.6	4.8
1977	6.9	3.4	4.3	4.1	2.9	4.9	4.0
1978	6.6	2.5	3.6	2.4	1.7	5.0	4.1
1979	6.5	2.9	3.8	2.0	1.4	5.3	4.4
1980	7.4	3.5	4.5	3.3	3.0	5.7	4.9
1981	6.6	2.7	3.7	2.7	2.2	5.3	4.4
1982	7.1	4.0	4.8	4.5	2.8	5.8	4.9
1983	8.1	4.8	5.6	5.1	4.2	6.3	5.1
1984	7.7	4.1	5.0	4.5	3.6	5.9	5.0
1985	7.1	3.5	4.4	3.4	3.4	5.3	4.6
1986	7.5	3.5	4.5	3.9	3.2	5.8	4.4
1987	6.2	3.3	4.0	2.7	2.5	5.2	3.9
1988	7.0	3.7	4.5	3.8	2.9	5.5	4.2
1989	8.6	4.8	5.8	6.5	4.3	6.9	4.9
1990	8.1	4.4	5.3	5.0	3.9	6.3	5.7
1991	7.7	4.5	5.3	4.8	4.2	6.0	5.4
1992	7.5	4.6	5.3	5.0	4.0	6.1	5.0
1993	7.5	4.0	4.9	4.4	3.4	5.8	5.4
1994	7.7	3.9	4.8	4.6	3.4	6.4	5.3
1995	7.6	4.9	5.6	5.9	4.3	6.1	5.2
1996	7.6	3.7	4.7	5.2	2.9	5.8	4.7
1997	7.3	3.4	4.4	4.2	2.8	5.6	4.1
1998	8.4	3.4	4.7	2.1	1.9	6.0	[3)]
1999	7.4	3.8	4.7	3.8	3.1	6.2	5.3
2000	7.6	4.5	5.3	5.8	4.1	5.7	5.1
2001	6.9	4.0	4.7	5.6	4.0	5.7	4.9
2002	8.6	4.8	5.8	4.0	3.7	-	5.4
2003	7.2	4.0	4.8	4.2	3.3	-	-
2004	9.0	4.7	5.7	5.0	4.2	-	5.8
Average (1965-2004)	7.4	3.9	4.8	4.3	3.3	5.8	4.7

[1)] Earlier presented temperatures have been slightly adjusted (Tereshchenko, 1992).

[2)] 1-3: Murmansk Current; Kola section (70º30´N-72º30´N, 33º30´E)
4: Cape Kanin section (68º45´N-70º05´N, 43º15´E)
5: Cape Kanin section (71º00´N-72º00´N,43º15´E)
6: North Cape Current; North Cape-Bear Island section (71º33´N, 25º02´E – 73º35´N, 20º46´E)
7: West Spitsbergen Current; Bear Island – West section (74º30´N, 06º34E – 15º55´E).

[3)] In 1998 only the central branch and the eastern branch of the West Spitsbergen Current were covered, and the temperatures were 5.4 and 4.5ºC respectively.

Table 2.2.1. Abundance indices of 0-group fish in the Barents Sea and adjacent waters in August-September 1965-2004

Year	Capelin[1]	Cod[2]	Haddock[2]	Herring[3]	Polar cod		Redfish	Greenland halibut	Long rough dab
					West	East			
1965	37	11	13	-		0	159	-	66
1966	119	2	2	-		129	236	-	97
1967	89	62	76	-		165	44	-	73
1968	99	45	14	-		60	21	-	17
1969	109	211	186	-		208	295	-	26
1970	51	1097	208	-		197	247	1	12
1971	151	356	166	-		181	172	1	81
1972	275	225	74	-		140	177	8	65
1973	125	1101	87	-		26	385	3	67
1974	359	82	237	-		227	468	13	93
1975	320	453	224	-		75	315	21	113
1976	281	57	148	-		131	447	16	96
1977	194	279	187	-	157	70	472	9	72
1978	40	192	110	-	107	144	460	35	76
1979	660	129	95	-	23	302	980	22	69
1980	502	61	68	-	79	247	651	12	108
1981	570	65	30	-	149	93	861	38	95
1982	393	136	107	-	14	50	694	17	150
1983	589	459	219	-	48	39	851	16	80
1984	320	559	293	-	115	16	732	40	70
1985	110	742	156	-	60	334	795	36	86
1986	125	434	160	-	111	366	702	55	755
1987	55	102	72	-	17	155	631	41	174
1988	187	133	86	-	144	120	949	8	72
1989	1330	202	112	-	206	41	698	5	92
1990	324	465	227	-	144	48	670	2	35
1991	241	766	472	-	90	239	200	1	28
1992	26	1159	313	-	195	118	150	3	32
1993	43	910	240	188	171	156	162	11	55
1994	58	899	282	120	50	448	414	20	272
1995	43	1069	148	73	6	0	220	15	66
1996	291	1142	196	378	59	484	19	5	10
1997	522	1077	150	390	129	453	50	13	42
1998	428	576	593	524	144	457	78	11	28
1999	722	194	184	242	116	696	27	13	66
2000	303	870	417	213	76	387	195	28	81
2001	221	212	394	77	110	146	11	32	86
2002	327	1055	412	315	179	588	28	34	173
2003	630	694	705	277	164	337	57	9	58
2004	288	983	977	639	62	355	98	29	35
1985-2004	312	695	316		115	294	307	18	111
1965-2004	288	488	221				371	17	95

[1] Assessment for 1965-1978 in Anon. 1980 and for 1979-1993 in Ushakov and Shamray 1995

[2] Indices for 1965-1985 for cod and haddock adjusted according to Nakken and Raknes (1996)

[3] Calculated by Prozorkevich (2001)

Table 2.2.2. Logarithmic indices with 90% confidence limits of year-class abundance for 0-group herring, cod and haddock in the Barents Sea and adjacent waters in August-September 1966-2004.

Year	Herring			Cod			Haddock		
	Index	Confidence limit		Index	Confidence limit		Index	Confidence limit	
1966	0.14	0.04	0.31	0.02	0.01	0.04	0.01	0.00	0.03
1967	0.00	-	-	0.04	0.02	0.08	0.08	0.03	0.13
1968	0.00	-	-	0.02	0.01	0.04	0.00	0.00	0.02
1969	0.01	0.00	0.04	0.25	0.17	0.34	0.29	0.20	0.41
1970	0.00	-	-	2.51	2.02	3.05	0.64	0.42	0.91
1971	0.00	-	-	0.77	0.48	1.01	0.26	0.18	0.36
1972	0.00	-	-	0.52	0.35	0.72	0.16	0.09	0.27
1973	0.05	0.03	0.08	1.48	1.18	1.82	0.26	0.15	0.40
1974	0.01	0.01	0.01	0.29	0.18	0.42	0.51	0.39	0.68
1975	0.00	-	-	0.90	0.66	1.17	0.60	0.40	0.85
1976	0.00	-	-	0.13	0.06	0.22	0.38	0.24	0.51
1977	0.01	0.00	0.03	0.49	0.36	0.65	0.33	0.21	0.48
1978	0.02	0.01	0.05	0.22	0.14	0.32	0.12	0.07	0.19
1979	0.09	0.01	0.20	0.40	0.25	0.59	0.20	0.12	0.28
1980	-	-	-	0.13	0.08	0.18	0.15	0.10	0.20
1981	0.00	-	-	0.10	0.06	0.18	0.03	0.00	0.05
1982	0.00	-	-	0.59	0.61	0.77	0.38	0.30	0.52
1983	1.77	1.29	2.33	1.69	1.34	2.08	0.62	0.48	0.77
1984	0.34	0.20	0.52	1.55	1.18	1.98	0.78	0.60	0.99
1985	0.23	0.18	0.28	2.46	2.22	2.71	0.27	0.23	0.31
1986	0.00	-	-	1.37	1.06	1.70	0.39	0.28	0.52
1987	0.00	0.00	0.03	0.17	0.01	0.40	0.10	0.00	0.25
1988	0.32	0.16	0.53	0.33	0.22	0.47	0.13	0.05	0.34
1989	0.59	0.49	0.76	0.38	0.30	0.48	0.14	0.10	0.20
1990	0.31	0.16	0.50	1.23	1.04	1.34	0.61	0.48	0.75
1991	1.19	0.90	1.52	2.30	1.97	2.37	1.17	0.98	1.37
1992	1.06	0.69	1.50	2.94	2.53	3.39	0.87	0.71	1.06
1993	0.75	0.45	1.14	2.09	1.70	2.51	0.64	0.48	0.82
1994	0.28	0.17	0.42	2.27	1.83	2.76	0.64	0.49	0.81
1995	0.16	0.07	0.29	2.40	1.97	2.88	0.25	0.13	0.41
1996	0.65	0.47	0.85	2.87	2.53	3.24	0.39	0.25	0.56
1997	0.39	0.25	0.54	1.60	1.35	1.86	0.21	0.12	0.31
1998	0.59	0.40	0.82	0.68	0.48	0.91	0.59	0.44	0.76
1999	0.41	0.25	0.59	0.21	0.11	0.34	0.25	0.11	0.44
2000	0.30	0.17	0.46	1.49	1.21	1.78	0.64	0.46	0.84
2001	0.13	0.04	0.25	0.23	0.12	0.36	0.67	0.52	0.84
2002	0.53	0.36	0.73	1.22	0.97	1.50	0.99	0.75	1.25
2003	0.51	0.36	0.68	0.85	0.63	1.10	0.85	0.61	1.12
2004	1.20*	0.92	1.51	1.92*	1.67	2.19	1.44*	1.19	1.71
Mean (1985-2004)	0.48			1.45			0.57		

*One 0-group area (18) was reduced from 7800 to 2000 due to undersampling of this area

Table 2.2.3. Length distribution 0-group fish in the Barents Sea and adjacent waters, August-October 2004, %

Length, cm	Herring	Capelin	Cod	Haddock	Polar Cod	Red fish	Sandeel	Green-land halibut	Long rough dab
1.0-1.4									
1.5-1.9				0.01		0.21			
2.0-2.4		1.65			0.13	2.26			1.50
2.5-2.9		5.04			1.91	8.67			3.38
3.0-3.4		4.58			12.49	26.61	1.08		16.17
3.5-3.9		1.77			20.64	26.06	1.29	1.45	23.68
4.0-4.4	0.03	9.72	0.01	0.01	26.10	29.96	2.15	8.82	27.07
4.5-4.9	2.66	14.33	0.02	0.01	19.82	5.68	1.08	9.81	16.17
5.0-5.4	8.28	22.36	0.05	0.07	14.78	0.53	4.30	14.71	6.02
5.5-5.9	1.88	28.99	0.16	0.01	3.93	0.02	3.23	14.17	
6.0-6.4	2.24	8.14	1.10	0.06	0.15		2.80	20.77	
6.5-6.9	4.99	2.98	4.06	0.24	0.05		3.33	12.79	
7.0-7.4	9.97	0.29	12.50	0.67			5.38	5.84	1.50
7.5-7.9	19.01	0.16	18.08	1.87			6.92	5.82	2.26
8.0-8.4	24.49		19.94	2.67			3.46	3.11	1.50
8.5-8.9	14.12		13.67	4.48			2.74	2.29	0.75
9.0-9.4	6.39		12.13	8.64			9.00	0.42	
9.5-9.9	3.35		8.89	9.49			14.05		
10.0-10.4	0.78		3.53	15.05			18.69		
10.5-10.9	0.16		2.14	16.49			8.38		
11.0-11.4	0.12		0.99	15.03			6.84		
11.5-11.9	0.24		0.60	11.21			3.88		
12.0-12.4	0.33		0.43	8.47			1.06		
12.5-12.9	0.38		0.42	3.24			0.09		
13.0-13.4	0.26		0.50	1.35			0.18		
13.5-13.9	0.15		0.41	0.68			0.04		
14.0-14.4	0.12		0.37	0.27			0.04		
Tot.catch	691130	96047	107922	104539	201681	5235	464	352	124
Mean length (mm)	77.7	50.3	85.0	105.9	42.5	36.6	88.6	59.6	42.0

Table 2.3.1. Acoustic estimate of Barents Sea capelin, August-September 2004

Length (cm)	Age/Year class 1 2003	2 2002	3 2001	4+ 2000-	Sum (10^6)	Biomass (10^3 t)	Mean weight (g)
6.0 - 6.5	203				203	0.2	0.8
6.5 - 7.0	492				492	0.5	1.0
7.0 - 7.5	892				892	0.9	1.0
7.5 - 8.0	1867				1867	3.3	1.7
8.0 - 8.5	2816				2816	5.5	2.0
8.5 - 9.0	5835				5835	13.6	2.3
9.0 - 9.5	9120	3			9123	24.7	2.7
9.5 - 10.0	6745	48			6794	22.8	3.4
10.0 - 10.5	7308	250			7558	30.2	4.0
10.5 - 11.0	5355	199			5554	26.1	4.7
11.0 - 11.5	4779	595			5374	30.6	5.7
11.5 - 12.0	3458	1138			4597	30.1	6.6
12.0 - 12.5	1497	2125			3622	28.3	7.8
12.5 - 13.0	517	3341			3858	33.6	8.7
13.0 - 13.5	224	4069	3		4296	43.2	10.1
13.5 - 14.0	39	3479	29		3547	40.9	11.5
14.0 - 14.5	12	3519	97		3628	49.3	13.6
14.5 - 15.0	15	2533	414		2962	45.1	15.2
15.0 - 15.5	7	1872	661	49	2589	46.4	17.9
15.5 - 16.0	5	973	1138	80	2197	43.9	20.0
16.0 - 16.5	2	569	1351	142	2063	45.7	22.1
16.5 - 17.0		78	1205	190	1473	36.4	24.7
17.0 - 17.5		9	486	215	711	18.6	26.1
17.5 - 18.0		2	186	24	212	6.2	29.3
18.0 - 18.5		2	23	3	29	0.9	32.8
18.5 - 19.0			3		3	0.1	29.7
19.0 - 19.5			6	6	12	0.5	43.4
19.5 - 20.0				2	2	0.1	40.4
20.0 - 20.5				4	4	0.2	52.3
20.5 - 21.0						0.0	
21.0 - 21.5				2	2	0.1	52.1
TSN (10^6)	51188	24804	5602	717	82315		
TSB (10^3 t)	195.3	293.9	121.4	17.4		628.0	
Mean length (cm)	9.9	13.6	16.1	16.7	11.5		
Mean weight (g)	3.8	11.9	21.5	24.2			7.6
SSN (10^6)	41	9557	5570	717	15885		
SSB (10^3 t)	0.7	154.2	121.1	17.4		293.5	

Based on TS value: 19.1 log L - 74.0, corresponding to $\sigma = 5.0 \cdot 10^{-7} \cdot L^{1.91}$

Table 2.3.2. Acoustic estimates of the Barents Sea capelin stock by age in autumn 1973-2003.Biomass (B) in 10^6 tonnes, average weight (AW) in grams. All estimates based on TS = 19.1Log L -74.0 dB.

Year	Age 1		2		3		4		5		Sum
	B	AW	B	AW	B	AW	B	AW	B	AW	B
1973	1.69	3.2	2.32	6.2	0.73	18.3	0.41	23.8	0.01	30.1	3.47
1974	1.06	3.5	3.06	5.6	1.53	8.9	0.07	20.8	+	25.0	4.66
1975	0.65	3.4	2.39	6.9	3.27	11.1	1.48	17.1	0.01	31.0	7.15
1976	0.78	3.7	1.92	8.3	2.09	12.8	1.35	17.6	0.27	21.7	5.63
1977	0.72	2.0	1.41	8.1	1.66	16.8	0.84	20.9	0.17	22.9	4.08
1978	0.24	2.8	2.62	6.7	1.20	15.8	0.17	19.7	0.02	25.0	4.01
1979	0.05	4.5	2.47	7.4	1.53	13.5	0.10	21.0	+	27.0	4.10
1980	1.21	4.5	1.85	9.4	2.83	18.2	0.82	24.8	0.01	19.7	5.51
1981	0.92	2.3	1.83	9.3	0.82	17.0	0.32	23.3	0.01	28.7	2.98
1982[1]	1.22	2.3	1.33	9.0	1.18	20.9	0.05	24.9			2.56
1983	1.61	3.1	1.90	9.5	0.72	18.9	0.01	19.4			2.63
1984	0.57	3.7	1.43	7.7	0.88	18.2	0.08	26.8			2.39
1985	0.17	4.5	0.40	8.4	0.27	13.0	0.01	15.7			0.68
1986	0.02	3.9	0.05	10.1	0.05	13.5	+	16.4			0.10
1987[2]	0.08	2.1	0.02	12.2	+	14.6	+	34.0			0.02
1988	0.07	3.4	0.35	12.2	+	17.1					0.35
1989	0.61	3.2	0.20	11.5	0.05	18.1	+	21.0			0.25
1990	2.66	3.8	2.72	15.3	0.44	27.2	+	20.0			3.16
1991	1.52	3.8	5.10	8.8	0.64	19.4	0.04	30.2			5.78
1992	1.25	3.6	1.69	8.6	2.17	16.9	0.04	29.5			3.90
1993	0.01	3.4	0.48	9.0	0.26	15.1	0.05	18.8			0.79
1994	0.09	4.4	0.04	11.2	0.07	16.5	+	18.4			0.11
1995	0.05	6.7	0.11	13.8	0.03	16.8	0.01	22.6			0.15
1996	0.24	2.9	0.22	18.6	0.05	23.9	+	25.5			0.27
1997	0.42	4.2	0.45	11.5	0.04	22.9	+	26.2			0.49
1998	0.81	4.5	0.98	13.4	0.25	24.2	0.02	27.1	+	29.4	1.25
1999	0.16	4.2	1.01	13.6	0.27	26.9	0.09	29.3			2.12
2000	1.70	3.8	1.59	14.4	0.95	27.9	0.08	37.7			2.57
2001	0.37	3.3	2.40	11.0	0.81	26.7	0.04	35.5	+	41.4	3.25
2002	0.23	3.9	0.92	10.1	1.04	20.7	0.02	35.0			1.98
2003	0.20	2.4	0.10	10.2	0.20	18.4	0.03	23.5			0.53
2004	0.20	3.8	0.29	11.9	0.12	21.5	0.02	23.5	+	26.3	0.63
Average	0.67	3.6	1.36	10.3	0.87	18.5	0.26	24.2	0.07	27.4	2.42

[1] Computed values based on the estimates in 1981 and 1983
[2] Combined estimates from multispecies survey and succeeding survey with "Eldjarn"

Table 2.3.3. Age-length distribution of bottom component of the Barents Sea capelin stock estimated by swept method based on bottom trawl catches only (numbers should be treated on a relative scale because the method of estimation is under development).

	Age/Year class						
Length (cm)	1 2003	2 2002	3 2001	4 2000	5 1999	Sum (10^6)	% by length
6.0 - 6.9							
7.0 - 7.9	3.38					3.38	0.1
8.0 - 8.9	76.14					76.14	2.2
9.0 - 9.9	313.36	17.97				331.33	9.5
10.0 - 10.9	343.08	18.36				361.44	10.4
11.0 - 11.9	202.41	39.7	1.23			243.34	7.0
12.0 - 12.9	97.71	89.9	4.94			192.55	5.5
13.0 - 13.9	13.32	362.13	23.25			398.70	11.5
14.0 - 14.9	12.81	153.29	45.74			211.84	6.1
15.0 - 15.9	1.24	302.52	143.83	6.38		453.97	13.1
16.0 - 16.9	0.1	328.22	248.7	9.4	0.78	587.20	16.9
17.0 - 17.9		73	178.18	54.28	0.98	306.44	8.8
18.0 - 18.9		0.34	0.34	306.88		307.56	8.9
19.0 - 19.9							
TSN (10^6)	1063.55	1385.43	646.21	376.94	1.76	3473.89	
% by age	30.6	39.9	18.6	10.9	0.1		100 %

Table 2.3.4. Survey mortalities for capelin from age 1 to age 2

Year	Year class	Age 1 (10^9)	Age 2 (10^9)	Total mort. %	Total mort. Z
1984-1985	1983	154.8	48.3	69	1.16
1985-1986	1984	38.7	4.7	88	2.11
1986-1987	1985	6.0	1.7	72	1.26
1987-1988	1986	37.6	28.7	24	0.27
1988-1989	1987	21.0	17.7	16	0.17
1989-1990	1988	189.2	177.6	6	0.06
1990-1991	1989	700.4	580.2	17	0.19
1991-1992	1990	402.1	196.3	51	0.72
1992-1993	1991	351.3	53.4	85	1.88
1993-1994	1992	2.2	3.4	-	-
1994-1995	1993	19.8	8.1	59	0.89
1995-1996	1994	7.1	11.5	-	-
1996-1997	1995	81.9	39.1	52	0.74
1997-1998	1996	98.9	72.6	27	0.31
1998-1999	1997	179.0	101.5	43	0.57
1999-2000	1998	155.9	110.6	29	0.34
2000-2001	1999	449.2	218.7	51	0.72
2001-2002	2000	113.6	90.8	20	0.22
2002-2003	2001	59.7	9.6	84	1.83
2003-2004	2002	82.4	24.8	70	1.20

Table 2.3.5 Acoustic estimate of polar cod in August-September 2004

Length (cm)	Age/Year class 1 2002	2 2001	3 2000	4 1999	5+ 1998-	Sum (10^6)	Biomass (10^3)	Mean weight (g)
6.5 - 7.0	721					721	1.4	2.0
7.0 - 7.5	1867					1867	4.8	2.5
7.5 - 8.0	4437					4437	14.1	3.2
8.0 - 8.5	8625					8625	33.6	3.9
8.5 - 9.0	13400					13400	62.0	4.6
9.0 - 9.5	15665	584				16249	87.9	5.4
9.5 - 10.0	15024	25				15049	91.8	6.1
10.0 - 10.5	15700	397				16097	109.3	6.8
10.5 - 11.0	9874	553	1			10428	83.7	8.0
11.0 - 11.5	7451	555				8006	68.7	8.6
11.5 - 12.0	3675	1214	29			4918	50.9	10.3
12.0 - 12.5	1285	2335	34			3653	46.1	12.6
12.5 - 13.0	1172	1778	91			3041	43.9	14.4
13.0 - 13.5	272	2545	242			3058	57.4	18.8
13.5 - 14.0	180	2659	165			3004	48.9	16.3
14.0 - 14.5	4	2262	195	19		2479	46.0	18.5
14.5 - 15.0	41	2069	88	16		2213	45.2	20.4
15.0 - 15.5	14	1878	218			2110	44.9	21.3
15.5 - 16.0		1320	125			1446	36.1	25.0
16.0 - 16.5		1207	78	7		1292	34.5	26.7
16.5 - 17.0		504	268	2		774	23.6	30.5
17.0 - 17.5		475	94	2		571	19.5	34.0
17.5 - 18.0		232	200	24		455	16.8	37.0
18.0 - 18.5		126	204	9	1	340	13.7	40.3
18.5 - 19.0		20	210	19		249	11.4	45.7
19.0 - 19.5		39	119	2	20	181	8.2	45.1
19.5 - 20.0			125	68	9	202	10.0	49.6
20.0 - 20.5			84	28		113	5.8	51.3
20.5 - 21.0			39	37		76	4.3	56.1
21.0 - 21.5			13	47		61	3.8	63.3
21.5 - 22.0			1	88	3	91	6.4	70.6
22.0 - 22.5			5	51	2	58	3.9	68.2
22.5 - 23.0				14		14	1.0	71.8
23.0 - 23.5				7		7	0.5	70.9
23.5 - 24.0				5	11	16	1.5	96.2
24.0 - 24.5					1	1	0.1	73.7
24.5 - 25.0					1	1	0.1	112.6
25.0 - 25.5					14	14	1.7	119.5
25.5 - 26.0							0.0	
26.0 - 26.5							0.0	
26.5 - 27.0							0.0	112.0
27.0 - 27.5							0.0	
27.5 - 28.0							0.0	
28.0 - 28.5					2	2	0.2	112.0
TSN (10^6)	99404	22777	2627	445	65	125319		
TSB (10^3 tonnes)	627.1	404.9	82.2	24.6	5		1143.8	
Mean length (cm)	9.7	13.8	16.4	20.2	22.1	10.6		
Mean weight (g)	6.3	17.8	31.3	55.3	76.1			9.1

Based on TS value: 21.8 log L - 72.7, corresponding to $\sigma = 6.7 \cdot 10^{-7} \cdot L^{2.18}$

Table 2.3.6. Acoustic estimates of polar cod by age in August-September 1986-2004

TSN and TSB is total stock numbers (10^6) and total stock biomass (10^3 tonnes) respectively.

Numbers based on TS = 21.8 Log L - 72.7 dB.

Year	Age 1		Age 2		Age 3		Age 4+		Total	
	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB
1986	24038	169.6	6263	104.3	1058	31.5	82	3.4	31441	308.8
1987	15041	125.1	10142	184.2	3111	72.2	39	1.2	28333	382.8
1988	4314	37.1	1469	27.1	727	20.1	52	1.7	6562	86.0
1989	13540	154.9	1777	41.7	236	8.6	60	2.6	15613	207.8
1990	3834	39.3	2221	56.8	650	25.3	94	6.9	6799	127.3
1991	23670	214.2	4159	93.8	1922	67.0	152	6.4	29903	381.5
1992	22902	194.4	13992	376.5	832	20.9	64	2.9	37790	594.9
1993	16269	131.6	18919	367.1	2965	103.3	147	7.7	38300	609.7
1994	27466	189.7	9297	161.0	5044	154.0	790	35.8	42597	540.5
1995	30697	249.6	6493	127.8	1610	41.0	175	7.9	38975	426.2
1996	19438	144.9	10056	230.6	3287	103.1	212	8.0	33012	487.4
1997	15848	136.7	7755	124.5	3139	86.4	992	39.3	28012	400.7
1998	89947	505.5	7634	174.5	3965	119.3	598	23.0	102435	839.5
1999	59434	399.6	22760	426.0	8803	286.8	435	25.9	91463	1141.9
2000	33825	269.4	19999	432.4	14598	597.6	840	48.4	69262	1347.8
2001	77144	709.0	15694	434.5	12499	589.3	2271	132.1	107713	1869.6
2002	8431	56.8	34824	875.9	6350	282.2	2322	143.2	52218	1377.2
2003	15434	114.1	2057	37.9	2038	63.9	1545	64.4	21074	280.2
2004	99404	627.1	22777	404.9	2627	82.2	510	32.7	125319	1143.8
Average	31615	235.2	11489	246.4	3972	145.0	599	31.2	47727	660.7

Table 2.3.7. Survey mortalities for polar cod from age 1 to age 2, and from age 2 to age 3.

Year	Year class	Age 1 (10^9)	Age 2 (10^9)	Total mort. %	Total mort Z
1986-1987	1985	24.0	10.1	58	0.86
1987-1988	1986	15.0	1.5	90	2.30
1988-1989	1987	4.3	1.8	58	0.87
1989-1990	1988	13.5	2.2	84	1.81
1990-1991	1989	3.8	4.2	-	-
1991-1992	1990	23.7	14.0	41	0.53
1992-1993	1991	22.9	18.9	17	0.19
1993-1994	1992	16.3	9.3	43	0.56
1994-1995	1993	27.5	6.5	76	1.44
1995-1996	1994	30.7	10.1	67	1.11
1996-1997	1995	19.4	7.8	59	0.91
1997-1998	1996	15.8	7.6	52	0.73
1998-1999	1997	89.9	22.8	75	1.37
1999-2000	1998	59.4	20.0	66	1.09
2000-2001	1999	33.8	15.7	54	0.77
2001-2002	2000	77.1	34.8	55	0.80
2002-2003	2001	8.4	2.1	75	1.38
2003-2004	2002	15.4	22.7	-	-

Year	Year class	Age 2 (10^9)	Age 3 (10^9)	Total mort. %	Total mort Z
1986-1987	1984	6.3	3.1	51	0.71
1987-1988	1985	10.1	0.7	93	2.67
1988-1989	1986	1.5	0.2	87	2.01
1989-1990	1987	1.8	0.7	61	2.57
1990-1991	1988	2.2	1.9	14	0.15
1991-1992	1989	4.2	0.8	81	1.66
1992-1993	1990	14.0	3.0	78	1.54
1993-1994	1991	18.9	5.0	74	1.33
1994-1995	1992	9.3	1.6	83	1.76
1995-1996	1993	6.5	3.3	51	0.68
1996-1997	1994	10.1	3.1	69	1.18
1997-1998	1995	7.8	4.0	49	0.67
1998-1999	1996	7.6	8.8	-	-
1999-2000	1997	22.8	14.6	36	0.44
2000-2001	1998	20.0	12.5	38	0.47
2001-2002	1999	15.7	6.4	59	0.90
2002-2003	2000	34.8	2.0	94	2.86
2003-2004	2001	2.1	2.6	-	-

Table 2.3.8. Acoustic estimate of young herring in the Barents Sea August-September 2004

Length (cm)	Age 2003 1	2002 2	2001 3	Total* (10^6)	Biomass (10^3t)	Mean weight (g)
12.0 - 12.5	19			19	0.2	10.9
12.5 - 13.0	72			72	0.9	13.0
13.0 - 13.5	287			287	4.2	14.7
13.5 - 14.0	497			497	8.2	16.4
14.0 - 14.5	786			786	14.0	17.8
14.5 - 15.0	1097			1097	21.8	19.9
15.0 - 15.5	1483	120		1603	34.7	21.7
15.5 - 16.0	1885	54		1939	47.3	24.4
16.0 - 16.5	1282	133		1415	37.4	26.4
16.5 - 17.0	1972	512		2484	73.4	29.5
17.0 - 17.5	1813	162		1975	64.5	32.7
17.5 - 18.0	1015	461		1476	53.8	36.4
18.0 - 18.5	749	524		1272	48.2	37.9
18.5 - 19.0	650	505		1155	49.3	42.7
19.0 - 19.5	231	613		844	38.1	45.2
19.5 - 20.0	169	1128		1297	65.3	50.3
20.0 - 20.5	188	1888	44	2121	123.5	58.2
20.5 - 21.0	38	2951		2989	183.7	61.5
21.0 - 21.5		3892		3892	258.5	66.4
21.5 - 22.0	32	5428		5460	398.1	72.9
22.0 - 22.5		5828	16	5843	456.4	78.1
22.5 - 23.0		4213		4213	354.4	84.1
23.0 - 23.5		3364	145	3509	318.5	90.8
23.5 - 24.0		1997	26	2024	195.6	96.6
24.0 - 24.5		1217	224	1441	148.0	102.7
24.5 - 25.0		644	137	781	87.2	111.6
25.0 - 25.5		605	5	609	71.0	116.5
25.5 - 26.0		138	17	156	20.4	131.0
26.0 - 26.5		83	87	170	22.1	130.4
26.5 - 27.0		36	34	70	10.0	143.5
27.0 - 27.5				0		0.0
27.5 - 28.0				0		0.0
28.0 - 28.5			28	28	5.1	182.1
28.5 - 29.0			93	93	14.6	157.0
29.0 - 29.5				0		0.0
29.5 - 30.0				0		0.0
30.0 - 30.5			44	89	20.0	225.9
TSN (10^6)	14265	36495	901	51717		
TSB (10^3 t)	406.4	2725.3	106.6		3251.9	
Mean length (cm)	16.4	21.8	25.1			20.4
Mean weight (g)	28.5	74.7	118.3	62.9		
						TS=20.0* lg(L) - 71.9

* including older age groups not shown in the table

Table 2.3.9. Acoustic estimate of blue whiting in the Barents Sea August-September 2004

Length (cm)	Age 2003	2002	2001	2000	1999	1998	1997	Sum (10^6)	Biomass (10^3t)	Mean weight (g)
	1	2	3	4	5	6	7			
15.0 - 15.5	9							9	0.2	16.7
15.5 - 16.0	18							18	0.3	18.7
16.0 - 16.5	41							41	0.9	20.8
16.5 - 17.0	173							173	4.0	23.1
17.0 - 17.5	311							311	8.1	26.1
17.5 - 18.0	486							486	14.1	28.9
18.0 - 18.5	795							795	22.3	28.0
18.5 - 19.0	701							701	23.0	32.8
19.0 - 19.5	753							753	26.8	35.6
19.5 - 20.0	748							748	28.7	38.4
20.0 - 20.5	425							425	18.0	42.4
20.5 - 21.0	414							414	19.6	47.4
21.0 - 21.5	281							281	13.8	48.9
21.5 - 22.0	299	336						635	34.3	54.1
22.0 - 22.5	100	33	410					544	32.8	60.3
22.5 - 23.0		695	91					786	50.0	63.6
23.0 - 23.5	110	371	361					842	55.5	65.9
23.5 - 24.0		744	88	88				920	67.3	73.2
24.0 - 24.5	74	444	197	89				805	63.4	78.7
24.5 - 25.0	49	568	112	182				911	77.2	84.8
25.0 - 25.5		377	367	426				1170	106.7	91.1
25.5 - 26.0		143	507	294				944	93.9	99.4
26.0 - 26.5			55	532	323			910	99.8	109.7
26.5 - 27.0		89	168	285	55			597	69.6	116.6
27.0 - 27.5			122	500	28			650	79.7	122.7
27.5 - 28.0			126	280	20			427	54.4	127.5
28.0 - 28.5			133	322	24			480	64.4	134.0
28.5 - 29.0			65	146	35			246	34.3	139.1
29.0 - 29.5			7	132	70	23		231	35.4	153.1
29.5 - 30.0			68	93	170			331	50.8	153.5
30.0 - 30.5				65	84		3	152	25.3	165.9
30.5 - 31.0				32	87	32		151	24.5	162.4
31.0 - 31.5				40	45	6		91	16.9	186.3
31.5 - 32.0				19	44		15	77	14.7	189.9
32.0 - 32.5				11	24		27	62	12.2	195.9
32.5 - 33.0				8		8	12	28	5.2	187.6
33.0 - 33.5						18	18	37	7.6	205.8
33.5 - 34.0						6	6	12	2.8	240.0
34.0 - 34.5						2	2	5	1.1	234.6
34.5 - 35.0						3		3	0.6	236.0
35.0 - 35.5							5	5	1.3	231.8
35.5 - 36.0							1	1	0.3	237.0
36.0 - 36.5							7	7	1.7	242.0
36.5 - 27.0							1	1	0.3	237.0
37.0 - 37.5							2	2	0.9	404.0
37.5 - 38.0							15	15	4.3	286.3
38.0 - 38.5							3	3	1.0	362.0
38.5 - 39.0									0.0	
39.0 - 39.5									0.0	
39.5 - 40.0							1	1	0.2	449.1
40.0 - 40.5									0.0	
40.5 - 41.0									0.0	
41.0 - 41.5									0.0	
41.5 - 42.0									0.0	
42.0 - 42.5									0.0	
42.5 - 43.0									0.0	
43.0 - 43.5							11	11	6.4	600.1
TSN (106)	5787	3801	2878	3543	1009	97	131	17268		
TSB (103 t)	219.1	285.5	264.8	414.1	142.2	17.6	33.2		1376.8	
Mean length (cm)	19.4	23.8	25.1	26.9	28.6	31.4	34.7	23.6		
Mean weight (g)	37.9	75.1	92.0	116.9	140.9	180.4	254.7			79.7

TS=21.8* lg(L) - 72.7

Figure legend

Figure 2.1 Survey routes and trawl stations for "Johan Hjort", "Jan Mayen", "Nansen" and "Smolensk" August - October 2004.

Figure 2.2 Survey routes and hydrographic stations for "Johan Hjort", "Jan Mayen", " Nansen", and "Smolensk" August - October 2004.

Figure 2.3 Survey routes and plankton stations for " Johan Hjort ", "Jan Mayen", " Nansen", and "Smolensk" August - October 2004.

Figure 2.1.1 Temperature (ºC) on the Kola section, August 2004.

Figure 2.1.2 Salinity (S) on the Kola section, August 2004.

Figure 2.1.3 Temperature (ºC) on the Kanin section, August 2004

Figure 2.1.4 Salinity (S) on the Kanin section, August 2004.

Figure 2.1.5 Temperature (ºC) on the Bear Island -vest section, August 2004.

Figure 2.1.6 Salinity (S) on the Bear Island -vest section, August 2004.

Figure 2.1.7 Distribution of temperatures (ºC) at surface, August- October 2004

Figure 2.1.8 Distribution of salinities (S) at surface, August - October 2004.

Figure 2.1.9 Distribution of temperatures (ºC) at 50 meters depth, August - October 2004.

Figure 2.1.10 Distribution of salinities (S) at 50 meters depth, August - October 2004.

Figure 2.1.11 Distribution of temperatures (ºC) at 100 meters depth, August - October 2004.

Figure 2.1.12 Distribution of salinities (S) at 100 meters depth, August - October 2004.

Figure 2.1.13 Distribution of temperatures (ºC) at 200 meters depth, August - October 2004.

Figure 2.1.14 Distribution of salinities (S) at 200 meters depth, August - October 2004.

Figure 2.1.15 Distribution of temperatures (ºC) at bottom , August - October 2004.

Figure 2.1.16 Distribution of salinities (S) at bottom , August - October 2004.

Figure 2.2.1. Distribution of 0-group Herring August - September 2004.

Figure 2.2.2. Distribution of 0-group Capelin August - September 2004.

Figure 2.2.3. Distribution of 0-group Cod August - September 2004.

Figure 2.2.4. Distribution of 0-group Haddock August - September 2004.

Figure 2.2.5. Distribution of 0-group Polar cod August - September 2004.

Figure 2.2.6. Distribution of 0-group Saithe August - September 2004.

Figure 2.2.7. Distribution of 0-group Redfish August - September 2004.

Figure 2.2.8. Distribution of 0-group Greenland halibut August - September 2004.

Figure 2.2.9. Distribution of 0-group Long rough dab August - September 2004.

Figure 2.2.10. Distribution of 0-group Catfish August - September 2004.

Figure 2.2.11. Distribution of 0-group Sandeel August - September 2004.

Figure 2.2.12. Distribution of 0-group Gonatus August - September 2004.

Figure 2.3.1 Estimated density distribution of one-year-old capelin (t/ nautical mile^2) August - October 2004.

Figure 2.3.2 Estimated density distribution of two years old capelin (t/ nautical mile^2) August - October 2004.

Figure 2.3.3 Estimated density distribution of three years old capelin (t/ nautical mile^2) August - October 2004.

Figure 2.3.4 Estimated density distribution of four years old capelin (t/ nautical mile^2) August - October 2004.

Figure 2.3.5 Estimated total density distribution of capelin (t/ nautical mile^2) August - October 2004.

Figure 2.3.6 Echo-records of capelin in typical daytime registrations 27.09.2004. Echogram obtained at Johan Hjort. See also figure 2.3.9 obtained immediately after this echogram.

Figure 2.3.7 Echo-records of capelin in the transition phase between daytime schools and night time scattered distribution 28.09.2004. Echogram obtained at Johan Hjort. See also figure 2.3.8 obtained immediately before this echogram.

Figure 2.3.8 Echo-records of capelin in near-bottom concentrations 28.09.2004. Echogram obtained at Johan Hjort. Note the echo extending from the capelin layer; this is a diving humpback wale.

Figure 2.3.9 Age and length distribution of capelin in the three sub-areas used for stock size estimation August - October 2004.

Figure 2.3.10 Total length and age distribution of capelin August - October 2004.

Figure 2.3.11 Bottom trawl stations with capelin in multspec areas 1-7, August - October 2004

Figure 2.3.12 Estimated density distribution of one year old polar cod (t/ nautical mile^2) August - October 2004.

Figure 2.3.13 Estimated density distribution of two years old polar cod (t/ nautical mile^2) August - October 2004.

Figure 2.3.14 Estimated density distribution of three years old polar cod (t/ nautical mile^2) August - October 2004.

Figure 2.3.15 Estimated density distribution of four years old polar cod (t/ nautical mile^2) August - October 2004.

Figure 2.3.16 Estimated total density distribution of polar cod (t/ nautical mile^2) August - October 2004.

Figure 2.3.17 Length and age distribution of polar cod in the three sub-areas used for stock size estimation August - October 2004.

Figure 2.3.18 Total length and age distribution of polar cod August - October 2004.

Figure 2.3.19 Estimated density distribution of one year old herring (t/ nautical mile^2) August - October 2004.

Figure 2.3.20 Estimated density distribution of two years old herring (t/ nautical mile^2) August - October 2004.

Figure 2.3.21 Estimated density distribution of three years old herring (t/ nautical mile^2) August - October 2004.

Figure 2.3.22 Estimated total density distribution of herring (t/ nautical mile^2) August - October 2004

Figure 2.3.23 Estimated total density distribution of blue whiting (t/ nautical mile^2) August - October 2004.

Figure 2.4.1. Density distribution of cod, kg* hour of trawling^{-1}, August - October 2004.

Figure 2.4.2 Density distribution of haddock, kg* hour of trawling^{-1}, August - October 2004..

Figure 2.4.3 Density distribution of saithe, kg* hour of trawling^{-1}, August - October 2004.

Figure 2.4.4 Density distribution of long rough dab, kg* hour of trawling^{-1}, August - October 2004.

Figure 2.4.5 Density distribution of redfish, kg* hour of trawling^{-1}, August - October 2004.

Figure 2.4.6 Density distribution of Greenland halibut, kg* hour of trawling^{-1},August - October 2004.

Figure 2.4.7 Density distribution of shrimp, kg* hour of trawling^{-1}, August - October 2004.

Figure 2.4.8 Density distribution of Kamtshatka crab, kg* hour of trawling^{-1}, August - October 2004.

Figure 2.5.1 Distribution of zooplanktron (g/m^2), data from "J. Hjort" and "J. Mayen", August-October 2004.

Figure 2.6.1 Distribution of marine mammals, data from "Johan Hjort", "Smolensk", "Nansen" and the PINRO airplane Arctica, August - October 2004.

Figure 2.6.2 Observations of seabirds from "F. Nansen" and "J. Hjort" during the period August-October 2004.

Figure 2.7.1 Map of stations where macro-benthos was sampled during the 2004 ecosystem survey. Samples were made using bottom trawl (RV "*J.Hjort*"), bottom trawl and grab (RV "*Smolensk*"), or grab and Sigsby trawl (RV *"F. Nansen"*).

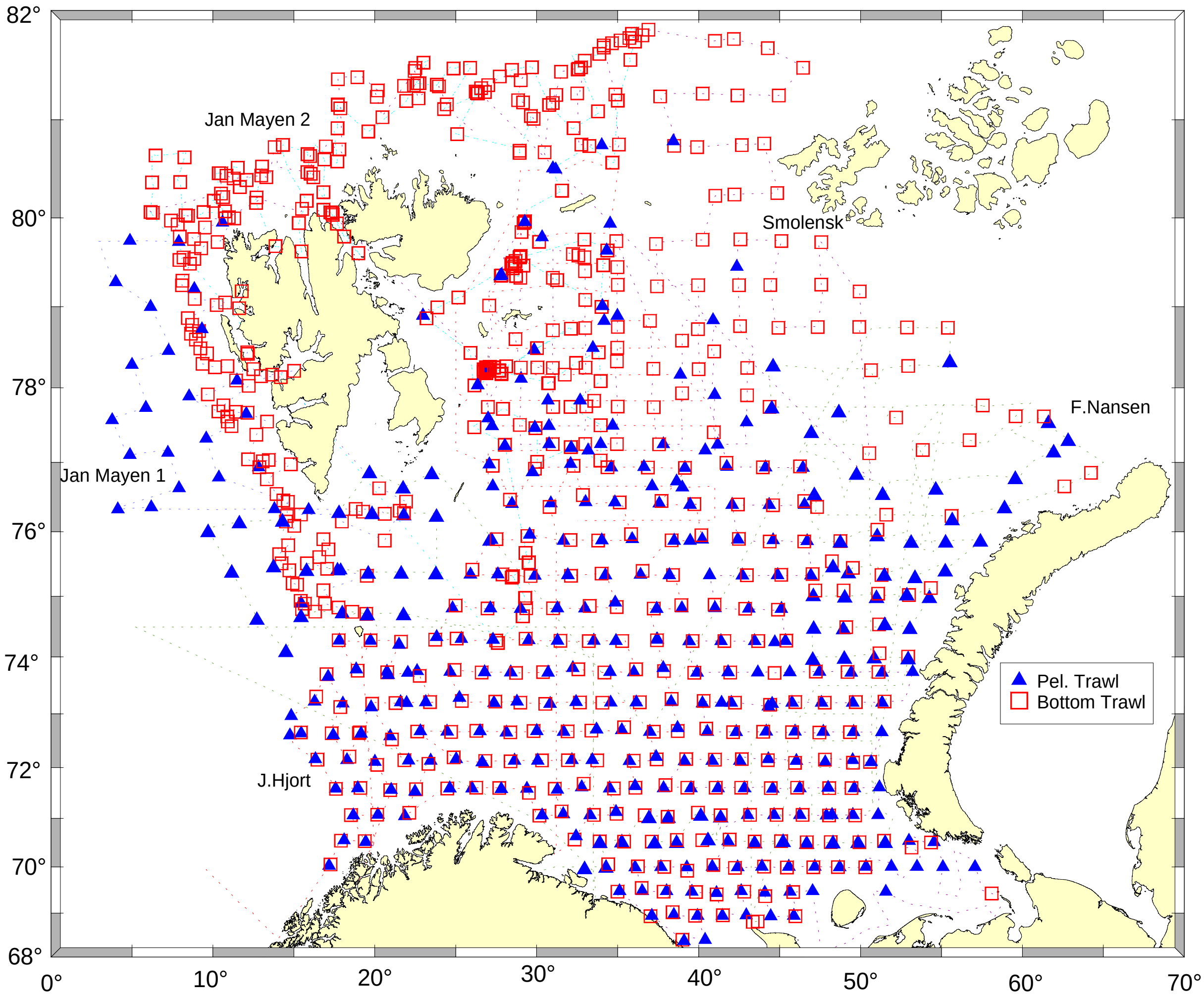

Figure 2.1 Survey routes and trawl stations for "Johan Hjort", "Jan Mayen", "Nansen" and "Smolensk" August - October 2004.

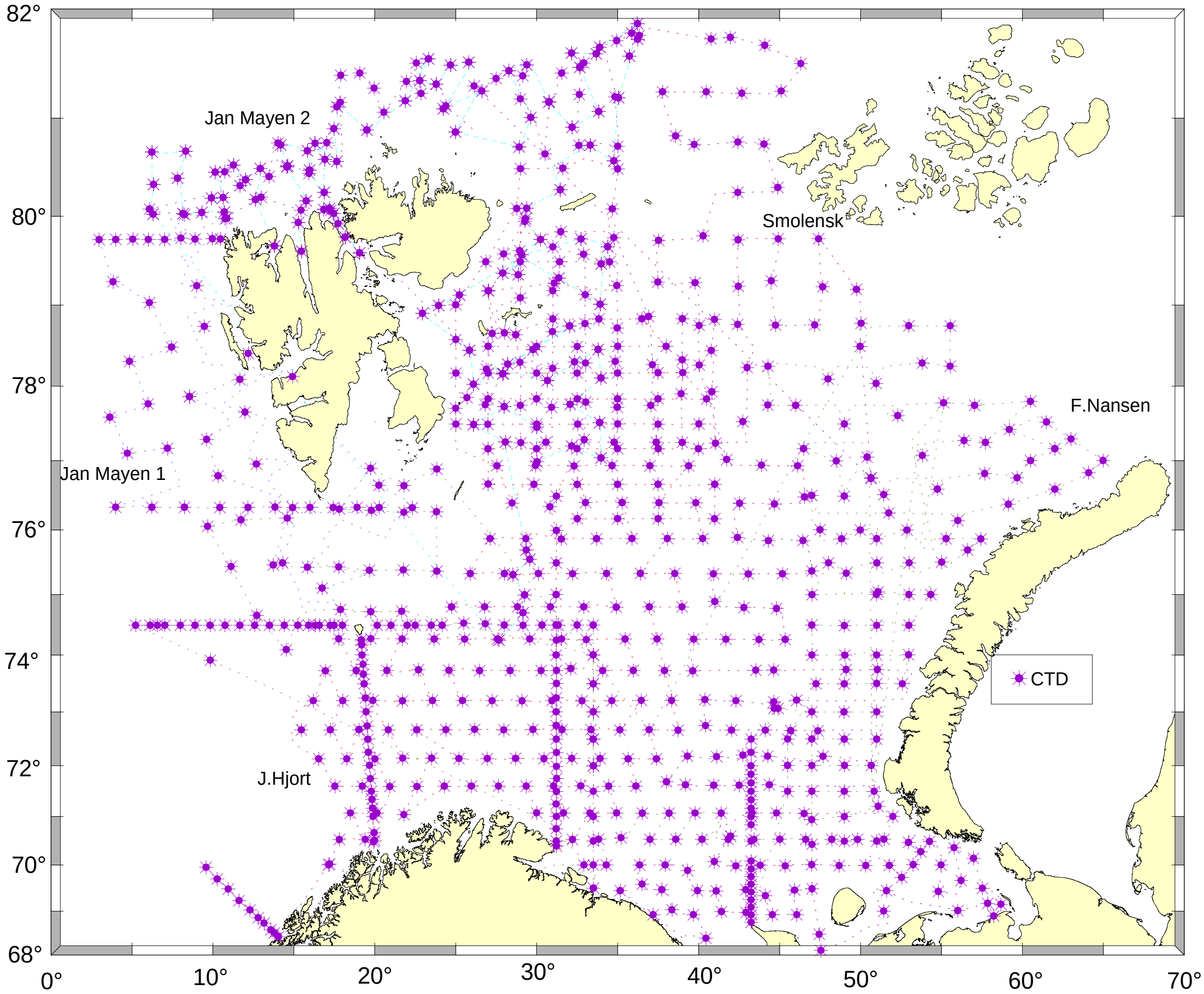

Figure 2.2 Survey routes and hydrographic stations for "Johan Hjort", "Jan Mayen", " Nansen", and "Smolensk", August - October 2004.

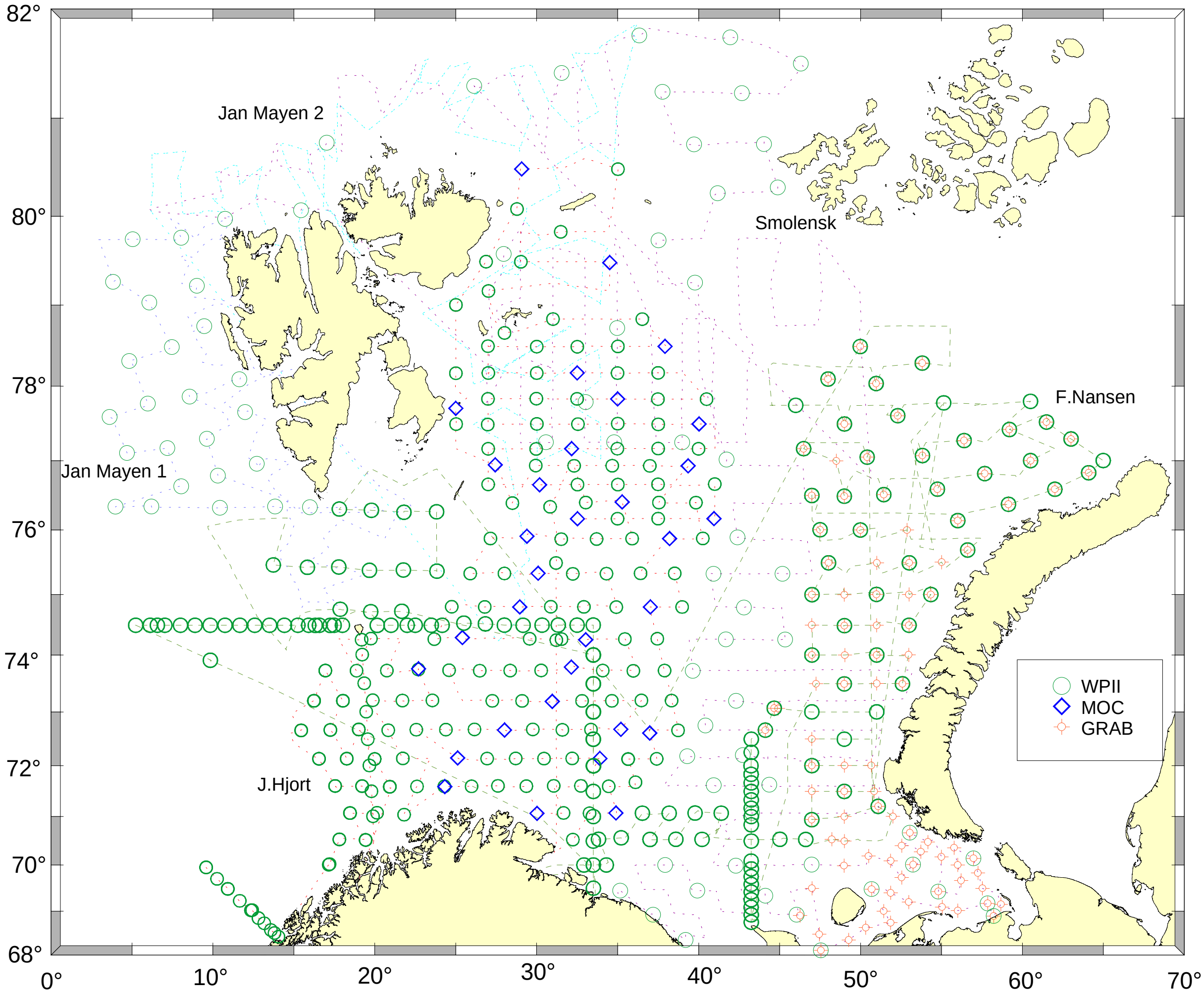

Figure 2.3 Survey routes and plankton stations for " Johan Hjort ", “Jan Mayen”, " Nansen”, and "Smolensk" August - October 2004.

APPENDIX 1

Ecosystem survey 2004

Research vessel	Participants
"Smolensk" (06/08-03/10)	G. Zuikov, V. Kapralov, S. Klinushkin (06-20/8), P. Lyubin (06-20/8), N. Mukhina, A. Nikifirov, D. Prozorkevich (cruise leader), T. Prokhorova, S. Ratushnyy, O. Sazhenkov, I. Trofimov, S. Kharlin, T. Yusupov
"F. Nansen" (07/08-03/10)	Amelkin A., T. Gavrilik, I. Dolgolenko (cruise leader), S. Ivanov, R. Klepikovsky, S. Klinushkin (21/8-03/10), A. Klyuykov, P. Lyubin (21/8-03/10), P. Murashko, V. Popov, T. Semochkina, V. Sergeev, T. Sergeeva, V. Tataurov, N. Torgunova, L. Shibaev, N. Zozulya, V. Zubarevich, V. Zubov
"J. Hjort" (01/08-04/10)	**Part 1 (01/08-12/08):** S. Aanes (cruise leader), O.O. Arnøy, K.B. Eriksen, K. Hansen, J. Johannessen, H. Larsen, S. Lemvik, L. Rey, T. Sivertsen, A. Storaker, Ø. Torgersen, J. Welcker. **Part 2(13/08-19/08):** J. Andersen, O.O. Arnøy, A. Dommasnes (cruise leader), K.B. Eriksen, K. Hansen, H. Larsen, S. Lemvik, M. Mjanger, L. Rey, T. Sivertsen, A. Storaker, Ø. Torgersen, N. Ushakov, J. Welcker. **Part 3 (20/08-08/09):** J. Andersen, B. Bogstad, G. Dingsør, B. Endresen, M. Fonn, P. Fossum (cruise leader), H. Græsdal, H. Larsen, J. de Lange, F. Midtøy, M. Mjanger, J.E. Nygaard, E. Olsen, B. Skjold, T. Sivertsen, N. Ushakov, J. Welcker. **Part 4 (11/09-04/10):** J. Alvarez, L. Drivenes, K.A. Fagerheim, H. Gjøsæter (cruise leader), M. Johannessen, G. McCallum, A. Kristiansen, R. Pettersen, B. Røttingen, B.V. Svendsen, Ø. Torgersen, N. Ushakov, J. Welcker.
"Jan Mayen" (04/08-22.08 and 10.09-01/10)	**Part 1 (04-22/08):** I. Ahlquist, M. Aschan (cruise leader, 04-12/08), P.J. Helgesen, A. Harbitz, T. Haugland, E. Johannesen, H. Miran, W. Richardsen, J. Størkersen (12-22/08), K. Sunnanå (cruse leader, 12-22/08), G. Søvik (04-12/08). **Part 2 (10/09-01/10):** O.T. Albert, E.D. Eliassen, E. Hermansen, J. Johannesen, S. Kleven, W. Richardsen, L. Solbakken, A. Sæverud, T. Wenneck (cruise leader)

Appendix II

Ecosystem survey 2004

SPHERE CALIBRATION OF ECHOSOUNDERS EK-500, ER60

(on copper sphere CU60, TS=33,6 dB, at frequency 38 kHz)

Research vessel	Johan Hjort	Jan-Mayen	Smolensk	F. Nansen
Type of echosounder	EK500	ER60	ER60	ER60
Date	12.09.2004	06.08.2004	06.08.2004	11.03.2004
Place	Tyttebærbukta (Bøkfjord),	Coles bay, Spitsbergen	Orlovka bay 69º12´N,35º15´E	Bøkfiord, 69º49´N,30º08´E
Bottom depth (m)	120	389	56	
Depth to sphere (m)	45.25	20.50	27.51	19.15
Temperature (ºC)	7.28	2.70	11.8	
Salinity (‰)	33.72	31.7	33.9	
TS of sphere (dB)	-33.6	-33.8	-33.6	-33.7
Transducer type	ES38B	ES38B	ES38B	ES38B
Transducer depth (m)	0		4.5	0
Real sphere depth (m)	50.25		27.51	19.15
Sound velocity (m/sec)	1476.1	1451.1	1495	1461
Absorption coefficient (dB/km)	10	9.32	9.8	10.1
Pulse length (Short/Med./Long, ms)	MED	1.024	1.024	1.024
Bandwidth (Wide/Narrow)	WIDE		2.43 kHz	2.43
Maximum power (W)	2000	2000	2000	2000
Transmit power (W)	2000	2000	2000	2000
Angle sensitivity	21.9	21.9	21.9	21.9
2-way Beam Angle (10lgΨ , dB)	-21.0	-20.6	-20.76	-20.9
Adjusted Sv Transducer Gain (dB)	27.53			
Adjusted TS Transducer Gain (dB)	27.73	26.17	26.32	25.45
3-dB Beamwidth Alongship (deg.)	7.0	6.84	6.99	7.09
3-dB Beamwidth Athwartship (deg.)	6.7	7.08	6.96	6.95
Alongship (fore/aft.) Offset (deg.)	-0.08	-0.06	-0.02	-0.10
Athwartship Offset (deg.)	-0.03	-0.03	0.02	-0.04
Theoretical Sa (m /nm)	1154		2964	5904
Measured Sa (m /nm)	1148		2913	5860-6060
			$Sa=\sigma*1852^2/(r^2\Psi)$	$\sigma=4\pi*10^{0,1\ TS}$