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The Baltic Floating University: Training Through Research in the Baltic, Barents and White Seas – 1997

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ABSTRACT

The results of field work carried out in 1997 within the UNESCO-IOC-HELCOM Baltic Floating University (BFU) project are presented. In the summer of 1997, the BFU field work covered four different coastal environments: (i) the Murmansk coast of the Barents Sea; (ii) the tidal, saline, estuarine Kandalaksha Gulf in the semi-enclosed White Sea; (iii) the brackish, estuarine eastern Gulf of Finland; and (iv) the tideless, brackish western Estonian archipelago, which juts out into the semi-enclosed Baltic Sea. The areas studied experience significant impact from human activities, such as: the development of new port facilities in Luga Bay (eastern Gulf of Finland) and in Kandalaksha Gulf; mariculture development along the coasts of the Barents and White Seas; a tidal power station in Kislaya Bay (Barents Sea), etc. Socio-economic studies in the Kandalaksha District in the Murmansk region were, for the first time, included in the BFU programme as the essencial component of integrated coastal management.

ACKNOWLEDGEMENTS

In 1997, the Baltic Floating University (BFU) facility received financial support from: UNESCO's Environment and Development in Coastal Regions and in Small Islands (CSI) programme and the Hiiumaa Centre for the Biosphere Reserve of the West-Estonian Archipelago (HCBRWEA, Estonia) (for studies in the Muhu Strait); the Intergovernmental Oceanographic Commission (IOC) and the Russian Federation's Ministries of Science and Technology, and of Common and Professional Education (for studies in the Baltic proper); the State Committee on Fisheries; the White Sea Research and Technology Programme; and the Integration Target Programme Foundation (for studies in the Barents and White Seas).

Valuable assistance to the project was also provided by the Gulf of Finland Environment Society (SULA, Finland), the Baltic Sea Environment Protection Commission (HELCOM), the Head Department of Navigation and Oceanography (HDNO) of the Ministry of Defence of the Russian Federation, the National Oceanographic Committee of the Russian Federation, the Northwest Administration of the Russian Federal Service for Hydrometeorology and Environmental Monitoring, LENMORNIIPROEKT Co., the St. Petersburg City Government and the Leningrad District Administration.

The support of all the above-mentioned international organizations, governmental and non-governmental entities is gratefully acknowledged.

Thanks are due to several people in the various organizations responsible for making the 1997 BFU field campaign possible and whose individual effort helped to ensure the success of the project in 1997; they include: Dr. D. Nakashima and Dr. A. Suzyumov (UNESCO/CSI), Dr. G. Kullenberg and Dr. I. Oliounine (IOC), Mr. R.T. Coon (SULA Chairman), and Rear-Admiral Komaritsine (HDNO). The Director of LENMORNIIPROEKT Co., Mr. A.F. Pafernov, kindly provided invaluable data on the volume of Baltic Sea shipping.

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All other organizations, institutions and persons who assisted in the realisation of the BFU activities and took part in the implementation of the project in 1997 are gratefully thanked.

Mr. Ray C. Griffiths did the technical/linguistic editing of the present report. Publication of the report was made possible with the help of a grant provided by the Intergovernmental Oceanographic Commission. The present Report is prepared in accordance with the Memorandum of Understanding signed between IOC and RSHU in 1998.

INTRODUCTION

In 1993, UNESCO, in co-operation with the Russian State Hydrometeorological Institute (as of 1998, the Russian State Hydrometeorological University, RSHU), launched a new component of the "Floating University" project, the "Baltic Floating University" (BFU). Since 1995, BFU has been co-sponsored by the Baltic Marine Environment Protection Commission (HELCOM) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO; since 1996, its coastal components (and in particular socio-economic studies) have been co-sponsored also by the Environment and Development in Coastal Regions and in Small Islands (CSI) programme of UNESCO. BFU provides advanced training to undergraduate and postgraduate students and executes research projects in the fields of oceanography, marine ecology and integrated coastal management (ICM).

Two key areas were selected for the BFU fieldwork: (i) in the eastern Baltic Sea; and (ii) the coastal zone of the White and Barents Seas. From the ICM standpoint, these areas are important because of: (i) the development of new port facilities (port complexes in Luga Bay, eastern Gulf of Finland, and in Kandalaksha Bay, the White Sea); and (ii) present trends in marine coastal resource development (especially mariculture) in the coastal zone of the northern seas, and a tidal power station in Kislaya Bay in the Barents Sea, etc. Increased human activity leads, as a rule, to increasing environmental impacts, often negative for marine and coastal ecosystems.

The two areas mentioned above also include regions requiring nature-protection measures, wildlife and biodiversity conservation (Kandalaksha State Biosphere Reserve in the White Sea region, Kurgalsky Reef in the Gulf of Finland, etc.). Recognition of the need for environmental protection in these areas is increasing. The establishment of an international system of Baltic Sea Protected Areas (BSPAs) is on the HELCOM agenda; there is also a sub-regional initiative to create a protected area in the eastern Gulf of Finland that can be integrated into the BSPA system through the joint effort of governmental and public organizations of Finland and Russia. [Fokin, Yu.V. (1996). The SPNA (Strictly Protected Natural Area) "Gulf of Finland East System". *BFU Research Bulletin* No. **2**, p. 87. Helsinki.] It is for the foregoing reasons that the resolution of possible conflicts in coastal-zone development and coastal-resource use requires a broad approach to the environmental processes and interaction among the various actors. To ease pressure on the coastal zone, a combination of broad-scale and targetted (local level) coastal-management actions is necessary and one of the goals of a targetted approach is the establishment of protected coastal areas, in particular. [UNESCO (1993). Coasts. *Environment and Development Briefs* No **6**, 16 pp.]

The main lines of the BFU's action, aiming at the sustainable development of the coastal region, can be defined as follows:

- research activities covering marine (offshore) and coastal (onshore) areas
- strengthening of the socio-economic domain when implementing the BFU field programme (development of cross-sectorial co-operation through the involvement of the local administrations and the public in BFU activities)
- involvement of research staffs, students and young scientists in solving practical problems to achieve constructive, cross-sectorial dialogue between coastal management theory and practice
- introducing ICM into higher-education curricula
- learning from international experience in ICM and the related training, in particular.

Within the BFU framework, students are involved in integrated coastal management through field work. In 1997, they took part in collecting data on socio-economic conditions in the Kandalaksha area.

A good example of BFU co-operation with the public is participation in the annual "Days of the Living Sea" at Suomenlinna (a UNESCO world heritage site in the region of Helsinki, Finland). In view of the specificity of the ICM approach, which includes scientific investigations and the application of the research results, and taking into account the main BFU educational objective of improving training in ICM, it was proposed (Resolutions of the BFU Mid-Cruise Workshop, Helsinki, 27-28 August 1997) to determine the main BFU operational principle as "Training through Practice and Research" leading to the elaboration of integrated coastal management practices.

Training in interdisciplinarity is an important part of ICM. In 1997, RSHU (Faculty of Oceanography) launched a new educational programme leading to a degree in "Management" with specialization in ICM. To establish the above-mentioned course, an international seminar on "Teaching Integrated Coastal Management" was held in St. Petersburg (May 1997) with the support of the Ministry of Science and Technology of the Russian Federation and of UNESCO/CSI. [RSHU (1997). First International Seminar on Teaching Integrated Coastal Management. 29-30 May. (Abstracts). St. Petersburg, 48 pp.]

The BFU operations in 1997 included:

- Field Training Seminar (Russia-Germany) on Run-off and Coastal Waters (10-23 February, in the vicinity of St. Petersburg, Russian Federation)
- annual international BFU Planning Meeting (27-28 May, St. Petersburg, Russia)
- International Seminar on Teaching Integrated Coastal Management (29-30 May, St. Petersburg)
- field work (July) in the eastern Gulf of Finland aboard the HRV *Persey* and the sail catamaran *Orients* (July)
- expedition (July-August) to selected areas of the coastal zone of the White and Barents Seas
- oceanographic survey (August) in the Baltic proper by the HRV *Persey*
- international (Estonia-Russia-Finland) expedition (August-September) to the West-Estonian Archipelago aboard the catamaran *Orients*
- Fourth International UNESCO-IOC-HELCOM Baltic Floating University Mid-Cruise Workshop (27-28 August, Helsinki, Finland)
- Second International Conference on Rational Exploitation of the Coastal Zone of the Northern Seas (2-5 August, Kandalaksha, the White Sea region)
- participation of BFU representatives in the Baltic Marine Biologists (BMB — a regional NGO)
- Summer School on Eutrophication in the Baltic Sea (August, Kiel, Germany).

During the summer of 1997, the BFU fieldwork continued in four different coastal environments: (i) on the Murmansk coast of the Barents Sea; (ii) in the estuarine, tidal, saline Gulf of Kandalaksha in the (semi-enclosed) White Sea; (iii) in the estuarine, brackish, eastern Gulf of Finland; and (iv) in the tideless, brackish, West-Estonian archipelago in the (semi-enclosed) Baltic proper. The fieldwork thus covered a wide variety of coastal environmental conditions. [Coon, R.T. (1997). BFU. *HELCOM News,* No. **4**, pp. 13-21. Helsinki.]

In 1997, the BFU facility received financial support from UNESCO/CSI, UNESCO/IOC, the Hiiumaa Centre for the Biosphere Reserve of the West-Estonian Archipelago (HCBRWEA) within the HELCOM/BSPA programme, the Russian Federation's Ministry of Science and Technology, the Ministry of Higher and Professional Education, the Fisheries Department of the Ministry of Agriculture (now Ministry of Fisheries), the White Sea Research and Technology Programme and the Integration Target Programme Foundation (Russia). The total cost of the BFU expeditions in 1997 was about US$ 80,000. The Mid-Cruise Seminar in Helsinki (Finland) was organized with the kind assistance of the Gulf of Finland Environment Society (SULA).

The BFU Research Bulletin No.2 was published in 1997. The BFU activities were reflected in the mass media in Russia, Finland and Estonia. An overview of the BFU activities in 1997 was published in the HELCOM News. [Coon, R.T. (1997). BFU. *HELCOM News,* No. **4**, pp. 13-21. Helsinki.] Reports presented at the Second International Conference on the Rational Exploitation of the Coastal Zone of the Northern Seas (2-5 August, Kandalaksha, the White Sea region) will be published in Russian and English.

The present Report summarizes the BFU research results obtained in 1997; they have been compiled at RSHU by N.L. Plink, A.V. Nekrasov, G.G. Gogoberidze, Ye.Yu. Kliukov, S.V. Lukianov and M.B. Shilin. A review of the hydrological conditions of the Neva and Luga Rivers was prepared by G.N. Ugreninov (RSHU). Field work in the Luga River estuary was carried out by the staff and students of the RSHU Faculty of Hydrology (Chief Scientist, D.I. Isaev). The results of studies of the biological regime in the eastern Gulf of Finland were presented by specialists of the Northwest Administration of the Russian Federal Service for Hydrometeorology and Environmental Monitoring who took part in the *Persey* cruise (Chief Scientist, S.A. Basova). Material on the Baltic Sea maritime transport and port development was provided by LENMORNIIPROEKT (Director, A.F. Parfenov).

MAIN RESULTS OF THE BFU CRUISES IN THE BALTIC SEA AND THE GULF OF FINLAND

The main task of the field investigations in the Baltic Sea and the Gulf of Finland was to continue collecting, processing and analysing various environmental data (hydrophysical, hydrochemical and hydrobiological) and to study their variability in space and time. Also, the ecological conditions due to natural and human factors were evaluated.

Investigations in the central Baltic Sea (at the HELCOM stations, Fig. 1) allowed spatial variations of complex hydrological, hydrochemical and hydrobiological characteristics to be evaluated and their normal state to be determined. Temperature (Fig. 2) and salinity distributions there were typical of the summer season. The upper mixed layer was well defined; its average thickness was 15-20 m, with a temperature range of 14-22°C. The thermocline was sharper in 1996 than in 1997, when strong heating and weak mixing occurred in the Baltic Sea. The estimation of the average heat content by area of the 0-50 m layer of the Baltic Sea was 1.46 MJ/m^3 in August 1997, compared to 1.20 MJ/m^3 in 1996.

In the east Bornholm area (stations 5.1-5.5 and 5.8-5.14, Fig. 1), work was devoted to the study of the North Sea water intrusion through the Oresund, between Denmark and Sweden. Cluster analysis was used to distinguish the main types of sea water present in August 1997. Figure 3 illustrates the vertical profile of the water types in the Bornholm study area. A surface type was observed to a depth of 15 m. The deep-sea type was confined to the narrow part of the Oresund. The eastern section of this area (Fig. 3) is different from the western one in respect of the number and distribution of the water types. These two sections, although not far apart, had different characteristics in August 1997.

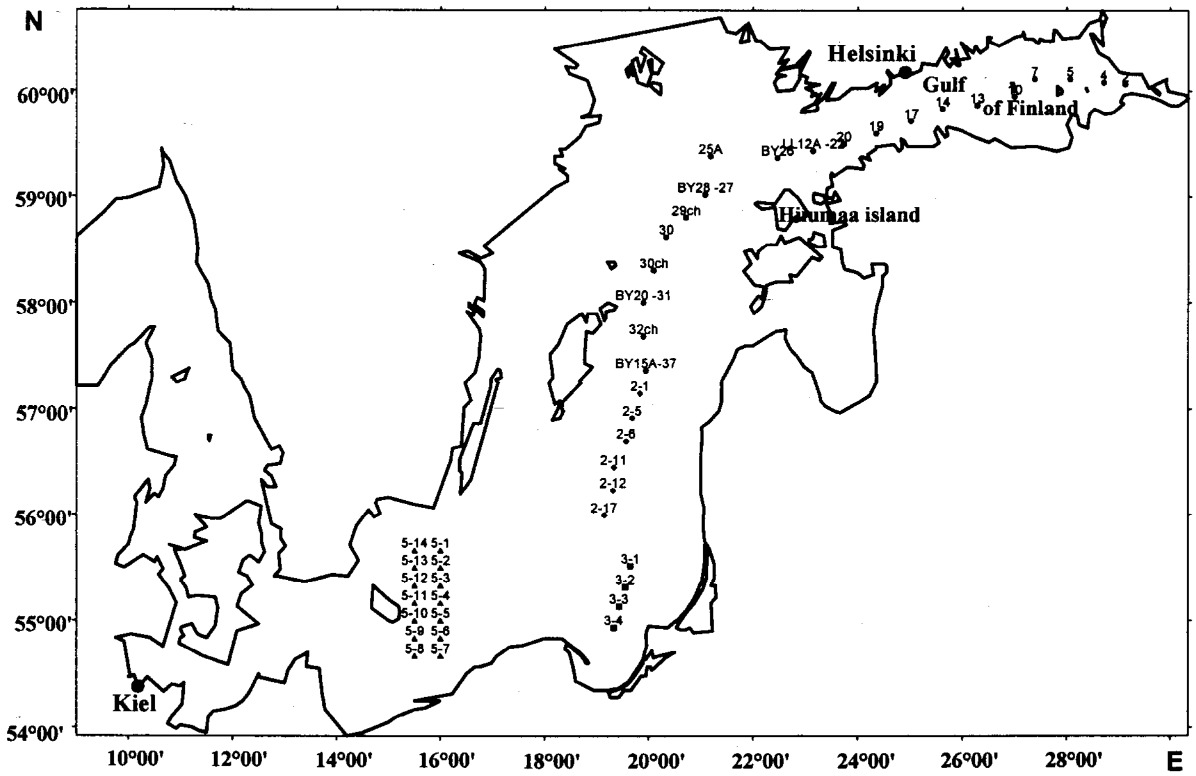


Fig. 1 Baltic Sea station arrays

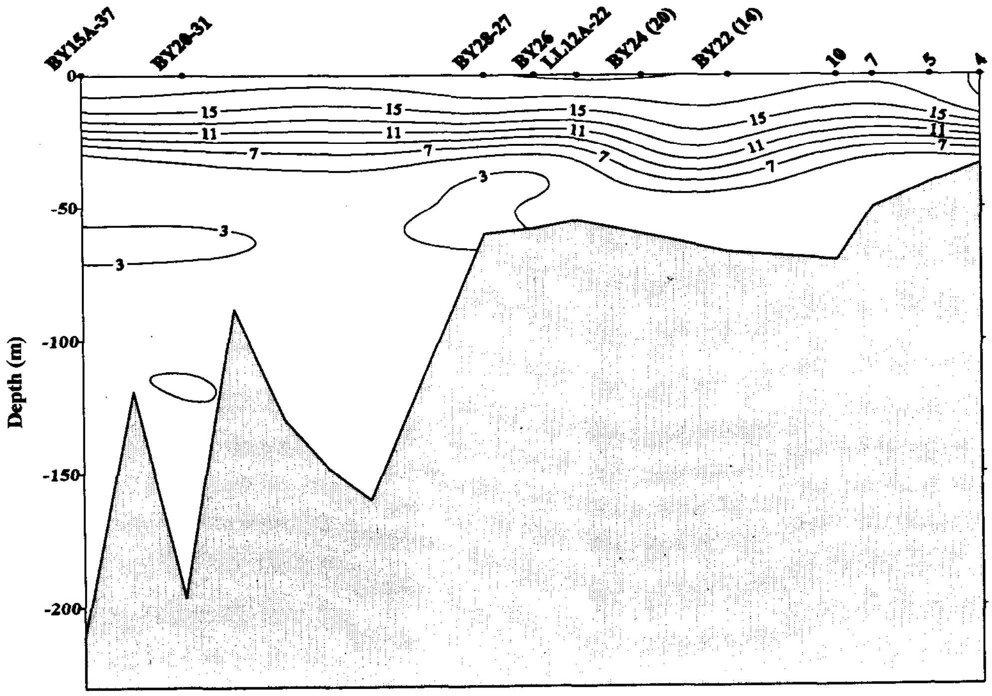


Fig. 2a Isotherms (contour interval: 2°C) along the HELCOM section in August 1996; thick black line shows the sea bottom (depth in metres).

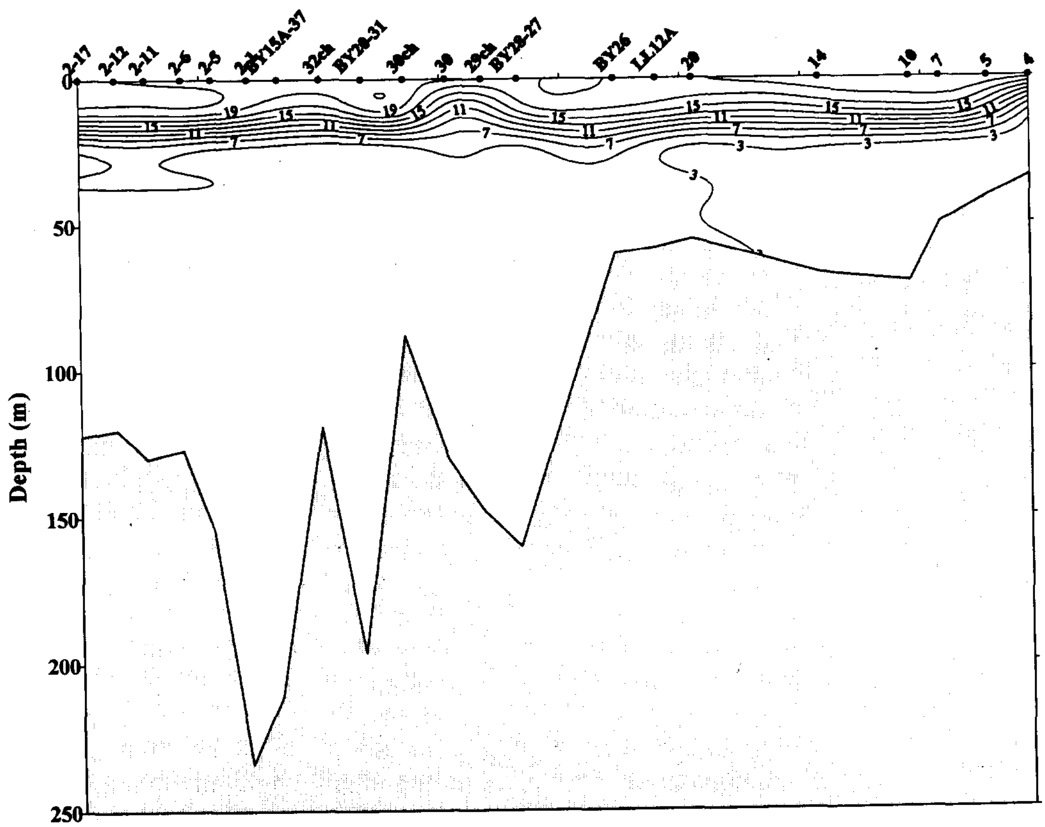


Fig. 2b Isotherms (contour interval: 2°C) along the HELCOM section in August 1997; thick black line shows the sea bottom (depth in metres).

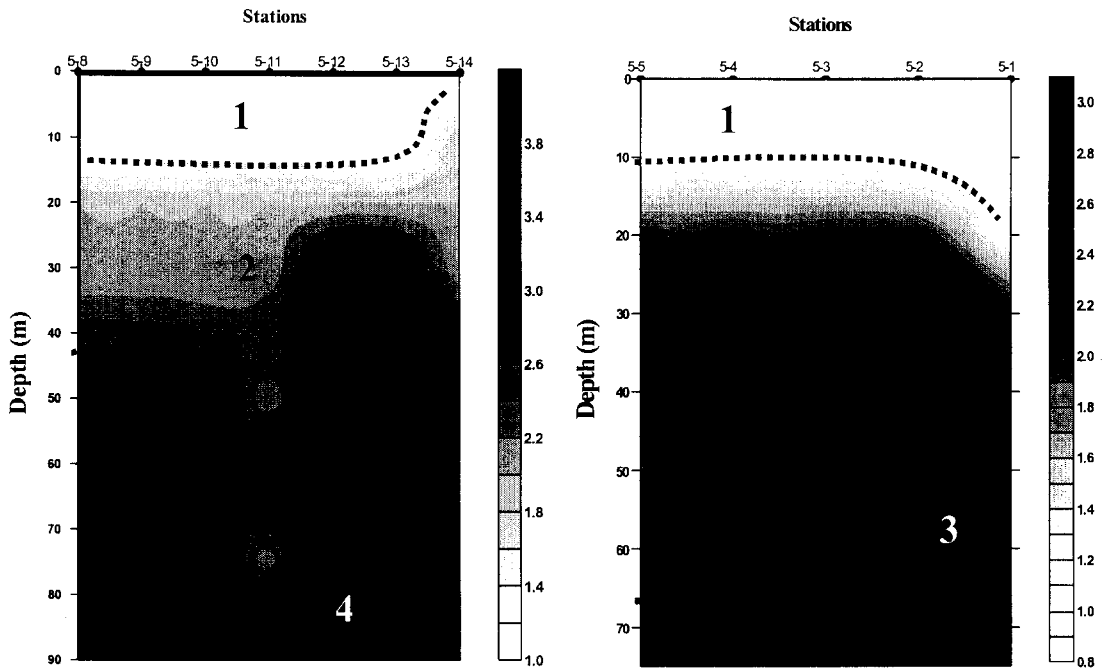


Fig. 3 Distribution of water types in the eastern section (right)
and western section (left) of the Bornholm study area, in August 1997.

As the index, the temperature change in the thermocline (thermocline depth was about 10-15 m) was 14-15 °C. The average temperature of the upper mixed layer was 21-21.5 °C and the average temperature of the layer under the thermocline was 5.5-7.5 °C. Salinity changed from 6-7 in the upper layer to 12-15 at depths of 50-60 m. The North Sea water (4) was restricted to depths of more than 70 m. It extended along the Bornholm Trench and was observed only in the western section.

The vertical distribution of plant nutrients in the Baltic Sea was characterized by: minimum values in the near-surface layer; increased concentration at the halocline; phosphate maximum and nitrite and nitrate minima in the Gotland Deep; phosphate and nitrate maxima and a nitrite minimum in the vertical profiles of the Bornholm area. The macro- and meio-benthic samples were collected in the central part of the Baltic Sea within the 20-230 m depth range. At shallow depths, with medium and coarse sands, the macro- and meio-benthos were rich in variety. At greater depths with grey and black oozes, the macrobenthos was practically absent or only single specimens of different animal groups were found. Small meio-benthic animals were present, but the taxonomic variety of the meio-benthos was not big, and quantitative characteristics (number and biomass) were tens to hundreds of times less than those in the eastern Gulf of Finland, for example, or in the shallow-water stations in the central part of the Baltic Sea.

Generally, the characteristics and composition of the benthos were typical for this season, and the characteristics of the central part of the Baltic Sea were close to normal.

At the same time, the hydrological state of the Gulf of Finland in the summer of 1997 was unique. This fact cannot be explained solely by a interannual variation in the Baltic Sea regime; it must involve processes on a synoptic scale. The Gulf of Finland station array is shown in Figures 4 and 5.

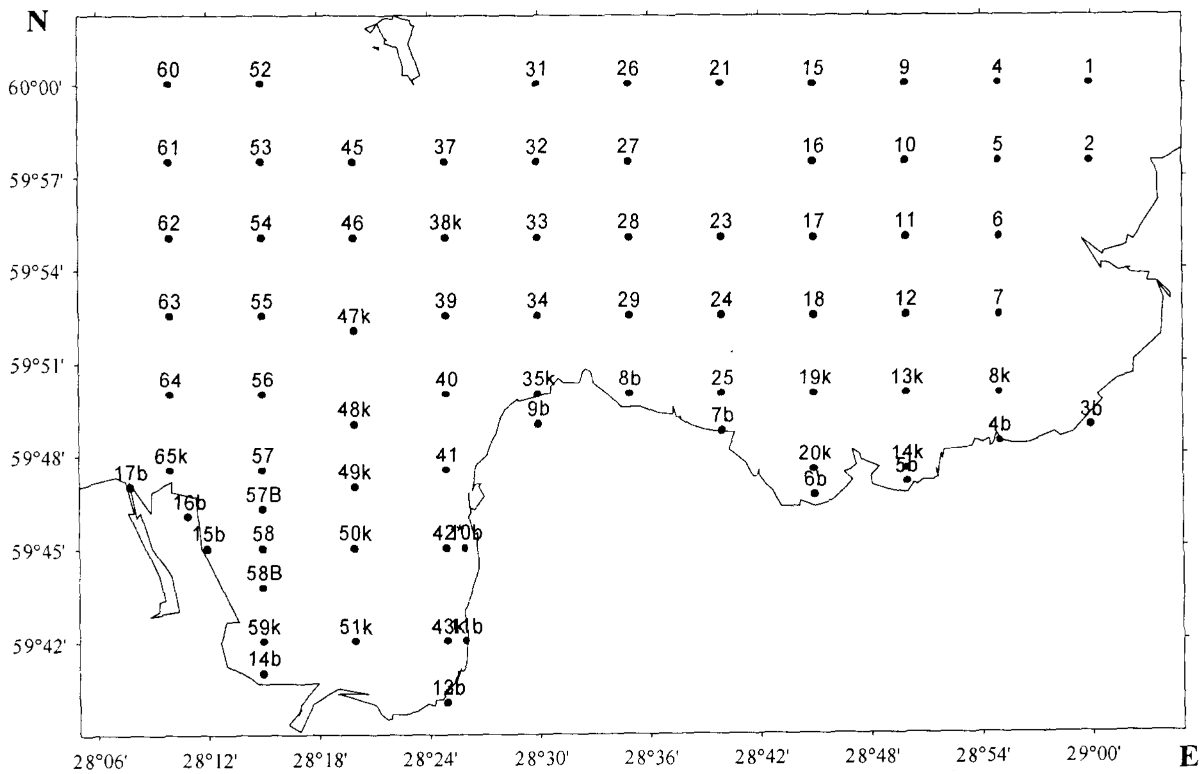


Fig. 4 Station array in the Luga Bay-Koporye Bay region, south-eastern Gulf of Finland

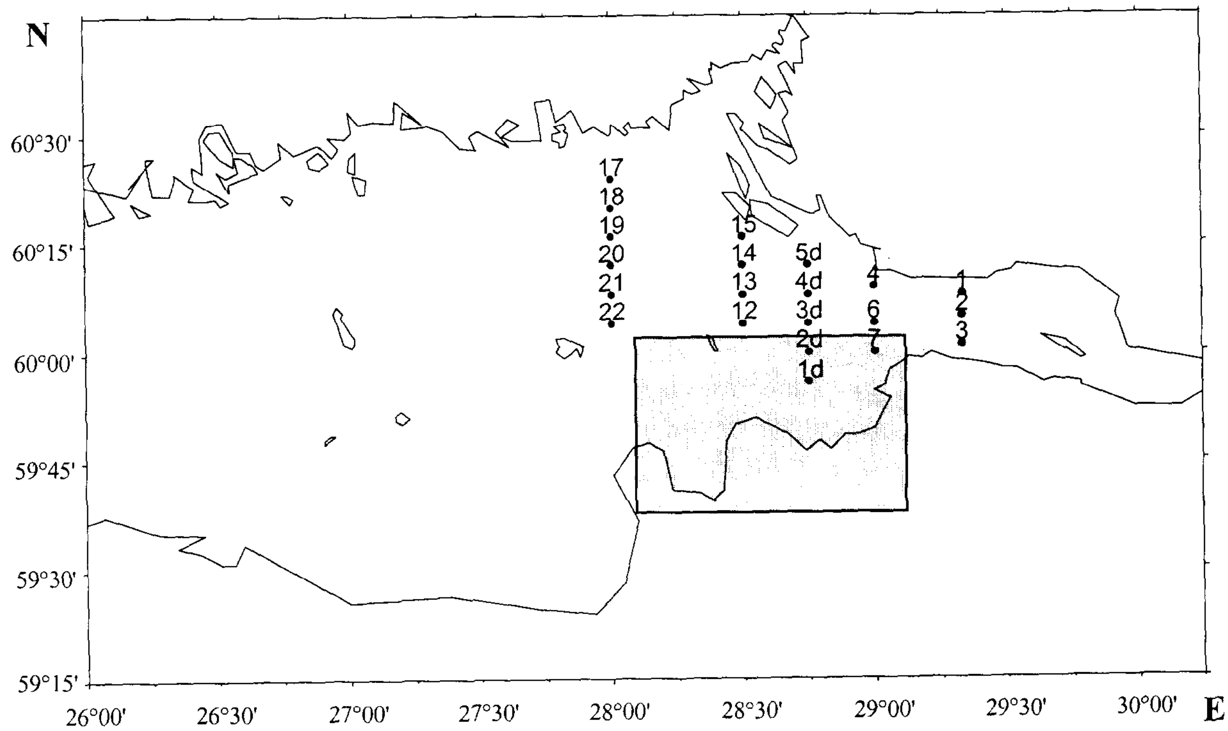


Fig. 5 Station arrays in the eastern Gulf of Finland. The superimposed rectangle represents the area covered in Figure 1

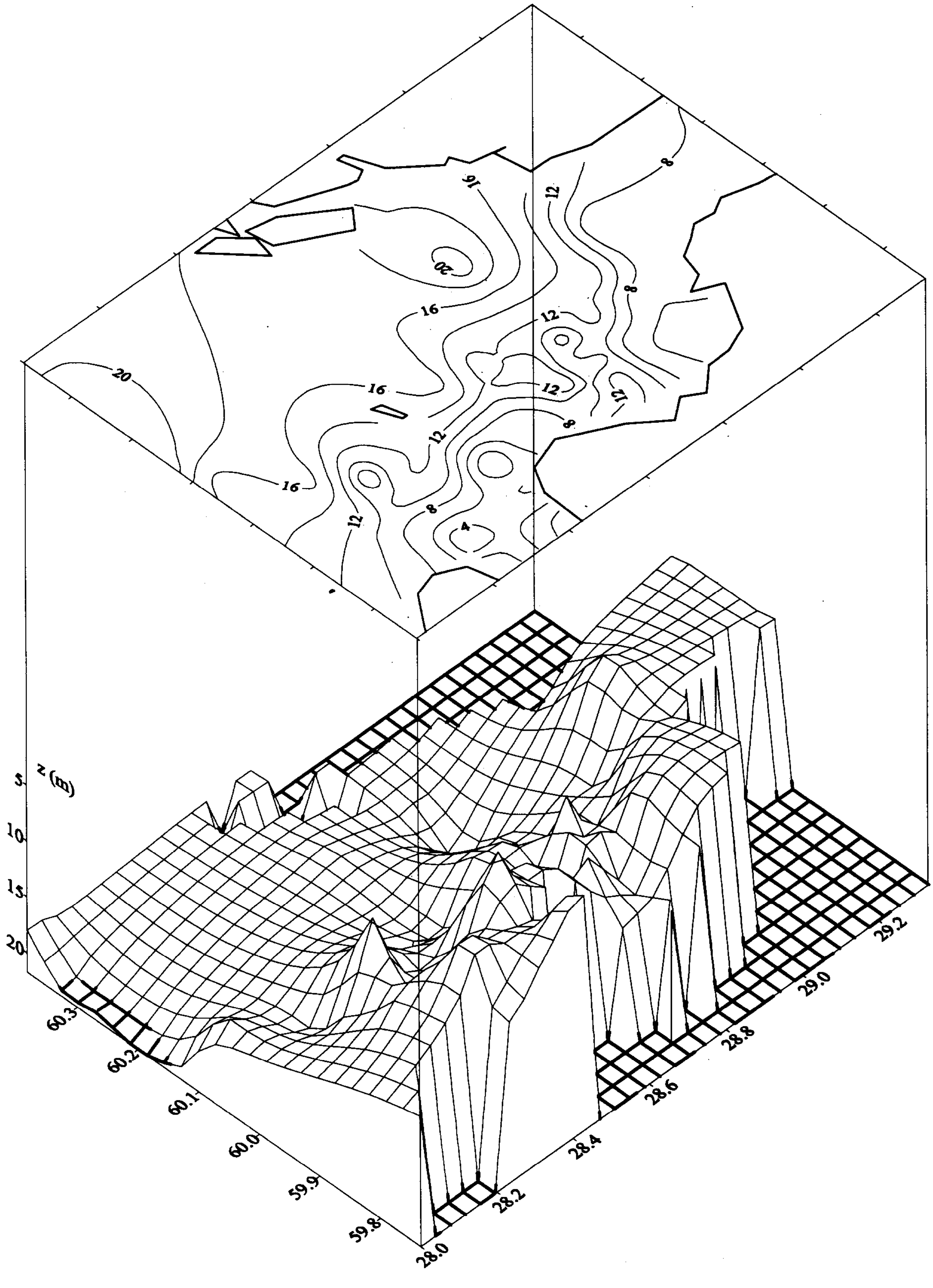


Fig. 6 Depth of the 5°C isotherm in the eastern Gulf of Finland, July 1997
(contour interval: 2 m)

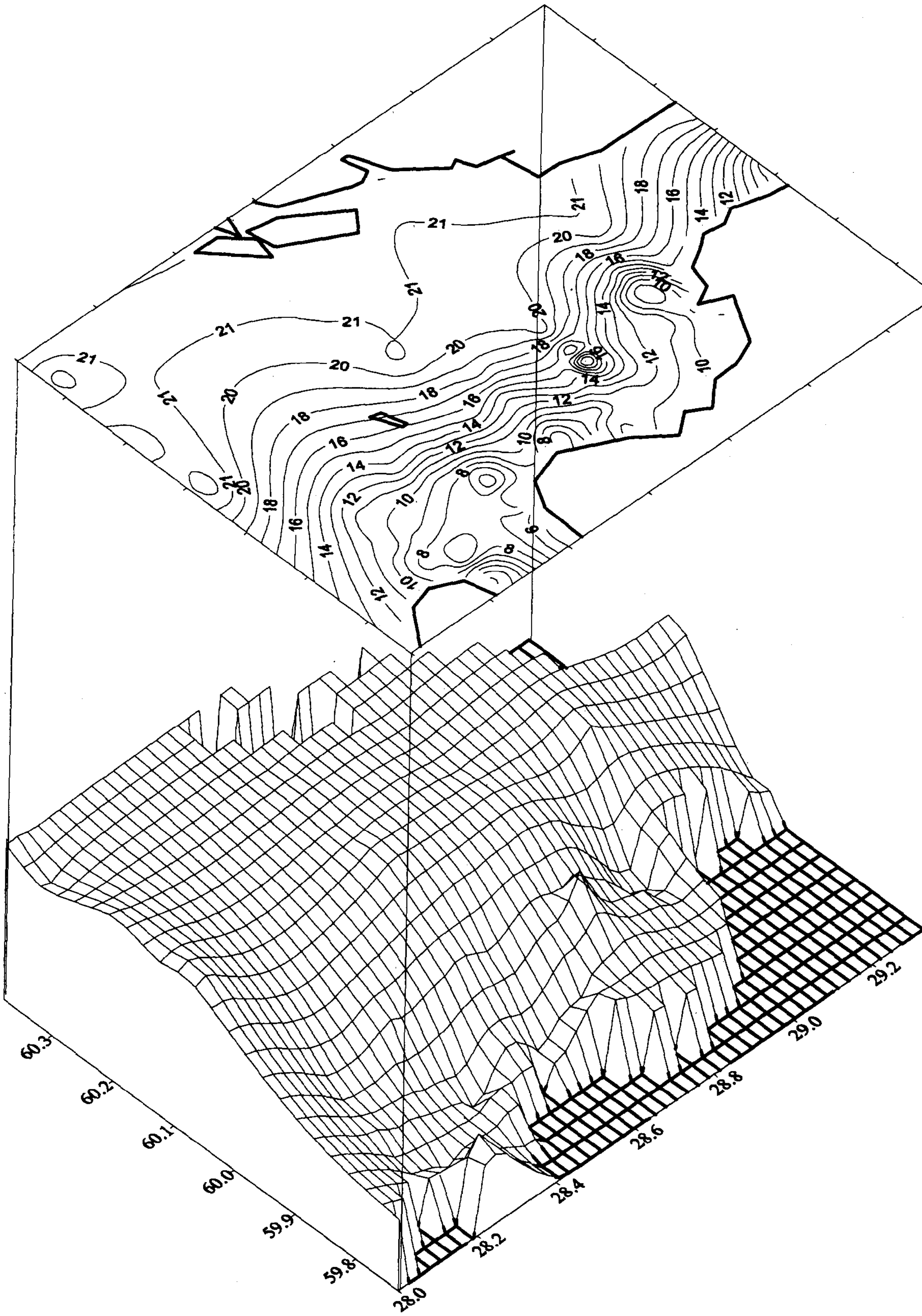


Fig. 7 Surface-temperature distribution in the eastern Gulf of Finland, July 1997
(contour interval: 1°C)

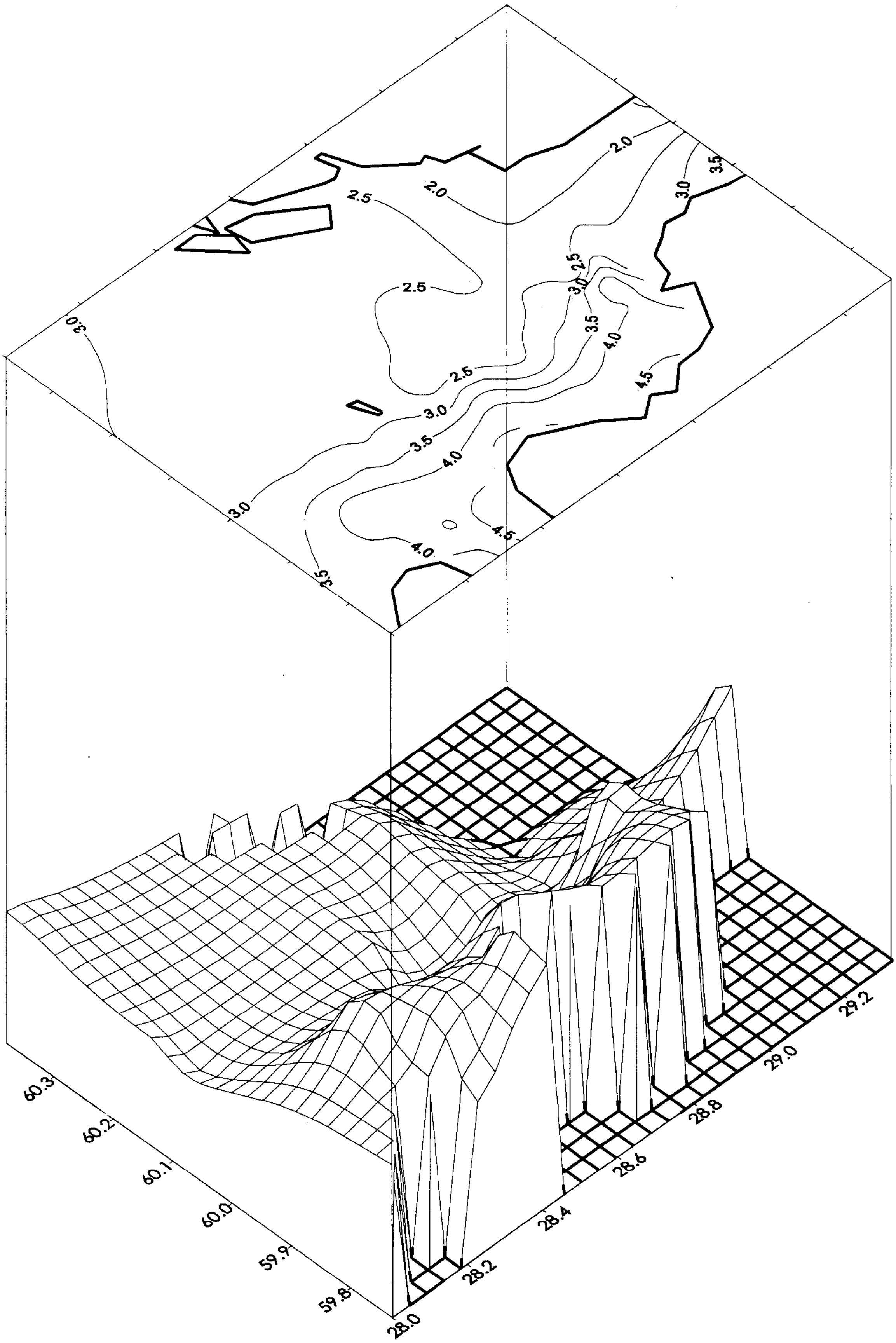


Fig. 8 Surface-salinity distribution in the eastern Gulf of Finland, July 1997 (contour interval: 0.5)

The unique situation in the Gulf of Finland in the summer of 1997 was primarily due to the meteorological conditions, which were abnormal for July 1997. The anomalous heating and pressure distribution induced strong upwelling in the southern part of the Gulf of Finland. As a result, the surface temperature decreased from north to south and surface salinity increased from north to south. This upwelling is well shown in Figure 6 which shows the depth distribution of the 5°C isotherm. In the surface-temperature and surface-salinity distributions, as shown in Figures 7 and 8, the temperature minimum (T < 5°C) and salinity maximum (S > 6) * were observed in the south-eastern part of Luga Bay where the upwelling was most intense. In the northern part of the eastern Gulf of Finland, surface temperature and salinity were comparatively homogeneous (surface temperature 19-21°C and surface salinity 1.5-2.5).

In spite of the upwelling of the cold water, the estimate of the average heat content, by specific heat-absorption of the 0-10-m layer in the eastern Gulf of Finland in July 1997, was 14 times greater than that for July 1996 (5.6 MJ/m^3 in July 1997 and 0.4 MJ/m^3 in July 1996). So the upper layer outside the upwelling zone was anomalously heated in 1997. Moreover, as a result of upwelling and river discharge of the anomalously heated water, as shown by the concurrent hydrological observation of the Luga River run-off, large-scale frontal zones (Fig. 9) and variability of the hydrographic structure were observed. The spectral analysis of the current data of three buoy stations demonstrated the important variability at the oscillation period of 13-14 hours (time of the energy transfer from the upper dynamic layer to the deep layer), 4-7 hours (seiche oscillations) and 2-3 hours (diurnal variability).

* With the review of salinity measurement in oceanography by IAPSO and UNESCO [UNESCO Technical Reports in Marine Science, No 45, 1985], salinity is considered to be a ratio, therefore dimensionless, and, using formally accepted analytical techniques, may be specified in Practical Salinity Units – PSUs or as a simple number.

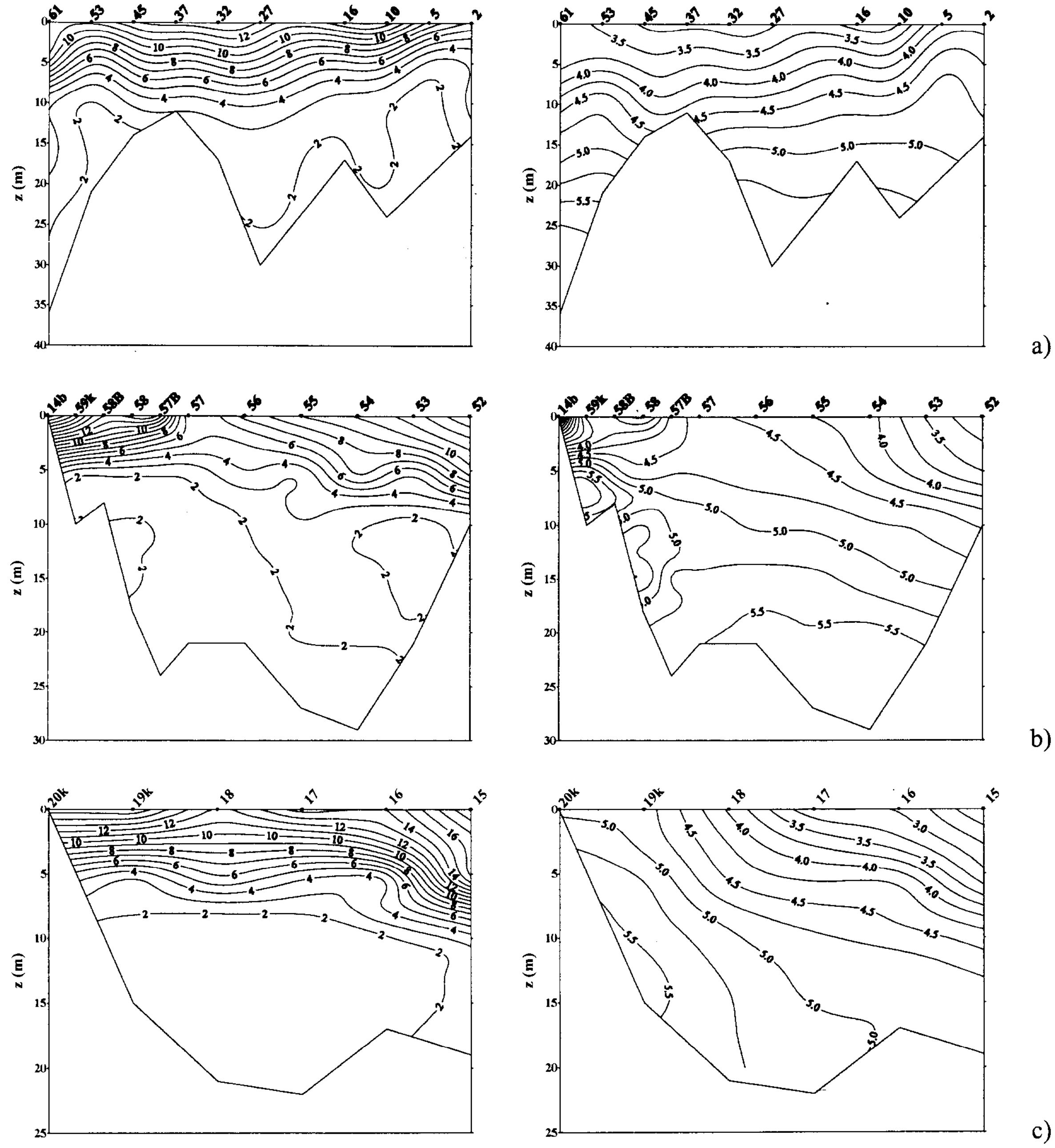


Fig. 9 Temperature (left, contour interval: 1°C) and salinity (right, contour interval: 0.25) in vertical sections of the Luga Bay-Koporye Bay region. (a) W-E section at 59°57.5′ N; (b) S-N section at 28°15′ E; (c) S-N section at 28°45′ E.

Data on the Luga River run-off zone showed the anomalously large heated river-water discharge in May-July 1997, though it decreased to the normal value by the end of the period (Table 1).

Table 1
Average monthly heat discharge to Luga Bay in May-July 1997 and the normal [climatic] value (underlined)

Month	Water discharge (m^3/s) normal value 1997 value	Heating discharge (kJ/s) normal value 1997 value	Water temperature (°C) normal value
May	234 279	$1.136 \cdot 10^7$ $1.285 \cdot 10^7$	11.6
June	69.3 136	$0.511 \cdot 10^7$ $1.025 \cdot 10^7$	17.6
July	42.5 40.0	$0.350 \cdot 10^7$ $0.352 \cdot 10^7$	19.7

The thermodynamic structural features naturally influenced the distribution of the hydrochemical parameters and the biotic conditions. This fact confirms the necessity of the complex integrated investigations including hydrological, hydrochemical and hydrobiological observations.

According to the 1997 data, the Neva and Luga River discharge of plant nutrients stayed at the 1996 level and was much less than the 1993-94 level (Table 2; Fig. 10). But, as shown in Figures 11 and 12, the relative contribution of rivers to the surface nitrite and surface nitrate distributions is large.

Table 2
Average values of the hydrochemical parameters in the Luga Bay-Koporye Bay region during the period 1993-1997 (upper value: 0-10-m layer; lower value: 10 m-bottom)

Parameter	July 1993	August 1994	July 1995	July 1996	July 1997
Oxygen saturation (%)	132 105	105 85.0	106 85.0	95.6 80.3	100 67.5
pH	8.73 7.15	8.25 7.60	8.50 8.05	8.17 8.01	7.90 7.85
Phosphates (µg/l)	10 32	2.0 3.8	1.7 20	8.1 30	10 28
Nitrites (µg/l)	2.0 15	~0 4.0	0.25 2.6	0.37 1.1	3.5 9.0
Nitrates (µg/l)	50 210	25 180	2.0 9.2	4.7 16	29 45

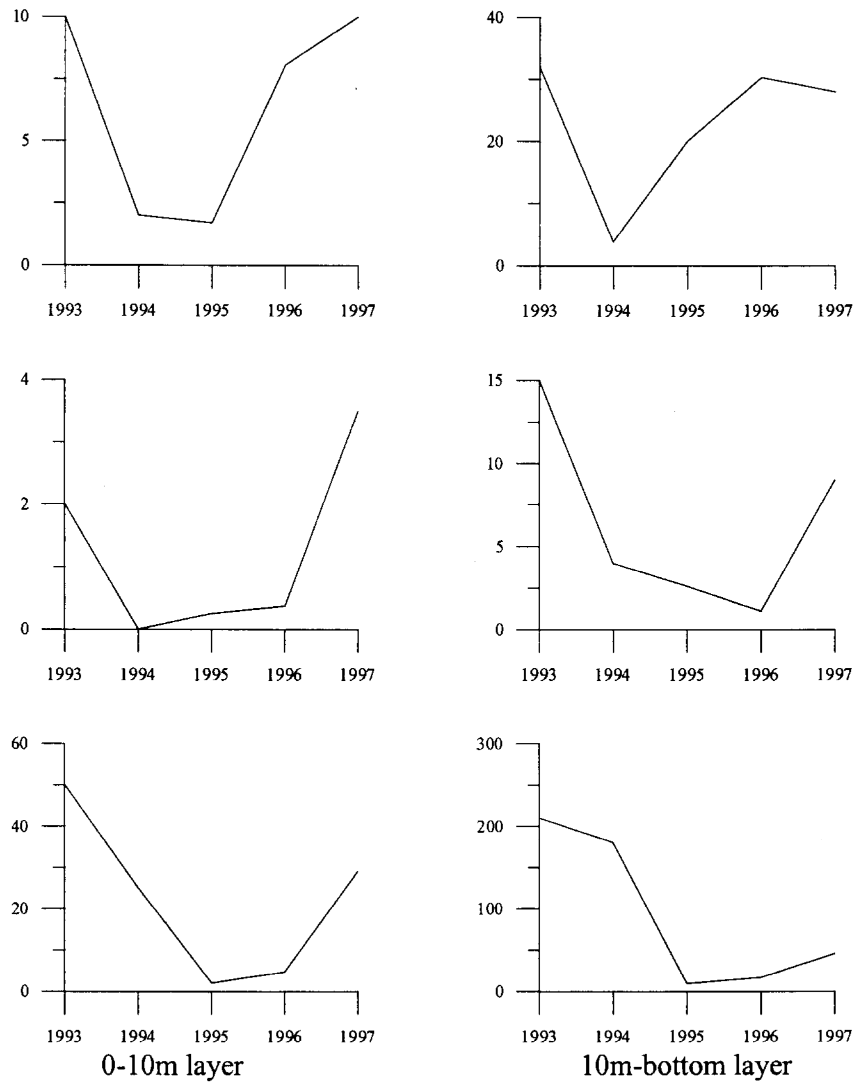


Fig. 10 Variation in the average values (in µg/l) of the hydrochemical parameters (phosphates, nitrites, nitrates) in the Luga Bay-Koporye Bay region during the period 1993-97

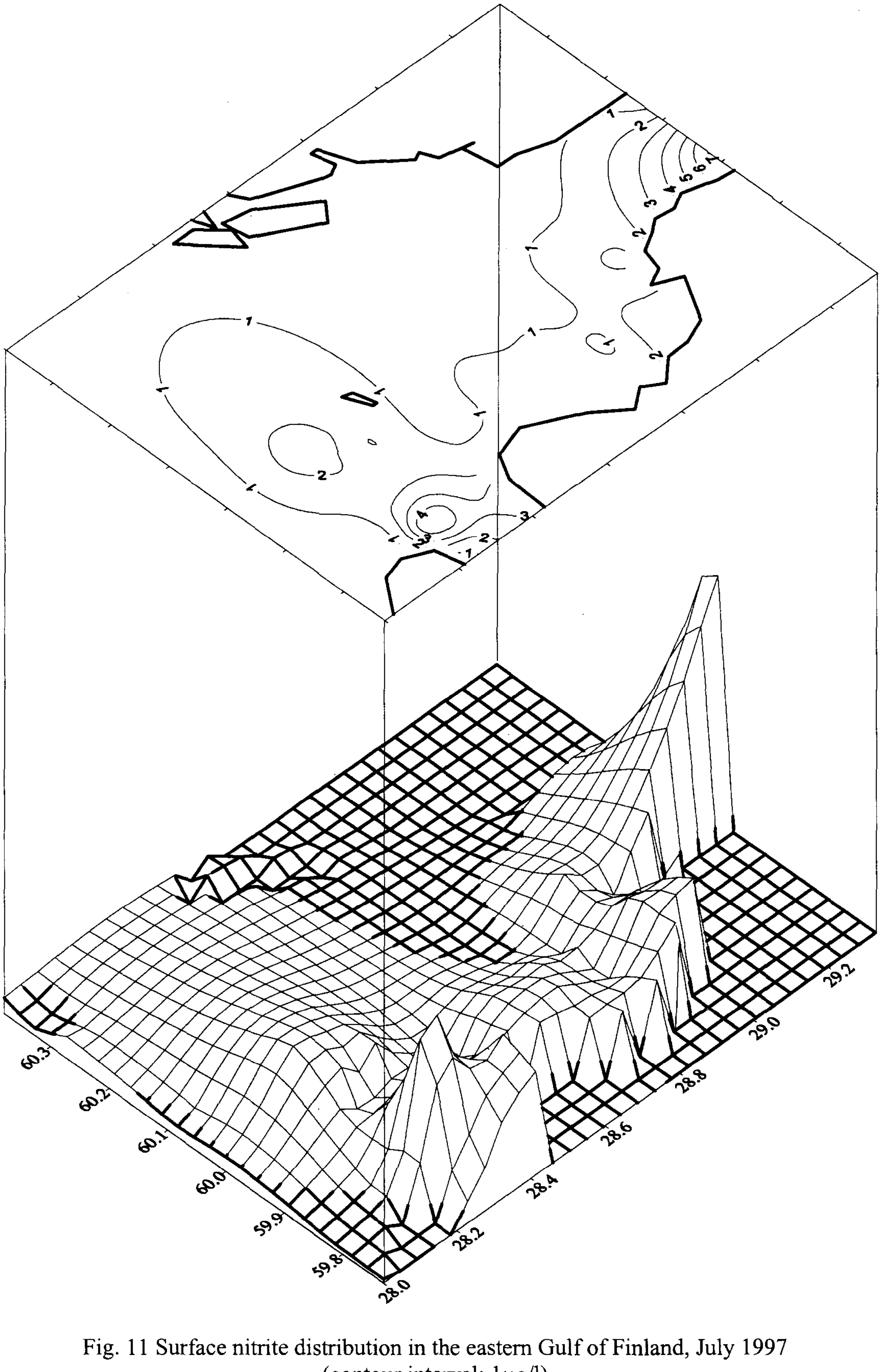


Fig. 11 Surface nitrite distribution in the eastern Gulf of Finland, July 1997
(contour interval: 1μg/l)

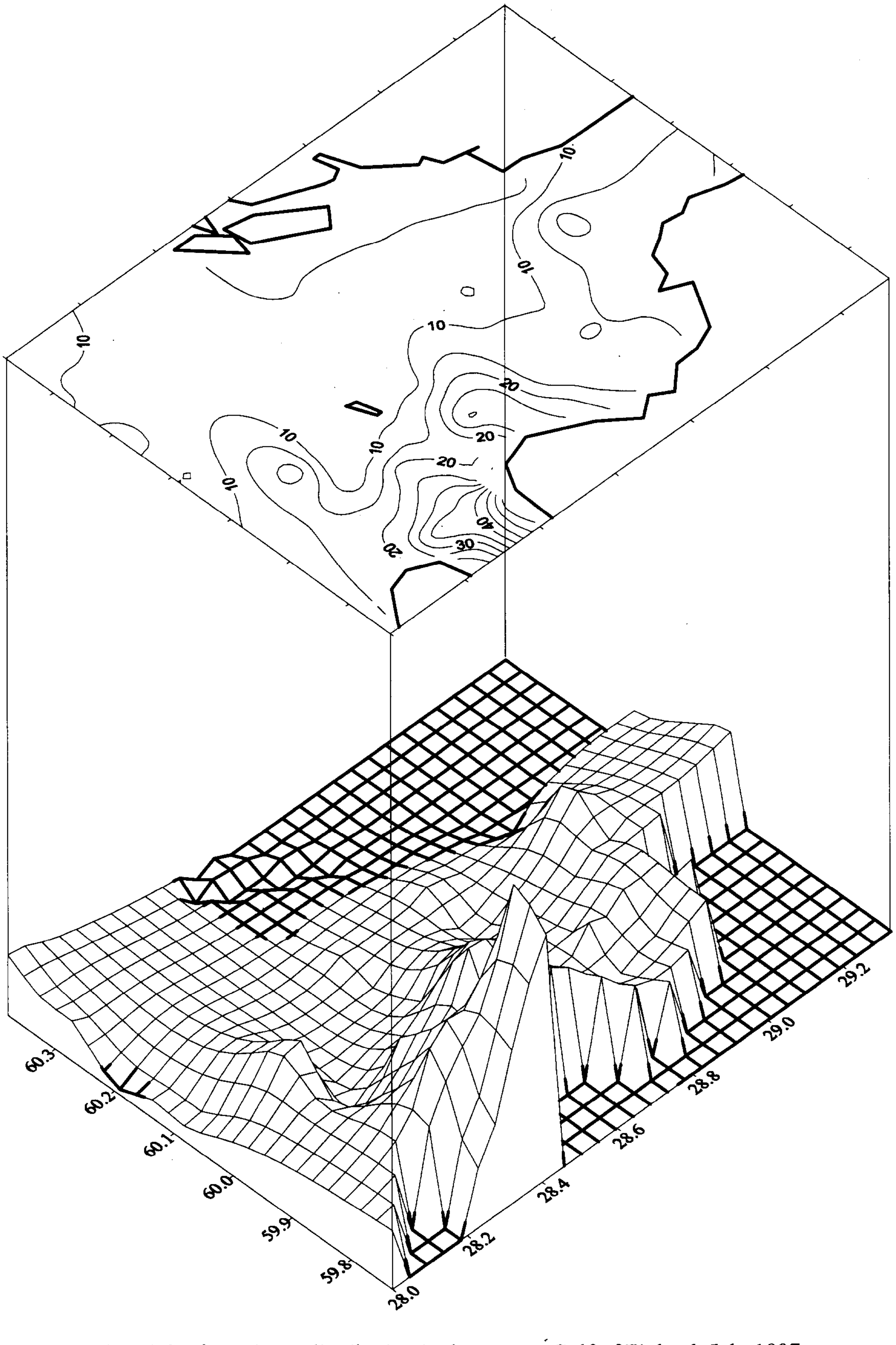


Fig. 12 Surface nitrate distribution in the eastern Gulf of Finland, July 1997
(contour interval: 5μg/l)

The average, for May-June, of the Neva River discharge into the Gulf of Finland was about 86% of the normal value. Hydrochemical observations of the Luga River discharge showed that the water in July 1997 was cleaner than it was during previous years (Table 3), although the dissolved-oxygen concentration was near the upper permissible limit.

Table 3
Chemical composition of the Luga River discharge in July 1997

Parameter	pH	O_2 (mg/l)	PO_4 (μg/l)	NO_3 (μg/l)	NO_2 (μg/l)
Value (range)	7.6-8.2	5.8-6.2	5-7	220-270	1-16

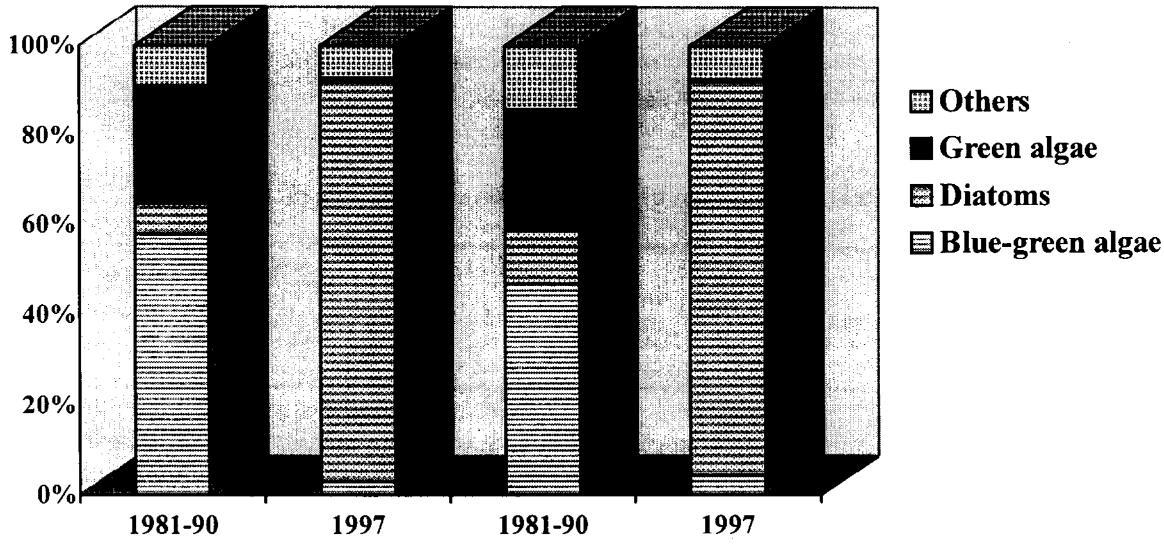
On the whole, extreme values of plant-nutrient concentration in the eastern Gulf of Finland (dissolved-oxygen minimum near 90% saturation, pH 8.03) were found along the south coast. These values are modified with the raising of deep cool water towards the surface. The estimation of the sediment input to Luga Bay (Table 4), as an estimate of future soil-mass transport by fringe currents and siltation of the future port, is of interest here.

Table 4
Luga River sediment input (tons) to Luga Bay in May-July 1997

Month	May	June	July	Total
Sediment load	1,120	780	220	2.120

Total sediment load in May-July 1997 was 66 % of the long-term mean (3,210 tons). This decrease was confirmed by the decrease in the water turbidity. At the same time, in the central part of Luga Bay, there was a marked decrease in water transparency (information provided by the Russian Hydrometeorological Office from satellite data). This fact shows the influence of the start of port construction.

Hydrobiological observations in the eastern Gulf of Finland and the Luga Bay-Koporye Bay region, in particular, showed that biotic conditions act upon abiotic factors (and vice-versa). Analysis of the quantitative and qualitative composition of phytoplankton revealed a significant reduction in the proportion of blue-green algae, in favour of diatoms, in the Luga Bay-Koporye Bay region in 1997 as a result of the anomalous hydrological situation (colder water due to upwelling) (Table 5). The predominance of the blue-green algae, which is normal for summer in the Luga Bay-Koporye Bay region (data for 1981-1990, Fig. 13), did not prevail in July 1997. The diatoms, in the summer of 1997, occupied 60-90% of the total phytoplankton biomass, and this association is abnormal for mid-summer in this region. The basis of the normal association is the cryophilic species that develop in spring and autumn. The contrast between the biomass for normal summers and that for the 1997 summer, as well as the range (from station data), is shown in Table 5.



Koporye Bay Luga Bay

Fig. 13 Proportions of the main phytoplankton groups in Koporye Bay (left) and Luga Bay (right) for the summer of years 1981-1990 and for 1997

Table 5
Summer phytoplankton biomass in Koporye and Luga Bays in normal years (1981-1990) and in 1997, and the corresponding ranges from station data

	Average biomass (mg/l)		Biomass range (from station data) (mg/l)	
Year	1981-1990	1997	1981-1990	1997
Koporye Bay	0.82	2.20	0.20-2.01	1.86-2.54
Luga Bay	0.70	1.17	0.06-1.78	1.10-1.24

In contrast, near the northern coast of the eastern Gulf of Finland, the situation was usual. In keeping with the temperature increase, the blue-green algae became the main group (30-80% of the total biomass, Fig. 14). Compared with July 1995-96, the total biomass value did not exceed the limits of the interannual variation. At that time, in the western Gulf of Finland near the Finnish coast, an intensive blue-green algae bloom was observed. This led to closing some of the beaches and resort areas to people (communication by Dr. Lepponen, Mid-Cruise Seminar, Helsinki, 28-29 August 1997).

The measurement of chlorophyll-a, a measure of the phytoplankton biomass and photosynthetic activity, has been carried out since 1983. In July 1997, the chlorophyll value at most of the stations (Table 6, Fig. 15) was low and decreased from east to west. The range of values was normal for end-autumn and was the result of the upwelling.

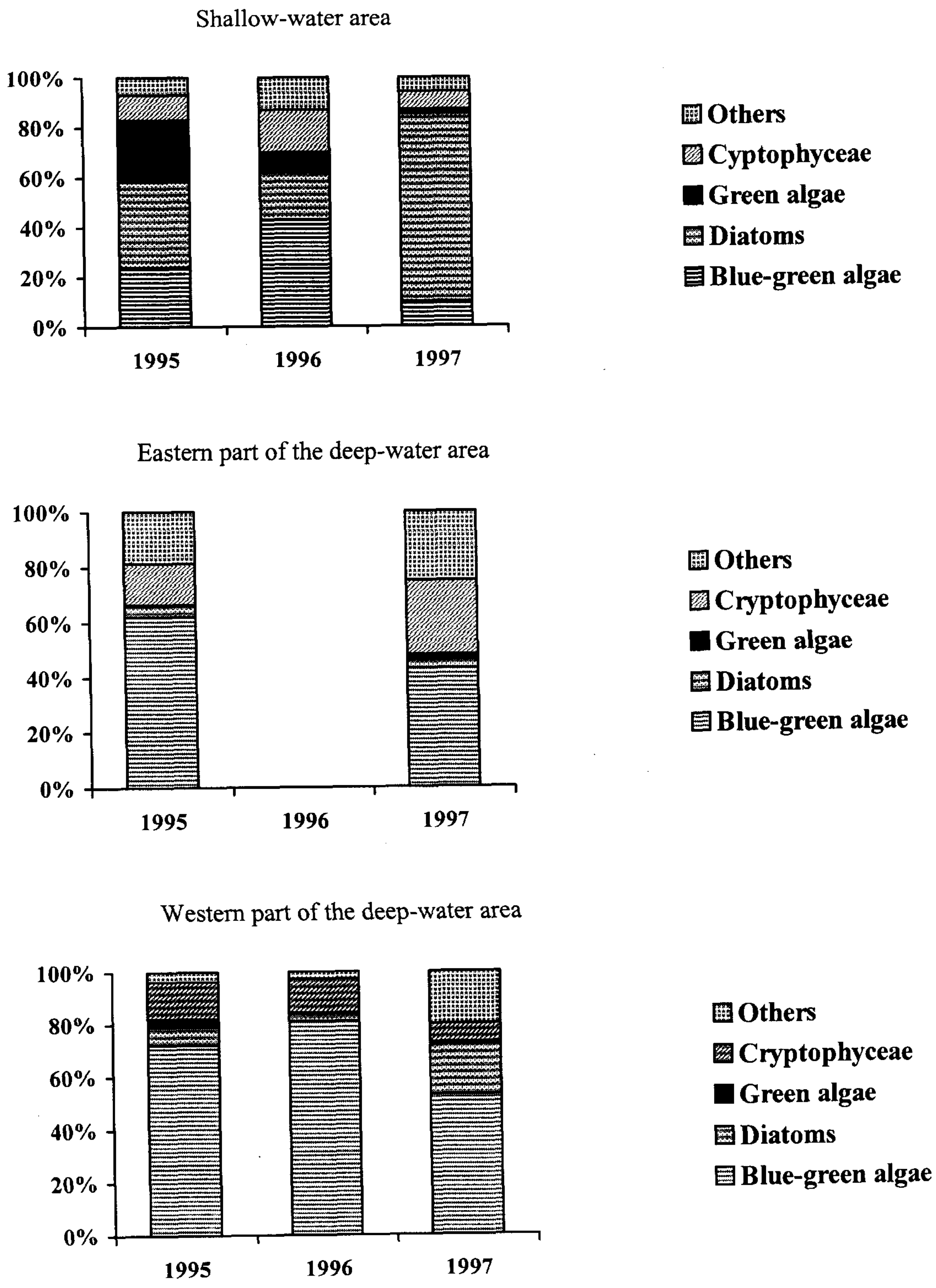


Fig. 14 Proportions (%) of the main phytoplankton groups in the eastern Gulf of Finland, July 1995-97

Table 6
Average concentration and range of chlorophyll-a (µg/l) in various parts of the eastern Gulf of Finland (minimum and maximum values are underlined)

Area	Year	Min-max average	Year	Mean chlorophyll-a (µg/l)
Shallow water	1985-1996	5.62-19.24 13.52	1997	2.83
Deep water	1985-1996	2.51-9.75 4.43	1997	2.3
Koporye Bay	1983-1996	2.3 3-8.08 4.17	1997	5.19
Luga Bay	1983-1996	3.61-10.81 6.35	1997	3.1

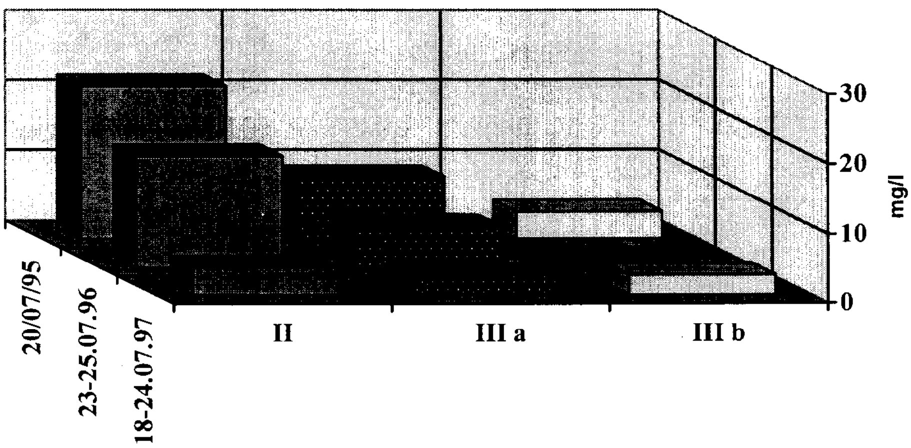


Fig. 15 Chlorophyll-a (µg/l) in the eastern Gulf of Finland, July 1995-97
II - shallow-water area; III a - eastern part of the deep-water area;
III b - western part of the deep-water area

Zooplankton observations showed that mean numbers and biomass in the surface layer did not exceed the limits of the interannual variation (according to the monitoring data provided by the Northwest Hydrometeorological Office). In the deep layers, the influence of upwelling was expressed by the presence of marine polychaetes, which were observed for the first time during the last ten years.

As for macrozoobenthos, Luga and Koporye Bays have similar species composition in respect of bottom invertebrates, according to the monitoring data. Zoobenthos was similar in species composition as well as quantitatively, but, for Koporye Bay, the quantitative parameters were somewhat above normal.

Investigations in the framework of the UNESCO-IOC-HELCOM "Baltic Floating University" project have allowed long-term (5-year) observations of environmental conditions in the research area to be made taking into account the impact of human activities. Oceanographic, hydrochemical and hydrobiological data were also obtained. Some regularity in the formation of the hydrological regime in the coastal zone was revealed. Thus, the upwelling regime was discovered and described as a special phenomenon determining the specific distribution of the biotic and abiotic characteristics during the summer of 1997 in the eastern Gulf of Finland.

INVESTIGATIONS IN THE WESTERN PART OF THE MUHU STRAIT

Introduction

The 15th research cruise of the sailing catamaran *Orients* was carried out in 1997 under an agreement between the Russian State Hydrometeorological University (RSHU) and the Hiiumaa Centre for the Biosphere Reserve of the West-Estonian Archipelago (HCBRWEA), embodied in a Memorandum of Understanding signed in 1997 between the two institutions. The main purpose of the Memorandum was to ensure the co-ordination of the work of the two institutions in accomplishing joint research relevant to the implementation of the HELCOM recommendation on developing the Baltic Sea Protected Area (BSPA). In accordance with this recommendation, two BSPAs must be located in the Hiiumaa region: (i) Kopu BSPA on the western side of Hiiumaa Island; and (ii) Väinameri ("the Hiiumaa Islets") BSPA in the south-east of Hiiumaa Island. In 1996, RSHU and HCBRWEA carried out a study of the bottom habitats and hydrographic conditions in shallow waters around the Kopu Peninsula during the 13th cruise of the catamaran *Orients* within the framework of the UNESCO-IOC-HELCOM Baltic Floating University (BFU) programme. The 15th cruise of the *Orients* was intended as a follow-up of the preceding years' investigations with the inclusion of the Väinameri area in the study. This has been fulfilled, with the collaboration of research workers from Estonia (HCBRWEA, the Estonian Marine Institute and Tartu University) and from Finland (Alleco ky) operating from other boats. The close interaction between the Estonian, Russian and Finnish teams was arranged within the framework of a joint expedition which allowed, in particular, repeated complementary observations and sampling at precisely specified points.

Main objectives

The main objective of the expedition was to describe the area surrounding the islets to the south-east of Hiiumaa Island, with a view to the creation of the Väinameri BSPA, by incorporating the existing local, relatively small, protected areas of Käina Bay, Kassari Island, Sõrve Peninsula and Hiiumaa Island (Fig. 18). In 1997, a preliminary investigation of the area was carried out with a view to undertaking further thorough research. The joint expedition focused on the following objectives: hydrometeorological and hydrochemical investigations of the area with a view to understanding hydrological conditions and their influence on protection planning; classification of the local bottom biotopes; creation of preliminary bottom-topography maps to be used in the preparation of proposals for zoning the area, with a view to marine environment protection.

Description of the cruise

The sail catamaran *Orients* arrived in Heltermaa (Hiiumaa) on 25 August. The same day, a workshop involving all the participants took place on the island of Saarnaki (the permanent research base of the expedition) to co-ordinate the field work and assign duties to the research teams. The field work continued till 1 September and included:

- an oceanographic survey of the area using a square array of hydrographic stations with 1.5-2.0 nautical miles between stations (oceanographic and meteorological observations at 28 stations, Fig. 19);
- diving work along four SW-NE transects (sea-bottom and benthic sampling at 18 stations, Fig. 19); the diving station positions were specified with high accuracy, agreed with the Estonian and Finnish partners, to allow unbiased comparison of each other's data.

In the 3-digit number of each SCUBA-diving station, the first digit signifies the transect number, and the two ensuing digits refer to the number of the station on the transect.

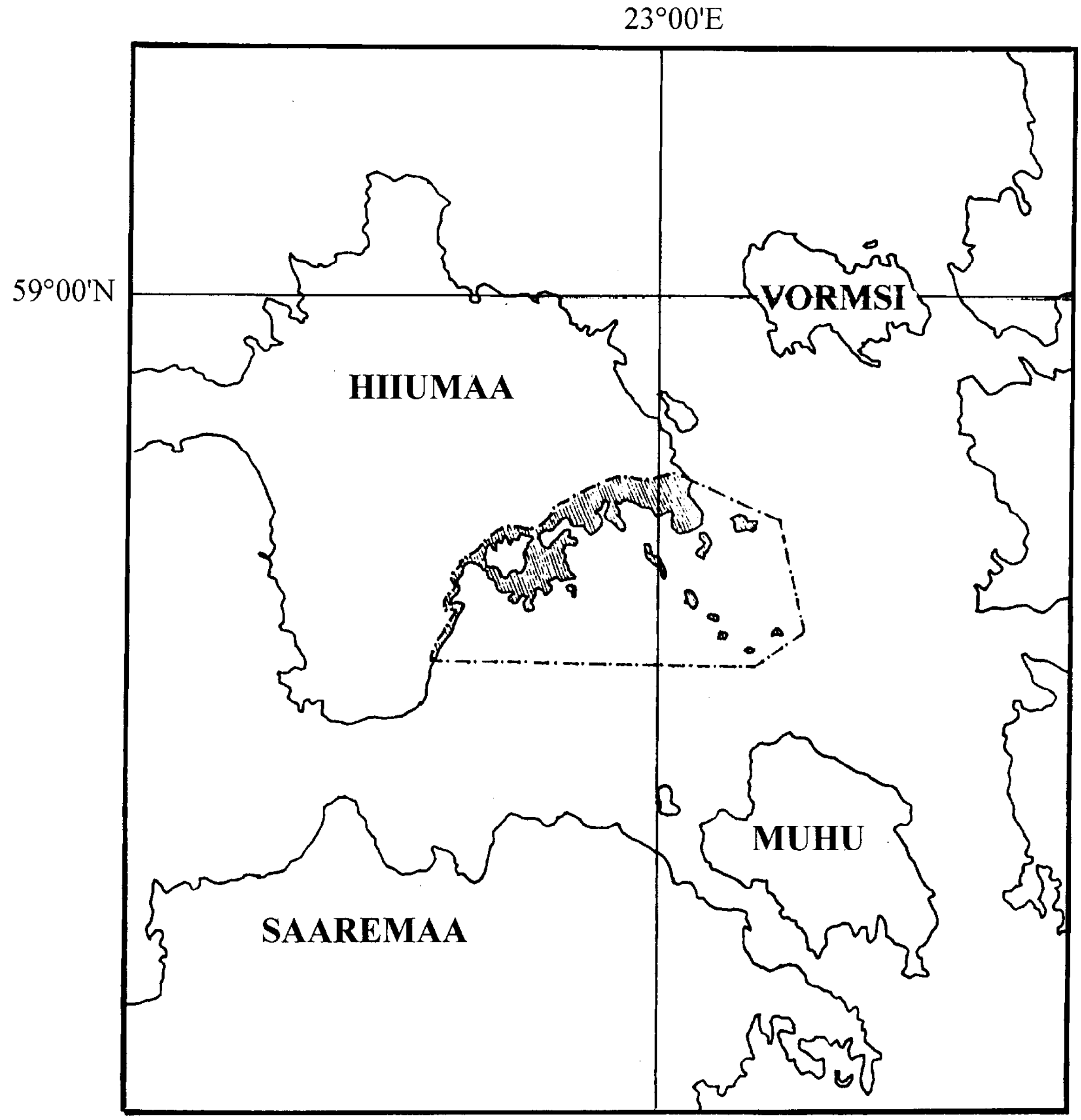


Fig. 18 The Hiiumaa Island protected area to be incorporated into the BSPA system. The area of coastal studies is shaded; the dash-dotted line encircles the Väinameri area studied in 1997

The seawater samples from the hydrographic stations were analysed for salinity, pH and dissolved oxygen content (mg/l) on board the catamaran immediately after sampling, whereas the samples destined for nutrient analysis were preserved to be analysed later under stationary laboratory conditions. The benthic samples could be studied only in a preliminary fashion on board, and required further examination under laboratory conditions to obtain a qualitative assessment.

Having finished the scheduled work, the catamaran left the island of Saarnaki on 2 September. General information about the expedition and its initial findings were presented (together with the results of the Kopu'96 Expedition) at the 4th BFU Mid-Cruise Workshop in Helsinki (28-29 August 1997).

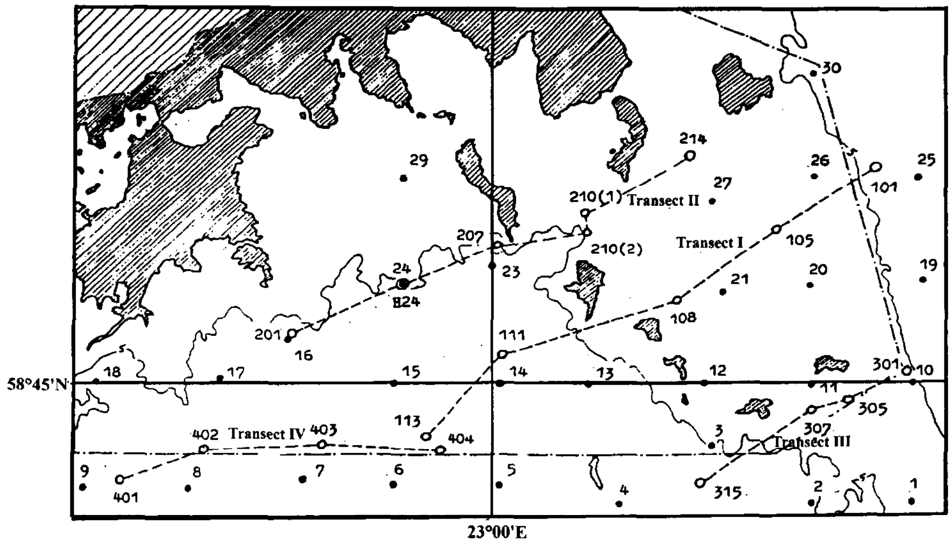


Fig. 19 Hydrographic (solid dots) and scuba diving (open dots) stations in the Väinameri area. The 5-m isobath, as well as the position of the transects are shown; the heavily shaded area is the same as that in Fig. 18

Results

Hydrography and meteorology

The most pronounced hydrographic feature of the area studied is its shallowness. The mean depth of the stations was only 5 metres, with the maximum being 8 metres in the south-west corner of the station array, at stations 6 to 9. The relatively thin water layer was therefore mixed almost completely by the fairly windy conditions preceding the survey period. Vertical gradients of parameters were, consequently, featureless and the horizontal distribution of some parameters at the sea surface was very similar to that at the bottom.

No intensive heating or cooling was observed during the survey period. The daily variations predominated in the air temperature, with the maximum at about 1600hr and the minimum in the early morning. The daily variations in sea-surface temperature were less evident and those observed were mainly in the form of horizontal irregularities in the temperature field. It is notable that the sea-air temperature difference became positive at some time in the morning, so there is effective heat loss through vertical turbulence, which must be largely compensated during the day. In general, the situation corresponded to the period of peak heat content just prior to the start of cooling.

The horizontal distribution of temperature is given in Fig. 20. The gradients were fairly weak and cannot be considered with great confidence, being partly conditioned by the daily variations. The most reliable features were as follows: (i) a band of warmer water adjacent to the Hiiumaa coast; and (ii) an area of cooler water in the eastern part of the study area adjacent to the deeper Muhu Strait. The salinity was also relatively homogeneous within the area under consideration (Fig. 21), falling within the range 5.97 (station 30) to 6.96 (station 18). The predominant feature of the salinity field was the gradual increase in salinity from east to west, reflecting the twofold influence of, on the one hand, the influx of water from the western Gulf of Finland through the Muhu Strait and, on the other hand, the influx from the northern Baltic proper through the Soela Strait. According to the data obtained, the latter influence seemed to prevail.

The dissolved-oxygen concentration (mg/l) was moderate, implying a relatively low intensity of local photosynthesis. It is generally close to total saturation, with scarcely any oversaturation having been found. Intensive mixing ensures vertical homogeneity in the dissolved-oxygen concentration over the entire area, except in the south-western part, at stations 6, 7, 8 and 9, at which the water depth is greatest. The data from these four neighbouring stations suggested the existence of a local oxygen deficit near the bottom. This peculiarity can hardly be explained by the penetration of deep oxygen-depleted waters through the Soela Strait connecting western Väinameri to the Baltic proper, the navigable part of the Muhu Strait and the Gulf of Riga, since all these straits are too shallow to allow deep water to pass through them.

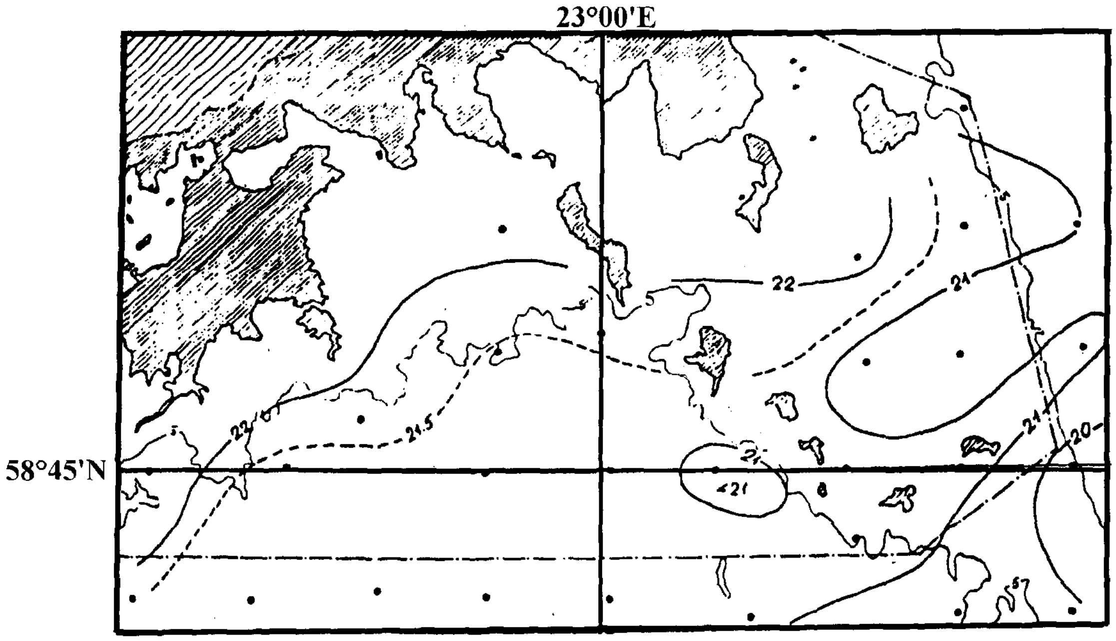


Fig. 20 Horizontal distribution of the sea-surface temperature (°C) in the Väinameri area.
The 5-m isobath, as well as the position of the transect stations are shown;
the heavily shaded area is the same as in Fig. 18

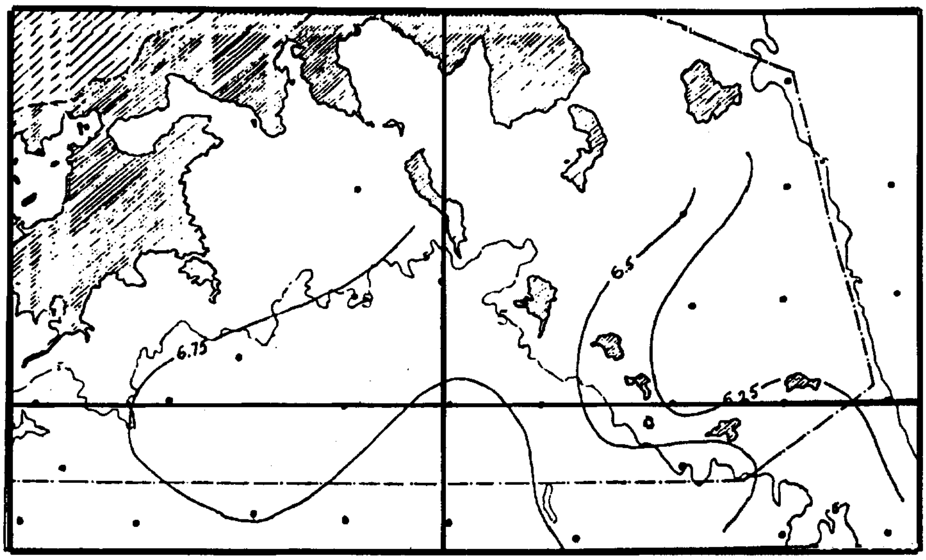


Fig. 21 Horizontal distribution of salinity at the sea surface in the Väinameri area

The most probable cause of oxygen depletion in the bottom water is local decomposition of organic matter within the relatively deep (9 m and more) hollow in western Väinameri to the south of stations 6-9. This assumption seems to be confirmed by the extreme value of the phosphate concentration (22.2 μg/l) near the bottom at station 8. Another maximum observed in the bottom-oxygen-content data (6.6 mg/l or 113% saturation, at station 27) was excluded from the profile since it was considered as being a doubtful measurement.

The horizontal distribution of pH showed a general increase in this parameter from the open sea to the coast of Hiiumaa Island, at the surface and at the bottom. The pH values fell into the range 7.8 to 8.5 and can be considered as typical for sea water, without indication of a drastic influence due to land run-off.

The concentrations of nutrients (phosphates and nitrites) were rather low, providing evidence that the local impact of human activities was of minor importance as far as the disposal of nutrients is concerned. Some extreme values, which appeared to be erroneous, were also removed from consideration.

Hydrobiology and seabed characteristics

Information on the composition and distribution of the benthos, as well as that on seabed characteristics, was obtained by the SCUBA divers at 19 stations along four transects oriented roughly transversely to the predominant slope of the bottom topography (see Fig. 19). These transects were adopted as operating areas for all three diving groups (Estonian, Finnish and Russian). While the Estonian and Finnish teams were inspecting these transects very thoroughly (with a high density of diving points), using mainly visual description and underwater photography, the Russian team was engaged in seabed and benthic sampling at previously agreed positions. Seabed characteristics at each station were obtained within a survey radius of about 10 m. Station 210(2) was specifically occupied so as to locate the border between two different biotopes. An additional station, H24, was carried out because the hydrographic station 24 fell just on the line of the dive transect.

In studies of bottom biota, apart from the macrobenthos, sampling of the meiobenthos was also carried out. Since the latter process is highly laborious and time-consuming, the relevant results are not yet available. The distribution of bottom characteristics is given in Figures 22 and 23. A short description for each transect follows:

Transect I. The bottom was covered with fine- and medium-grain sand, with stones and pebbles strewn over its surface. At a depth of 4-5 m, the vegetal cover comprised brown algae and green filamentous algae generally attached to a hard substratum. The prevalent forms of macrozoobenthos were *Dreissena* (zebra mussel), *Mya* (sand gapes) and Amphipoda (gammarid shrimps, sand fleas, etc.). *Idotea baltica* (an isopod), *Macoma baltica* (Baltic macoma or tellin) and *Mytilus edulis* (common mussel), as well as representatives of the Oligochæta (earthworms), also occurred within the mentioned depth range. At a greater depth (6-8 m), the vegetal cover was very similar, but there were some changes among the principal macrobenthic forms, with Gastropoda (marine snails) occupying the first place. The bivalve *Macoma baltica* and roundworms (Nematoda) also occurred, though in small proportions.

Transect II. Two stations (210(1) and 210(2)) were carried out in close proximity with the aim of locating the line separating two biotopes: sandy and rocky. Except at these two stations, the bottom along this transect was sandy, silted in places and with loose stones. The typical biocoenosis here is characterized by a predominance of amphipod crustaceans and the molluscs *Mya* and *Dreissena*. The rocks and boulders are covered with filamentous algae. Here, the sedentary organisms (the bivalve *Mytilus edulis*) were prevalent, as were Bryozoa, which occupied 30-60% of the boulders not covered with fouling. The zebra mussel *Dreissena* remained the most abundant, however.

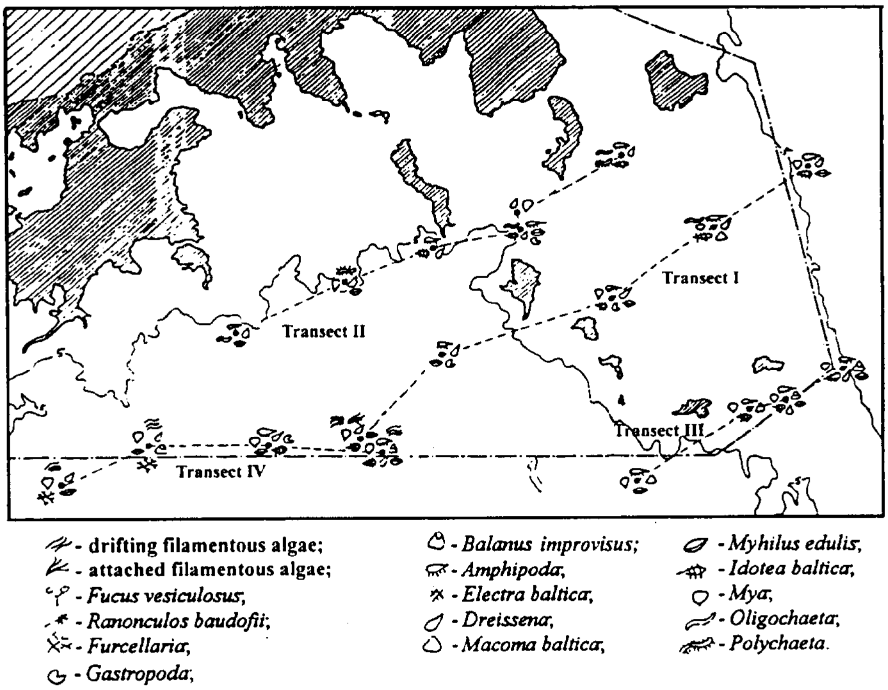


Fig. 22 Benthic organisms found in the Väinameri area

Transect III. At a depth of 2-3 m, the bottom was covered with fine sand and pebbles; in some places, stones and boulders occurred. 60% of the stones were covered with the barnacle *Balanus improvisus*, and 7-10% with *Mytilus edulis*. As much as 50% of the total area was covered with filamentous algae. The numerically predominant genera were *Balanus* and *Mytilus*, but the number of *Dreissena* was also fairly considerable. Oligochæta dominated the sandy areas. Gammarid shrimps were found in the algal growth. At a depth of 5-6 m, the bottom was covered with fine sand and stones. 50-60% of the stones were covered with the barnacle *Balanus*, the remaining part, with brown filamentous algae. The Oligochæta (earthworms) and the isopod *Idotea baltica* were dominant. The subdominant position was occupied by the mollusc *Mya*.

Transect IV. Along this transect, the depth varied from 7.3 to 8.5 m. The bottom was covered with silted sand of various grain sizes, large pebbles and sometimes big stones. The stones were commonly fouled by Cladophora (hawkweed) and the red alga *Polysiphonia*, and the exposed parts of stones were covered with *Mytilus* and *Balanus*. The distribution of bottom organisms was of a belt-like type. The dominant species was *Mytilus edulis* (on the stones), the mollusc *Mya* (on the sandy bottom) and Amphipoda (in algal growths).

Results obtained on the 15th cruise of the catamaran *Orients* made it possible to form a reasonably accurate view of the hydrometeorological and hydrochemical characteristics of the western part of the Muhu Strait; these characteristics were typical of an average summer near the peak in heat content. The quantitative description of the main parameters helped to clarify the interaction with adjacent waters, the in situ biological processes, and the role of river run-off in the local hydrological regime. It is significant that, as may be inferred from the hydrological and hydrochemical data obtained, the impact of human activities in this area is minor, thus attesting to its suitability as a BSPA. The results of seabed and benthic sampling by scuba divers can be used for the classification of the local seabed biotopes, and for seabed bathymetry, with a view to the environmental zoning of the proposed Väinameri BSPA. Further measures to provide a scientific basis for the establishment of a BSPA on the west coast of Hiiumaa Island require a more comprehensive study of the Kopu and Väinameri areas, as well as the western Estonian archipelago.

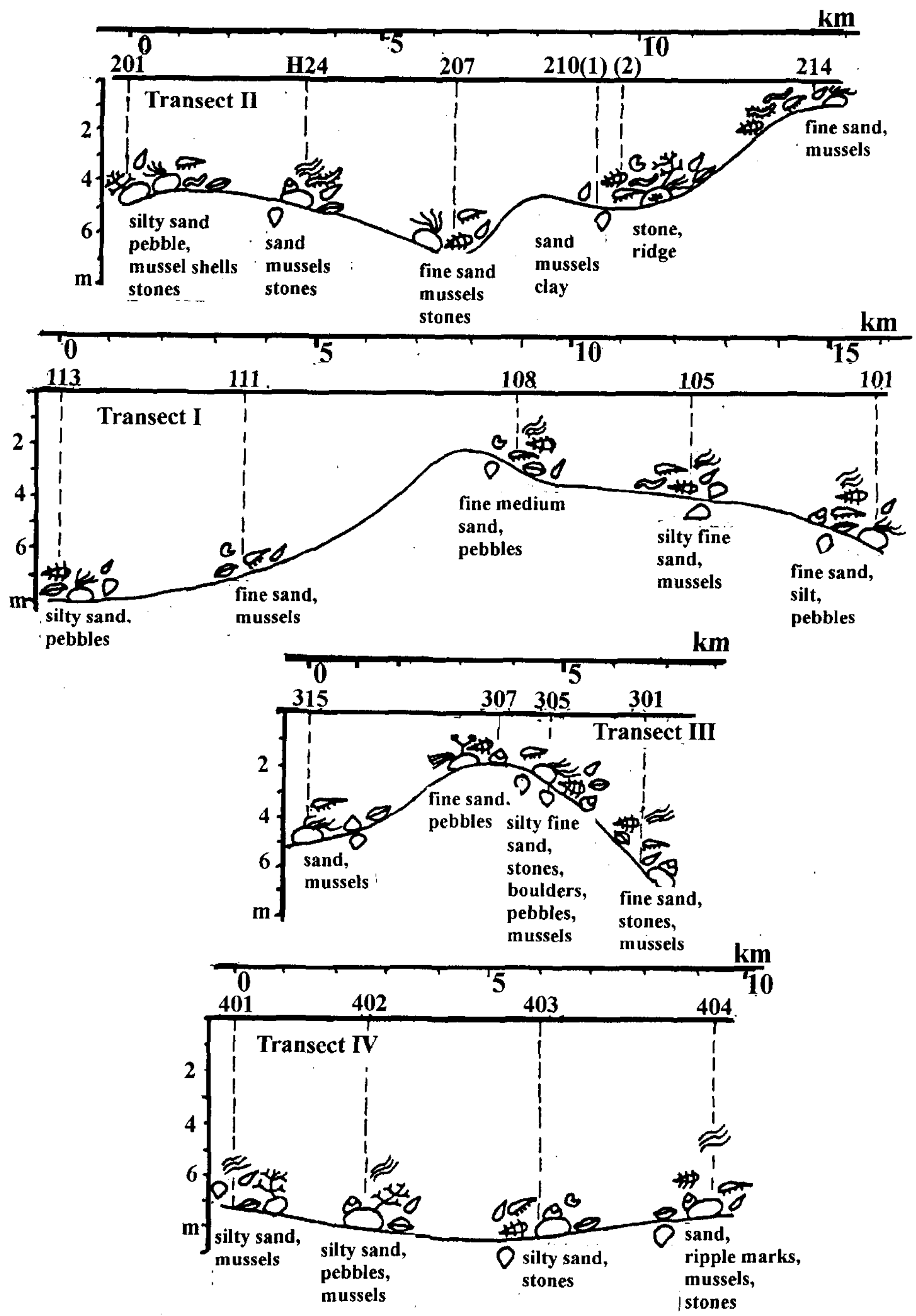


Fig. 23 Benthos and seabed characteristics on the transects I-IV. See Figures 19 and 22 for the transect positions. See Fig. 22 for the benthos symbols

MAIN RESEARCH RESULTS OF THE BFU–NORTH PROGRAMME

The purpose of the research in the coastal zone of the White and Barents Seas was to provide integrated hydrometeorological support to various groups of natural-resource users, with a view to the sustainable development of natural and artificial hydro-ecosystems. The investigations involved observations of: abiotic environmental characteristics; hydrobiological parameters in accordance with the pattern of ecological monitoring; and the volume of direct run-off from the land. Ground sampling for comprehensive chemical analysis, following European standards, and benthic sampling for chemical analysis of pollutants in the tissues of benthic organisms.

In 1997, investigations of the influence of hydrophysical and hydrochemical factors on the state of the ecosystem were continued in the testing grounds at the head of Kandalaksha Gulf, in the White Sea, and in Kislaya Bay, and in Motovskoy Gulf, in the Barents Sea. These investigations included:

- time-and-space variation in key hydrophysical parameters (temperature, salinity, depths of the thermo-, halo- and pycno-clines) and hydrochemical parameters (dissolved-oxygen concentration, hydrogen-ion concentration, total alkalinity, bio-organic content)
- concentration and distribution of petroleum products in the surface layer
- chemical composition of the bottom sediments
- assessment of mainland surface run-off volume
- state of benthic communities
- location of points of high human impact on the stability of the hydro-ecosystems.

Following the recommendations of the Working Meeting on the Implementation of the BFU-97 Project (St.-Petersburg, May 1997), socio-economic studies in the Kandalaksha District of the Murmansk Region were, for the first time, included in the programme.

Results for Kandalaksha Gulf, in the White Sea

The research in Kandalaksha Gulf was conducted in the region of the northern archipelago of the Kandalaksha State Nature Reserve and in Palkin Bay in Kandalaksha Gulf, from 30 June to 16 July 1997. The work was done on board two small research vessels: the RV *Peleng* of PINRO and the RV *Kreçhet* (of the Kandalaksha State Nature Reserve).

During ten days, an oceanographic survey was conducted, covering 91 stations (Figs. 24 and 25). This allowed construction of vertical profiles and sufficiently detailed horizontal profiles of key parameters: temperature, salinity, density, dissolved-oxygen concentration, hydrogen-ion concentration, total alkalinity, and bio-organic content at all standard depths for this shallow sea. A multi-day station was carried out in the vicinity of a fish-breeding farm, as well as two STD surveys (Fig. 26), one of 22 soundings and the other of 65 soundings, from the surface to the bottom. During the period between the first and second STD surveys, a significant change in the hydrometeorological conditions occurred, which allowed the variability of the thermohaline field to be assessed quasi-synoptically (over several hours). Sampling for petroleum products was conducted in the vicinity of the piers of the White Sea Oil Terminal and in the water body of the port of Kandalaksha (Fig. 27).

In the coastal region, near the economic activity zones of numerous enterprises that are natural-resource users, bottom sampling was conducted for purposes of chemical analysis (Fig. 28). Samples for petroleum products in surface water and for pollutants in the superficial bottom sediments were analysed in the Ecology Laboratory of the LENMORNIIPROECT which has a State Certificate for carrying out such determinations.

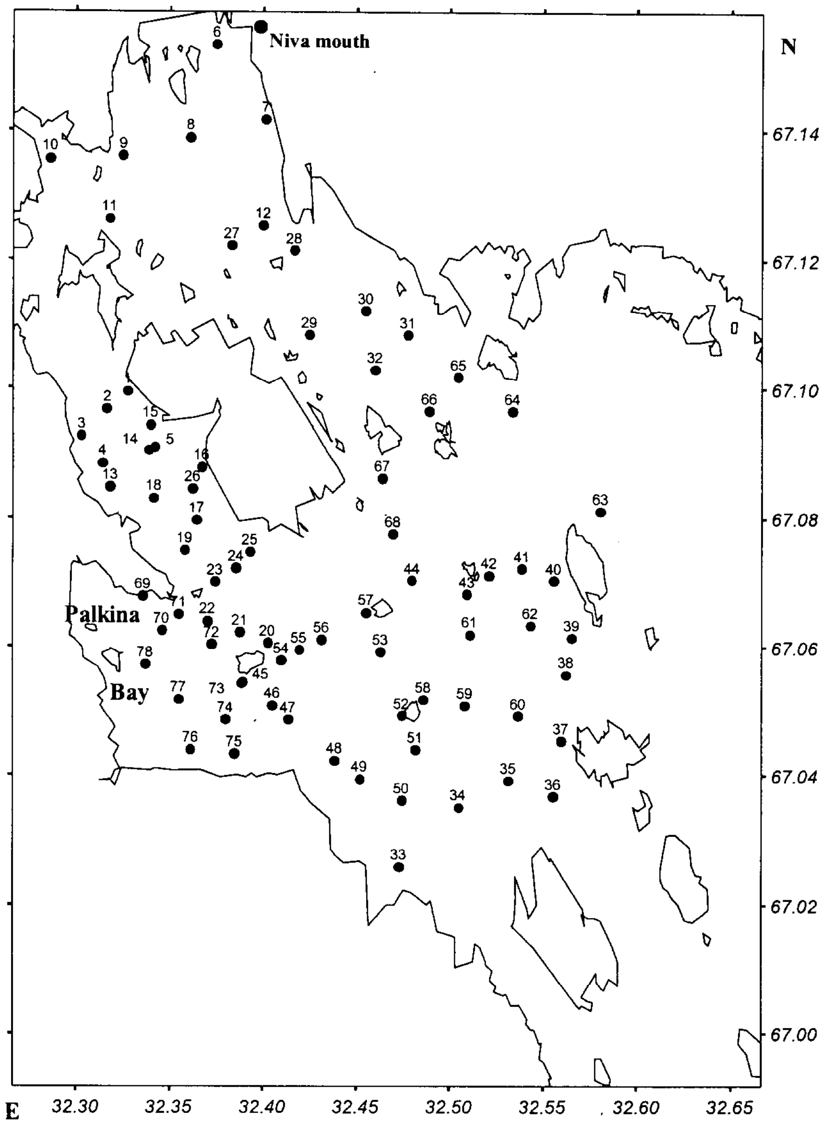


Fig. 24 Station array for hydrochemical sampling by the RV *Krechet.*

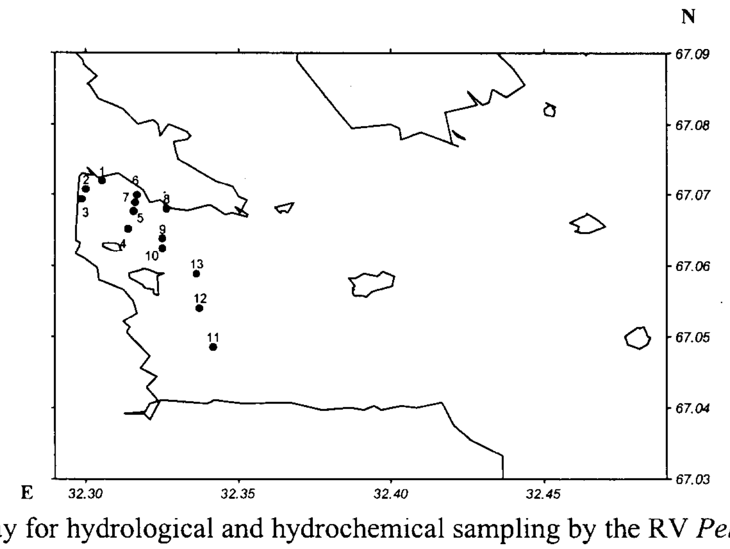


Fig. 25 Station array for hydrological and hydrochemical sampling by the RV *Peleng* in Palkin Bay.

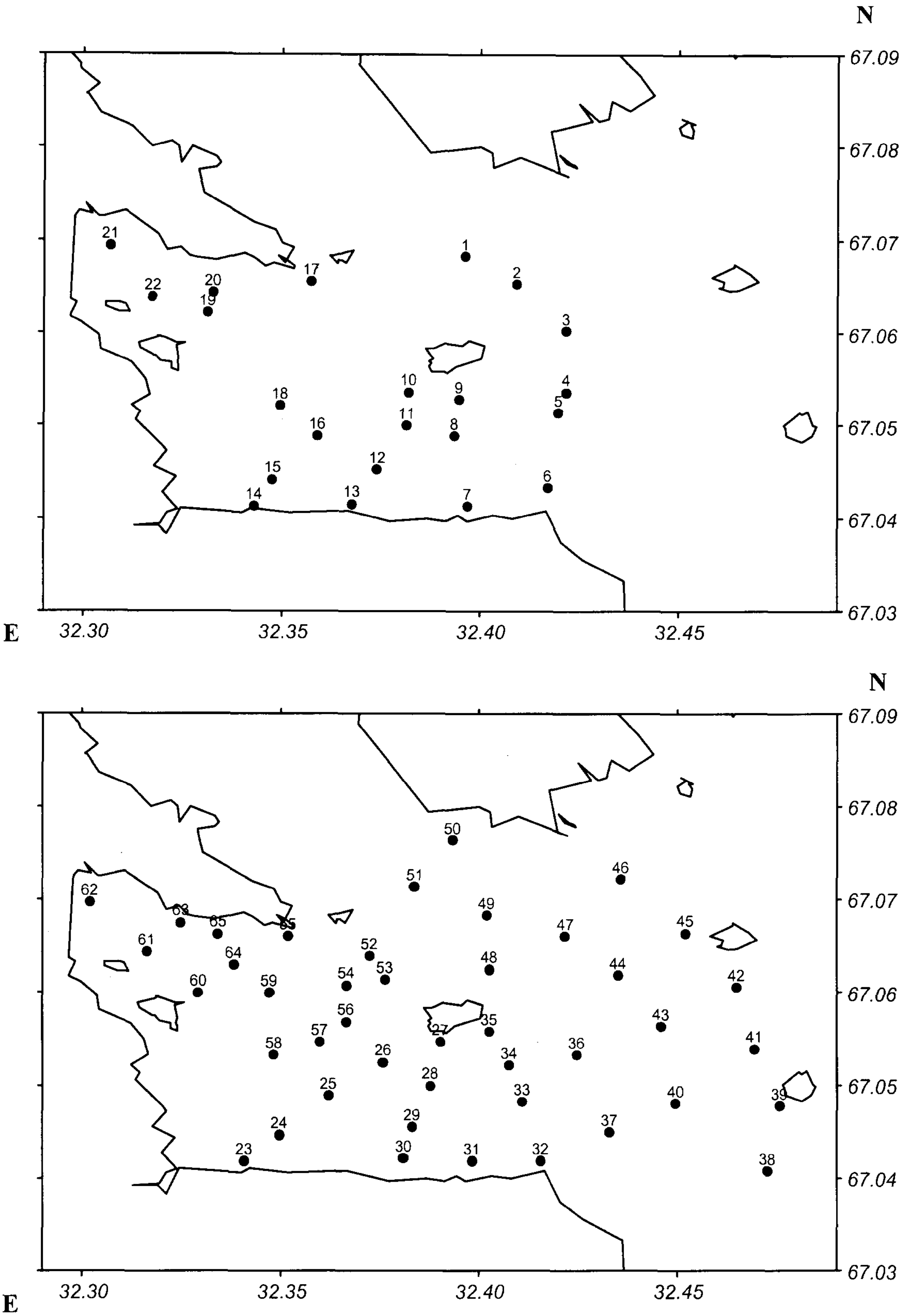


Fig. 26 Station arrays for STD soundings.
Upper figure – 13 July 1997; bottom figure – 15 July 1997

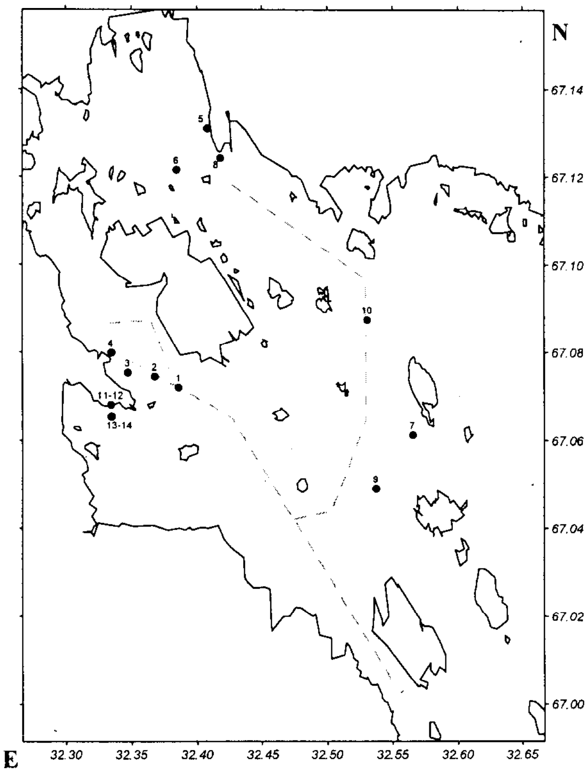


Fig. 27 Station arrays for the sampling of petroleum products; dashed lines represent the waterways of the Kandalaksha Gulf.

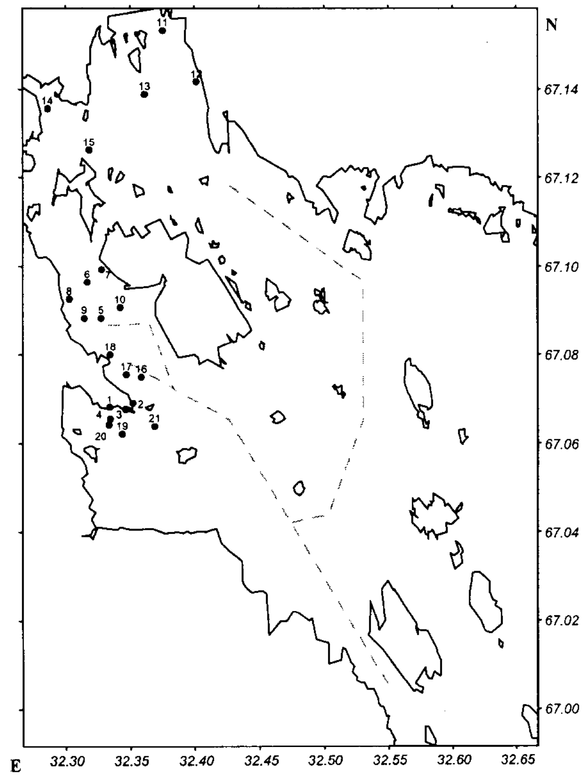


Fig. 28 Station arrays for bottom sampling; dashed lines as in Fig. 27.

Benthic sampling was conducted at points of assumed intensive human impact on hydro-ecosystems and at points remote from them (reference points) (Fig. 29). The samples were taken by *Okean-maly* dredge and by divers.

Preliminary analysis of the expedition research data showed that, on the whole, the ecological situation at the head of Kandalaksha Gulf is sufficiently stable to favour the development of stable biological communities. There are only small anomalies in the hydrochemical characteristics (lowered dissolved-oxygen content, increased concentration of bio-organic compounds). In particular, this was observed in shallow-water skerries at the head of Kandalaksha Gulf, which seems to be accounted for by the influence of the sea port, the town (with a population of 72,000) and 17 industrial enterprises located in the 50-km coastal zone. Moreover, the run-off of the Neva River carries industrial sewage from Imandra Lake, in the Monchegorsk District; the Lake is an ecological catastrophe. Small areas with adverse ecological conditions are found near the old dumping ground and shallow lagoons in Palkin Bay where there is extremely little water exchange. This year, in particular, hydrogen sulphide was recorded in Palkin Bay in the near-bottom layer of the shallow lagoon; this could be due to human activity and natural causes (e.g., the death of the nearby mussel beds).

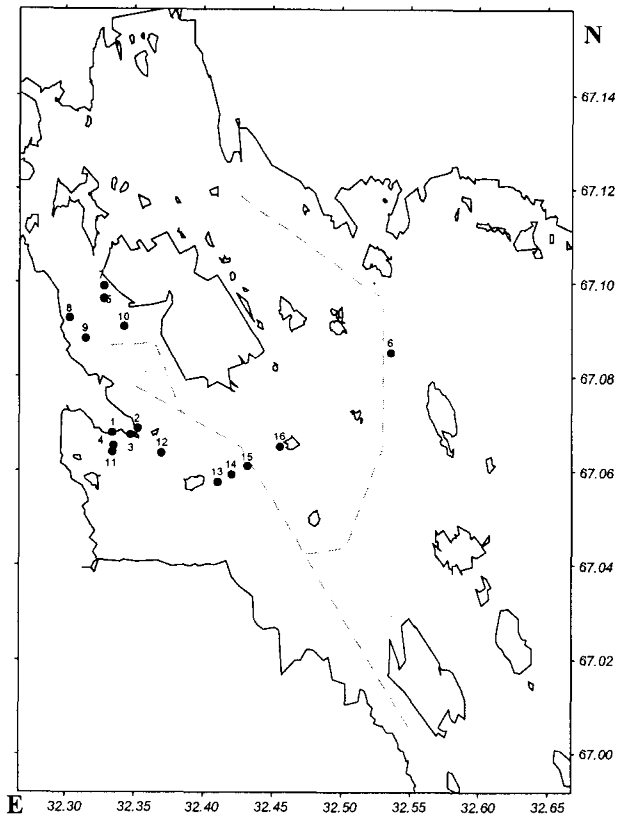


Fig. 29 Station arrays for biological sampling; dashed lines as in Fig. 27.

Results for the Barents Sea

The research in Kislaya Bay, Ura Bay and Motovskoy Gulf, in the Barents Sea, was performed from 18 to 31 July 1997. The work was done on board two small PINRO vessels (in Ura Bay and Motovskoy Gulf) and a yawl (Kislaya Bay). During the field observations, a multi-day bathymetric station was carried out in Kislaya Bay in the vicinity of the tidal-power-plant dam, in the zone of highly intensive water exchange; an oceanographic survey of Kislaya Bay, which included 32 stations (Fig. 30) and an STD-survey of Kislaya Bay, which included 55 stations (Fig. 31), were also made. With short pauses due to bad weather, bathymetric and STD transects were made (simultaneously with the work in Kislaya Bay) along the eastern branch of Ura Bay. Nine bathymetric casts were made in Motovskoy Gulf.

The results of the four-year-long research by RSHU and PINRO in Kislaya Bay showed that alterations in the operating regime of the water ducts in the tidal-power-plant (TPP) dam, aimed at increasing water exchange with Ura Bay, have, on the whole, resulted in an improved ecological situation. The hydrogen sulphide pollution descended from the 20 m isobath to the very bottom (36-42 m) of the basin the farthest and most isolated from the sea. Moreover, even in that basin, hydrogen sulphide was not recorded in every year of the past four-year period. A direct consequence of the improved abiotic environmental characteristics of Kislaya Bay was the somewhat increased biodiversity of its hydro-ecosystems and the restoration of some marine species. At the same time, vast accumulations of shells are reminders of the ecological catastrophes of the past. The bay usually freezes over in winter.

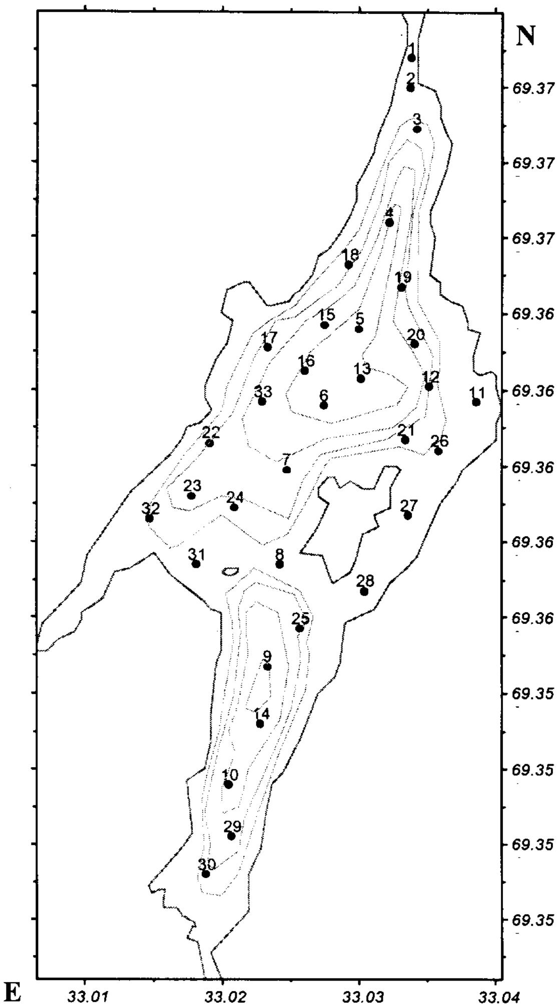


Fig. 30 Bathymetric station array in Kislaya Bay, Barents Sea, July 1997.

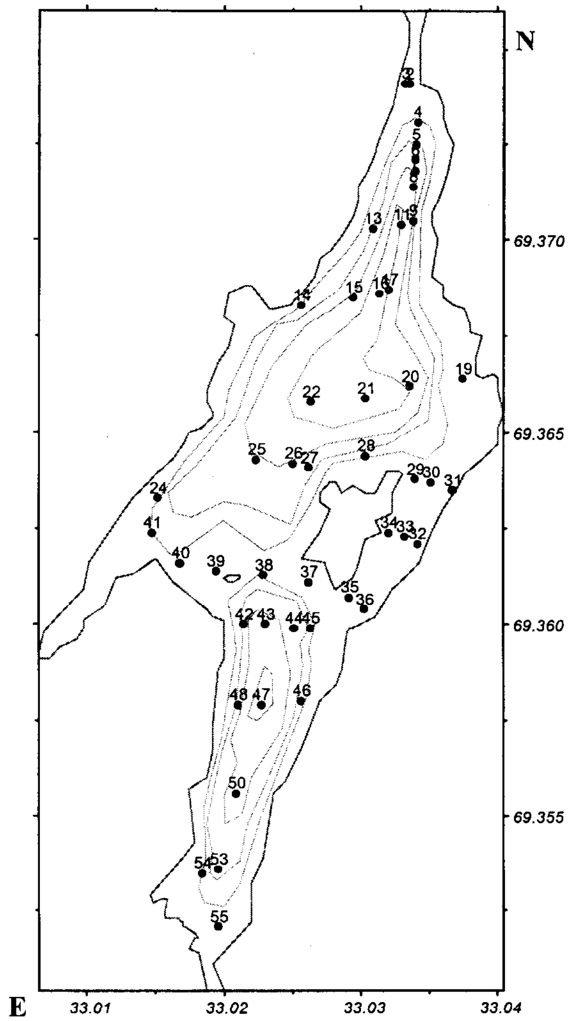


Fig. 31 STD station array in Kislaya Bay, Barents Sea, July 1997.

At present, the characteristics of Kislaya Bay hydrological regime are largely governed by the regulated water exchange through the TPP dam. With significant natural seasonal deviations from the average, in climatic processes, and with the regulated water exchange, the hydrological characteristics of the low-volume Kislaya Bay waters change much faster than those in neighbouring Ura Bay, which is freely connected with the Motovskoy Gulf in the Barents Sea. These variations in magnitude of the abiotic environmental characteristics significantly suppress the development of the brackish-water hydro-ecosystem of the Bay and the marine hydro-ecosystem which have not been able, up to now, to restore themselves fully after the ecological catastrophes of the 1970s.

The young researchers of the coastal zone of the northern seas gain extremely beneficial experience during the BFU expeditions to the White and Barents Seas. They have to face the problems of the very complicated adjustment of man's activities to the actual evolution of the hydro-ecosystems. The White Sea is still clean, so far, and the total human impact on the hydro-ecosystems is also not great, so far. In Kislaya Bay (Barents Sea) the catastrophes are already in the past, and the biological communities of the region are gradually restoring themselves.

The RSHU expedition culminated in a discussion of its preliminary results at the Second International Workshop on the Rational Exploitation of the Coastal Zone of the Northern Seas, in Kandalaksha, 3-5 August 1997. The participants were six RSHU teachers and 18 students, as well as representatives of leading research and educational organizations: Kandalaksha State Nature Reserve, PINRO, Murmansk Marine Biology Institute of the Kola Scientific Centre of the Russian Academy of Sciences (RAS), White Sea Biological Station of the RAS Institute of Zoology, White Sea Biological Station of Moscow State University, the Russian Geographical Society, as well as colleagues from Finland - SULA and a number of biostations.

NEW PORT FACILITIES IN THE EASTERN GULF OF FINLAND AS A PROBLEM OF INTEGRATED COASTAL MANAGEMENT

The BFU operations in the Baltic Sea region are focused on integrated coastal management and for this reason the study of the economic aspects of maritime shipping, as well as the problems of safety at sea, are included in the research and educational programmes of the BFU. The BFU studies also provide the environmental base-line prior to construction of new port facilities in the Gulf of Finland.

The study of coastal processes is part of the ecological study of the eastern Gulf of Finland implemented by the BFU as a contribution to environmental impact assessment. The administration of LENMORNIIPROEKT Co., which is responsible for the design of the new port, has provided official information; this, with other materials obtained through the mass media, provides the basis for certain conclusions regarding the possibility of negative processes developing in the Gulf of Finland and the Baltic Sea in the future as a result of the expansion of port facilities being planned in Russia as well as in other nations of the Baltic Sea region: Estonia, Latvia, Lithuania, Poland. Intensive construction of new ports and reconstruction of old ones, leading to rapid development of maritime traffic and oil transportation, in particular, accompanied by offshore exploitation of oil, could be considered as a "prelude to conflict". Oil, which is often called "black gold", is becoming a major environmental, economic and social threat in the Baltic Sea area. The main goal of the development of integrated coastal management in the Baltic region and the eastern Gulf of Finland, in particular, is not to permit this "prelude" to develop into real conflict. As evidence of changes in the coastal area of the Baltic Sea, the preliminary discussion of difficulties, misunderstandings and other problems seems to be useful, allowing for an exchange of ideas and information, the development of wise management that will provide decision-makers with the arguments upon which to base relevant policy and legislation. Among the problems important for the Russian Federation, the following may be mentioned: a general lack in development of integrated coastal management methods; and poor jurisdictional support under the new market conditions. Accordingly, for the requirements of sustainable development to be met, the Russian Coastal-Zone Exploitation Strategy, as well as the Federal Coastal-Zone Law, has been adopted.

The importance of global shipping is increasing because of the rapid growth in world trade relative to growth of the global economy. For European countries, the Baltic Sea offers an important sea route for the export and import of various kinds of goods. The changes in harbour facilities in the Gulf of Finland have come about a result of changing economic conditions following the disintegration of the Soviet Union and the re-establishment of the independent Baltic States: Estonia, Latvia and Lithuania.

Before its disintegration, the Soviet Union had in operation nine main ports on the Baltic Sea with a transportation capacity of about 87 million tons per year, which was about 30% of the USSR's total maritime cargo. Moreover, 30-40% of the Soviet Union's exports passed through these international ports.

At present, Russia has only four ports on the Baltic Sea. The Russian transport problem is complicated also because the existing ports were developed in the 1950s and 1960s, and containerized cargoes have since altered the nature of port facilities. Hence, in 1991, only 7.5 million tons (8% of Russia's total maritime shipping) passed through the Baltic ports of the Russian Federation. According to the presently available data, the shipping capacity of the Russian Baltic ports does not exceed 21 million tons, which is only about 4% of the total volume of the maritime shipping in the Baltic Sea (there are more than 40 ports on the Baltic Sea, with a shipping capacity of about 600 million tons per year).

Table 7
New port facilities in the eastern Gulf of Finland

Port	Planned shipping capacity (million tons/year)	Types of goods	Observations
Batarejnaya	15	oil and oil products	Owner: Surgutneftegaz Oil Company. Pipeline is planned
Primorsk	45	oil and oil products	Total cost: US$3.7 billion Capacity of first oil terminal; 4.5 million tons Cost: US$467.5 million
Vysotsk	5-6	coal, iron ore, food, steel, aluminium	Owner: Port Vysotsk, a Russian joint stock company Present capacity: about 1 million tons
Viborg	2	wood and coal (both exports); food, steel and aluminium (all imports)	Owing to shallow water, this port cannot handle ships of 50,000dwt or more Present capacity: 1 million tons
Lomonosov	2.5	capital goods, containers, refrigerated goods	Ferry terminal Estimated cost of reconstruction: about US$170 million
Ust-Luga	40-50	coal, chemicals, iron ore, containers, oil and oil products, wood, capital goods	Car and rail ferry terminals and nine other terminals for various kinds of goods. Construction of the coal terminal (annual capacity: 8 million tons) was started in 1996. A terminal to handle 6-7 million tons of chemicals and mineral fertilizers is planned to start in the summer of 1998. Construction of a metal-fusion plant on an area of about 30ha near the iron-ore terminal is planned, with a capacity of about 2 million tons.
Vistino	2.5-5	capital goods, containers, food	—
St. Petersburg	35	oil and oil products, containers, capital goods, passenger transport	According to the 'Strategic Plan for St. Petersburg', new port districts at Litke (Kotlin Is.), Gorskaya and Bronka, as well as new transport-technology comlexes at Kirovsky Zavod, Baltiysky Zavod, Severnaya Verf will be constructed. The Maritime Canal has to be widen and deepen. The River Port and the Nevsky cargo zone will also be reconstructed.

The deficit in port capacity was about 48 million tons in 1996. Taking into account future development of export and import by the year 2010, the deficit may reach 140-150 million tons if new port construction is not started. Such statistics provide compelling economic arguments for port development. The Russian government's proposal on new port construction will affect the maritime shipping in the Gulf of Finland. So far, four new ports (Ust-Luga, Primorsk, Batarejnaya and Vysotsk) have been officially approved for construction in the coming years in the eastern Gulf of Finland. There are plans for the expansion of existing ports (St. Petersburg, Viborg, and Lomonosov), as well as some proposals on the use of existing terminals by private companies.

The Table shows only the main features of the port facility changes. However, owing to the poor access to information and poor reliability of the sources of that information, as well as to the fact that not all submitted plans are made official, the picture is not at all clear.

The problem of the existing port facilities and of the construction of new ones in the eastern Gulf of Finland have been caused by the objective necessity for Russia to re-establish its turnover of cargo via the Baltic Sea. All the Baltic countries have commercial ports with international traffic and, in the current situation, various development plans are also under way. The port of Ust-Luga, the construction of which has already started, is also an example of Russia's readiness to examine the jurisdictional basis for the realization of great port initiatives under the new market conditions. Some negative aspects may be indicated, however:

(i) Environmental impact assessment (EIA) has to follow a methodology by which the total impact due to a certain activity can be evaluated. The impact will affect the human population and the natural and the urban environments. Such environmental impact should be evaluated in the pre-design phase. However, the environmental impact assessment of the construction of the port of Ust-Luga has been suspended owing to a lack of money, in spite of the start of construction of the first terminal in the summer of 1997. Planning of the EIA should be continued, but it is necessary to note that the Russian legislation on EAI is different from that in Western countries. LENCOMECOLOGY, the local office of the Russian Environment Committee, mainly checks whether the project complies with local norms and standards.

(ii) The construction of the port of Ust-Luga is being carried out by a specially organized Russian company, the Ust-Luga Co. As a private company, it is not interested in paying for the originator's control of the current construction. Furthermore, building companies, multilateral development banks and other financial institutions seem to be more prepared to support great infrastructure projects that destroy the natural landscape and marine coasts, as well as cause pollution, than they are to allocate money for projects aiming at environmental protection. It is not clear what institution is responsible for ensuring compliance with project standards and what mechanism of payment should be used.

(iii) It is also not clear what should be the mechanism of payment of compensation for the protection of wildlife from human impact. It would be assumed that, in the fight to conquer a shipping market, national planning and construction standards and regulations for environmental impact assessment are often violated. New partners are involved in a maritime shipping market and the licensing procedure for cargo operations should be improved in accordance with the necessity and cost of a compensatory expenditure, as well as for regulating the reduction of operational discharges. For instance, the list of problems in the improvement of harbour reception facilities is presented in the Black Sea Transboundary Diagnostic Analysis (1997) prepared under the Black Sea Environment Program. [GEF Black Sea Environmental Programme (1997). Black Sea Transboundary Diagnostic Analysis.] But the problems, including regulation of potential dumping activity, a lack of harmonized marine environmental quality objectives, and of enforcement mechanisms and so on, are very similar to those in the Baltic Sea region.

The new harbour projects of Russia and other Baltic countries, and new ideas on the integration of transportation, will lead to growth in the volume of the maritime shipping. Increasing traffic to and from Russia, between Finland and Estonia and between Sweden and the Baltic countries across the central Baltic Sea increase the risk of shipping accidents in the Gulf of Finland and in the Baltic Sea.

Early risk analyses have been based on the various statistics published by the authorities and government agencies. [Rytkonen, J. (1994). Environmental and Safety Aspects of the Marine Traffic in the Baltic Sea. Meeting of Experts on Ports and Maritime Transport. Naantali, Finland, 14-15 November 1994] Sea traffic through the Baltic Sea is heavy, in respect of the frequency of ships and of tonnage. The statistics of the Finnish Navigation Board (1984-1992) show the total transportation of oil and refined chemicals to and from the Finnish ports to be 20-25 million tons per year. In 1986, tanker traffic to the Finnish ports amounted to 2,700 port calls (about 10 % of all normal port calls). There may be more than 250,000 calls of ships to all Baltic ports, and the amount of transported oil and refinery products are at least 175 million tons per year for the whole Baltic Sea. Owing to the dense traffic, more than 150 shipping accidents occur on the average each year; 90% were caused by grounding, ramming and collisions, 10% by listing, foundering, weather and ice damage and fires.

The rapidly developing marine traffic in the Baltic Sea requires the elaboration of a new risk assessment system for the regulation of maritime safety and environmental issues. But the estimation of the total volume of the Baltic Sea transportation cannot be derived simply by summing up additional planned annual shipping volume through the new ports, because the inclusion of the new ports in overall shipping operations will result in a change in the turnover of cargo in the whole Baltic. For example, now, about 15% of Russian oil export passes through the port of Ventspils (Latvia).

The elaboration of the methods and tools of integrated coastal management relative to the sustainable development of port facilities in the Baltic Sea is a transboundary task, and co-operation in the different spheres and the environmental impact assessment, in particular, is necessary. National jurisdictions have to be based on international conventions such as SOLAS, Load Lines, MARPOL and others. Planning coastal-zone development must take into account approaches formulated in some pan-European documents such as the Pan-European Biological and Landscape Diversity Strategy.

SOCIO-ECONOMIC ASPECTS OF COASTAL-ZONE DEVELOPMENT IN THE NORTHERN-SEAS REGION

The Northern-Seas region is one of the richest in Russia. Its own raw material, fuel and energy resources have facilitated the development of many industries there. Solution of the scientific task of providing integrated hydrometeorological support for various natural-resource user groups, with a view to the sustainable development of the natural and artificial hydro-ecosystems in the coastal zone of the White and Barents Seas, is only feasible on the basis of a study of the economic interests and industrial technologies of the enterprises that are the natural-resource users.

The principal direct users of the natural resources of the coastal zone in the area covered by the RSHU expeditions in the White Sea are the following:

- Kandalaksha Commercial Sea Port
- Kandalaksha State Nature Reserve
- White Sea Oil Terminal
- "Udarnik" Ltd., a trout farm
- "Gandvig", a children's recreational centre
- "Maripal", a medical-mud-extracting company
- PINRO research base on the White Sea coast, with its experimental trout farm.

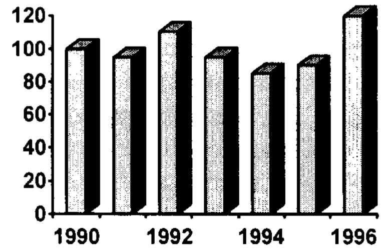
Three out of these natural-resource users cannot and should not, in principle, be profit making. These are the nature reserve, the recreational centre and the state research institute. But, at the same time, in the course of their activities, they are extremely interested in keeping the environment clean as well as in promoting the sustainable development of the coastal ecosystems. The total contribution of these organizations to the economy of Kandalaksha District is insignificant, however. According to the information provided by the District Administration, the bulk of the profit comes from the non-ferrous metallurgical industries and power plants (the Niva River hydro-electric station and the Kola Atomic Power Plant) which do not directly use the resources of the coastal zone, but which are sources of various types of pollutant in the water bodies concerned.

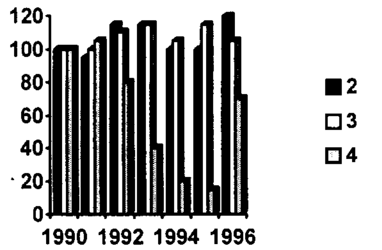
Over the past six years, the production of the main industries in the Kandalaksha District has been rather unstable, and the analysis of relevant information points to more or less stable production, or even — to some extent — increasing production, only in the power-generating and non-ferrous metallurgical industries. In 1996, the production of the other industries decreased by 0.2-46.3 %, compared to 1990 (Fig. 32).

The decline in economic development had two diametrically oppose consequences. The first one was a reduction in the level of environmental pollution in the past 3-4 years, owing to the considerable decrease in industrial production or even the complete shutdown of some enterprises. According to the 1996 information, there were 17 more or less active large and medium enterprises in Kandalaksha District, compared to 20 in 1990. The second consequence was negative, related to a general deterioration in the living conditions, associated with natality, mortality and unemployment (Fig. 33). As a rule, if one is considering ways to provide a minimum living standard for oneself, then the last things one would think of are the ecological situation and the ecology of the soil.

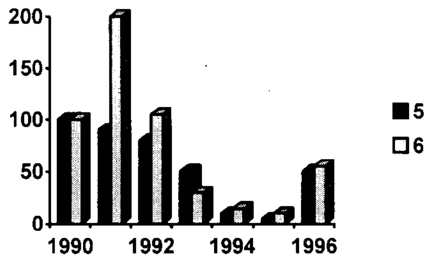
Hence, it follows that economic deterioration is more important, from all points of view. It will more than exceed any insignificant improvement in the environment that could result from a decrease in the level of production.

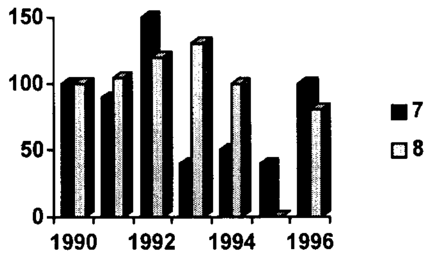
The decrease in the size of the population is not due to any catastrophe; the drop in the birth rate is due to deliberate family planning. In many countries, the problem is solved in the same way.





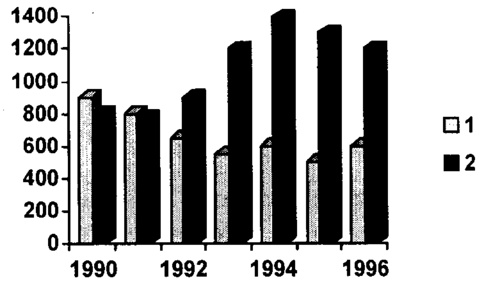
(a) (b)





(c) (d)

Fig. 32 Percentage changes in production in large and medium enterprises, for specified industries, 1990-1996 (baseline: 1990 = 100%). (a) - change in total production for all industries; (b) - electric-power industry (2), non-ferrous metallurgy (3), machine-making and metal working (4); (c) - forestry and wood-working industries (5) and light industry (6); (d) - food (7) and printing (8) industries



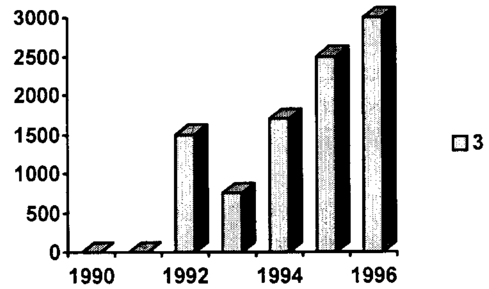


Fig. 33 Population changes in the city and suburbs (1990-1996)
1 - number of births; 2 - number of deaths; 3 - number of unemployed

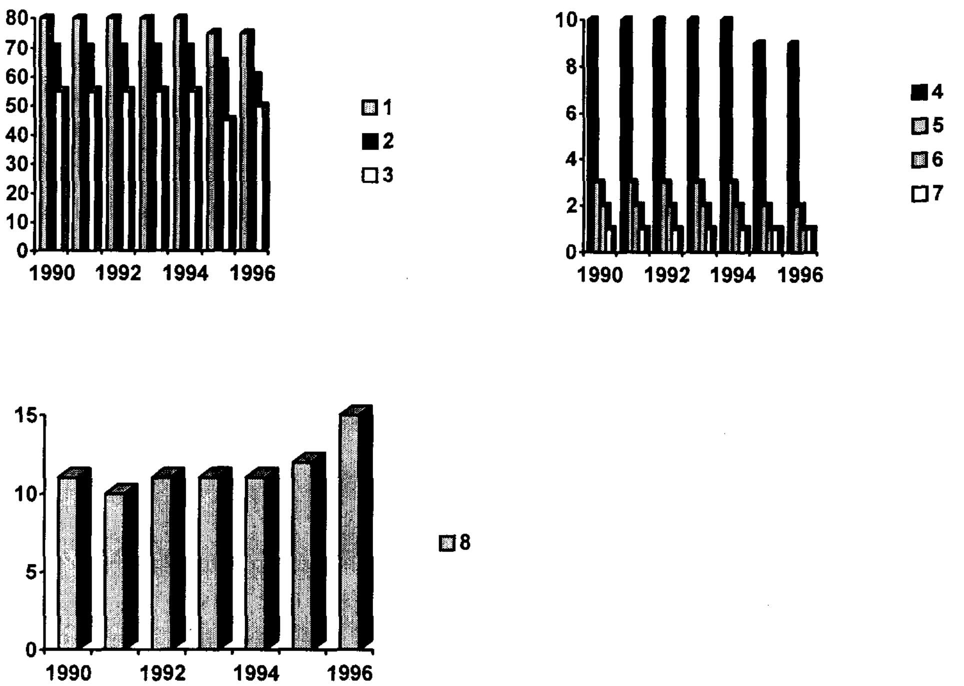


Fig. 34 Population size (thousands) at the beginning of the year. 1 - the city and suburbs; 2 - the urban population; 3 - the city of Kandalaksha; 4 - the settlement of Zelenoborsky; 5 - the settlement of Nevsky; 6 - the settlement of Zarechensk; 7 - the settlement of Lesozavodsky; 8 - the rural population.

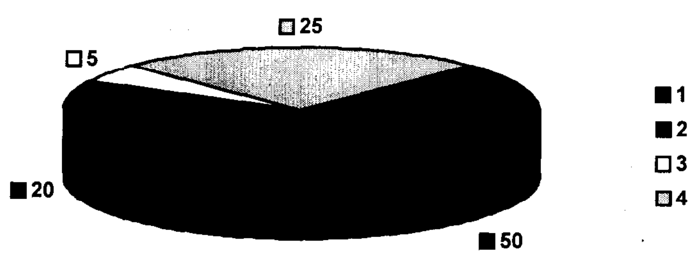


Fig. 35 Overall population size (percentages) in the city and suburbs, by major groups. 1 - employable population; 2 - children, 1-16 years old; 3 - adolescents, 16-18 years old; 4 – pensioners.

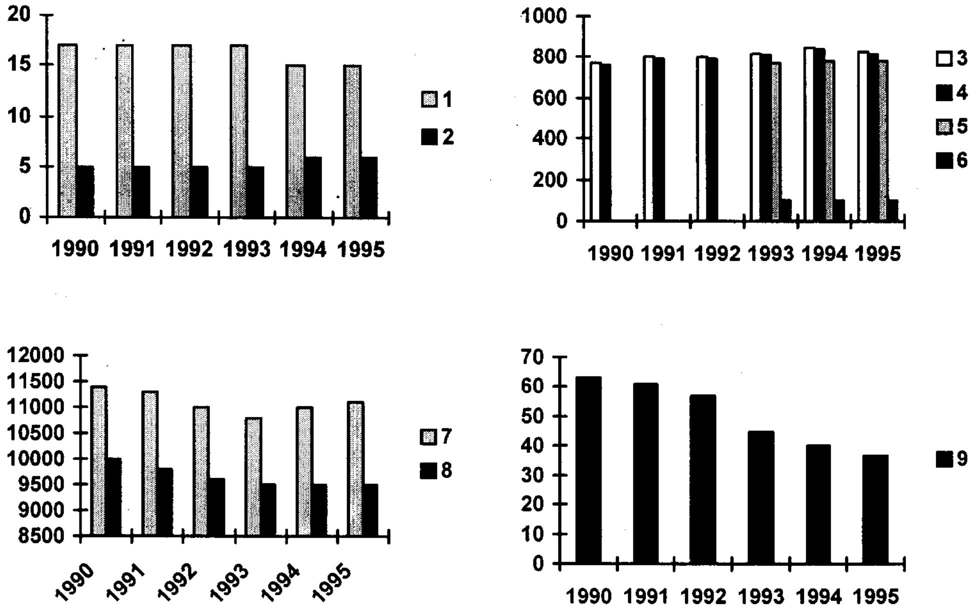


Fig. 36 Parameters of the education system (1990-1995). 1 - number of urban schools; 2 - number of rural schools; 3 - total number of teachers; 4 - number of day-time secondary-school teachers; 5 - number of teachers in urban areas; 6 - number of teachers in rural areas; 7 - total number of pupils; 8 - number of pupils in urban areas; 9 - number of pre-school institutions for children.

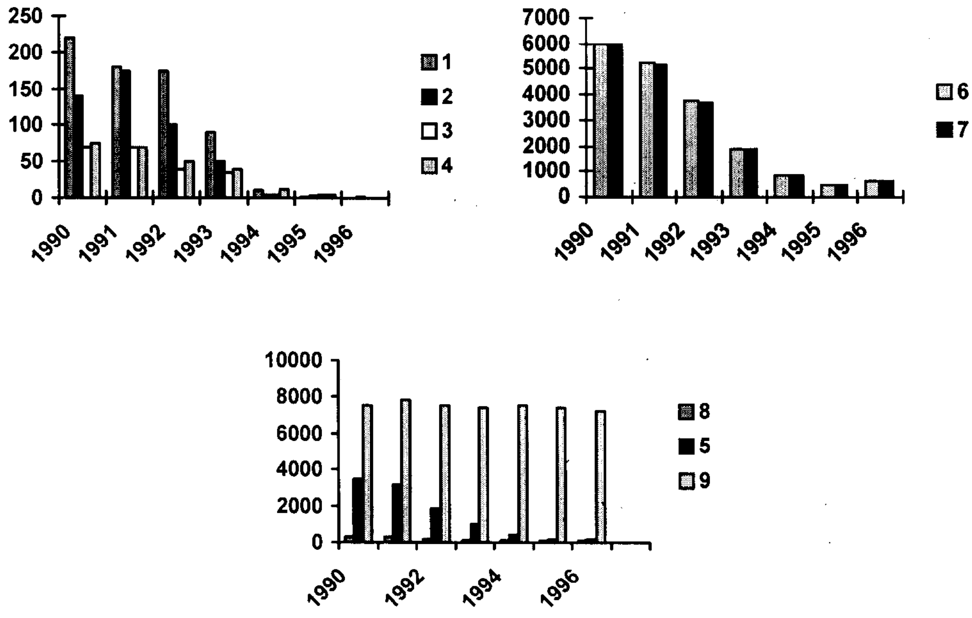


Fig. 37 The most important kinds of industrial products (1990-1996). 1 - timber (in the round, m^3); 2 – lumber (m^3); 3 - window blocks (m^3); 4 - door-blocks (m^3), 5 - industrial food production, including canned fish (tons); 6 – preserves (tons); 7 - preserves, including canned fish (tons); 8 - industrial food production, including bread and baked goods (tons); 9 - industrial food production, including confectionery (tons)

All these problems (of ecology, sociology and the economy) are interrelated. The solution of many of them, including ecological ones, depends on political strategy. And, in the present case, the solution of most of the problems depends on the local authorities. To foresee the situation in the future, it is necessary to conduct large-scale sociological investigations and to make a regional forecast based thereon.

In the Barents Sea region, the principal natural-resource users in the study area are:

- the Northern Fleet of the Russian Federation Navy
- Co-operative fishery "Energya"
- Kislogubskaya Tidal Power Plant
- PINRO research base in Kislaya Bay.

It is the servicemen of the Northern Fleet and the co-operative fishery workers who have the most significant social and ecological problems in this area. A small decrease in the fish catch and the recently introduced transfer to coastal fishing have caused many problems, particularly a reduction in the number of workers. On the one hand, an almost complete shutdown of the Kislogubskaya Tidal Power Plant has meant an improvement in the environment. Ecological catastrophes in Kislaya Bay are now things of the past, and its ecosystems are gradually returning to their normal state; on the other hand, the almost complete reduction in service personnel has lead to huge social problems.

The main feature of the research performed was that it was the first attempt to address ecological and social problems together, but an analysis of the little information obtained still has to be made. The research was not aimed at discovering the polluting enterprises; its aim was to locate the areas of the coastal zone where the ecosystems are under maximum impact from human activities. Location of these sources, however, does not imply an indubitably negative influence of the production of the nearest enterprise that is a natural-resource user in the coastal zone. A search for cause-and-effect relationships in the extremely complicated evolution of coastal ecosystems, and the identification of natural and human factors affecting various abiotic environmental characteristics in the shelf zone of a tidal sea are problems that still have to be solved by research teams.

The data used in the drafting of this section of the report to characterize the dynamic regional development during the last six years were made available by the Kandalaksha District Administration.

ANNEX 1

PROGRAMME OF THE FOURTH INTERNATIONAL UNESCO-IOC-HELCOM BALTIC FLOATING UNIVERSITY MID-CRUISE WORKSHOP

"Training through Practice and Research"
aboard the HRV *Persey*

organized and co-sponsored by the
Russian State Hydrometeorological University and the
Gulf of Finland Environment Society

with assistance in kind from the
Hydrographic Service of the Russian Federation Navy and the
Port of Helsinki Authority

Canal Quay, Helsinki South Harbour
27-28 August 1997

August 26

Arrival of HRV *Persey* in Helsinki South Harbour
Practical arrangements and final adjustments to the programme.

August 27

10 00 Registration
10 30 Opening of the Workshop
Mr. Richard Thompson Coon, Gulf of Finland Environment Society (SULA)

10 40 Welcome Addresses
Dr. Nikolai Plink, Faculty of Oceanography, Russian State Hydrometeorological University (RSHU)
Counsellor Yury Morozov, Embassy of the Russian Federation, Finland
Dr. Vassili Rodionov, Baltic Marine Environment Protection Commission (HELCOM)

11 15 Presentation of Reports by Scientists
Chairman: *Mr. R.T. Coon* (SULA)

Dr. V. Chantsev (RSHU). Main results of expeditionary investigations within the framework of the 1997 BFU summer programme.
Prof. A. Nekrasov (RSHU). Preliminary results of investigations made from the BFU catamaran *Orients* in the Luga Bay-Koporye Bay coastal area during the summer of 1997.
Prof. A. Lyakhin (RSHU), *D. Reshetov* (RSHU). Hydrochemical monitoring of the eastern Gulf of Finland during the BFU cruise of the HRV *Persey* in summer 1997.
Prof. V. Galtsova (RSHU), *S. Makharova* (HRI), *A. Maximov* (HRI), *D. Bychenkov* (NWHS), *M. Nitishinsky* (RSHU). Hydrobiological monitoring of the eastern Gulf of Finland during the 1997 summer period.
Prof. V. Galtsova (RSHU), *Dr. T. Eremina* (RSHU), *Dr. A. Maximov* (HRI). Ecological investigations in the Baltic proper in summer 1997.

Dr. G. Gogoberidze (RSHU). Short-period variations in the fine thermohaline structure of coastal areas in the eastern Gulf of Finland.
A. Danshina (RSHU). Investigation of turbulence characteristics in coastal waters.
A. Isaev (RSHU). Researching hydrodynamic fields in the Luga Bay-Koporye Bay area.

Dr. D. Isaev (RSHU), *Dr. V. Ivanov* (RSHU), *Dr. G. Ugreninov* (RSHU), *V. Peroskov* (RSHU). Hydrological investigations in the Luga River estuary as an extension of BFU coastal studies in the Luga Bay-Koporye Bay area.

14 45 Presentation of Posters by RSHU students
***Chairman**: Dr. V. Chantsev* (RSHU, Chief Scientist of the 1997 BFU Cruise).

D. Reshetov (Scientific Director: *Dr. T. Eremina*). A new system for the graphic processing of hydrometeorological data.
A. Nikiforov (Scientific Director: *Dr. V. Korovin*). A method for intercalibration of STD equipment under field conditions.
E. Kirillova, D. Smirnov (Scientific Director: *Prof. Yu. Lyakhin*). Variability of nutrients in the eastern Gulf of Finland in summer 1997.
S. Yanovitch et al. (Scientific Director: *Prof. V. Galtsova*). Zooplankton of the Gulf of Finland.
A. Demidov et al. (Scientific Director: *A. Zimin, Ph.D. student*). The ecological significance of variations in hydro-optical parameters in Luga Bay in summer 1997.
E. Nikonov (Scientific Director: *Prof. V. Galtsova*). Meiobenthos of the Baltic Sea.
S. Efremov (Scientific Director: *Prof. V. Galtsova*). Methods for investigating hydrobionts of the Baltic Sea.
S. Butov, A. Manylov (Scientific Director: *Dr. T. Eremina*). The main features of dissolved-oxygen distribution in the Gotland Basin.
D. Smirnov, E. Kirillova (Scientific Director: *Dr. T. Eremina*). Nutrient distribution in the Luga Bay-Koporye Bay area according to observations in July 1997.
A. Fadeev, A. Demidov (Scientific Director: *A. Zimin, Ph.D. student*). Calculation of hydro-optical characteristics according to observations in the Luga Bay-Koporye Bay area in July 1997.

August 28

10 00 Main Theme: Integrated Coastal Management.
***Chairman**: Mr. R.T. Coon* (SULA)

Dr. N. Plink (RSHU). BFU activities in 1997 in the sphere of integrated coastal management.
Dr. Ye. Kluikov (RSHU), *Dr. S. Lukianov* (RSHU), *Dr. M. Shilin* (RSHU). Results of BFU research in the coastal zone of the White and Barents Seas, including some socio-economic aspects of local community life.
Dr. M. Kiirikki (FEI). Upwelling as a possible explanation for mass occurrences of filamentous algae.
Prof. A. Nekrasov (RSHU), *Dr. Toomas Kokovkin* (HCBRWEA). BFU expeditions with the sail catamaran *Orients* to the West Estonian Archipelago Biosphere Reserve in 1996 and 1997. Application of basic marine science to biosphere area management: joint Estonian-Russian-Finnish ecological investigations.
Dr. Juha-Markku Leppanen (FIMR). Factors underlying the phenomenal blue-green algae blooms in the western and central Gulf of Finland during summer 1997: their significance in terms of the need to reduce the nutrient load on the Baltic Sea.
Mr. Erkki Siirila (FEI). Coastal management: principles and approach.
Ms. Tiina Tihlman (UREC, LIFE-96 Project). Planning of coastal areas in the Gulf of Finland.

***Guest speaker**: Ms. Pirkoo Heikkinheimo* (Scientific Secretary, Finnish Academy of Sciences)

14 00 Discussion
General theme: Moving towards integrated coastal management through improved integration of off-shore, near-shore and on-shore coastal science.

Agreements and Resolutions

16 00 Closing of the 1997 BFU Workshop

August 29

09 30 Cruise for crew members of HRV *Persey* around Helsinki Harbour aboard the MV *Aranda* (Courtesy of the Port of Helsinki Authority).

16 00 Departure of the HRV *Persey* from Helsinki South Harbour for St. Petersburg.

ANNEX 2

LIST OF PARTICIPANTS IN THE FOURTH INTERNATIONAL UNESCO-IOC-HELCOM BFU MID-CRUISE WORKSHOP

"Training through Practice and Research"
aboard the HRV *Persey*

Canal Quay, Helsinki South Harbour
27-28 August 1997

Mr. Yury Morozov, Embassy of the Russian Federation in Finland, Helsinki
Dr. Vassili Rodionov, Baltic Marine Environment Protection Commission (HELCOM), Helsinki
R.T. Coon, Gulf of Finland Environment Society, Finland
Ms. Pirkoo Heikkinheimo, Scientific Secretary, Finnish Academy of Sciences
Dr. M. Kiirikki, Finnish Environment Institute
Dr. Juha-Markku Leppanen, Finnish Institute of Marine Research
Mr. Erkki Siirila, Impact Research Division, Finnish Environment Institute
Ms. Tiina Tihlman, LIFE-96 Project, Uusimaa Regional Environment Centre, Finland
N.L. Plink, Dean of the Oceanology Faculty, Russian State Hydrometeorological University
A.V. Nekrasov, Ocean Dynamics Department, Russian State Hydrometeorological University
V.Yu. Chantsev, Fisheries Oceanology Department, Russian State Hydrometeorological University
S.V. Lukianov, Oceanology Department, Russian State Hydrometeorological University
D.I. Isaev, Hydrology Department, Russian State Hydrometeorological University
T.R. Eremina, Fisheries Oceanology Department, Russian State Hydrometeorological University
V.V. Galtsova, Zoological Institute, Russian Academy of Sciences
A.A. Maksimov, Russian State Hydrological Research Institute
G.G. Gogoberidze, UNESCO-RSHU Baltic Regional Centre, Russian State Hydrometeorological University
A.V. Isaev, UNESCO-RSHU Baltic Regional Centre, Russian State Hydrometeorological University
A.V. Danshina, Fisheries Oceanology Department, Russian State Hydrometeorological University
A.V. Zimin, Oceanology Department, Russian State Hydrometeorological University

Students of the Russian State Hydrometeorological University:
D. Reshetov, A. Nikiforov, E. Kirillova, D. Smirnov, E. Nikonov, A. Pnyushkov, S. Kirillov, S. Butov, A. Manylov, S. Yanovitch, S. Efremov, A. Fadeev, A. Demidov, S. Vinogradov

ANNEX 3

PROGRAMME OF THE II INTERNATIONAL WORKSHOP ON THE RATIONAL EXPLOITATION OF THE COASTAL ZONE OF THE NORTHERN SEAS

Kandalaksha, 3-5 August 1997

August 3

Opening of the Conference: *A. S. Koryakin*, Deputy Director for Research, Kandalaksha State Nature Reserve.
Welcome address: *V. A. Shelepina*, Deputy Head of Kandalaksha Administration.
Letter of welcome from *Douglas Nakashima*, UNESCO (read by Ye. Yu. Kluikov).
Letter of welcome from *A. F. Alimov*, Corresponding Member of the Russian Academy of Sciences, Head of The White Sea Project (Zoological Institute, RAS) and *A. P. Alekseyev*, Chairman of the White Sea section of the Interdepartmental Ichthyology Commission (read by Prof. V. Ya. Berger, Director, White Sea Biological Station).

Presentations

Kluikov Ye. Yu., Lukianov S. V., Shilin M. B. (RSHU): "Training Through Research" at the UNESCO Baltic Floating University in the northern seas.
Berger V. Ja., Fedyakov V. V., Naumov A., D. (BBSZIN): To the Baltic Floating University of UNESCO: Proposal of collaboration in the field of student training.
Vorobjova N. K., Plotitsyna N. F. (PINRO): Ecological aspects of rainbow trout culture in inshore waters of northern seas.
Bianki V. V., Boyko N. S. (KSNR): The significance of the western Ryashkov Sound (Kandalaksha Gulf in the White Sea) for the birds.
Karasev A. B. (PINRO): Parasitological studies conducted by PINRO in the Kola Peninsula coastal area.
Shevchenko N. V. (MSU): Peculiarities of the coastal geomorphologic structure of the tidal sea, with the Kandalaksha Gulf in the White Sea as an example.
Zhuravleva N. G. (MMBI): Theoretical basis of marine culture of fish: new perspectives for the fishery in the Murmansk region.
Kovtsova M. V., Rudnev V. G. (PINRO): Distribution and abundance of non–target fish species in the Murmansk coastal area, and the fishery prospects.
Matyushkin V. B., Sennikov A. M. (PINRO, read by M. V. Kovtsova): Trophic relations of the king crab in the western Murmansk coastal ecosystem.
Orlova E. L., Kovtsova M. V., Karamushko O. V. (MMBI). Some specific features of the trophic behaviour of fish under conditions of unsteady food availability in the inshore waters of Murmansk.
Telegin A. V. (KSNR): History of the "JOLGA" Natural Park.
Kluikov Ye. Yu., Lukianov S. V., Shilin M. B. (RSHU): Problems of scientific support to sustainable coastal-zone development in the White and Barents Seas.
Khaimina O. V., Nasonova O. A. (RSHU): Variability of hydrochemical characteristics in the northern part of the Gulf of Kandalaksha during the summers of 1996 and 1997.
Tyuryakov C. A. (RSHU): Peculiarities of distribution of nutrients and dissolved oxygen in Kislaya Bay.
Lukianov S. V., Pnyushkov A. V. (RSHU): Mathematical modelling of transformations of temperature profiles.
Kirillov S. A., Nesterov A. V., Pnyushkov A. V. (RSHU): Variability of the temperature and salinity fields under the influence of external factors.

August 4

Ninburg E. A. (SPCPYC): "Training through research": the Russian path to training young scientists.
Pološkin A.V. (SPSU): Experience in biological monitoring of the littoral macrobenthic communities at the head of the Kandalaksha Gulf, in the White Sea.
Shvets O. P. (Udarnik Ltd, Palkin Bay, Kandalaksha Gulf): Industrial trout breeding in cages at Udarnik Ltd.
Krasnov Yu. V. (KSNR): Behaviour of the Greenland seal in coastal waters of the recreation zone of the town of Kandalaksha at the head of Kandalaksha Gulf.
Shklyarevich G. A. (KSNR): Algae and invertebrates in shallow parts of Porya Bay (Kandalaksha Gulf, in the White Sea)
Poloskin A.V., Rydlovskaya A.V. (SPSU): The present state of the *Zostera marina* L. community in the Kandalaksha State Nature Reserve, at the head of Kandalaksha Gulf in the White Sea.
Krasnova E. D. (BBSMSU): Spatial structure of communities of the littoral nematode *Chromadoropsis vivipara* (de Man, 1907) in Kandalaksha Gulf in the White Sea.
Khaitov V. M., Artemyeva A. V. (SPSU): Macrobenthos in mussel beds and banks in shallow parts of the White Sea..
Yevtushenko V. A., Naumova L. A. (RGS, Polar Zory Department): Northern stone labyrinths as monuments of labour tools
Krylov M. M., Lukianov S. V. (RSHU): Optical characteristics of water in the coastal zone.

Discussions

Participants: *V. G. Kulachkova* (ZINRAS), *G. G. Novikov* (BBSMSU), *N. K. Vorobyeva* (PINRO), *A. S. Koryakin* (KSNR), *Telegin A. V.* (KSNR).

Projection of movies of the Kandalaksha State Nature Reserve.

August 5 (Kandalaksha - Ryashkov Island)

Round-Table Presentations

Beck T. A. (BBSMSU): The White Sea Biological Station of the Moscow State University.
Koryakin A.S. (KSNR): Long-term biological data of the Kandalaksha State Nature Reserve.
Siira Jouko (RSGB, Finland): The Research Station of the Gulf of Bothnia.
Juha Viramo (OBS, Finland): Training and research.
Hietajärvi Teuvo (VBS, Finland): Research work of the Station of Vyärrio.
Hellå Timo. (EPSFRI, Finland): Nesting of birds on the Aina Isles in the 1920–1930s.
Koskiniemi Hemmo. (Project Co-ordinator, Rovaniemi, Finland): Laplandia-Murmansk Region: Cultural and Ecological Project.
Juha Ylimaunu. (Municipality of the town of Kemi, Finland): Contradictions between housing systems and environmental protection in the use of the coast in Finland and other EC countries.
Ves Haataja. (Public Movement "For Kutsa" Salla, Finland): Will the destiny of Kutsa be decided?
Bianki V. V. (KSNR): Ornithological research work of the Kandalaksha State Nature Reserve in the White Sea and opportunities for international co-operation.
Boyko N. S. (KSNR): Zoological research in the Kandalaksha State Nature Reserve.
Shklyarevich G. A. (KSNR): Stages of hydrobiological research in the Kandalaksha State Nature Reserve.
Shklyarevich F. N. (KSNR): Amphibians and reptiles in the Kandalaksha State Nature Reserve.
Moskvicheva L. A. (KSNR): Botanical research by the laboratory of the Kandalaksha State Nature Reserve.
Ninburg Ye. A. (SPCPYC): The work of the Marine Benthic Ecology (Hydro-ecology) Laboratory.

ANNEX 4

LIST OF PARTICIPANTS IN THE II INTERNATIONAL WORKSHOP ON THE RATIONAL EXPLOITATION OF THE COASTAL ZONE OF THE NORTHERN SEAS

Kandalaksha, 3-5 August 1997

Andreev O. M.	Student	Russian State Hydrometeorological University
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Kirillov S. A.	Student	Russian State Hydrometeorological University
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Kukushkina M. V.	Student	Russian State Hydrometeorological University
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Lukianov S. V.	Cand. Sc. (Phys. & Math.)	Russian State Hydrometeorological University
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Pnyushkov A. V.	Student	Russian State Hydrometeorological University
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Shelepina V. À.	Deputy Head	Kandalaksha Administration
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Shilin M. B.	Cand. Sc. (Biology)	Russian State Hydrometeorological University
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Shvaibovich A. A.	Student	Russian State Hydrometeorological University
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Skomoroh A. V.	Student	Russian State Hydrometeorological University
Telegin A.V.	Researcher	Kandalaksha State Nature Reserve
Tyuryakov C. A.	Student	Russian State Hydrometeorological University
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Yevtushenko V. A.	Chairman	Russian Geographical Society, Polar Zory Department

Zhuravleva N. G.	D. Sc. (Biology)	Marine Biological Institute, Kola Scientific Centre of the Russian Academy of Sciences
Siira Jouko	Researcher	Gulf of Bothnia Research Station, Finland
Juha Viramo	Researcher	Oulanka Biological Station, Finland
Hietajrvi Teuvo	Researcher	Vyärrio Biological Station, Finland
Hellå Timo	Researcher	Environmental Protection Society, Forestry Research Institute, Finland
Koskiniemi Hemmo	Project Co-ordinator	Rovaniemi, Finland
Juha Ylimaunu		Municipality of the town of Kemi, Finland
Ves Haataja		Public Movement "For Kutsa" Salla, Finland

ANNEX 5

LIST OF ACRONYMS

BBSMSU	White Sea Biological Station of the Moscow State University
BBSZIN	White Sea Biological Station of the Zoological Institute
BFU	Baltic Floating University
BMB	Baltic Marine Biologists
BSPA	Baltic Sea Protected Area
CSI	Environment and Development in Coastal Regions and in Small Islands (UNESCO)
EIA	environmental impact assessment
EPSFRI	Environmental Protection Society, Forestry Research Institute
FEI	Finnish Environment Institute
FIMR	Finnish Marine Research Institute
GEF	Global Environment Facility (of UNEP)
HCBRWEA	Hiiumaa Centre for the Biosphere Reserve of the West-Estonian Archipelago
HELCOM	Baltic Marine Environment Protection Commission (of the Helsinki Commission)
HRI	Russian State Hydrological Institute
HRV	Hydrographic Research Vessel
ICM	integrated coastal management
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
KSNR	Kandalaksha State Nature Reserve
LENMORNIIPROEKT	St. Petersburg Marine Research and Project Development Institute
MARPOL	[International Convention for the Prevention of Pollution from Ships, 1973/1978]
MMBI	Murmansk Marine Biological Institute (Kola Scientific Centre, of RAS)
MSU	Moscow State University
MV	Motor Vessel
NGO	Non-Governmental Organization
NWHS	Northwest Hydrometeorological Service
OBS	Oulanka Biological Station
PINRO	Knipovich Polar Research Institute of Sea Fisheries and Oceanography
PSU	Practical Salinity Unit
RAS	Russian Academy of Sciences
RGS	Russian Geographical Society
RSHU	Russian State Hydrometeorological University
RSGB	Research Station of the Gulf of Bothnia
RUR	Russian rouble
RV	Research Vessel
SCUBA	self-contained underwater breathing apparatus
SOLAS	[Convention on] Safety of Life at Sea
SPCPYC	St. Petersburg City Palace for Youth Creativity
SPNA	Specially Protected Natural Area
SPSU	St. Petersburg State University
STD	salinity-temperature-depth
SULA	Gulf of Finland Environment Society
TPP	tidal power plant
UNESCO	United Nations Educational, Scientific and Cultural Organization
UREC	Uusimaa Regional Environment Centre

VBS	Vyärrio Biological Station
ZINRAS	Zoological Institute of the Russian Academy of Sciences