

Summary

The report presents results from the environmental monitoring programme in Norwegian coastal and ocean areas. The areas are divided into four large ecosystems: (i) the Barents Sea, the Norwegian Sea, the Skagerrak and the North Sea, and the coastal zone including the fjords. Physical, chemical and biological properties of all these ecosystems have been monitored. For the Barents Sea and Norwegian Sea emphasis was placed on the monitoring of ocean climate, zooplankton and fish larvae. This provides the basis for the consideration of the environmental conditions for growth, distribution and recruitment of capelin, cod and herring. Since 1997 there has been an annual registration and monitoring of coral reefs in Norwegian waters. Coral reef registrations are collected in a data base. In the Barents Sea the monitoring of organic contaminants and radioactivity was increased after 1991, and in 1994 the investigations of organic contaminants in the Norwegian Sea started. The monitoring of the Skagerrak and the North Sea, the coastal zone and the fjords has focussed on the anthropogenic nutrient loads, harmful algae and organic contaminants.

The Barents Sea

Ocean climate. The highest yearly mean water temperatures in the Barents Sea were found in 2002. The summer temperatures were particularly high at about 1 °C above the long term mean. The reason for this was high air temperatures and strong inflow of Atlantic water. Throughout the fall the temperature decreased towards the long term mean at the end of the year. The amount of sea ice in 2002 was less than normal, and only in 2001 has the summer ice extent been less.

Plankton production. The highest plankton biomass in 2002 was observed in the southern part of the Barents Sea. The total plankton biomass increased from 5.85 to 6.88 g m⁻², being only about half of the maximum observed in 1994 (12.8 g m⁻²).

Capelin larvae. In 2002 there was an easterly distribution of capelin larvae. The larvae were distributed over a large area from 28 to 40°E and as far as 73°N. Such a large distribution area indicates that the spawning and larvae production have been successful. The total amount of capelin larvae is 22.4 x 10¹², about twice that of 2001.

The Norwegian Sea

Ocean climate. The relatively warm Atlantic water flowing into the Norwegian Sea in the south contributes to the mild climatic conditions in northern Europe. The amount of heat in the ocean current is a result of both the volume transport and the water temperature. In 2002 both the temperature and the salinity of the southern Norwegian Sea increased

significantly compared to 2001, indicating a stronger inflow of relatively warmer Atlantic water. The summer temperatures at the Svinøy Section were at a record high, about 0.7 °C above the long term mean. The transport of Atlantic water through the Svinøy Section has been high all year, with the winter transport being the highest recorded since the observations started in 1995, and almost twice the transport of the winter of 2001. In the northern Norwegian Sea, no increase in temperature or salinity was observed; there was a small decrease compared to 2001.

Plankton production and herring. The primary production is largely controlled by physical factors such as the light conditions and water stratification. For the past 11 years the Institute of Marine Research has made observations of the spring bloom at weather station M. In 2002 the spring bloom occurred early (in April) which was several weeks earlier than in 2001. Zooplankton is an important prey for herring in the Norwegian Sea. In 2002 zooplankton biomass in the Atlantic watermasses and in the coastal waters was higher than in 2001. In total, the zooplankton biomass of 2002 was about normal. This resulted in good feeding conditions for the herring.

Herring larvae. In 2002 herring larvae were found along the whole continental shelf from Troms to Stad. The centre of the observed larvae distribution was further north than usual for April. The total amount of herring larvae found was less than in 2001, but still among the highest recorded in the past 30 years. The average length of the larvae was record high (13.5 mm).

The North Sea and Skagerrak

Ocean climate. The circulation in the North Sea for 2002 was quite normal except for the second highest inflow in the first six months through the English Channel since 1955. For most of the year the surface temperature was about one degree higher than normal, and as much as 2.5 °C higher than normal in August and September. In the Skagerrak the surface temperatures were also higher than normal, with the warmest water in August ever recorded at 1 m depth at Forskningsstasjonen Flødevigen, Arendal, since 1924.

Plankton and nutrients. The amount of nitrate in the water masses along the Danish coast was high in April compared to 2001. As for April 2001, the quantities of phosphate and silicate were low, giving a record high N:P ratio. Along the Norwegian coast the level of nutrients was normal in 2002. The phytoplankton conditions in Skagerrak were also normal in 2002. No unusually large algae blooms were observed, nor were any harmful algae blooms detected. The number of diatoms in Skagerrak was significant during summer. No large blooms of dinoflagellates were observed. In the

northern North Sea, a numerical simulation has calculated a 10-20 % increase of annual primary production in 2002 compared to normal.

The coast and fjords

Coastal climate. The temperatures along the coast in 2002 were above normal except for the late fall when a cooling resulted in normal conditions. During August-September the surface temperatures between Sognesjøen and Troms were up to 5 °C above normal. At 150 m depth the water was relatively warm along the coast from Rogaland to Finnmark in 2002, e.g. with temperatures at both Utsira and Skrova for long periods being one standard deviation above normal.

Plankton. In a national collaboration, updated information on algae blooms along the Norwegian coast is presented on the internet (<http://algeinfo.imr.no>). The emphasis is on harmful species. The spring bloom of diatoms along the Skagerrak coast was relatively short in 2002, with a pronounced maximum in the second half of March. The total number of algae was normal, but relatively high in July and below normal in September-November. Along the coast between Rogaland and Finnmark, the spring bloom occurs in March-April. As usual, the bloom is earlier and stronger inside the fjords than outside. In general, the spring bloom starts in the south and has a gradually delayed start towards the north.

Organic load. The consumption of oxygen below the sill depth in a fjord basin indicates the organic load in the system. In the fjord basins along the Skagerrak coast and in Lysefjorden the dissolved oxygen decreased throughout 2002. Values are getting near the limit for maintaining life of 2.0 ml l⁻¹. No exchange of basin water with oxygen rich ocean water took place in 2002, and the situation will be critical if no such exchange occurs in 2003 as well.

Harmful algae. In general, there were in 2002 small problems with harmful algae causing fish deaths along the whole Norwegian coast. As to algae causing mussels to become poisonous, several occurrences of dangerously high concentrations were registered. Along the Skagerrak coast

this problem was more severe than usual due to the early bloom of *Dinophysis acuta*. An accumulation of diarrhetic poison in mussels was registered during the summer along the coast from Skagerrak to Stad. As usual, the highest amounts were found in mussels inside the fjords. North of Stad there were fewer problems with poisonous mussels.

Registering and monitoring coral reefs

The Institute of Marine Research has been registering and monitoring coral reefs on annual cruises since 1997. The investigations are concentrated on the continental shelf and the shelf edge from Stad to Lofoten. The areas north of this have not yet been covered. Calculations show that between 30 to 50 % of all Norwegian coral reefs might be destroyed or affected by human activity. All observations of coral reefs are gathered in a data base and the number of registrations early in 2003 is close to 800.

Pollution

Oil contamination in fish. Under the direction of the ICES, tests have been performed to evaluate methods for tracing biological effects of contaminants on pelagic organisms. The purpose is to use these methods in future monitoring. Moorings with blue mussels and cod in cages together with equipment to extract contaminants from the water, were positioned north (Staffjord) and south (German Bight) in the North Sea. The results from these tests are available on the internet (<http://www.niva.no/pelagic/web>).

Radioactivity. The Institute of Marine Research contributes to a national monitoring programme on radioactivity by collecting samples from and with knowledge on the marine environment. In 2002 samples from the Barents Sea (August-September) and a number of fjords (November-December) were collected (samples from the North Sea were collected in December 2001). All samples show levels of radioactivity well below the critical value of 600 Bq kg⁻¹. The Institute of Marine Research also monitors possible leaks from the sunken submarine "Komsomolets" at 1660 m depth SW of Bear Island. No alarming leaks of radioactive material are found so far.