IMR / PINRO
JOINT REPORT SERIES
1
2012

Norwegian-Russian workshop HAV 5
Biological – Geological Seabed Mapping and Monitoring in the Barents Sea

Murmansk, PINRO, 7-10 November 2011

Editors:
Lis Lindal Jørgensen (IMR), Natasja Anisimova (PINRO) and Anne Britt Storeng (DN)

Institute of Marine Research - IMR

Polar Research Institute of Marine Fisheries and Oceanography - PINRO

This report should be cited as:
Jørgensen, L.L., Anisimova, N., Storeng, A.B. 2012. Norwegian-Russian workshop, HAV 5, Biological–Geological Seabed Mapping and Monitoring in the Barents Sea. IMR-PINRO Joint Report Series 1-2012, 39 pp.

Norwegian-Russian workshop HAV 5

Biological – Geological Seabed Mapping and Monitoring in the Barents Sea

Murmansk, PINRO 07-10 November 2011

Editors:
Lis Lindal Jørgensen (IMR), Natasja Anisimova (PINRO)
and Anne Britt Storeng (DN)

HAVFORSKNINGSINSTITUTTET
INSTITUTE OF MARINE RESEARCH

Content

Introduction

The mixed Norwegian-Russian Environmental Commission agreed in St. Petersburg (19. – 20.05.10.) and Svanhovd (16. – 17.06.10.) to initiate a new benthic geo-bio project for the Barents Sea “HAV 5” for Nature Types.

Why this report/workshop

There is a long-term goal to map the Russian and Norwegian waters in the Barents Sea in a joint Norwegian-Russian mapping program. This workshop is a part of the HAV 5 project with the aim to develop cooperative between Norway and Russia on mapping, and classifying of Nature Types in the Barents Sea.

The aim of the workshop was to:

1. Inform about existing geo- and benthoswork in the Barents Sea
2. Establish network among and between geology and biology
3. Start on a working plan for mapping and classifying nature-types in the Barents Sea based on existent geological- and biological data (needs more meeting)

Existing knowledge and knowledge gaps

This workshop involved three sessions with speakers:

1. Biological and/or Geological Mapping and Monitoring (past, present and future) of the Barents Sea Seabed.
2. Sampling methods and analyzing of biological and geological seabed data for mapping and/or monitoring.
3. Biological/Geological Seabed Information used in the Barents Sea Management Plan.

1 Biological and/or geological mapping and monitoring (past, present and future) of the Barents Sea seabed

1.1 Total benthic survey and benthos investigation in PINRO

Natalya Anisimova (PINRO), Pavel Lyubin, Igor Manushin, Lis Lindal Jørgensen

Although often perceived as a 'pristine' environment, the Barents Sea is an area of intensive human activity. Historically, the main activities were fishing and hunting of marine mammals, but now also includes shipping, as well as oil and gas exploration. The annual catches of cod, haddock, saithe, redfish, Greenland halibut and shrimp are close to one million tonnes (Aanes et al. 2007). Such fishing intensity is likely to have effects both on the fish standing stocks and on the ecosystem as a whole (Stiansen and Filin 2007).

Independent of any anthropogenic impacts, the Barents Sea ecosystem is strongly influenced by interannual and seasonal climate-driven variations, including factors such as ice-cover and the strength of inflowing Atlantic water (Ottersen et al 2004). Sea temperatures in the Arctic have been rising over the past decades, and there has been a concurrent thinning and retreat of the ice edge (Cosmio et al. 2008).

The history of the Barents Sea investigation has three "full-scale benthic surveys" which were carried out by different organizations, in different time periods (Figure 1) (see also Anisimova et al 2011 for more details).

The first survey, in 1924-1935, was undertaken by the Russian Oceanographic Institute (PLAVMORNIN). The second survey (1968-1970) was carried out by PINRO, and finally, in 1991-1994, the benthic sampling was made by VNIIOkeangeologia.

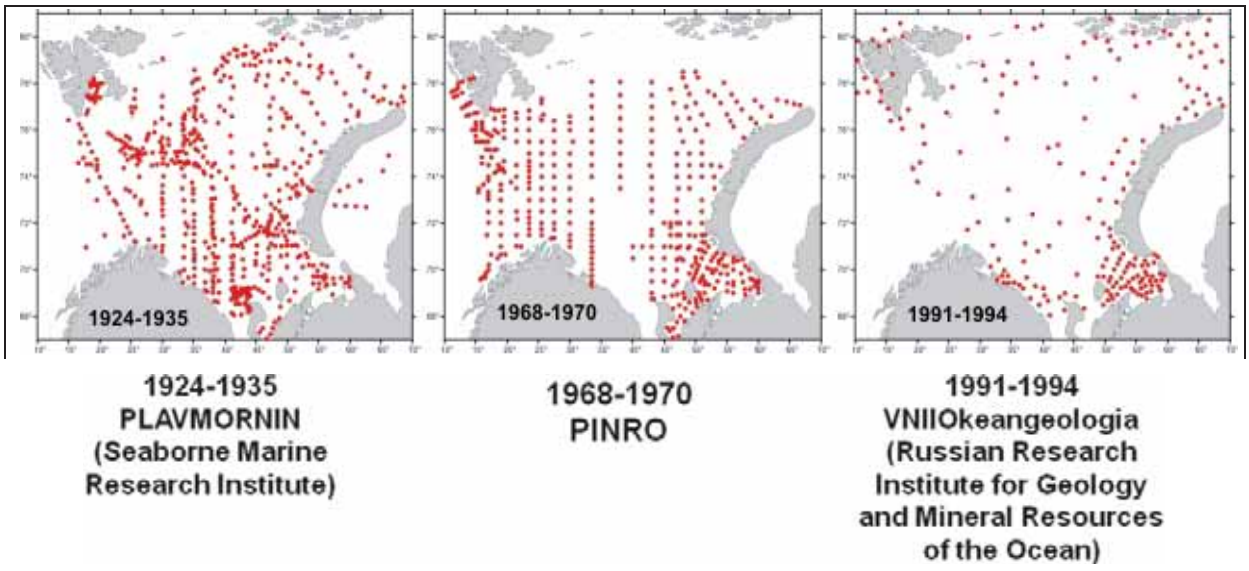

Figure 1. Stations collected from 1924 to 1994 by different Russian institutes. Equipment: Grab.

Because of the large changing's in the Barents Sea ecosystem during the few last decades PINRO launched yet another survey in 2003 (Figure 2). This was done in order to have the possibility to:

1. follow effects from possible climatic changes – now Arctic is in a extremely warm period;
2. follow effects from the intensification of the fisheries, including bottom trawling;
3. follow the effects from new benthic species, like red king crab or snow crab, that has been introduced to, or invaded the ecosystem of the Barents Sea;
4. follow the effects from exploration and development of the industry of gas and oil resource in the Barents Sea.

So, the main goal of the new benthic survey is to describe the prevailing state of the bottom fauna of the Barents Sea, and to study possible changes in the fauna by comparing the new results to the mapping done in the past century.

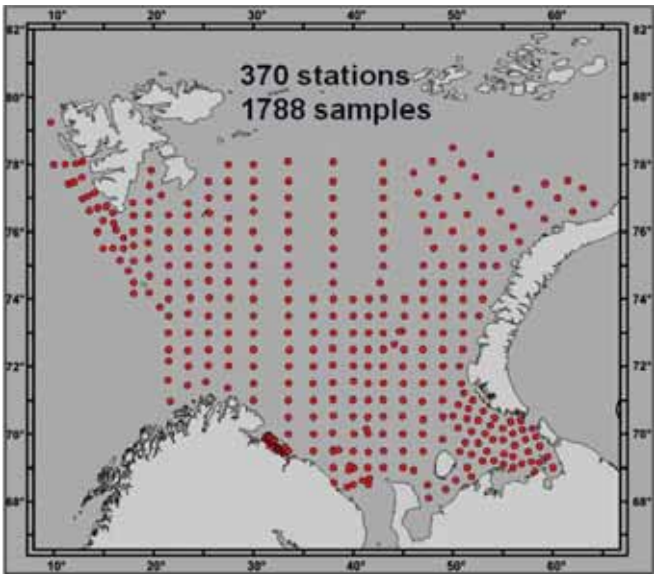

Figure 2. PINRO historical stations. Equipment Grab and partly Sigsby trawl. Processing of material is not finish. Need financing.

The chosen position per station was based on localities covered in the last benthic survey of PINRO and where the results are kept in the archive of the institute. The ability to follow temporal changes on these repetitive locations is important for all future analysis when used in direct comparison with new data.

The new survey started in 2003. During this year the samples was collected in the southern part of the Barents Sea and the following year the eastern part of the sea was investigated. In 2005 and 2006 the sampling was made in northern part of the Barents Sea and round Svalbard. In 2006 practically all the Barents Sea, except Norwegian Economical Zone, in the south-western part of the Barents Sea was covered with stations.

In 2006 IMR joined the survey and began to sample in the Norwegian Economical Zone that was not yet covered by PINRO in this new investigation. During the next three years IMR covered all the south-western part of the Barents Sea.

So, in 2008, after six years of the sampling, the field part of investigation was finish. Identical methods of sampling (van Veen grab (0.1 m^2)) was used both on Russian and Norwegian research vessels. Equipment for the washing of samples differed in Norwegian (steel sieves) and Russian (sieving bag) ships but in the both case the mesh size of the sieve were identical – 1/2 mm. All samples were preserved with 5% formalin.

Totally, 1788 grab samples (Table 1) were taken on the 370 stations (Figure 2). The biggest part of the samples are kept and processed in PINRO, but collected material from the south western part of the Barents Sea is kept and processed at IMR, Tromsø, Norway.

Processing of benthic grab samples consist of two main steps: i) the processing with the preliminary sorting of the samples and ii) taxonomical identification of the animals down to species level. Preliminary sorting of the samples includes: extraction of the animals from the sediment, sorting of animals to the main taxonomical group and transferring of the animals from formalin to alcohol. The transportation from formalin to alcohol is important to do, as fast as possible, due to the erosion character for the formaldehyde on calcified plates, thorns and skeleton of many groups of the animals.

At present, the preliminary sorting of almost all collected samples is completed. Last and the most important and difficult step of the sample processing is the taxonomical identification of the animals.

The Barents Sea bottom fauna holds a biodiversity with more than 2500 macrobenthic species (40 classes and 20 phyla of invertebrates). Consequently will such high biodiver-sity need advanced skills in order to overcome a proper taxonomical identification of this material.

Molluscs, echinoderms and partly crustaceans and polychaets are identified by PINRO's taxonomical experts. But for identification of other taxonomic groups, experts from other institutes need to be engaged. For this there is a need of additional founding, and both PINRO and IMR are trying to solve this financial problem.

The identification of bryozoans, Hydroidea, Anthozoa, Sipuncula and animals from some groups of the crustaceans and polychaetes need to be made by experts from the Zoological Institute and University of St-Petersburg and from MMBI in Murmansk.

At present, the biggest part of the collected samples is fully processed (Table) and about 2/3 of the Barents Sea area can be mapped with the main benthic parameters such as biomass, abundance and biodiversity.

Moreover the data set allows mapping other parameters such as the distribution of the main communities, and the biogeographical-, trophic- or ecological structure of the macrobenthos. Some results of the survey have already been presented at conferences and in publications (Anisimova et al. 2010).

Table 1. Status of processing of materials sampled in the Barents Sea during benthos survey 2003-2008.

	Collected	Processed	Not processed
	Material of PINRO		
Stations	336	213	123
Samples	1618	1027	591
	Material of IMR		
Stations	34	-	34
Samples	170	-	170

RESUME For a final realisation of the Barents Sea survey project, PINRO there is a need of additional financial support for the completion of the taxonomical processing of the samples.

Aanes, S., Drevetnyak, K.V., Grekov, A.A., Nedreaas, K. and K.M. Sokolov (2007) in: Stiansen, J.E. and A.A. Filin (editors) Joint PINRO/IMR report on the state of the Barents Sea ecosystem in 2006, with expected situation and considerations for management. IMR/PINRO Joint Report Series No. 2/2007. ISSN 1502-8828. 209 pp.

Anisimova NA, Jørgensen LL, Lubin P, Manushin I, (2010) Mapping and monitoring of benthos in the Barents Sea and Svalbard waters: Results of the join Russian Norwegian Benthic program 2006-2008. IMR/PINRO Joint Report Series 2009(1), 114 pp. ISSN 1502-8828.

Anisimova NA, Jørgensen LL., Lubin P., Manushin I. (2011) Benthos. *In* The Barents Sea. Ecosystem, resources, management. Half a century of Russian-Norwegian cooperation, pp. 315-328. Ed. by T. Jakobsen. and V.K. Ozhigin. Tapir Academic Press, Trondheim. Chapter 4.1.2.

Cosmio, J.C., Parkinson, C.L., Gersten, R., Stock, L. 2008. Accelerated decline in Arctic sea ice cover. Gephysical Research Letters, 35, L01703, doi:1029/2007GL031972.

Stiansen, J.E. and A.A. Filin (2007) in: Stiansen, J.E. and A.A. Filin (editors) Joint PINRO/IMR report on the state of the Barents Sea ecosystem in 2006, with expected situation and considerations for management. IMR/PINRO Joint Report Series No. 2/2007. ISSN 1502-8828. 209 pp.

Ottersen, G., Alheit, J., Drinkwater, K., Friedland, K., Hagen E. and Stenseth, N.C., (2004). 'The response of fish to ocean climate variability'. pp 71-94. In: Stenseth, N.C., Ottersen, G., Hurrell, J. and Belgrano, A. (eds.) Marine Ecosystems and Climate Variation: North Atlantic. Oxford University Press, Oxford, UK.

1.2 Megabenthos of the Barents Sea

P.A. Lyubin *(*PINRO), L.L. Jørgensen, N.A. Anisimova, I.E. Manushin, T.A. Prohorova, D.V. Zakharov, V.S. Viaznikova, N.E. Juravleva, A.V. Golikov, A.R. Morov, O.L. Zimina, O.S. Lyubina

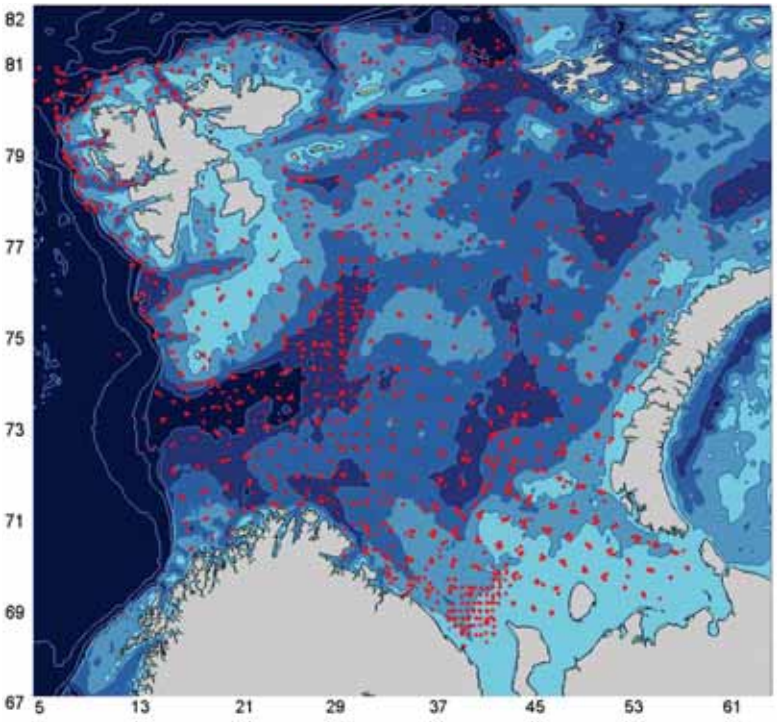

Figure 3. Stations of the annual Russian-Norwegian Ecosystem Survey from 2005-2011. Equipment: Campelen trawl.

Annually since 2004, the Polar Research Institute of Fisheries and Oceanography- NM Knipovich (PINRO) and the Norwegian Institute of Marine Research (IMR) have had cooperation on studying and monitoring the invertebrate benthic animals, taken by bottom trawls, from the Norwegian-Russian Ecosystem Surveys covering the entire Barents Sea (Anisimova et al. 2010, 2011; Golokov et al. 2011; Jørgensen 2008; Jørgensen et al. 2007, 2008, 2009; Lubin et al 2009). Benthic organisms harvested by this gear are dominated by "megabenthos". In this presentation will the ecological group of benthic organisms consisting of both “megabenthos” (this presentation) and “macrobenthos” (see the presentation above) be compared.

The material was collected in August-September 2006-2011 with the research vessels "F. Nansen ","Smolensk" and "Vilnus" administrated by PINRO, and "G.O.Sars", "Jan Mayen" and "Johan Hjort", administrated by IMR. The trawling was made by a «Campelen-1800 trawl» (McCallum and Walsh, 1996), representing an active fishing gear targeting shrimps. The trawl was equipped with an outer trawl bag (mesh size 125 mm), and a inner net (mesh size of 22 mm). Standard time of trawling is 15 minutes, with a average speed of 3.2 knots. The width of the trawl is 15m, and the height 4 m. The average trawling area was close to 22 thousand m ². The sorting of the catch, the taxonomic identification to closest possible taxon, counting of the number of each taxon and the weight to the nearest 0.1 g were carried out on board. The northern shrimp catches (*Pandalus borealis*) was excluded from the data analyze

of the benthic invertebrates because this species is benthopelagic, and not a truly benthic species. Furthermore is the Campelen trawl particularly targeting this shrimp species, and quantitative comparison with other species of the zoobenthos would be incorrect. The annual trawl station covers almost all the Barents Sea, including the adjacent waters of the Barents Sea shelf. A total of 1902 bottom trawl has been analyzed, approximately 2.6 million specimens of animals has been taxonomical evaluated, counted and viewed, and 625 taxa of invertebrate has been identified so far.

In the future it is necessary to continue this annual monitoring of megabentos at the Joint Ecosystem Surveys of the Barents Sea. Particular attention should be paid to the study of bottom trawl catch ability to different groups of the megabentos, and video can be applied in this concern. The trawl catch are under evaluation as a monitoring tool for environmental and anthropogenic impacts.

Anisimova NA, Jørgensen LL, Lubin P, Manushin I, (2010) Mapping and monitoring of benthos in the Barents Sea and Svalbard waters: Results of the join Russian Norwegian Benthic program 2006-2008. IMR/PINRO Joint Report Series 2009(1), 114 pp. ISSN 1502-8828.

http://www.imr.no/publikasjoner/andre_publikasjoner/imr-inro_samarbeidsrapporter/2010/nb-no

Anisimova NA, Jørgensen LL., Lubin P., Manushin I. (2011) Benthos. *In* The Barents Sea. Ecosystem, resources, management. Half a century of Russian-Norwegian cooperation, pp. 315-328. Ed. by T. Jakobsen. and V.K. Ozhigin. Tapir Academic Press, Trondheim. Chapter 4.1.2.

Golikov A.V., Morov A.R., Sabirov R.M., Lubin P.A., Jorgensen L.L., Rizvanov A.A., Sugimoto M.(2011) Taxonomy of arctic sepiolids (Cephalopoda) on morpho-functional and molecular-genetic data // Proc. 2nd All-Russian Conf. devoted to 105 years since academician A.V. Ivanov birth. Sankt-Petersburg: ZIN RAN. Pp. 102-105. (in Russian)

Jørgensen L.L. (2008) Artssammensetning og mengde av bunndyr og fisk i forskningstrål in: Knut Sunnanå og Maria Fossheim. Forvaltningsplan Barentshavet -rapport fra overvåkingsgruppen 2008 Fisken og havet, særnummer 1 b–2008

Jørgensen L.L, Anisimova N., Ljubin P. Benthic investigations (2007) in: Stiansen, J.E. and A.A. Filin (editors) Joint PINRO/IMR report on the state of the Barents Sea ecosystem in 2006, with expected situation and considerations for management. IMR/PINRO Joint Report Series No. 2/2007. ISSN 1502-8828. 209 pp.

Jørgensen L.L, Anisimova N., Ljubin P. Benthic investigations (2008) in: Stiansen, J.E. and A.A. Filin (editors) Joint PINRO/IMR report on the state of the Barents Sea ecosystem in 2006, with expected situation and considerations for management. IMR/PINRO Joint Report Series No. 2/2007. ISSN 1502-8828. 209 pp.

Jørgensen L.L, Anisimova NA., Lubin P (2009). Dyreliv på havbunnen: langtidsovervåkning og jakten på miljø- indikatorer. In: Mortensen LB, Hodnesdal H., Thorsnes T. (Eds.) Til Bunns i Barentshavet og havområdene utenfor Lofoten. Norges Geologiske Undersøkelse 2010. ISBN: 978-82-7385-142-0

Lubin P., Jørgensen L.L., Anisimova N. (2009) Benthos. In: Stiansen, J.E., Korneev, O., Titov, O., Arneberg, P. (Eds.), Filin, A., Hansen, J.R., Høines, Å.,Marasaev, S. (Co-eds.) 2009. Joint Norwegian-Russian environmental status 2008. Report on the Barents Sea Ecosystem. Part II – Complete report. IMR/PINRO Joint Report Series, 2009(3), 375 pp. ISSN 1502-8828.

McCallum, B. R., and Walsh, S. J. 1996. Groundfish survey trawls used at the Northwest Atlantic Fisheries Centre, 1971–present. NAFO Scientific Council Studies, 29: 93–104.

1.3 History of underwater landscape research of the Barents- and White Sea

Frolova, E.A. (MMBI)

Sea bottom investigations carried out in Murmansk Marine Biological Institute, applying hydro-photo survey, started in 1977. The group of scientists of the laboratory of the underwater investigations, headed by V.E. Dzhus, was the first to begin these studies. Regularities of clam quantitative distribution in the East Murman coastal zone were studied applying underwater photo survey (Denisenko S., Petrunin, 1982). V.B. Pogrebov, L.S. Sadkova (1982) studied the possibility of application of the stereoscopic hydro-photo survey for the investigations of statistical regularities of separate macro-zoobenthos species distribution. The results of stereo-photo survey were used to estimate and to study the bottom micro-relief regularities (Tarasov, Kanivets, 1982). G.A Tarasov (1982) used the photo materials to investigate the algae role in the modern sedimentogenesis. A method for the current's thin structure studies and turbulence in the biogeocenosis zone applying underwater survey of the painted water volumes was developed in the Murmansk Marine Biological Institute (Sadkov, 1982).

The value of the data received during hydro photo-survey increases greatly if photographing is combined with trawling or with grabs. This kind of work carried out in MMBI in August 1988 during the 48th cruise of the R/V"Dalnye Zelentsy" (Frolova, 2000). 14 photo stations were carried out (Fig. 4). On the 7 stations among these 14 stations along with photographing there carried out sampling and trawling. The estimation of the settlement density and biomass of large epi-fauna forms became possible only due to the application of the underwater photo-survey. It was possible to identify till species belonging and to calculate a reliable distribution density of the near-bottom hydroid medusa *Ptychogastria polaris* (Panteleeva et al., 1999).

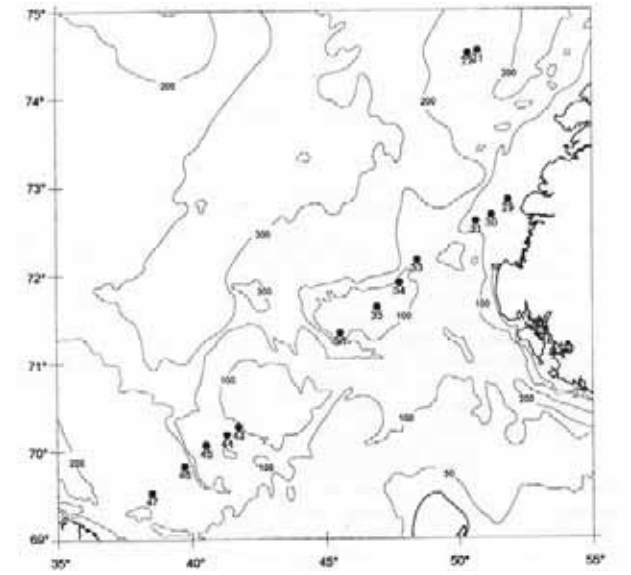

Figure 4. Transect of stations in the south eastern Barents Sea. Southern Novaja Zembla at the right side of the figure. The photographing per station was combined with trawling and with grabs.

In all, 69 station were carried out in 1983-1988 (24-in the White Sea and 42- in the Barents Sea) and 659 photos of the sea bottom at depths 8-188m were obtained. 256 photos were received in the White Sea and 381 photos were received in the Barents Sea. These

investigations were carried out on the base of the installation for the underwater stereo photo survey “Zelenetskaya” capable to work off sea at depth up to 250m (Džus, 1981). It consisted of 2 photo cameras and two impulsive illuminating devices in boxes, power blocs, command device, control system and the bearing frame. The installation descended on the cable from the ship and carried out photographing either using an underwater switch or automatically. The source of the electric power for the installation is a battery of cadmium-nickel accumulators in 1982 the installation was modernized (“Zelenetskaya2”): instead of narrow film photo cameras the cameras for air-photo surveys with wide film (70mm) began to be used.

Underwater photographing allows gaining some objective estimates of underwater biocenosis. Macrophytes, large zoobenthos forms, types and character of the grounds and near bottom water currents as well as several traces of anthropogenic impact are fixed on the photos. (Yuksha, 1979). It should be noted that nature does not suffer damage- the bottom surface is not hurt, organisms inhabiting the bottom do not die. It seems to me that the publication of the Barents Sea underwater landscapes atlas would be useful. I am sure that the archive of underwater photographs obtained in MMBI might be used to map the sea bottom and to observe the processes and changes being taken place there.

Denisenko, S.G. & I.I. Petrunin 1982. The features of quantitative distribution of the Icelandic scallop in the coastal zone of the Eastern Murman. – Pp. 9-17 in: Underwater biological studies. USSR Academy of Sciences Press, Kola Center, MMBI, Apatity.

Pogrebov V.B. & L.S. Sadkova 1982. Calculation of separate macro-zoobenthos species with application of the stereoscopic hydro-photo survey. – Pp. 18-21 in: Underwater biological studies. USSR Academy of Sciences Press, Kola Center, MMBI, Apatity.

Tarasov G.A. & V.V. Kanivets 1982. The results of study the bottom nano-relief of the Murman coast of the Barents Sea (based on the stereo-photo survey data). – Pp. 53-57 in: Underwater biological studies. USSR Academy of Sciences Press, Kola Center, MMBI, Apatity.

Tarasov G.A. 1982. The role of algae in movement and sedimentation of sedimentary material in the Murman coast of the Barents Sea environment. – Pp. 57-63 in: Underwater biological studies. USSR Academy of Sciences Press, Kola Center, MMBI, Apatity.

Sadkov S.V. 1982. Prospect of study current’s thin structure in biogeocenosis area applying underwater survey of the painted water volumes. – Pp. 3-9 in: Underwater biological studies. USSR Academy of Sciences Press, Kola Center, MMBI, Apatity.

Frolova E.A. 2000. Landscape observations and zoobenthos structure in the southern part of the Novaya Zemlya shallow-water area on the section Novaya Zemlya the settlement of Dalnye Zelentsy (based on the resalts of the 48th cruise of R/V “Dalnye Zelentsy”, 1988). – Pp. 23-43 in: Current Benthos of the Barents and the Kara seas. Kola Science Centre RAS, Apatity.

Panteleeva N., Frolova E., Sheiko O. 1999. New records of the benthic medusa *Ptychogastria polaris* Allman 1878 (Trachylida, Hydroidea) in the Barents sea and off the Kurile islands (Pacific ocean) // Pol. Biol. 1999. № 22. P.372-378.

Džus V. 1981. Biostereometrische Underwasserausrüstung “Selenezkaja” // DDR, Bild und Ton, N7, Leipzig, 1981, S. 192, 214-215.

Yuksha V.V. 1979. Experience of used of the stereo photo plant “Zelenetskaya” for underwater photo survey – Pp. 5-21 in: Underwater methods in marine biological research. USSR Academy of Sciences Press, Kola Center, MMBI, Apatity.

1.4 Megabenthos of the Kola Bay (Barents Sea)

Yury Zuyev (RSHU) and Ludmila Pavlova (MMBI)

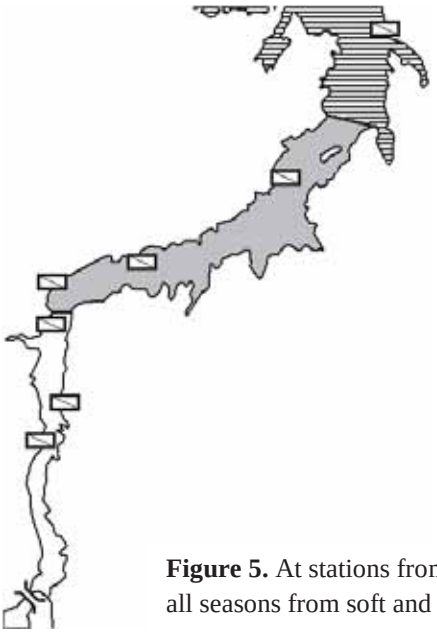

Figure 5. At stations from inner to outer Kola Bay, megabenthos was collected by using divers in all seasons from soft and hard bottoms in the period 2006 to 2009.

Kola Bay is the largest fjord of the Russian coast of the Barents Sea. However, the data on the current biodiversity and distributional patterns of large invertebrates are nearly absent. A detailed description of the fauna of the bay, including megabenthos, but without reference to the quantitative parameters, was performed in 1908–1909 by Professor K. M. Deryugin. Later studies were local or were focused at the distribution of certain commercial species.

The Laboratory of Underwater Research of the Russian State Hydrometeorological University and the Murmansk Marine Biological Institute studied the fauna and ecology of shallow-water megabenthos in the Kola Bay in all seasons in the period 2006 to 2009 (figure 5). The large invertebrates distribution on soft and hard bottoms was studied at 17 stations, which were located for specific sediment type on certain depths (the 0–40 m depth range in the northern and central parts of the bay, and the 0–20 m depth range in the southern part). In total, 39 species of megabenthos were found, which belonged to Anthozoa, Malacostraca, Gastropoda, Bivalvia, Asteroidea, Ophiuroidea, Echinoidea and Holothuroidea. The abundance and biomass of large individuals on soft and hard bottom have been identified for the first time. We have compared the abundance of macrobenthos and megabenthos and determined of the proportion of unaccounted megabenthos around benthic community.

We investigated the megabenthos habitat in the shallow-waters of the Kola Bay, and collected new data about hydrologic conditions and bottom surface in the areas of research. Effect of temperature, salinity and other hydrological factors on the species composition and abundance of large invertebrates were analyzed. In comparing modern species composition and biogeographical data of megabenthos with data of K.M. Deryugin, we identified of climate change impacts and registered the changes in species composition. We obtained data

on the effect of the complex of external factors on the composition and distribution of megabenthic faunal groups of Kola Bay. This enables prediction of the benthic community's composition on the basis of measured hydrologic and geomorphic data on the environment.

What equipment has been used

The megabenthos was investigated using diving equipment and underwater cameras. Distribution was studied using the frame with a 1 m^2 sampling area. Small and underground animals (individuals) were collected using a diving grab an area of 0.0625 m^2 equipped by removable net for samples. Hydrological data on were obtained using a sonde SEA Berds YS-120.

What is need to be done in future and how?

To complete the work are planned explore megabenthos over the entire range of hydrological conditions of the Kola Bay. To achieve this goal it is necessary to find the boundary distribution of marine species and to research macroinvertebrates of the most freshened area. Also it will be investigated megabenthos of open sea coast of the Barents Sea. Thus, we will obtain data about megabenthic communities in the whole range of hydrological conditions from the river to the sea.

This will create a basis for predicting the composition of communities on the basis of environmental data. In the future we plan to continue periodic monitoring in the shallow-water subtidal zone of the Kola Bay, which will monitor further changes in megabenthic communities due to climatic changes and human impact in the whole range of conditions of the Kola Bay.

2 Sampling methods and analyzing of biological and geological seabed data for mapping and/or monitoring

2.1 Database, and maps of vulnerability to oil spills in the littoral and the coastal zone: Testing of complex algorithm for mapping the sensitivity of the coastline to oil spills

Vaschenko P.S. (MMBI), Kalinka O.P., Shavykin A.A.

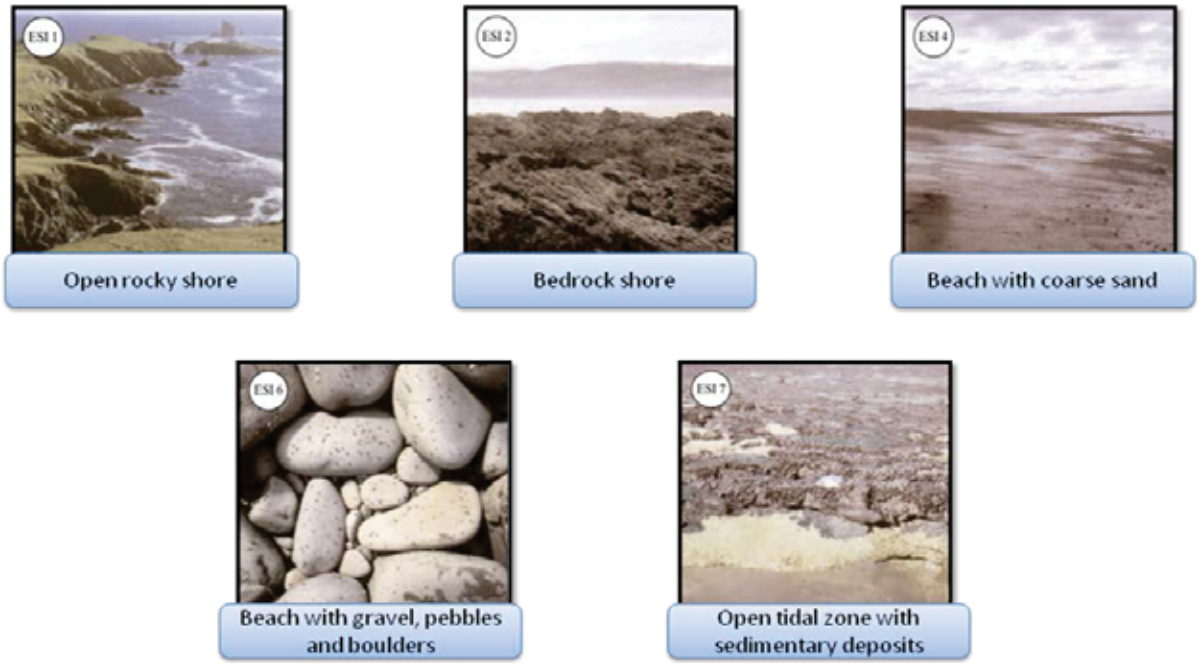

Figure 6. ESI index with codes (1-7) and image information

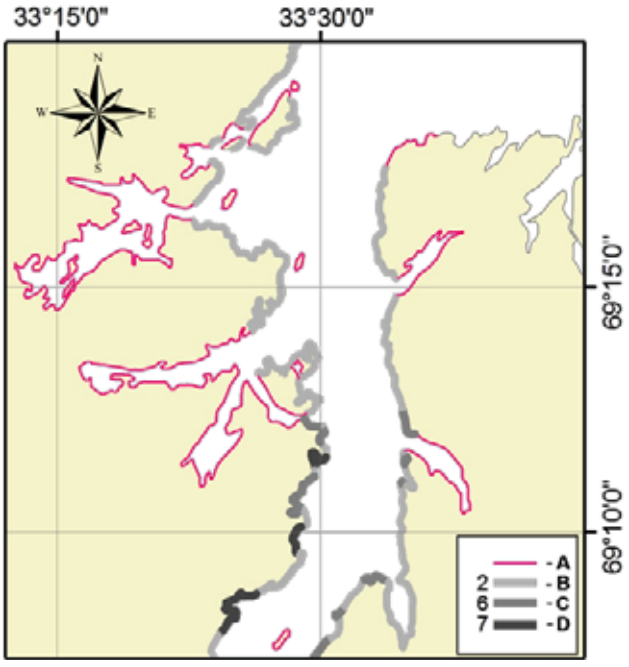

Figure 7. Schematic map of the shore line sensitivity to oil spill (Kola bay). A – shore line with undefined ESI index, B - D shore line with defined ESI index.

What has been done?

The shoreline of the Kola Bay was pictured during the expedition.
The database of pictures and the type of shoreline was formed.
The map of coastline types of the Kola Bay was formed based on ESI indexes.

What equipment has been used?
ESRI Program software, Sony A-300 camera.

What is needed to be done in future and how?
Shore line of all Kola Peninsula should be mapped using ESI index, which is necessary for assessment of shoreline sensitivity to oil spills.

2.2 Bottom sediments of Barents Sea: distribution and sorption capacity

Gennady I. Ivanov (SEVMORGEO)

Monitoring of pollutants and the environment status of the Arctic Shelf bottom sediments are considered as an important research field. This type of field involves analysis of the sources and supply of pollutants, the migration pathways of the pollutants, and the mechanisms of transformation and accumulation of the pollutants in the sediment. This type of analyses also involves a selection of geochemical methods that need to be applied when assessing the bottom environment for different type of sediment. Techno-genesis is defined as the combination of mechanical, geochemical and geophysical processes connected with human activity. In this context the major objective of environmental investigations is to determine the techno-genic component and relate this to the degree of the prevailing sedimentation process. In terms of geochemistry this will also involve the measure of the concentration and dissemination of new and known chemical elements. All together will such an investigation, also termed as Eco-Geo-Chemistry Sedimentology (Ivanov et al1996, Ivanov, 2002, 2006), help to get an overview of the locations that has been inspected, the scale of the investigation, and the different methods used both in the field observations and in the laboratory studies.

Pollutants: the pathways of migration, and the mechanisms of transformation and accumulation.

The intensity of physical, chemical and biological processes in the water column and on the seabed is chaotic, and the transformation processes of the substances in the ocean and on the shelves are usually non-stationary. The sea has sharp changes in chemical and physical properties within relatively narrow zones due to active mixing in the interface of two meeting water masses. In such areas with sharp changes (mixing zones) a high intensity of natural processes usually occurs, and with different intensity on each side of these interfaces (Emelyanov, 1982). Therefore might these active surfaces be natural barriers while the rest of the sea are relatively homogenous, non-gradient and relatively chemically inert. This concept, which has been extensively developed during the last years, is based on the existence of external and internal active boundaries connected with fronts and the associated systems of dispersion, ecology and geology (sedimentation, hydrothermal, volcanic etc.). The large variety of contents and scales of boundary effects in the sea (from physical and physical-chemical and biologic processes, and from planetary fronts to the smallest suspended particles) highlight the importance of essential properties within these internal and external interfaces. It is within these interfaces-barriers increased transformation of substance occurs. The interfaces-barriers therefore serve as a source and as a controlling function of the integral systems of the sea. There are an extensive number, variety and complexity of natural barriers. It is therefore necessary to investigate the natural barriers, and to evaluate the methodology used in this study and particularly, to develop the theory of sedimentation studies and associated transformation of pollutants in relation to the natural barriers.

From the characteristic pattern of migrating chemical elements and the dominating sedimentation processes it is possible to distinguish the following types of the barriers:

mechanical (hydrodynamic), physical-chemical and biogeochemical, and by their spatial position - vertical, horizontal and not depending on the spatial position. We suggests that the main barrier zones classification for the Arctic shelf (Ivanov, 2002, 2006) are distinguished as: river-sea, littoral-ocean, sea-atmosphere, near-bottom water-sediments, mud water-sediment, photosynthesis layer, jump layer, "Atlantic water" layer, near bottom currents, divergences, other hydro-frontal interfaces, areas of submarine discharge, pellet flow (Figure 8).

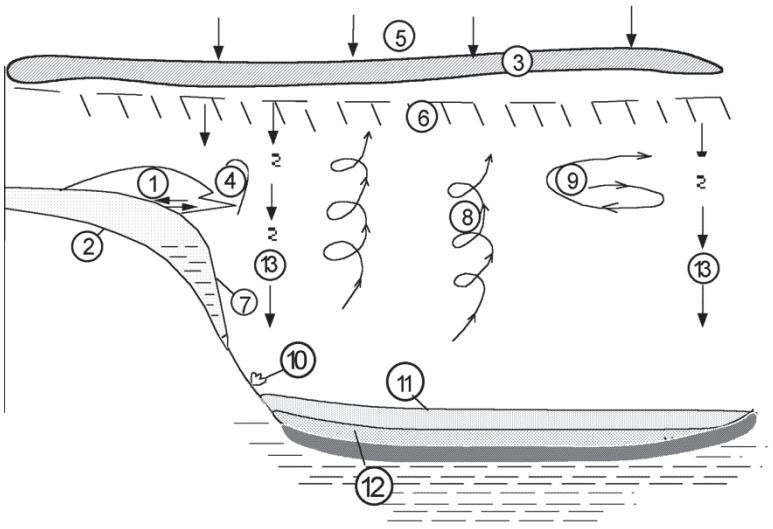

Figure 8. Principal Lithogenetic Ocean Barriers (after Ye.M. Yemelyanov's model, 1982**).**
1. river - sea; 2 – coast(littoral) - sea;
3 – photosynthesis layer;
4 – upwelling; 5 – sea - atmosphere;
6 – layer of discontinuity; 7 – bottom - deep current; 8 – divergences;
9 – other hydrofrontal divides;
10 - areas of subsea discharge of underground waters;
11 – natural water – sediment;
12 – muddy water – sediment;
13 – pellet flow
Produced by Sevmorgeo.

The most significant geo-chemical barrier is the water-sediment boundary. This boundary defines the character and the intensity of the interaction between the hydro-sphere and lithosphere. This barrier is also a sensitive indicator of the sedimentation. The indicators of the physical-mechanical condition can be measured in the laboratory of the research vessel, and includes i) moisture (relative and at the liquid limit), ii) fluidity boundary, iii) sediment contraction, and iv) specific penetration resistance. These indicators is then used when calculating the coefficients of the dehydration and condensation of mud, and also when calculating the sedimentation intensity and the coefficients of sediment contraction anisotropy (Svertilov, Ivanov, 1999).

Assessment of bottom environment

The assessment of the Pollution Level Concentration (PLC) of the shelf zone of the Arctic ecosystems, in terms of the eco-geochemical criteria, does not currently exist. We suggest adding the eco-geochemical parameters and criteria to the existing current methods. The background concentrations of the major groups of contaminants in the water and in the bottom sediments, calculated for various levels of complexity of geological objects, is a geochemical criteria that should be measured trans-regionally for the Barents Sea (Ivanov et al. 1997), regionally for the White and Pechora Seas (Ivanov, Gramberg, Ponomarenko, 1999), local for the Shtockman gas condense field (Ivanov, 2003), the Prirazlomnoe oil field (Ivanov, Gramberg, 1999), the mouse of Pechora-, the Ob- and the Yenesey rivers, and as special depth-polygons for dumpsites of nuclides. To assess the degree of contamination of

marine near-bottom ecosystem, by a definite set of contaminants, it is possible to use the geochemical index of the contamination of bottom sediments (C_{sed}) and bottom water(C_{wat}) described in Ivanov and Gramberg (1999). Calculation of additional indicators of bottom sediments is based on the cumulative effect of the contamination degree, as so far there are no other quantitative characteristics of the mutual influence of various groups of contaminants. To eliminate errors connected with the methods of investigation and for inter-laboratories discrepancies, only values which exceed background concentrations more than one standard deviation, are taken into account. Investigation has shown that the pelite fraction of bottom sediment (Figure 9) is the major potential trap for contaminants. It is therefore obligatory to normalize the summed content of the pelite fraction in order to get a correct correlation between the natural level of contaminant and the potential possibility of its accumulation in the sediment.

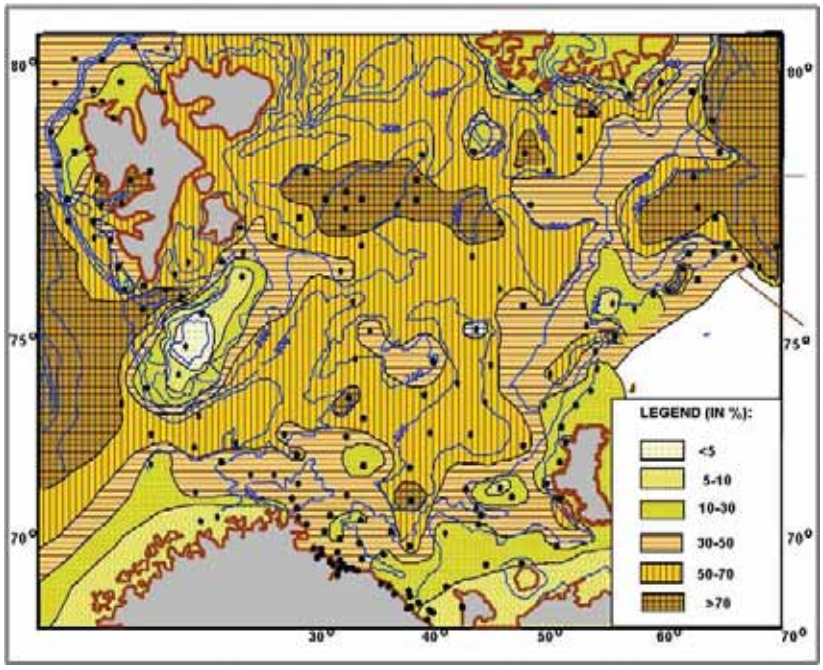

Figure 9. Sediment map of the Barents Sea as an example of maps produced by Gennady Ivanov (SC Sevmorgeo).

The heave metal, radionuclide activity, PAHs, and the content of various fractions of poly-cyclical aromatic hydrocarbons were investigated trans-regionally in the Barents Sea, regionally in the Pechora Sea and St.Anna Trough. The results showed that the concentrations of these chemical compounds vary abruptly at the boundary between pelites and aleuropelites. This point toward a lithological eco-geo-chemical barrier, that restricts the accumulation of pollutants in the sediment. A map showing the pelite fraction content in the Barents Sea (Figure 9) can be used to set pollution norms.

Emelyanov E.M. Sedimentation in the Atlantic ocean. Moscow, Nauka, 1982, 190 p. (in Russian).

Gennady I. Ivanov Methodology and results of ecogeochemical investigation of Barents sea.//VNIIOkeangeologia, SPB, 2002, 155 pp.

Gennady I. Ivanov Geoecology of Western Arctic Shelf of Russia: lithological and ecogeochemical aspects.// SPb, Nauka, 2006, 303 pp.

Ivanov G. I. Pollutant Concentrations in Bottom Water of the Shtokman Condensed Gas Deposit//Transactions (Doklady) RAS, v.390, N 4, 2003, pp.1-7.

Ivanov G.I., Gramberg I.S., Ecogeochemical parameters and criteria of assessment of the environment of the Western Arctic Shelf of Russia. In.: Development of the Russian Arctic Offshore (RAO-99), St. Petersburg, CNII A.N. Krylov, v.1, 1999, p. 370-378.

Ivanov G.I., Gramberg I.S., Kryukov V.D. Levels of concentrations of pollutants in bottom marine environment of the Western Arctic Shelf. Transactions (Doklady) RAS, v.355, N 3, 1997, pp.365-368

Ivanov G.I., Gramberg I.S., Ponomarenko T.V., Geoecology of Arctic shelf: methodology. Exploration and protection of Earth's interiors, v.12, 1996, p. 122-132

Ivanov G.I., Gramberg I.S., Ponomarenko T.V., Levels of concentrations of pollutants in bottom marine environment of the Pechora Sea. Transactions (Doklady) RAS, v.365, N 5, 1999, pp.689-693

Ponomarenko T.V., Ivanov G.I. Assessment of the environmental conditions of Western Arctic Shelf of Russia by biotesting methods. In: Geology of the seas and oceans. Moscow, Oceanology Institute RAS, v.2, 1997, pp. 98-100

Svertilov A.A., Ivanov G.I. Physical-mechanical properties of surface sediment layer and classification of sedimentation environments in the St. Anna Trough. Berichte zur Polarforschung, v. 342, 1999, p.183-205

2.3 Contour (3d) maps as a tool for regression analysis in the Barents Sea ecology

Stanislav Denisenko (ZIN)

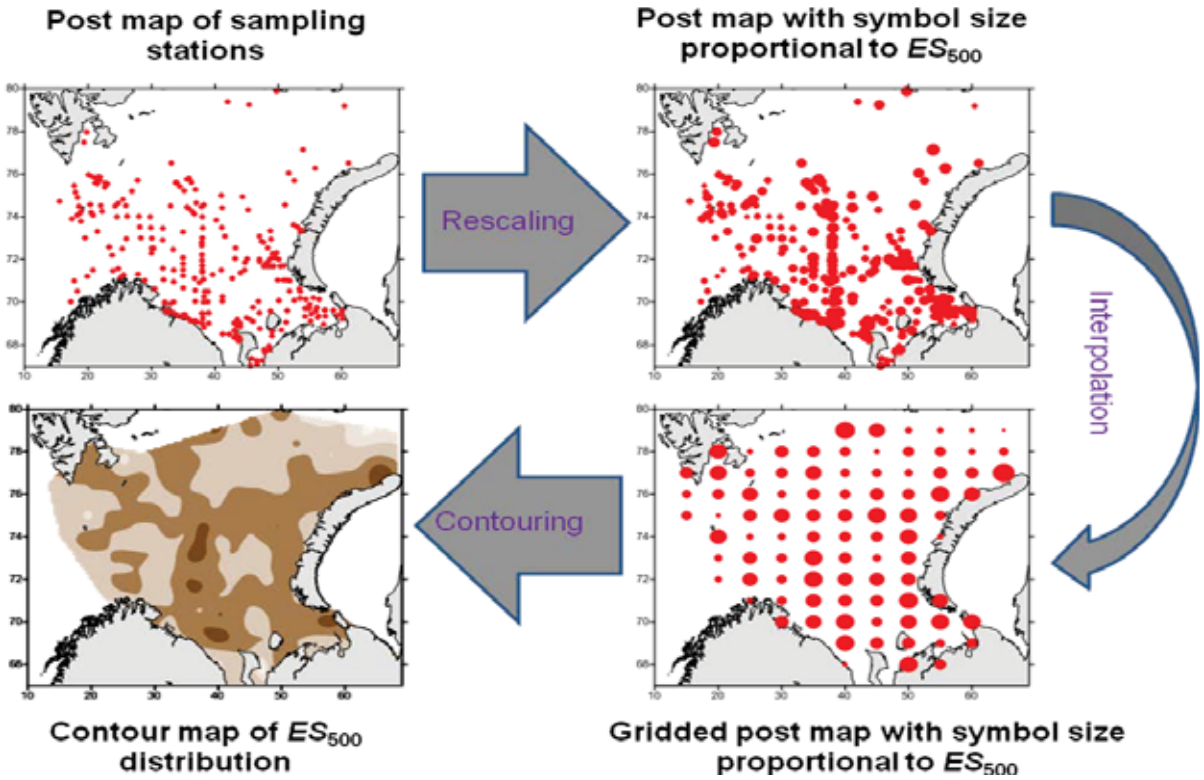

Figure 10. Schematic illustration of building the interpolation grids and contour maps, which show spatial distribution of ES500 for macrozoobenthos in the Barents Sea.

The method allowing to use different maps for regression analysis was suggested. It is based on comparison of interpolation grids with the same spatial parameters. These grids can be computed for any type of mapped datasets. The described method has been used for regression analysis of the Barents Sea zoobenthos. It allowed to find out many relations between different zoobenthos and environmental parameters and make the known previously relations more clear and statistically reliable.

What tools have been used

Geostatistical methods and archive zoobenthos data were used for constructing this method.
What is needed to be done in future and how?

Next step will be focused on the beta-biodiversity and biogeographical gradients mapping. It requires a big amount of quantitative datasets from the Arctic seas. They must be available for analysis.

2.4 The MAREANO program - Seabed topography mapping in Barents Sea

Hanne Hodnesdal (NMA)

MAREANO has the following dataflow: First Norwegian Mapping Authority Hydrographic Service (NHS) is responsible for collecting bathymetry data. These data are used by Institute of Marine Research (IMR) and Norwegian Geological Survey (NGU) to plan common geological, biological and chemical surveys. After this second survey all data are analysed and combined to produce a variety of results and maps that can be used to develop the Norwegian management plans.

Bathymetry data has been collected by multibeam echo sounder (mostly EM710) mounted on a surface vessel. Backscatter data and water column data has also been collected. The areas that have been covered in the period 2005-2011 are shown as coloured areas in figure 9. The areas has been surveyed partly by own vessel and mainly by purchase of bathymetry surveys.

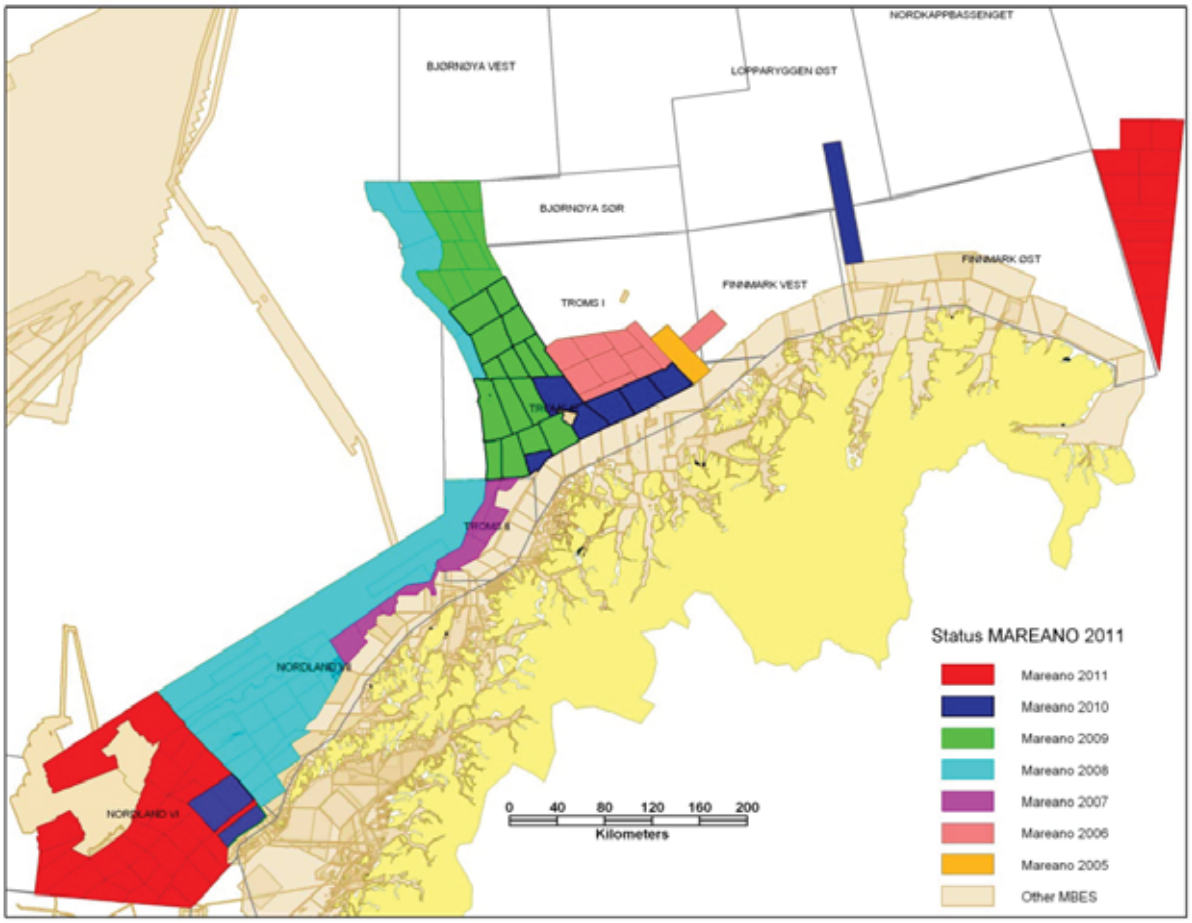

Figure 11. MAREANO bathymetry surveys in the period 2005-2011.

Bathymetry data from different other sources have also been used: Defence, gas- and oil industry, universities and other projects.

There are still a lot of areas that are not covered by multibeam echo sounder data, as shown in Figure 12.

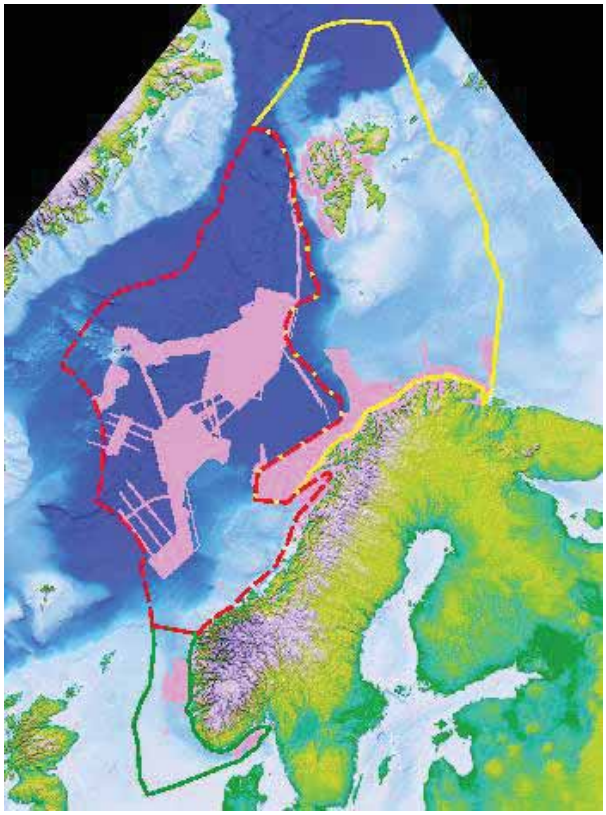

Figure 12. Coverage multi beam echo sounder data in Norwegian waters.

Other projects that have collected multibeam data are for example common Norwegian-Russian surveys with R/V Academik Nikolaj Strakhov. These data are not included in Figure 11.

The Norwegian Company Olex has collected a lot of single beam echosounder data from many different fishing boats. The company has combined all these data to make a depth model as shown in Figure 13.

IBCAO (International Bathymetric Chart of the Arctic Ocean) collects bathymetry data north of 64 degrees north to make terrain model of the seabed in this area. In 2012 IBCAO will make a new version of this terrain model with resolution down to 500m x 500m where possible. Norway is represented in the editorial board by Norwegian Mapping Authority Hydrographic Service and Russia is represented by Geological Institute of Russian Academy of Science (GIN RAS).

In October 2010 Arctic Regional Hydrographic Commission (ARHC) was established by the five Arctic Coastal States; Canada, Denmark, Norway, the Russian Federation and the United States. The aim of this organization is to exchange knowledge and information by providing quality assured data to facilitate an environmentally responsible exploration of Arctic waters, and to contribute in the development of the maritime infrastructure required for safe

navigation and protection of the marine environment. Participating from Norway is Norwegian Mapping Authority Hydrographic Service and from Russia is Hydrographic Service of the Russian Federation Navy

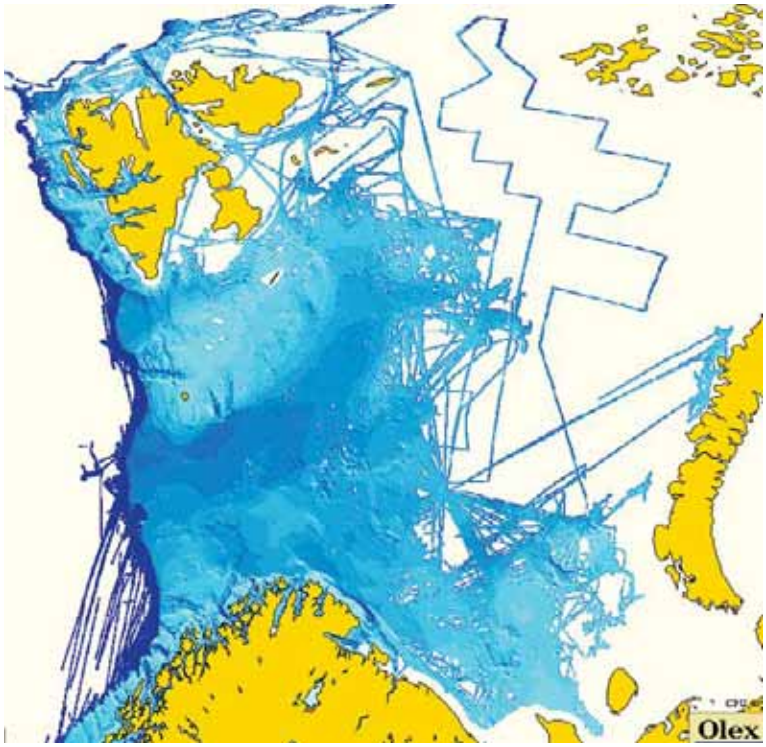

Figure 13. Olex depth data**:** Combination of single beam echo sounder data from many different fishing boats.

2.5 Geological mapping for ocean management in the Barents Sea – results and plans in Norway

Terje Thorsnes (NGU)

Figure 14. Sampling area for producing geological maps.

Geologial mapping within the MAREANO is done in order to provide knowledge on the physical part of the seabed habitats, and to provide general seabed geology maps (Sediment grain size, sediment genesis, sedimentary environment, backscatter strength, and landscape&land forms – for more information visit www.mareano.no). The process from data acquisition to published maps, reports and papers are typically:

- an initial phase where existing multibeam bathymetry with backscatter, or regional bathymetry data, are analysed and used to design the sampling program. Unsupervised classification using ArcGis tools such as BenthicTerrainModeler, extracting indices like BPI (BathymetricPositionIndex) forms an integral part of this. Available high resolution seismic lines are also used in the design phase.

- the next phase is cruises, usually using the IMR vessel G.O.Sars. This vessel is used for high resolution video recording (700 m long transects), geological sampling with grabs and box corers, and geochemical sampling with a multicorer. It is also equipped with TOPAS PS18 chirp, which gives very high resolution seismic data. The sampling of geological and geochemical material is done in sequence with the biological sampling by IMR. The video transects are analysed visually onboard.

- After the cruises, the geological and geochemical material is brought to the laboratories of NGU and IMR (geochemical, for organic contaminants). Standard analysis includes XRI studies of cores, grain size analysis, TOC/TC analysis and geochemical analysis using GV-AAS and ICP-MS.

- After completing the analyses, all available data are integrated in an ArcGis environment, including multibeam bathymetry and backscatter, any seismic data, video observations, grain size data and geochemical data. For the geological maps, these are produced by digitising the borders between different geological units. For the habitat/nature type maps, the geological data and acoustic data are integrated with biological data, using the MAXENT software.

- The final stage is to publish all maps and accompanying reports on the publicly available Internet portal www.mareano.no. All maps are available in both Norwegian and English.

2.6 Biological sampling and analyzing methods in the ongoing Norwegian baseline off-shore mapping

Børge Holte (IMR)

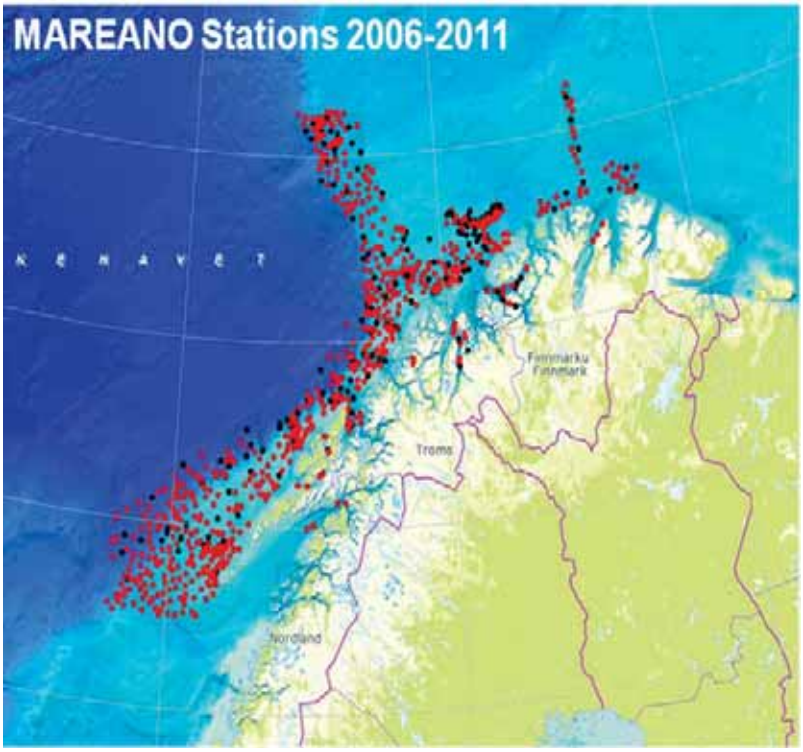

Figure 15. Benthos stations covered by the Norwegian program MAREANO. Red dots: video transects, black dots: video, grab, trawl, sledge, boxcore, multicore.

During the period 2006–2011 MAREANO has mapped 89 700 km^2 sea bottom within Norwegian seas using video combined with benthic sledge, beamtrawl and grab (see Fig. 12). By using these complementary sampling gears, total biomass and benthic production data from infauna, epifauna and hyperfauna are collected. 822 video stations, each consisting of one 700 m long transect, and 134 stations where all four sampling gears have been used, ranging from 30 to 2700 m depth have been sampled. Several new species to science have been found, and ten-fold of species that are new to the areas surveyed.

Bottom fauna in combination with geological information are mapped at each station, whereas continuous biotope classification maps – also between stations – is carried out by using backscatter echosounder signals that are calibrated towards physically sampled data and also by using modelling techniques. One of the main aims is to deliver biotope and information to be used in official decisional processes regarding exploitation of marine resources. However, there is an open access to the results at www.mareano.no.

The mapping of the Barents Sea is planned to be finished within 2020, while also the Norwegian Sea is to be mapped, partly parallel to, or after having finished the Barents Sea mapping. The project is nationally headed by a program group with representatives from several Norwegian directorates and a steering board consisting of representatives from four ministries. The project is financed by the Norwegian Government.

3 How to include Geo-Bio Mapping in the Norwegian and Russian Management Plan of the Barents Sea

3.1 Integrated management plan for the Barents Sea

Anne Britt Storeng (DN)

Figure 16. Map showing the three areas "Barents Sea", "Norwegian sea" and "North Sea" where Norway has/will produce Management Plans.

The decision to make the management plan was made by the government in 2002. That year the Norwegian government presented the report Protecting the Riches of the Seas – which we might call the Norwegian Marine Strategy.

The government also decided that an inter-ministerial group, led by the Ministry of Environment, should direct the preparation of the plan. Other ministries participating in the preparation of the plan was the Ministry of Oil and energy, Ministry of Fisheries and Coastal Affairs and the Ministry of Foreign Affairs. This was an important decision as we consider

cross-sectoral co-operation and integration to be a prerequisite for ecosystem-based management in practice and a key aspect of successful implementation of the plan.

The purpose of the management plans is to provide a framework for value creation through the sustainable use of natural resources and ecosystem services in the sea areas and at the same time maintain the structure, functioning, productivity and diversity of the ecosystems of the areas.

The management shall ensure that activities in the area do not threaten the environment and living resources and thus future opportunities for continued value creation. The management plan includes targets for a range of subjects on different levels:

Biological diversity – including fisheries
Pollution prevention – including hazardous substances
Acute oil pollution/environmental risk
Safe seafood
Value creation from economic activity

Different projects improves knowledge to the management plan: Environmental monitoring and research

Seabed mapping
Geological mapping
Seabird distribution
Screening of hazardous chemicals

The management plan will be flexible and regularly updated taking into account new knowledge and development. The first update took place in 2010.

3.2 Conservation of Arctic Flora and Fauna. Circumpolar Biodiversity Monitoring Program (CBMP) - Marine Plan

Lis Lindal Jørgensen (IMR)

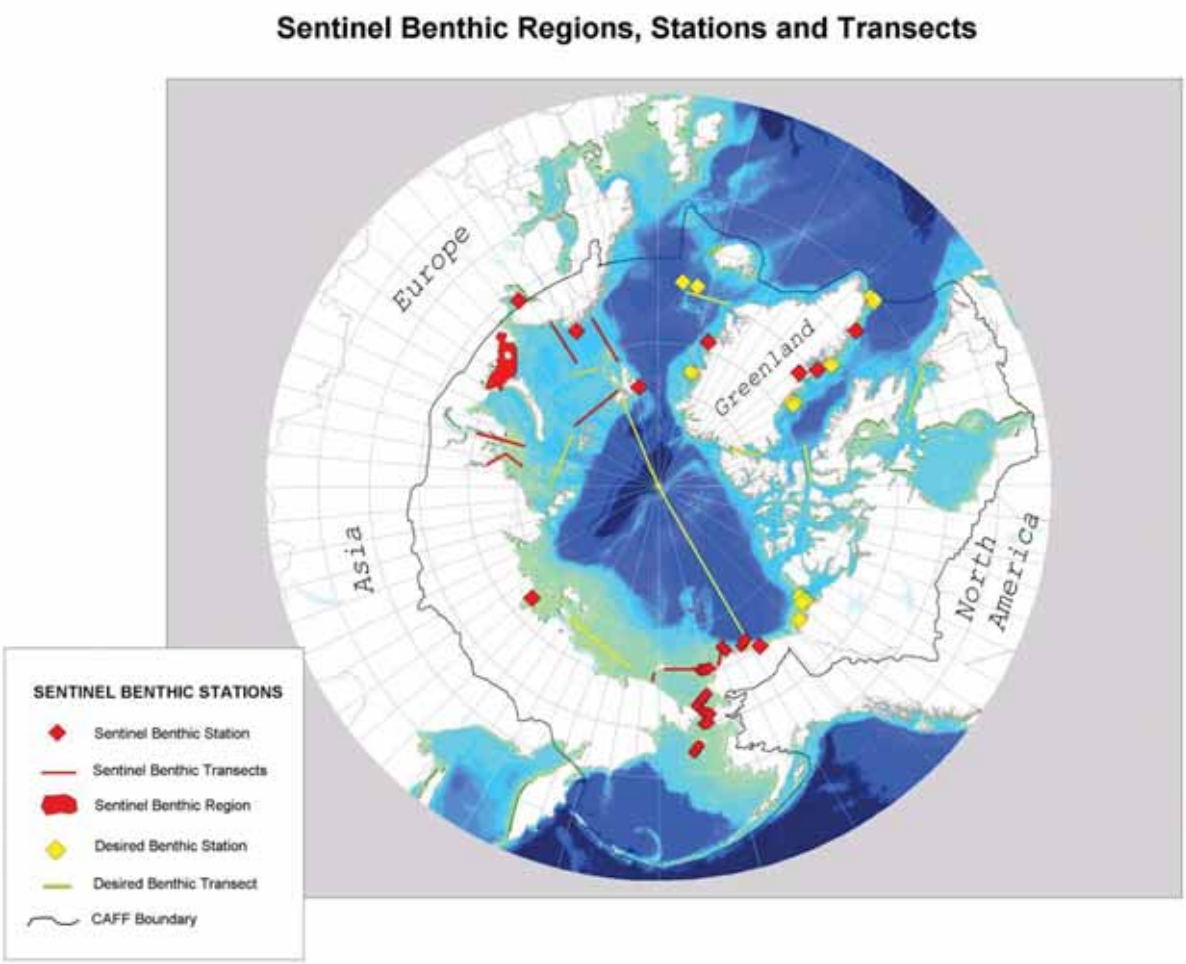

Figure 17. Map showing the Pan-Arctic area where Norway, Russia, Canada, USA, Greenland, Island and the Faroe Islands are making monitoring plans for benthic fauna.

The Circumpolar Biodiversity Monitoring Program (CBMP) is an international network of scientists, government agencies, Indigenous organizations and conservation groups working together to harmonize and integrate efforts to monitor the Arctic's living resources.

The goal of CBMP is to facilitate more rapid detection, communication, and response with respect to the significant biodiversity-related trends and pressures affecting the circumpolar world. The CBMP is the cornerstone program of the Arctic Council's Conservation of Arctic Flora and Fauna (CAFF) Working Group. The CBMP has been endorsed by the Arctic Council and is the biodiversity component of the Sustaining Arctic Observing Networks (SAON).

Between 2008 and 2011 Norway (Reidar Hindrum, Directorate of Nature Conservation) and the United States (Kathy Crane) led the Marine Expert Monitoring Group (MEMG). From 2011 Canada (Jill Watkins) with members from Russia (Vadim Olegovich Mokievskiy),

Denmark/Greenland (Aili Lage Labansen), Iceland (Gudmundur Gudmundsson), and the Faroes (Jan Sørensen) along with the Arctic Council Working Groups **AMAP (**Jason Stow), **PAME** (unconfirmed) and the CBMP Secretariat **(**Mike Gill).

The Marine Expert Monitoring Group's goal was to promote, facilitate, coordinate and harmonize marine biodiversity monitoring activities among circumpolar countries, and to improve ongoing communication amongst and between scientists, community experts, managers and disciplines both inside and outside the Arctic.

The Benthic Marine Expert Monitoring Group consist of Canada (Philippe Archambault), USA (Katrin Iken), Norway (Lis L. Jørgensen), Greenland (Thomas Juul Pedersen) and Iceland (Gudmundur Gudmundsson). During 2011 an Invitation to Pan-Arctic Monitoring of Benthos will be circulated to all Pan-Arctic countries.

Further information:

- The Arctic Biodiversity Marine Monitoring Plan
- Marine Ecosystem Monitoring Background Paper

Discussion

- Whole coverage of the Barents Sea with benthic biomasse distribution (PINRO) – how to plot these biological data onto geological maps? But need financing for processing (bring the sorted samples to species identification and measuring) existing grab samples taken on historical stations in the Barents Sea (PINRO).
- Need of compilation of all Barents Sea geological (NGU, Sevmorgeo) and biological (PINRO, MMBI, ZIN, IMR) data within and between Russia and Norway by corporative working plans.
- Possible meeting between NGU and SEVMORGEO to discuss what geological data exists and possibilities for corporative work between NGU and Sevmorgeo.
- Sevmorgeo have geological data (1:1 mill scale) for the entire Barents Sea available on the internet.
- Use of the former ”Grey-zone” and ”Smutthullet” as a case for corporative work between Russia and Norway and biological (PINRO, MMBI, ZIN, IMR) and geological institutes (NGU and Sevmorgeo).
- Standardising of benthic data between institutes
- Financing of scientific work within the environmental area and fishery area is different between countries and institutes.
- Need of cross linking of Environmental and Fishery financing.
- Need for guidance from Russian authorities on what they want for the Russian Management plan and financing for realizing this work.
- Financing on Norwegian and Russian side is very different and not synergistic as it is today (only Norwegian money).
- Russian biological and geological institutes have much data that can be used in Management plan, but need of coordinating and finance.

An ATLAS should be made showing the geological (NGU/ Norwegian Mapping Authority and Sevmorgeo) and the biological (PINRO, MMBI, ZIN and IMR) work done by all institutions. This ATLAS should contain map on geological sediment maps, pollution maps, benthic biomass maps, productivity maps, plankton productivity maps, map of vulnerable habitats etc. This ATLAS should be printet in paperform in order to be given to the Norwegian and Russian ministries, but also be available on the internet. The www.Barentsportalen.no, among others, might be choosen.

It was agreed by all partners that SEVMORGE shoud take responsibility to arrange next workshop in the localities of Sevmorgeo in St. Petersburg during 2012.

The workshop will discuss and plan which data and which form of data should be brought forward by the partners for the maps inside the ATLAS.

Conclusion

This workshop has brought forward knowledge on what biological data is available at PINRO/IMR and geological data is available at Sevmorgeo for a total coverage of the Barents Sea. MMBI has shown investigations from the south eastern Barents Sea. It is not known at present what biological data is available at ZIN at present.

A workshop in and arranged by Sevmorgeo is planned for 2012, and an Atlas should be planed and started on the workshop in 2012 at Sevmorgeo.

List of Participants

Pavlova L. Murmansk Marine Biological Institute (MMBI), Murmansk, Russia

Denisenko S. Zoological Institute of St. Petersburg (ZIN), Saint-Petersburg, Russia

Kalinka O.P. Murmansk Marine Biological Institute (MMBI), Murmansk, Russia

Vashchenko P.S. Murmansk Marine Biological Institute (MMBI), Murmansk, Russia

Shavykin A.A. Murmansk Marine Biological Institute (MMBI), Murmansk, Russia

Lyubina O. Murmansk Marine Biological Institute (MMBI), Murmansk, Russia

Zimina O. Murmansk Marine Biological Institute (MMBI), Murmansk, Russia

Frolova E. Murmansk Marine Biological Institute (MMBI), Murmansk, Russia

Ivanov G.I. Northern State Scientific-Production Company of Marine Geological Prospecting (State Company "SEVMORGEO"), St. Petersburg, Russia

Anisimova N. POLAR RESEARCH INSTITUTE OF MARINE FISHERIES AND OCEANOGRAPHY **(**PINRO), Murmansk, Russia

Lubin P. POLAR RESEARCH INSTITUTE OF MARINE FISHERIES AND OCEANOGRAPHY **(**PINRO), Murmansk, Russia

Manushin I. POLAR RESEARCH INSTITUTE OF MARINE FISHERIES AND OCEANOGRAPHY **(**PINRO), Murmansk, Russia

Viaznikova V. POLAR RESEARCH INSTITUTE OF MARINE FISHERIES AND OCEANOGRAPHY (PINRO), Murmansk, Russia

Zaharov D. POLAR RESEARCH INSTITUTE OF MARINE FISHERIES AND OCEANOGRAPHY **(**PINRO), Murmansk, Russia

Fomin S. WWF Murmansk

Storeng A.B. Directorate of Environmental Research (DN), Trondheim, Norway

Bysveen I. Directorate of Environmental Research (DN), Trondheim, Norway

Thorsnes T. Geological Survey of Norway (NGU), Trondheim, Norway

Hodnesdal H. The Norwegian mapping authorities (SKSK), Stavanger, Norway

Holte B. Institute of Marine Research (IMR), Tromsø, Norway

Jørgensen L.L. Institute of Marine Research (IMR), Tromsø, Norway

Sætran G. Department of information at IMR

Lund V. Institute of Marine Research (IMR), Tromsø, Norway

Appendix 1 The involved institutions

The Institute of Marine Research (IMR) is the largest scientific marine biological institute in Norway and holds a large national and international scientific network. The institute has a national goal within marine science and as an advisory organ for the management of the marine ecosystems in all the Norwegian Seas. IMR has 700 employees and operates five scientific research vessels (1600 survey hours/year) and rents commercial vessels (1000 hours/year). Science and advises from IMR is fundamental for a national sustainable harvest of marine recourses in the ocean and coasts. The cooperation with Russian scientific institutions covering the ecosystem in Barents Sea is a central part of the work of IMR. IMR and the Polar Institute of Marine Biology and Oceanography (PINRO) in Russia have had a formal and active cooperation in marine research since the 1950is.

Polar Research Institute of Fisheries and Oceanography, NM Knipovich (PINRO) is the oldest scientific institution in the northern Russia, the successor to the Ship-based Marine Research Institute established by V.I.Lenin's Decree in March 1921. In 1935, PINRO was named after N.M.Knipovich, an honorary member of the USSR Academy of Sciences, renowned as the founder of fisheries research in the Russian North. Marine areas studied by PINRO are the Barents and White Seas, the North Atlantic, the Greenland and Kara Seas, the Laptev Sea, the Arctic Basin and other marine areas. The main objectives of the institute's research are the development of scientific advice for rational fisheries and the provision of scientifically substantiated forecasts of resource supply and fishing conditions. A comprehensive approach to these research objectives helped PINRO establish its own scientific school and become a centre for scientists' training. PINRO is one of the fisheries research centres on a global scale. Its scientific cooperation with foreign institutions is based on the assumption that the oceans of the world make up an integrated system, and only a concerted effort of many nations can reveal its mechanisms and contribute to rational harvesting of its resources. PINRO cooperates with such reputable international fisheries organizations as ICES, NAFO, NEAFC, NASCO and NAMMCO. It represents Russia's interests at the meetings of intergovernmental Russian-Norwegian, Russian-Faroese, Russian-Icelandic commissions and at Russian-Greenlandic Consultations. The institute possesses a wealth of scientific expertise, with more than 60 scientists having a PhD degree. Every year over 400 scientific papers are being published in Russia and abroad. PINRO researchers make a great contribution to the sustainability of fisheries and conservation of biological resources in the arctic seas.

The Geological Survey of Norway (NGU) is the country's central institute for the collection, processing and distribution of information on the bedrock geology, supercial deposits, mineral resources and groundwater of mainland Norway. NGU is a government agency under the administration of the Ministry of Trade and Industry. NGU currently has 225 employees and an annual turnover of c. NOK 210 million. The agency also has its own public geoscience library.

Northern State Scientific-Production Company of Marine Geological Prospecting (State Company SEVMORGEO) is placed under the authority of the Federal Agency for Resources Management. Staff of the SEVMORGEO numbers over 230 specialists including 6 Doctors of Science, 4 professors among them, and 26 Candidates of Science (Phd). Main activity of SEVMORGEO are multidisciplinary geochemical investigation; engineering geology and geological environment monitoring in shelf; multidisciplinary geophysical investigations of the Earth crust deep structure; 2D, 3D& 4C seismic survey in transition (shallow water) zone; complex seismic, gravity and magnetic data processing and interpretation; geology of ARCTIC Shore and Islands; development of technologies and design of equipment for geophysical, engineering and geological prospecting in the World ocean and in offshore zones; economical, juridical and managing support of natural resources control systems; marine geological prospecting Analysis System.

Norwegian Mapping Authority (NMA) is the national provider and administrator of geodesy, geographical and cadastre information covering Norwegian land and waters. NMA has 850 employees.

The Norwegian Hydrographic Service (NHS) is a part of NMA. NHS is responsible for surveying of all waters within the Norwegian Exclusive Economic Zone, including polar waters and for preparing and updating nautical charts and descriptions of these waters. NHS has the national responsibility for the management of bathymetric data. The activities also include studies of tides and currents and publishing tide tables. NHS has the operational responsibility for the international electronic navigational chart (ENC) distribution centre Primar. NHS represents Norway in the International Hydrographic Organization (IHO) and is also represented in the Nordic Hydrographic Commission, the North Sea Hydrographic Commission, the South Africa and Island Hydrographic Commission, the Hydrographic Commission on Antarctica, Arctic Regional Hydrographic Commission (ARHC), ESEAS (European Sea Level Service), GLOSS (Global Sea Level Observing System) and IBCAO (International Bathymetric Chart of the Arctic Ocean).

Murmansk Marine Biological Institute (MMBI) is the oldest institution of the Russian Academy of Sciences in the North of Russia. Since 1935 the Institute has been pursuing complex research of northern seas consistently expanding geography of activities from Dalnie Zelentsy Bay (Kola Peninsula coast) to the Greenland Sea in the west and the Laptev Sea in the east. In 1996 the Institute has included the southern seas of Russia into the scope of its interests, and since then both the Barents Sea and the Sea of Azov have always been the focus of MMBI research activities. MMBI fundamental and applied studies deal with actual problems of climate, marine periglacial, biologic productivity, quaternary and modern geology, aquaculture, bioresources and environmental safety. Primary tasks include investigations of ecosystem processes, and monitoring of the Northern Sea Route, nuclear fleet bases, offshore oil and gas deposits and other areas of the Arctic which are subject to man-caused influence. MMBI also develops marine biotechnologies, works out simulation models of oceanologic processes, and makes environmental assessments of coastal and

marine industrial projects. MMBI possesses three research vessels *Dalnie Zelentsy*, *Pomor*, and *Prof. Panov*. More than 20 sea and coastal expeditions are carried out annually.

Zoological Institute of the Russian Academy of Sciences (ZIN) is a leading research institution and one of the most significant zoological institutions in the world. Its scientific collections comprise approximately 60,000,000 items. These enormous collections became the basis for the development of a great number of fundamental scientific problems concerning the fauna of Russia and of the whole world, including such issues as species diversity of the animal world, its evolution and ecology. The Library of Zoological Institute has more than 500.000 scientific books and journals. All information concerning the book collection is assembled alphabetically by author and systematically by subject. Each of these catalogues contains over one million cards. Every year from 100 to 150 libraries borrow books from the Institute library, and the number of readers coming here approaches 12.000 individuals annually. The recent projects, in which the Institute participated, are following: "Biological Diversity of Russia ", "Lead Laboratory on Biodiversity of the Baltic", "Saline Lakes and Lagoons of Europe ", "Caspian Sea Biodiversity Project ", "An integrated system for zoological data bases ", "An interactive multi-entry polychotomous key for identification of organisms by intensive use of images", "The interactive identification programs for Internet users ", "Arctic Ocean Diversity (= Arctic Census of Marine Life)", "Census of Antarctic Marine Life", "Computer Network for Arctic Marine Fauna".

Russian State Hydrometeorological University (RSHU) is the first university in the world and the only educational institution in Russia for training experts in the field of Hydrometeorology. It was founded in 1930 in Moscow, transferred to Leningrad (at present Saint-Petersburg) in 1944 and named Leningradsky Hydrometeorological Institute. In 1992 it was renamed as State Hydrometeorological Institute of the Russian Federation. In 1995 the institute was declared as Regional Training Center of World Meteorological Organization (WMO). In 1998 it took the university status and since then it bears present name. At the present over 3 000 students study at the University including foreign students from all over the world. The RSHU’s diplomas are world-wide recognized. The University includes seven faculties: Meteorology, Hydrology, Oceanography, Ecology and Environmental Physics, Socio-Humanitarian Sciences, Corresponding Learning and Advanced Education.

JOINT

Institute of Marine Research
Nordnesgaten 50,
5817 Bergen
Norway

Polar Research Institute of Marine Fisheries and Oceanography (PINRO)
6 Knipovich Street,
183763 Murmansk
Russia

REPORT