THE BALTIC SEA

Bengt-Owe Jansson, Dept. Systems Ecology, Stockholm University, S-106 91 Stockholm, Sweden

Surrounded by 9 countries (Finland, Russia, Estonia, Lathvia, Lithuania, Poland, Germany, Denmark, Sweden) with a drainage area four times the sea area and a climate, leaving the northern part covered with fast ice during 60% of the year, the semi-enclosed, shallow Baltic is a sensitive sea. The brackish water with an estuarine circulation allows only hardy marine specimens to persist, though in high individual numbers.The persistent horisontal salinity stratification (Fig.) causes oxygen deficiency in the deep water when wind-driven pulses of salty water from the North Sea does not bring reviving oxygen to wiped-out bottom communities.

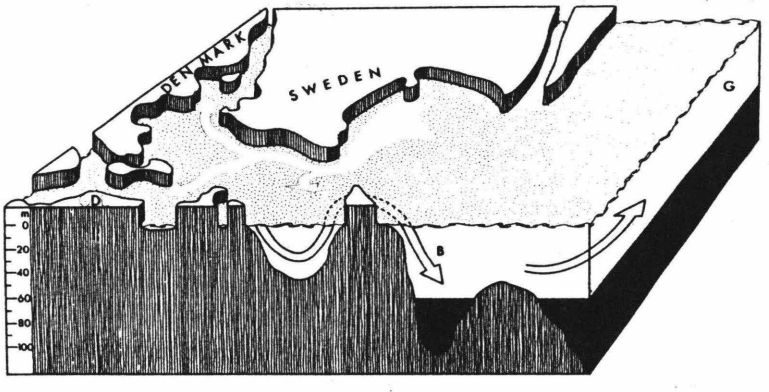

Fig. showing the outflow of surface water and deeper inflow of saline North Sea water through the Straits and the primary halocline in the Bornholm Deep (B) and the Gotland Deep (G) with underlying often anoxic bottom water (black). From Jansson 1972.

Eutrophication effects

Different land-use activities in the drainage area - mainly industry and agriculture in the south and forestry in the north - has turned the originally oligotrophic (nutrient-poor) system to a eutrophic (nutrient-rich) one, in the absence of tide and a residence time of water as long as 25 years. This receiving area of wastes from some 85 million people now has levels of nitrogen and phosphorus 4 and 8 times, respectively, higher than during the 1900s. The transparency of the water has decreased 3-4 m and together with increased growth of filamentous, annual algae restricted the area of the important brown algae association of *Fucus vesiculosus* . At the same time softbottom communities above the permanent halocline at 60 m depth have increased in biomass about four times, offering more food for fish.

Baltic fisheries

The total Baltic fish-landings reached a maximum in the early 1980s, when close to a million tons of mainly herring, sprat and cod - ca 1 per cent of the world catch - was obtained from a sea, in size ca 1ppt of the total area of the ocean. Cod eggs need to develop floating in the water, which means a salinity of < 12ppt , in the Southern Baltic met at depths > 70 m. Here the oxygen levels are very low during stagnation periods, causing a low, if any, recruitment of cod. The internittent inflows from the North Sea are thus a prerequisite for the maintenance of a cod population, the more as overfishing occurs. At present cod is slowly increasing after a inflow of oxygenated North Sea water in 1992, breaking the longest stagnation period in recent time.But the recovery is held back partly by overfishing, partly by strong populations of herring and eating the cod larvae. Salmon was for long economically important even after the construction of

hydroelectric dams in the major Swedish salmon rivers, thanks to artificial hatching and release of young fish. In the early 1970s, however, a disease, M74, together with overfishing has brought down the populations close to zero.

Nutrient loads

Building of sewage plants, especially in the western countries, have decreased much of the phosphorus emissions, but almost none of the nitrogen. Of the 1.4 million tons of N emitted to the Baltic Sea annually, most part comes from agriculture and car traffic and one third as atmospheric fallout. Fixation of atmospheric nitrogen by nitrogen fixing cyanobacteria is a typical Baltic phenomenon, answering for a considerable amount of extra nitrogen (Table).

Sources	Period	N, tonnes yr $^{-1}$	P, tonnes yr $^{-1}$
Riverine	1980-1993	830 000	41 000
Coastal point sources	1990	100 000	13 000
Atmospheric deposition	1985-1989	300 000	5 500
Nitrogn fixation	1980	130 000	-
Total		1 360 000	59 500

Table showing major, estimated annual inputs of nitrogen and phosphorus to the Baltic Sea (from Stålnacke, 1996).

Accumulation of toxic substances

Besides eutrophication, accumulation of heavy metals and persistent organic pollutants such as DDTs, and PCBs are the great threats to the Baltic ecosystem. Fish-eating top carnivors such as seals, and white-tailed eagles were close to extinction during the 1970s but after banning the use of these substances the populations are now clearly recovering.

Rehabilitation of the Baltic ecosystem

Tourism is an increasing industry in the Baltic Basin and, based on nature´s diversity of site and clean and clear water, a strong driving force of rehabilitation of the Baltic ecosystem. Economic incentives are examplified by the European Community (EU) -project "The Baltic Drainage Basin Project ", where the costs of nitrogen reduction well matched the benefits. At the institutional level the Helsinki Commission (HELCOM) has successfully regulated the use of the international Baltic waters during the difficult "Cold War Period" and is now incorporating also the drainage area in its rehabilitation schemes, e.g. "Joint Comprehensive Program". Non-Governmental Organizations play an important role as pressure groups in the rehabilitation work on the Baltic. Several of them have been appointed observers in governmental organizations, e.g. HELCOM. Some 30 of them have formed the "Coalition Clean Baltic" (CCB).

Growing urban systems of immigration to the coastal zone increase resource use of the Baltic Basin. Calculations show that only the 29 largest cities in the area for their need of space areas ("ecological footprints ") producing food, clean air and fresh water would need an area of 75-150 % of the total drainage basin (Folke et al, 1997). Current scientific research on the resource base of the Baltic Sea are examplified in the EU-projects "BASYS", dealing with the biophysical dynamics of the sea, and "The Baltic Basin Case Study (BBCS), which synthesizes current natural and socioeconomic findings in the total dranage basin.