

FINAL REPORT BY THE COMMISSION ON THE MARINE
ENVIRONMENT

THE SEA

– time for a new strategy



STATENS OFFENTLIGA
UTREDNINGAR

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To the Minister and Head of the Ministry of the Environment

At the cabinet meeting on 11 July 2002, the Government authorised Minister Kjell Larsson to appoint a commission charged with the task of summarising current understanding of the state of the environment in Sweden's coastal and sea areas, designing overall strategies both for the short and the long term and proposing measures that might reverse the on-going negative trend in the marine environment. The overall aim is to render the three environmental quality objectives *A balanced marine environment, sustainable coastal areas and archipelagos, A Non-toxic environment and Zero eutrophication* achievable by the year 2020.

A commission was appointed on 14 July 2002 comprising the following members: Hans Jonsson, chairman, Director-General Marie Hafström, Professor Kerstin Johannesson, Chief Executive Måns Lönnroth and Henrik Österblom, MSc. The commission secretariat has comprised Katarina Veem, principle secretary, Katja Awiti, Sture Nellbring, Anita Tullrot and Henrik Österblom.

The commission, which took the name the Swedish Commission on the Marine Environment, now submits its report, *The Sea – time for a new strategy*. The commission's assignment has thereby been completed.

Stockholm, 24. June 2003

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Summary

The state of the marine environment

For decades, our oceans and seas have been seriously affected by emissions of nutrients and toxic substances both from land and from air. Furthermore, the marine ecosystems risk being disturbed by the over-extraction of fish. According to scientists, completely different species than previously may start to dominate marine ecosystems. Stickleback are replacing young plaice on the west coast, sprat is replacing cod in the Baltic and our bays and beaches are being invaded by fine-threaded algae. Blue-green algae is replacing diatom in plankton blooms and the European population of long-tailed duck is threatened by oil discharges in the Baltic. We are far from knowing the true extent of damages caused by over-fishing, eutrophication, emissions of toxic substances and oil. Nevertheless, the Commission on the Marine Environment appointed by the Swedish government, can ascertain that substandard shipping, insufficiently regulated fisheries, hazardous emissions and eutrophication are having and will continue to have such a negative impact on marine ecosystems that their ability to provide goods and services is dramatically being undermined. In addition, climate change may further impact the conditions for healthy ecosystems.

Essentially, the state of the Baltic and the North Sea has not improved over the last 15 years despite the numerous measures implemented. Some examples of successful environmental protection can be found, however. When widespread damage to seals and white-tailed eagles was discovered in the 1960s, the use of PCB and DDT was banned or limited at the beginning of the 1970s. As a result of the measures, the occurrence of these substances in the marine environment decreased considerably. The white-tailed eagle has now returned to our archipelagoes and the grey seal population is improving.

After decades of bathing restrictions, people can again swim in the sea and enjoy the sandy beaches along the coast of Estonia, Latvia, Lithuania, Poland and the former DDR. A large number of point sources have been rectified within the framework of the Joint Comprehensive Programme, initiated by the Heads of State and Government in 1990. This programme aims to address the most significant point sources of pollution and is seen as one of the successes of international environmental protection.

But the way in which marine environment protection currently is being conducted suggests that the state of our seas will either remain unchanged or deteriorate further in the next decade or two. Shipping is expanding rapidly in the Baltic Sea. Oil exports from Russian and Baltic ports has risen substantially over the last few years, which increases the risk of accidents. Ships are also increasing in size. A serious problem as regards oil transportation is the occurrence of substandard vessels, which, in combination with insufficient maintenance, substantially increases the risk of accidents. Accidents often occur due to a combination of factors, such as a substandard vessel that has a crew lacking the necessary skills or training. Many ports and harbours still lack facilities for forcing vessels to deposit oil and other waste while in port. Up to one thousand illegal discharges of oil waste are thought to occur every year when vessels flush out their oil tanks, clean their machinery and empty unfiltered water into the Baltic.

Numbers of demersal (bottom-dwelling) fish have radically decreased over the last 25 years. For many demersal fish species, the number of sexually mature individuals at the end of the 1990s was only a tenth of what it was at the beginning of the 1970s. For certain species, such as cod, the numbers of sexually mature individuals have dwindled even more drastically. These severe reductions risk leading to dramatic changes in marine ecosystems (so-called "flips") that can make it impossible for cod stocks to recover which, in turn might lead to the disappearance of bladder wrack over large areas. Furthermore, exploratory fishing data indicate almost a complete disappearance of local cod stocks along the Swedish Skagerrak coast. If these stocks were genetically unique, there is a risk that they will not be replaced, should they die out. The amount of cod landed by Swedish fisheries has decreased substantially since the 1980s, whilst sprat, used to produce animal feed, now constitutes a predominant proportion of the total catch. Sprat

has benefited from the disappearance of cod and large stocks of sprat hinder cod reproduction by eating up its eggs.

Baltic herring and salmon should not be eaten in large quantities since the levels of toxic substances in them are too high. The amount of toxic substances used in today's society is increasing, which may lead to more dietary restrictions. One example is the use of pharmaceuticals in Sweden which has risen drastically. The amount of active substances in pharmaceuticals sold every year in Sweden is the same as the amount of pesticides used in agriculture. Residues of these active substances are flushed out in the wastewater of households and hospitals and reach the sea via municipal treatment plants.

Eutrophication causes great problems in coastal waters and leads to more extensive algal blooms out at sea. Many bathing areas and beaches along our coast are covered by large amounts of decomposing algae. The depth dispersion of bladder wrack is decreasing as the water becomes more and more clouded with plankton. Shallow sandy bottoms are becoming overgrown with fine-threaded algae, which for example prevents plaice from breeding properly. Oxygen deficiency in the deep waters of the Baltic is threatening the reproduction of cod and the dying seabed extending over large parts of both the Baltic and the North Sea is eradicating demersal species. Large areas covered with fluffy-white hydrogen sulphide bacteria are also a common problem affecting the shallow waters of our archipelagoes in the summer.

In addition, climate change will have an impact on our seas. Rising atmospheric temperature leads to warmer seas which in turn will reduce the ice-caps in the winter and impact populations of grey and ringed seal. Changes in water temperatures and salt content primarily affect the species composition of floral plankton and the risk is that toxin-producing species will become more common if temperatures and precipitation rise. Increased nutrient concentrations and a higher water temperature also promote fast-growing and fine-threaded algae in shallow sea areas.

We are far from achieving our national environmental quality objective for a healthy marine environment.

Anthropogenic impact

Our seas and oceans belong to everybody and nobody. At the same time as many people claim the right to use our marine resources, no-one takes ultimate responsibility for what is happening to our seas. Industries which utilise the sea have assumed a right to do so but they do not take on sufficient responsibility for protecting marine ecosystems. There is a lack of comprehensive responsibility both internationally and nationally. Coordination on all levels is found wanting. There is insufficient analysis of the activities of different sectors and their impact on the sea and what analysis there is, is uncoordinated. The imposition of sector responsibility has not yielded the desired results for the sea; namely a healthy environment and ecological sustainability.

The discord in efforts to improve the marine environment is further exacerbated by poor dialogue and coordination among the various stakeholders, scientists and authorities. Protecting the environment is essentially a matter of altering and stimulating human behaviour, which requires considerable changes to current attitudes.

It is not a lack of appropriate proposals and measures that has put our seas in such a serious state. The problem lies in extensive and systematic shortcomings in implementing proposed measures. If all the measures proposed both nationally and internationally had been implemented and if the precautionary principle had been applied, our marine environment would have been in a considerably better state.

The Commission on the Marine Environment concludes that the environmental state of our surrounding seas is that short-term economic interests, in combination with insufficient understanding of the complexity of marine ecosystems, have been allowed to dictate how the sea is managed. The sea is a victim of the tragedy of the commons.

The Commission on the Marine Environment believes that current methods must undergo a fundamental change. Makeshift repairs to the current system are not enough. Our way of working and addressing the issues has led us to the end of the road. Our current regulatory frameworks do not protect our seas. Our seas must be decoupled from the regulatory frameworks which currently restrict the efforts.

Sustainable management of the sea

Ecosystems consist of different components, partly of flora, fauna and other organisms and partly of the surrounding environment. The various organisms in an ecosystem make up a food web, where everything is interconnected and where the different levels influence each other as the result of complex and dynamic relationships. If a critical species decreases in number or disappears, these relationships can break down. The ecosystem can then "flip" and take on a completely different state. Sustainable management must be based on this perspective and consider the impact of proposed measures in a holistic manner. The Commission on the Marine Environment bases its new management proposals on an ecosystem approach.

The ecosystem approach places more far-reaching demands on protection measures than is the case with the current "sectorised" method. Management must be more adaptive and instructive with clear links between implemented measures, environmental monitoring and research. Management must be based more on the obligations of the sectors and less on their rights. The environmental requirements placed on the sectors must be founded on the limitations of marine ecosystems. The aim is to preserve the structure and function of marine ecosystems and hence maintain their capacity to provide us with goods and services.

Ecosystem-based management would pioneer marine environmental protection. Such an approach has been a matter of course for the European air quality work. In comparison with measures within the Convention on Long Range Transboundary Air Pollution (CLRTAP), the Commission on the Marine Environment has identified a number of areas within regional marine conventions that are lacking. The analysis indicates that the work done to protect the marine environment lacks four essential components:

- unanimity and collaboration among authorities, the research community, industries and other stakeholders,
- common effect-based targets for both national and international work,
- the flexibility to implement cost-effective measures within relevant sectors and establish legally binding agreements at the national level.

Management of the sea within current decision-making structures must change both nationally and internationally. A new form of management must be intersectoral and able to handle complex relationships. Fish and fisheries can for instance not be separated from other marine environmental issues. International decision-making structures must be changed to allow relevant coastal states the autonomy to decide how the sea is to be protected.

If we are to reverse the negative trend in our seas, it is absolutely essential that there is international coordination. The Commission on the Marine Environment therefore proposes a new regional management structure, through a regional pilot initiative in the Baltic Sea (including the Kattegat). The Commission sees the Baltic Sea as the ideal area for a new management strategy. The work should be evaluated so that experiences gained can be passed on and benefit other marine areas, e.g. the North Sea (including the Skagerrak).

Revising the Helsinki Convention

The aim of using the Baltic Sea (in accordance with the definition of the Helsinki Convention) as an international pilot initiative is to transpose the ecosystem approach into concrete legal principles.

This presupposes a revision of the Helsinki Convention to bring about sustainable use of the seas. A new form of management should be based on biological systems, on an ecosystem approach, and implemented by using a *modus operandi* that is broadly international, intersectoral and adaptive.

The proposal of the Commission on the Marine Environment means that the Baltic Sea states, as the result of a jointly binding commitment, supported by a strengthened Helsinki Convention, can generate the necessary force to regionally adapt the common European fisheries policy and the relevant environmental components of the agricultural policy to the sensitive environment of the Baltic Sea.

In order to achieve this the Heads of State need to agree to a joint initiative to reverse the negative trend in our seas.

The Helsinki Convention must develop legally binding decisions and estimation models, which make it possible to evaluate proposals for action strategies established in relation to various set objectives for marine ecosystems. Fisheries and agriculture must be

an integral part of the Convention's remit. A revised Helsinki Convention must also incorporate a mechanism for resolving disputes.

Moreover, a revised Helsinki Convention should divide the Baltic into different zones. Such zoning should consist of a core of areas where no resource extraction is allowed, a large network of areas where some types of resource use is permitted, and other areas where special rules of consideration apply for various activities.

This kind of zoning is similar to what has been applied on land for some considerable time.

The Commission on the Marine Environment also proposes a temporary, time-limited ban of fishing in the Baltic Sea. In order to effectively combat the over extraction of fish, the common European fisheries policy must be implemented within the framework for a revised Helsinki Convention. A total fishing ban should cover all stocks which, currently are outside biologically safe limits. The ban would be lifted only when stocks are once more within biological limits. The sooner such a ban is imposed, the greater chance stocks will have of recovery. The longer such a ban is postponed, the greater the risk is of stocks collapsing and disappearing.

The Commission on the Marine Environment proposes that measures aimed to combat eutrophication are urgently needed. The measures should be based on effect-based criteria, modelled on European air quality initiatives. The system of environmental subsidies which are incorporated in the European agriculture policy should be adjusted so that the Baltic Sea states are given the opportunity to direct support to areas where the greatest benefits for the marine environment can be achieved.

The Commission on the Marine Environment proposes a number of minimum requirements for shipping within the framework of a revised Helsinki Convention. These requirements must be developed in partnership with the IMO. The proposed requirements include: only high-quality vessels being allowed to transport hazardous cargo; vessels being classified by a well-reputed classification society and be subject to "black listing" from previous harbour visits; vessels being equipped with control and tracking devices; shipping lanes and traffic regulations being designed so as to protect especially sensitive areas. It should also be possible to control ballast water discharges so as to avoid the input of non-native species. Practical, efficient harbour facilities to dispose of

different forms of waste and wastewater should be available. There should be sufficient capacity for coping with and limiting the impact of collisions/shipwrecks.

The Commission on the Marine Environment feels that a strengthened legal structure is required to reverse the negative trends in the Baltic Sea.

A national marine strategy

The Commission on the Marine Environment also feels that Sweden as a nation is in a position to unilaterally implement a number of measures and proposes the establishment of a national marine strategy. The strategy must overcome the disarray that currently characterises marine environment efforts. The national environmental quality objectives for *A balanced marine environment, sustainable coastal areas and archipelagoes, A non-toxic environment* and *Zero eutrophication* should therefore be supplemented and elaborated further.

The proposal from the Commission on the Marine Environment for measures within the framework of a national marine strategy are:

- The Swedish Environmental Protection Agency (Swedish EPA) shall be given the overall responsibility for the marine environment.
- The Swedish EPA shall be charged with the task of drafting a plan for Sweden's marine environment, in partnership with relevant actors.
- Zoning shall regulate the use of the sea. The Swedish EPA shall be responsible for planning and implementing zoning, preferably in partnership with relevant actors.
- The effects of implemented measures shall constantly be evaluated. Evaluation results are to be used in an adaptive management system, adjusted to suit each river basin, coastal zone and sea basin.
- Information initiatives shall stimulate active participation and changes in attitude.

According to the Commission on the Marine Environment, the measures that can be taken immediately pending the implementation of more extensive measures mentioned above are as follows:

- As a first step to zoning the sea, the Commission supports the proposal to extend the trawling limit.
- Four areas with fishing bans in both the Baltic Sea (excluding the Kattegat) and the North Sea (including the Skagerrak and the Kattegat) shall be established based on available knowledge. In each of these specified sea areas, two coastal areas and two deep-sea sub-areas are to be established.
- All shipping shall be moved south and east of Hoburg Bank.
- The Swedish EPA shall be charged with developing a preliminary planning basis using the available knowledge. This planning basis shall then be regularly reviewed using information from inventories and surveys that will be carried out as part of the inventory programme proposed in point 2 above.

The Commission on the Marine Environment has had the help of four working groups made up of experts within the fields of shipping, fisheries, chemicals and eutrophication. Each of these groups has carried out extensive analyses of the situation, reviewed current lists of measures and proposed additional action. Based on their findings, the Commission on the Marine Environment proposes more precise details, interim targets and measures to supplement the initiatives already being implemented to achieve the environmental quality objectives.

Shipping

The Commission on the Marine Environment proposes that the following details be added to the environmental quality objective *A balanced marine environment, sustainable coastal areas and archipelagoes*.

1. No sub-standard vessels shall operate in our surrounding seas.
2. The most valuable areas shall be protected from negative impact of shipping.
3. Rescue contingency plans shall be guaranteed.

The Commission on the Marine Environment proposes supplementary measures for shipping:

- The charterer should assume greater responsibility for his choice of transport.
- Measures to facilitate quality shipping shall be taken.
- All shipping traffic shall be diverted away from the most valuable areas.
- Rescue contingency plans shall be strengthened regarding the capability of rescue services to carry out emergency towing, emergency lightering and fire extinguishing at sea.

Fisheries

The Commission on the Marine Environment also proposes national measures for fisheries. The overarching perspective is that fish should be managed as part of the ecosystem. The precautionary principle shall also be applied. The Commission on the Marine Environment proposes a revision of interim targets 4 and 5 of the environmental quality objective *A balanced marine environment, sustainable coastal areas and archipelagoes*.

1. Annual by-catches of marine mammals shall be less than 1 per cent of the population of each species no later than 2010. By-catches of seabirds, unwanted fish species and young fish shall not have a negative impact on populations nor on the ecosystem.
2. By 2010, the percentage of fish caught by fisheries shall not exceed what is needed to maintain the natural role of fish in the ecosystem.

The Commission on the Marine Environment proposes the following supplementary measures:

- The prerequisites for enacting a fish conservation law shall be examined.
- The proportion of fish stocks caught shall be reduced and extraction shall be based on biological grounds.
- Catch restrictions shall be established for all species and stocks.
- The size of the catch shall be adapted to the available resource.
- Selective and considerate fishing methods and gear shall be developed and employed.

- Consultation groups shall be set up to reduce by-catches.
- An institute for fishing technology shall be established.
- Environmental Impact Assessments (EIAs) shall be introduced for exploratory fishing and when testing fishing methods, the Best Available Technology (BAT) principle shall be applied.
- Training initiatives for professional fishermen and research in fish and fish ecology shall be established.
- More and broader scientific advice shall be provided to the ICES.
- An eco-labelling system for fish shall be developed and applied.

Chemicals

Amendments to the environmental quality objective *A non-toxic environment* should also be made.

1. All fish caught in Swedish seas shall be suitable for human consumption.
2. The impact of toxic substances on the marine ecosystem shall be negligible.

Necessary measures include:

- Sources of toxic substances which lead to current dietary restrictions shall be identified and addressed as far as possible.
- The input of toxic substances caused by combustion shall be reduced to harmless levels.
- Environmental monitoring shall be able to predict risks before damage occurs.
- Environmental monitoring activities shall be linked to the need for measures.
- The capacity of municipal wastewater treatment plants to treat new substances shall be guaranteed.
- An information requirement for chemical substances shall be introduced.

Eutrophication

Eutrophication represents one of the largest problems in the Baltic and the North Sea. The Commission on the Marine Environment has ascertained that achieving the environmental quality objective

Zero eutrophication will necessitate a reduction in nitrogen emissions to the level they were in the 1940s. According to the Commission on the Marine Environment calculations, this is equivalent to 40 000 tonnes of nitrogen emissions each year.

The Commission on the Marine Environment proposes that supplementary measures be added to the *Zero eutrophication* objective:

1. The cultivation of follow-up crops (catch crops) shall be set at a permanent level of 100 000 hectares.
2. The area of arable land tilled in the spring instead of in the autumn shall be set at a permanent level of 100 000 hectares.
3. The supply of nitrogen during cultivation shall not exceed the crops' need.
4. The spreading of liquid fertiliser from animals in the autumn for autumn-sown seed shall be reduced.
5. Permanent fallow land shall be introduced.
6. 12 000 hectares of wetlands shall be constructed.
7. Farmers shall be required to take part in compulsory environmental studies.
8. An inquiry into the geographical distribution of farm animals shall be conducted.
9. Further nitrogen removal shall be implemented in some treatment plants.
10. Private wastewater facilities shall be improved.

Environmental monitoring must be better coordinated both with research and with the evaluation of various action strategies.

1 The assignment

Sweden is to be a driver and pioneer of sustainable development. This was established in Government Bill 1996/97:150, *A Sustainable Sweden*. The aim of environmental policy is to be able to pass on a society in which the major environmental problems in Sweden have been solved to the coming generation. In order to define the desirable state of the environment towards which we should be aiming, the Swedish Riksdag has adopted 15 environmental quality objectives (Government Bill 1997/98:145, report 1998/99 MJU6, parliamentary communication 1998/99:183). The three objectives relevant to the marine environment are *A balanced marine environment, coastal areas and archipelagoes*, *A non-toxic environment* and *Zero eutrophication*. Fulfilling these objectives is necessary for the sustainable development of industries that are dependent on a healthy sea. The trend for our surrounding seas is negative. The Environmental Objectives Council, which is responsible for monitoring and reporting on development towards the quality objectives, has ascertained that it will be very difficult to achieve the so-called “generation targets” (targets to be achieved within one generation) for *Zero eutrophication* and *A non-toxic environment* within the set time-frame. Concerning the quality objective *A balanced marine environment, coastal areas and archipelagoes*, the Council makes the assessment that it is possible to achieve the objective but that further measures are needed. Achieving this objective also presupposes the attainment of the *Zero eutrophication* and *Non-toxic environment* objectives.

In July 2002, the government appointed a commission charged with the task of summarising current understanding regarding the state of the environment in Sweden’s coastal and sea areas, designing overall strategies both for the short and the long term and proposing measures that might reverse the on-going negative trend in the marine environment in order to render the three quality

objectives achievable by 2020. The directive (Government Directive 2002:102, *see appendix 1*) also stipulates that the commission's work should complement current work towards the environmental quality objectives, that the commission should review the overall research requirements and, where necessary, put forward proposals for national or international initiatives within the framework of Sweden's commitments. The directive also states that the work done by the commission should be based on an ecosystem approach. The assignment also included an analysis of the socio-economic consequences of the proposals. Due to a lack of time, it has not been possible to look into the socio-economic consequences. In short, the proposals will probably lead to lower social costs since today's environmental problems entail substantial costs to society through deteriorating of public health and losses in production and biodiversity.

The commission, named Commission on the Marine Environment, has held numerous public hearings and had broad contact with authorities, organisations, institutions and private individuals as part of its work. To aid it in its work, the commission appointed working groups comprising experts, *see appendix 2*, within the four problem areas specified in the directive. These areas are shipping, fisheries, toxic substances and eutrophication. After a dialogue with the relevant actors, the working groups have prepared proposals for measures and reviewed background texts that describe the current extent of knowledge within the various areas (the background texts will not be translated to English). Experts from the Swedish Regional Climate Modelling Programme (SWECLIM) assisted the commission with an analysis of future climate scenarios. The commission has also had a broad dialogue with international experts.

2 The state of the marine environment

2.1 Marine ecosystems

Ecosystems consist of different components, both flora, fauna and other organisms as well as the ambient environment. The various organisms in the ecosystem make up a food web, in which everything is interconnected and where the different levels influence each other through complex and dynamic relationships. All life on land is dependent on the sea's capacity to circulate nutrients and regulate the climate. Certain human needs are met by the ability of marine ecosystems to produce goods and services. A large number of products that we consume contain components originating from the sea. The sea also provides considerable potential for relatively "green" and inexpensive transport. It also offers plenty of opportunity for recreation and tourism, not to mention being an important area for research and other studies. The ecosystem comprises flora and fauna that have adapted to specific conditions and are part of a food web. The different components of an ecosystem determine its function and if one part of it is affected by environmental disturbance or climate change, it can impact the entire ecosystem.

A report, "Resilience and sustainable development" (2002:1) from the Environmental Advisory Council's describes several international examples indicating that ecosystems find themselves in temporary states of equilibrium where the balance may soon be tipped, causing them to alter dramatically. The ecosystem is then said to "flip". The consequence of an ecosystem flipping is that its capacity to produce goods and services will be seriously affected. One example is the marine ecosystem off the coast of Newfoundland which changed dramatically when cod stocks crashed at the beginning of the 1990s. Such extensive change in the structure and function of the ecosystem can mean that the previous state of equilibrium cannot be restored. Several reports suggest that

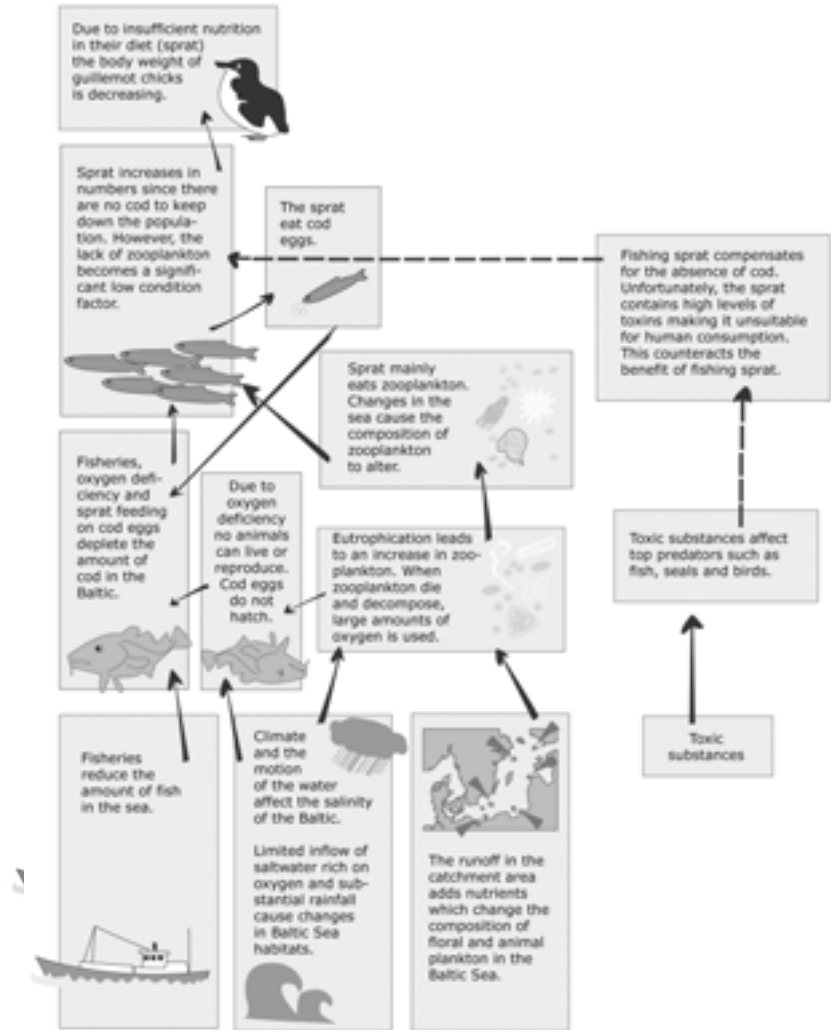
the ecosystem off Newfoundland has shifted to a new state of equilibrium which lacks the necessary conditions for the cod to recover.

Another example of a flipped ecosystem can be found on the west coast of North America, where large parts of the coastal zone are covered by fifteen-metre-high kelp forests, a giant seaweed species. These kelp forests are an important environment as they constitute key breeding grounds for fish and other animals. The sea-otters of the Pacific Ocean feed on sea-urchins which in turn eat kelp. The fact that sea-otters eat sea-urchins restricts the number of sea-urchins and their feeding on kelp. As a result of intensive sea-otter hunting and its subsequent near-extinction, sea-urchins increased to huge numbers and the ecosystem flipped to become completely dominated by sea-urchins who ate up the kelp. The kelp forests disappeared and the fish lost an important breeding ground.

The above examples illustrate the importance one single or a small number of species can have for an entire ecosystem. By affecting several parts of an ecosystem simultaneously, humans often aggravate the situation, making it difficult to predict what the effects of different degrees of impact will be on other components of the food web. Fossils and other archaeological and historical information have shown that numbers of marine vertebrates such as sea-cows, seals, turtles, whales, sharks and other large predatory fish have decreased dramatically as a result of hunting and over-fishing in historical and pre-historical times. The dramatic decline of these species has seriously affected the dynamics of the ecosystems. In addition, other disturbances in the form of eutrophication, toxic substances, physical exploitation, climate change, disease and the introduction of non-indigenous species (e.g. from ballast water) have emerged as major threats in the wake of industrialism. *Nature* magazine recently published a comprehensive report on large-scale anthropogenic impact. The report shows that 90 per cent of the world's predatory fish have been caught during the second half of the 20th century. Dramatically reduced populations of predatory fish probably have a major effect on all marine ecosystems, and hence threaten the conditions for our sustainable use of them.

Another example of how anthropogenic disturbance can have unforeseen effects is the guillemots in the Baltic Sea. The guillemot is a sea-bird that feeds on fish. The reduced cod stocks in the Baltic

have contributed to a dramatic increase in the sprat population during the 1990s. Sprat consumers such as the guillemot should benefit from an increased population, but in the Baltic, the situation is the opposite. The sprat competes for marine zooplankton and the increase in its population seems to have affected the composition of the zooplankton. Zooplankton which also is further affected by climate change, eutrophication and changes in the composition of floral plankton. This has caused weight reduction in sprat which, in turn has resulted in weight reduction in guillemot chicks despite them being fed with more sprat (see figure 2.1).



Source: Österblom et al. (2001). Illustration: Linda Gustavsson.

Figure 2.1. The weight of guillemot chicks is affected by complex relationships. With our current understanding, it is difficult to establish what the most significant factors are for the dynamics of Baltic Sea ecosystems.

The example of sprat and guillemot illustrates how complex the interaction is within ecosystems and how anthropogenic impact (e.g. fisheries, climate change and eutrophication) can lead to substantial changes in ecosystems. It is also an example of how anthropogenic impact and natural variation interact, making it more difficult to predict the consequences of various human activities. The only thing we can be sure about is that whereas we cannot control natural dynamics, we can regulate the degree and type of anthropogenic impact.

For decades, our oceans and seas have been seriously affected by emissions of nutrients and toxic substances both from land and from the air. Furthermore, the marine ecosystems risk being disturbed by the disproportionate over-extraction of fish. If current trends continue, completely different species will begin to dominate. Sticklebacks are replacing young plaice on the west coast, sprat is replacing cod in the Baltic, fine-threaded algae are replacing vegetation-free sandflats and are also threatening shoreline seaweed belts in the most affected areas. Blue-green algae and flagellates are replacing diatom in floral plankton blooms and the long-tailed duck is disappearing as a result of oil spills. We are far from knowing the true extent of the damage caused by over-fishing, discharges of toxic substances, oil and eutrophication. The Commission on the Marine Environment has ascertained that shipping, fisheries, the use and discharge of toxic substances and eutrophication are the anthropogenic activities which have the most severe effect on marine ecosystem dynamics. Climate change may also have a major impact on the conditions for a healthy ecosystem. A short description of the problems associated with shipping, fisheries, toxic substances, eutrophication and climate change is given below. More comprehensive status reports for the various areas are found in part II of the Swedish edition of the Commission report.

2.2 Shipping

Direct oil exports from Russian or Baltic ports have increased substantially over the last few years, increasing the risk of accidents. A 50-percent increase from the largest ports has been recorded during the period 1997–2000 and the forecast until 2015 suggests a continued increase. The size of vessels is also increasing. The reasons for this include the fact that freight costs per tonne of oil

decrease considerably when cargo volumes are high. A serious problem as regards oil transportation is the occurrence of substandard and insufficiently maintained vessels, factors which substantially increase the risk of accidents. Such vessels are frequently manned with an inadequately trained crew which further increases the risk of accidents.

A large accidental oil spill can eradicate significant numbers of European populations of birds if the release, occurs at an important wintering site. Besides the risk of accident, there is also the problem of illegal oil discharges from vessels, which causes considerable damage to populations of various sea-birds each year. Even small amounts of oil contaminating birds' feathers lead to hypothermia, making it difficult for them to look for food and hence die a painful death. Several hundred individuals probably meet this fate every year. Small oil residues on beaches can also cause major damage to wading birds and other shore-inhabiting birds if the oil is there during breeding and resting periods. Fish are also affected by oil discharges. Above all it is their eggs that incur the most damage. The water in the Baltic is contaminated with three times more fossil oil than the water of the North Sea. This substantial environmental load is partly due to the one thousand illegal discharges of oil waste that are thought to occur every year when vessels flush out their oil tanks and machinery and empty unfiltered water into the Baltic.

Ballast water can carry organisms from one sea to another, causing domestic species to be driven out by new ones or suffer from newly introduced diseases. Toxic antifouling paints on ships constitute a further threat to marine ecosystems since they can cause hormonal imbalance in flora and fauna. Air pollution and greenhouse gases from shipping are considerable compared to the total emissions of sulphur and nitrogen oxides in Europe as a whole. The proportion of air pollution coming from shipping is increasing as the industry expands and land-based pollution sources are being rectified. Calculated per tonne of transported goods, sulphur dioxide emissions are already higher from shipping than from other modes of transport. Emissions of nitrogen oxides will also rise and shipping will be the dominating source of these emissions in 2010. Currently, the largest sources of nitrogen oxides are land transportation and combustion plants.

In coastal areas, leisure crafts also cause problems, partly because most of them have two-stroke engines with poor combustion,

resulting in relatively large emissions of hydrocarbons compared to those from commercial shipping vessels, and partly because they also cause noise pollution and other disturbances. The environmental impact of leisure crafts is greatest in the archipelagoes when many marine mammals, fish and birds are at their most vulnerable. Emissions of polycyclic aromatic hydrocarbons (PAH) from leisure crafts are equivalent to nearly half the PAH emissions from the entire Swedish vehicle fleet (see also 2.4).

2.3 Fisheries

Numbers of demersal (bottom-dwelling) fish have radically decreased over the last 25 years. For many demersal fish species, the number of sexually mature individuals at the end of the 1990s was only one tenth of what it was at the beginning of the 1970s. For certain species, such as cod, the numbers of sexually mature individuals have dwindled even more drastically. The risk is that this drastic reduction may cause cod stocks to collapse completely which will render their recovery impossible in several areas. The worse-case scenario is that this has already happened as new research indicates that the majority of local breeding populations of cod have in principle been wiped out along the Swedish Skagerrak coast. These populations may have been genetically unique and are therefore irreplaceable in the event of them disappearing completely. As a result of reduced stocks of cod and other predatory fish, certain pelagic fish species and crustaceans, on which they feed, have expanded in numbers. When populations at the top of the food chain have been fished down, the fisheries turn their attention to the next level. The amount of cod landed by the Swedish fisheries has decreased substantially since the 1980s, whilst herring and sprat now constitute a predominant proportion of the total catch. The phenomenon is known as "*fishing down marine food-webs*" and can be observed in many of the world's fishing areas.

Apart from overfishing, there is also the problem of by-catches of small fish and unwanted species, such as non-commercial fish species, sea-birds, seals and porpoises. Fisheries statistics show that for every cod caught in recent years at least five small cod have been dumped as the result of unwanted by-catches. Dumped by-catches seldom survive.

An important cause of the problem of dwindling stocks is that the fisheries fleet has not been adapted to the available biological resources. The EU has awarded subsidies for the construction and modernisation of fishing vessels, the banks have granted large loans and the profits have been invested in newer, more modern and in most cases larger ships. There are also many other types of investments in new technology, which, with the exception of those in new ships, help to increase the capacity of existing vessels. Developments in technology have both made it much easier to locate fish and led to fishing efforts being intensified considerably. Previous technological limitations meant that some areas were protected against exploitation. These areas functioned as refuges for young fish. Many stocks that were not previously fished, or were only fished to a limited extent, are now utilised intensively because it is possible to fish at greater depths and in previously difficult fishing areas. The fisheries fleet is also too large. Some estimates say that a reduction in the fleet of 40 per cent or more is needed to adapt the fishing capacity within the EU to the production of stocks. Technically advanced fishing fleets from the EU also affect stocks in other parts of the world.

Fisheries are suffering from the same problems throughout large parts of the world. It is important to emphasise that the increased cultivation of fish, as has been suggested by many parties, is not a viable solution. The role of fish in the ecosystem cannot be replaced by aquaculture and cultivation would require even more extensive industrial fishing than we have today.

2.4 Toxic substances

In our modern society, a large number of chemical substances are incorporated in the enormous diversity of chemical products and consumer goods. Current estimates put the number of chemical substances in goods and products on the EU market at about 30,000.

Substances, the properties of which can harm living organisms, are said to be toxic. When such substances cause problems in our natural environment, we also refer to them as environmental toxins or toxic substances. In sufficiently high concentrations, almost all chemical substances have a toxic effect. Some, even in minute quantities, cause serious and immediate damage. These are known

as acutely toxic substances. Emissions of such substances normally cause local damage which often disappears when the emissions stop. Other chemical substances, however, can be harmful in the longer term; i.e. they can have delayed effects, even if the substance has been emitted in minute quantities (chronic toxicity). The impact of these types of substances may only slightly disturb one or more of an organism's functions to begin with but with time can be so serious as to affect the whole individual. This can be particularly serious if an organism is exposed to the substance over a long period of time. Long-term effects can also emerge after just one single exposure. The risk of damage increases, however, the longer the exposure occurs. This means that particular conditions prevail for persistent chemicals since such substances and the accompanying risk of damage remains in an organism or in its immediate surroundings for a long time. This also means that even if we succeeded in preventing the emission of a persistent chemical, the quantities of the substance that have already reached the marine environment will remain there for many years.

A "classic" toxic substance is the insecticide DDT which is spread on agricultural land, for example. There are also many toxic substances among the host of industrial chemicals on the market, such as PCB and brominated flame retardants. These were never meant for dispersion into the environment, but they gradually leak out when being manufactured, used or disposed of as waste. In addition, there are persistent organic substances that chiefly occur as by-products of various manufacturing and combustion processes. These include polycyclic aromatic hydrocarbons (PAH) and dioxins.

During the 1960s, it became increasingly obvious that certain toxic substances had been extensively dispersed into our natural environment. Some of these damaged living organisms even at low concentrations, since their effect was perpetuated over a long period of time. DDT, PCB and dioxins are examples of substances that have been dispersed worldwide in our environment. They are persistent and are stored in living organisms. In predators and other animals at the top of the food chain, these substances can accumulate to such concentrations so as to jeopardise the continual existence of these organisms.

These persistent substances can be spread globally and the effects can remain for many years after the emission has ceased. Organic environmental toxins disperse more slowly in water than

they do in the atmosphere due to their low rate of solubility. Persistent organic pollutants mostly occur in water bound to particles that subsequently settle on the bottom. In the Baltic Sea, where the exchange with neighbouring seas is limited, these organic toxins have accumulated in higher concentrations than in the majority of other sea-areas. The Baltic Sea is hence a kind of full-scale laboratory for chemical impacts on the marine environment.

A great many toxins can also act as endocrine disruptors, causing hormone imbalance for example. Dioxins and dioxin-like substances (including certain PCB variants) are lethal for several animal species, even in low doses. In addition, chronic damage to the central nervous system has recently been highlighted as one of the most serious effects of toxic substances. Even in very low doses, both DDT and some variants of PCB and brominated flame retardants can disturb the development of the brain in young individuals, with lifelong behavioural disturbances as the result.

Since the 1970s, levels of several of the most well known toxic substances have decreased considerably in the natural environment in Sweden as a result of implemented measures. This has contributed to the recovery of the white-tailed eagle and grey seal, which had been seriously affected by these toxic substances. However, although DDT has continued to decline, the decrease in PCB and dioxins has come to a halt. Both PCB and dioxins accumulate in fatty fish and still occur in the environment in concentrations that demand dietary advice regarding the consumption of fish. Dietary advice is given with respect to herring/Baltic herring, salmon and trout from the Baltic and the Gulf of Bothnia, as well as for perch, pike, pike-perch, burbot, eel, large halibut and concerning the regular consumption of liver from cod and burbot from the Baltic.

High levels of toxic substances in seals continue to weaken their immune defence system and probably contribute to the serious intestinal sore problem observed in grey seals from the Baltic. High levels of toxic substances may also be hampering the recovery of seal populations in the Öresund Sound which is much slower than in the Skagerrak after the fatal seal epidemic of 1988.

There is still a great deal of uncertainty regarding effects of toxic substances on the marine environment. First of all, the volumes of chemicals produced have never been as high as they are now. Secondly, our ignorance of the long-term toxicological and eco-toxicological effects of chemicals is considerable. Thirdly, it is difficult to take stock of the diffuse and large-scale distribution of chemi-

icals in products and there are no simple solutions at hand. Generally speaking, the trend has gone from a small number of individual toxic substances whose emission sources could be distinguished to one where an incredibly wide spectrum of chemical substances is in use. Even at low concentrations, each and every one of these substances may cause an unspecified impact that is difficult or quite simply impossible to link to any specific exposure. In Sweden, for example, there are fish species that are experiencing problems in reproduction and researchers suspect that organic toxins are to blame, but it is very difficult to clarify where the substances are coming from, i.e. if they are from softening agents in plastics, from pesticides, from pharmaceutical products or if they are from other sources. To then be able to comment with any degree of assuredness on the link between persistent chemicals and different forms of impact on animals at the top of the food chain and humans is for many of the substances so complex as to be near impossible. As a result, it is equally difficult to find a simple solution to the problem.

We know that certain flame retardants exhibit increased levels in the marine environment, a group of substances that is very similar to PCB. Even the amount of cadmium is increasing in the marine environment, something which cannot yet be explained. Another aspect that underlines how the problems are interconnected is the fact that there has been a dramatic rise in the use of pharmaceuticals in Sweden. Residues of biologically active substances from pharmaceuticals are flushed out with the wastewater of households and hospitals and reach the sea via municipal treatment plants. The amount of active substances in pharmaceuticals sold every year in Sweden is the same as the amount of pesticides used in agriculture.

2.5 Eutrophication

Eutrophication is caused by deposition of nutrients from air pollution, where a substantial percentage of the nitrogen content originates from road traffic, from various point sources such as factories and municipal treatment plants as well as from agriculture. Run-off from land contribute large amounts of nutrients that reach the sea. Extensive diking of wetlands, the increased use of artificial fertilisers and modified animal husbandry have rendered agriculture production more efficient and productive, with more nutrient leak-

age to the sea as a result. Increased nutrient discharges also cause greater biological production in the surface layer and above all gives rise to the dramatic growth of fine-threaded algae and plankton algae (known also as algal blooms). As a further consequence, the increase of organic material on the seabeds causes oxygen deficiency.

Eutrophication has caused great problems in coastal waters and led to more extensive algal blooms out to sea. Increased nutrient discharge also alters the composition of floral plankton species, which affects the production of zooplankton and of fish. Eelgrass is declining dramatically in some coastal areas, which might be due to it being suffocated by fine-threaded algae. The depth dispersion of bladder wrack is decreasing as the water becomes more and more clouded with plankton. Shallow sandy bottoms are becoming overgrown with fine-threaded algae which, for example, hinders plaice from breeding properly. Overgrown bays and plankton blooms of toxic blue-green bacteria also have a negative impact on people's recreational opportunities. Oxygen deficiency in the deep waters of the Baltic is threatening cod reproduction. The oxygen deficient seabed, extending over large parts of both the Baltic and the North Sea, is eradicating demersal species. Large areas covered with fluffy-white hydrogen sulphide bacteria are also becoming a common problem affecting the shallow waters of our archipelagoes in the summer.

The discharge of nitrogen and phosphorous to the sea from aerial precipitation, various point and diffuse sources in the catchment areas of the Baltic and North Sea has in general declined over the last 15 years. This reduction has been achieved through intensive efforts and at considerable cost. The fall of the Soviet Union contributed to the virtual cessation of agricultural activities in the Baltic States with a substantial reduction in the amount of fertiliser being used. Despite this reduction in environmental load, no improvements can be seen, either in coastal areas, at the surface or in deep water, apart from some local changes. This is partly due to nutrient retention in the soil whereby nutrients are gradually transported to the sea. The negative trend of eutrophication has not been broken and the imminent modernisation of agriculture in eastern Europe may well lead to a substantial increase in nutrient emissions.

2.6 Climate change

Current scientific models indicate that the climate will change in the future as a result of anthropogenic impact. Uncertainty in the estimates makes it difficult to assess just how much the climate will change and when, but it is possible to track trends. We do not know whether the average temperature in Sweden will be three, four or five degrees hotter in a hundred years time or whether it will rain 30, 40 or 50 per cent more in the winter. In all likelihood, however, it seems we are moving towards milder and wetter winters and hotter and, at least in southern Sweden, drier summers.

Climate change will affect both the North Sea and the Baltic but the immediate effects will probably be greater in the Baltic. Model calculations indicate that the catchment to the Baltic will be affected by climate change. In the future, milder winters will result in higher in-flow during the winter and lower in-flow during the spring but with considerable variation between the various parts of the Baltic catchment area. How this change will affect the transport of nutrients in the future is uncertain. The Baltic may benefit from a decrease in the net load due to less in-flow from the agriculture-rich areas of the south. But such positive effects may also be counteracted by an increased out-flow of nutrients during the winter.

Rising atmospheric temperature leads to warmer seas which in turn will reduce the ice-caps in the winter and impact populations of grey and ringed seal. Changes in water temperatures and salinity primarily affect the species composition of floral plankton and the risk is that toxin-producing species will become more common if temperatures and precipitation rise.

A higher average temperature will also increase mid-water stratification. This will benefit certain groups of floral plankton and damage others. Ecosystem changes of this type will have an impact a long way up the food chain. Increased nutrient concentrations and a higher water temperature also promote fast-growing and fine-threaded algae in shallow sea areas. This in turn will have a negative impact on, e.g. plaice and cod, that spawn in these environments.

2.7 Productive measures

Marine environment problems are not new and during the last 30 years a number of measures have been implemented that have improved the situation. When widespread environmental problems occur, support is often mobilised to solve them and prompt action is subsequently taken. The productive measures described below should not be seen as a comprehensive analysis of successful environmental action over the last 30 years, but rather as examples of different types of problems and solutions within the Commission on the Marine Environment's remit.

Major oil catastrophes in other parts of the world have brought attention to the need to reduce the risk of accidents in our seas and oceans. The Swedish Coast Guard has built up a relatively good capacity for monitoring the environment from the air and through targeted operations using satellite tracking equipment, aeroplanes and ships. Efforts both on the international and national level have led to the number of illegal oil discharges in Swedish waters being halved in recent years.

Measures have also been implemented nationally to restrict emissions of carcinogenic substances from leisure crafts by introducing tax relief on alternative fuels. There are also some good examples of local initiatives. The environmental issues affecting shipping were observed at an early juncture by Göteborgs Hamn AB (Port of Gothenburg), which has been tackling waste issues since the late 1970s. Ships can deposit all types of waste generated on-board ship at the port without it leading to long delays.

Fisheries also started to pay attention to environmental issues at an early stage. Trawlers were viewed to be harmful to both fish and ecosystems as early as 100 years ago. Since then professional fishermen and fishing gear developers are making continuous efforts to improve equipment; a case in point being the successful development of selection panels to minimise by-catches of fish in shrimp fishing nets. Trawling has been banned in the Öresund Sound since the 1930s and cod stocks there have a more normal size distribution compared to five other sampled areas where trawling is still permitted and where cod stocks are made up only of small individuals (see figure 2.2).

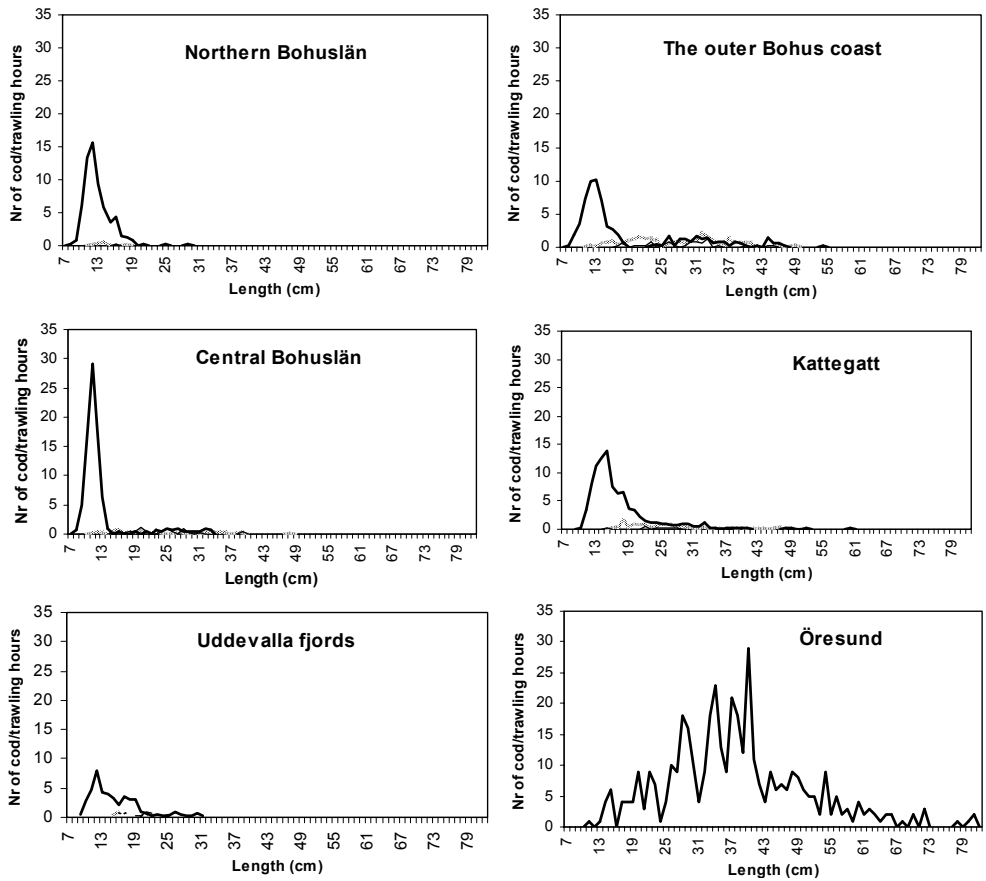


Figure 2.2. Estimated average occurrence of cod (number per trawling hour) in different areas along the west coast of Sweden in 2001 (fig. a-e) compared to the Öresund Sound where trawling is banned (fig. f). Exploratory trawling in February/March (grey line) and in May/June (thin black line) consistently indicate the absence of catches. Exploratory trawling in October/November (thick black line) indicates substantial catches of young cod that have reproduced during 2001.
 Source: Henrik Svedäng, Marine Fisheries Laboratory, National Board of Fisheries.

When widespread damage to seals and white-tailed eagles was discovered in the 1960s, a total ban or limit was imposed on the use of PCB and DDT at the beginning of the 1970s. The occurrence of these substances drastically decreased in the marine environment as a result, after which populations of affected species gradually began to recover. Today the white-tailed eagle once again inhabits our archipelagoes and the grey-seal population has increased from near-extinction levels.

After decades of bathing restrictions, people can swim in the sea and enjoy the sandy beaches along the coasts of Estonia, Latvia, Lithuania, Poland and the former DDR. A large number of wastewater treatment plants have been built as part of the so-called Joint Comprehensive Programme, initiated by the Heads of State and Government in Ronneby in 1990. This programme aims to rectify the most serious point sources of pollution and is seen as one of the success-stories of international environmental protection.

Damage caused by acidification and eutrophication in Europe resulted in the international Convention on Long-Range Transboundary Air Pollution (LRTAP). Efforts within the convention have been very successful in reducing transboundary air pollution (see also 3.5).

Voluntary measures by Swedish farmers have helped to reduce nitrogen leaching from Swedish agriculture. Nitrogen treatment at the Himmerfjärdsverket treatment plant in Södertälje has improved the water quality in the southern Stockholm archipelago. Other treatment plants in the Stockholm region have further helped to improve the situation.

These examples show that implemented measures can produce results, even if they cost both time and money. They also prove that problems can be solved locally, nationally, regionally and internationally. Some environmental problems can be solved through improved technology or restrictions on certain types of activities, whilst others require a continuous up-dating of information in order to promote changes in attitude. The majority of the examples do indicate, however, that we tend to tackle environmental problems reactively. Measures are only implemented when the damage has already been incurred, as the result of a large oil spill, when the white-tailed eagle has already disappeared or when our opportunities to go bathing are severely restricted.

2.8 The end of the road

Despite productive measures, the collective impact on the marine environment of shipping, fisheries, toxic substances, eutrophication and climate change contributes to a negative trend in our seas. The measures implemented aimed at improving the situation have not been sufficient. The state of the marine environment in the Baltic and the North Sea has basically not improved over the last 10–15 years. The prevailing trends also indicate that this state will remain unchanged or deteriorate within one or two decades. The risk of major oil spills and of emissions of other hazardous substances is rising as a result of the dramatic increase in oil transportation by sea. Substandard vessels are further aggravating the problem. Today, the sea produces a lot less fish than what would be possible from a well-functioning ecosystem with fish populations that are well over safe biological limits. The occurrence of toxic substances make it necessary for us to impose dietary restrictions on the consumption of fatty fish, an otherwise healthy foodstuff. Eutrophication is continuing to cause substantial disturbances. This means that our coastal areas and archipelagoes are losing their recreational value and tourism is losing income because of poor-quality bathing water and poorer opportunities for leisure fishing. We are a long way from achieving the national environmental quality objectives for the sea: *A balanced marine environment, coastal areas and archipelagos*, and the *Non-toxic environment*.

The Commission on the Marine Environment finds that we have reached the end of the road due to our current way of using and impacting our seas.

More powerful measures are immediately needed to solve the problems of the marine environment. The current way of using the sea has in some cases caused irreparable damage. Problems are tackled when the damage has already occurred and our use of nature's resources is unsustainable – we are eroding the natural values of the marine environment. A fundamental question for the commission has been whether it is possible to solve the problems within the framework of existing marine management structures. Are makeshift repairs to the current system enough?

To answer this question, the Commission on the Marine Environment has analysed current attitudes towards the sea and highlighted the strengths and weaknesses of the existing management systems.

3 Anthropogenic impact

3.1 Humans and the sea

Sweden is an agrarian nation – our involvement, activity and history are strongly linked to the development of agriculture and forestry. Our relationship to the sea is somewhat more diffuse. The fact that we only see the surface of the sea means that the condition it is in and the value of a flourishing marine environment have largely eluded our attention. It is more difficult to see the changes in the marine environment with the naked eye than to see those in the terrestrial environment. It is easier to gain active popular support for park trees threatened of being cut down than for endangered coral reefs. It is also easier to follow the development of the elk than the plaice, just as it is to document the distribution of the wood anemone than the occurrence of eelgrass. This is one of several reasons why there is a considerable lack of information and understanding regarding our marine environment. There are no comprehensive inventories of Swedish coastal waters. This should be considered in comparison to the vast amount of cartographic material there is for all our land areas. Apart from oil accidents or fishing bans on cod, the sea is rarely the subject of consistent political discussions and goal definitions.

The curse of the commons

Our seas and oceans belong to everybody and nobody. While many people claim the right to utilise the marine resources, no-one takes ultimate responsibility for what is happening to them. Fish have traditionally been regarded as an ownerless resource and there is no reason for a fisherman to preserve the resource for future use since another fisherman can catch it instead. Fish and other marine animals have no sense of national borders but can move over large

areas. Nutrients and toxic substances from agriculture, road traffic, factories and municipal wastewater treatment plants can be transported long distances before they impact the marine environment. The problems of and the responsibility for the sea are therefore both national and international, which complicates its management. The value of, power over and responsibility for the commons is further complicated by the fact that the sea has historically been seen as a symbol of freedom and independence. Industries which use the sea have assumed a right to do so but they do not take on sufficient responsibility for protecting marine ecosystems. There is a lack of overall responsibility both internationally and nationally. Coordination of marine issues within the Swedish Government Offices is found wanting. There is little collective analysis of the activities of business sectors and the authorities and their impact on the sea, and what analysis there is seems uncoordinated.

The Commission on the Marine Environment concludes that the environmental state of our surrounding seas is the result of short-term economic interests, combined with insufficient understanding of the complexity of marine ecosystems, being allowed to dictate how the sea is managed. The sea is a tragic victim of the curse of the commons.

3.2 Current management of the sea

One single country cannot solve transboundary environmental problems in the marine environment on its own. Approximately 50 per cent of the waterborne nitrogen load to the Baltic Sea comes from five rivers. None of these is in Sweden, nor do they currently flow through other EU member states. International cooperation regarding environmental matters is conducted on other terms than national cooperation due to the differences in approach and values. Membership in the EU provides us with the opportunity to influence environmental work within the whole Union whilst we at the same time must comply with EU decisions. For example, Sweden cannot unilaterally decide to impose a ban on cod fishing or reduce fishing quotas but must abide by the EU's common fisheries policy. The UN Convention on the Law of the Sea (UNCLOS) basically regulates all aspects of the use of the sea and the sea-floor during peacetime. The sea may be used for shipping by all nations and no state may claim sovereignty over any part of

the high seas. The right of a coastal state to intervene against foreign vessels is very limited. There is insufficient scope for preventing tanks and ballast water from being flushed out in violation of the regulatory framework. Considerable work remains to be done within the EU and within the framework of various regional and global conventions, if we are to achieve our national objectives for the marine environment. A brief presentation of the international regulatory framework and a review of current national marine management practices are given below. A more detailed description of the legal framework, can be found in *appendix 3*, in the Swedish edition.

Regional agreements

Since 1974, the Helsinki Commission for the Protection of the Marine Environment of the Baltic Sea Area (HELCOM) has carried out multilateral efforts to improve the environment in the Baltic Sea and international cooperation in the event of major oil and chemical accidents. The North-East Atlantic has been covered by the OSPAR Commission, which evolved from a merger between the Oslo Convention (for the Prevention of Marine Pollution by Dumping from Ships and Aircraft) and the Paris Convention (for the Prevention of Marine Pollution from Land-Based Sources), since 1992. The North Sea Conference is a political initiative among the countries around the North Sea, the aim of which is to protect and improve the North Sea's marine environment.

The EU

Under Article 174.2 of the Treaty of Rome, environmental policy is built on the precautionary principle. This implies that “where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation”.

The Nitrate Directive (91/676/EEC) aims to reduce and prevent water-related health and eutrophication problems caused by nitrates from agricultural sources; **the Drinking Water Directive** (98/83/EC) includes limit and guideline values for nitrate in water used for human consumption; **the Groundwater**

Directive (80768/EC) aims to prevent contamination of groundwater. The **Water Framework Directive** (00/60/EC) is a new overarching directive for water quality. It was adopted in December 2000 and presupposes that all Member States have implemented the nitrate, drinking water and groundwater directives mentioned above. The Water Framework Directive covers both surface water (inland, transitional and coastal waters) and groundwater. The ecological perspective is emphasised as the directive does not only refer to water quality but the water environment in its entirety, which means that all management of the sea (including fisheries) is covered by the directive.

The EU network for natural areas (Natura 2000) is a way of safeguarding nature types, species and their habitats, which EU Member States have identified as being of common interest. Natura 2000 sites are designated with the help of the Habitat Directive and the Birds Directive.

Fisheries within the EU are regulated by the European Common Fisheries Policy (CFP). The fisheries policy is a fully developed common policy, which means that all Member States are covered by the same provisions. The CFP regulates all aspects of the fisheries, from the sea to the consumer. In a similar fashion, agricultural policy is regulated within the framework of the Common Agricultural Policy (CAP).

The Swedish sector responsibility for the environment and sustainable development has its counterpart in the EU – the so-called Cardiff Process on the integration of environmental consideration and sustainable development. Article 6 of the Amsterdam Treaty emphasises the importance of integrating environmental consideration into the various other European policy areas.

Global conventions

International shipping regulations are developed and adopted by the shipping organisation of the UN, the International Maritime Organisation (IMO). IMO currently has 162 members. Environmental regulations are developed by the Maritime Environment Protection Committee (MEPC). Shipping is regulated by two legal systems, maritime law and the law of the sea. Put simply, we can say that the law of the sea constitutes the framework within which maritime law exists. As long as national and international maritime

provisions are not in violation of regulations and principles under the law of the sea, they are acceptable from the perspective of international law.

The Environmental Code

The Swedish Environmental Code came into force on 1 January 1999 and is a coordinated, broadened and tightened piece of legislation promoting sustainable development. It amalgamates the provisions of fifteen previous environmental acts. The purpose of the code is to promote sustainable development which will assure a healthy and sound environment for present and future generations. The Environmental Code forms overarching legislation that covers all environmental impact. The regulations under the code shall be applied so that; "human health and the environment are protected from damage and detriment, valuable natural and cultural environments are protected and preserved and biodiversity is safeguarded. Land, water and the physical environment shall be used so as to guarantee long-term resource-efficiency, from an ecological, social, cultural and socio-economic point of view. Reuse and recovery and other efficient use of materials, raw materials and energy shall be promoted to achieve sustainability.

Fisheries legislation

Swedish fisheries legislation contains both provisions that supplement and implement the European common fisheries policy, and provisions of a purely national nature. The Fisheries Act is parallel legislation to the Environmental Code. The aim of Swedish fisheries policy is for fish stocks to be used in a long-term sustainable manner in accordance with the precautionary principle and the ecosystem approach. The aim is also to provide consumers with high-quality foodstuff and ensure that the fishing industry maintains its status as a stable economic activity of major regional significance.

The environmental quality objectives – the ecological dimension of sustainable development

The concept of sustainable development has its roots in the Brundtland Commission report of 1987, entitled *Our common future*. As part of the *Agenda 21* action programme, adopted at the UN Conference on Environment and Development in Rio de Janeiro in 1992, it was decided that the social, economic and ecological dimensions of development had to be integrated to achieve sustainable development. The programme stipulates how the regions, municipalities and important social groups in the world should strive for a development that satisfies our present needs without jeopardising the environment or the ability of future generations to satisfy their needs.

In its report from 1997, *Ecological sustainability* (1997/98:13), the Government stresses that Sweden shall be a driving force and pioneer of ecologically sustainable development. By adopting Government Bill 1997/98:145, *Swedish Environmental Quality Objectives – an environmental policy for a sustainable Sweden*, the Riksdag took a new approach to environmental protection and established 15 national environmental quality objectives. This environment bill took sustainable development work to a new level and clarified it in more precise detail. In November 2001, the Riksdag also adopted Government Bill 2000/01:130, *Swedish environmental quality objectives – measures and strategies*, in order to achieve the stated objectives.

The environmental quality objectives clarify the ecological dimension of sustainable development. The ecological dimension concerns guaranteeing the right of future generations to a healthy living environment and well-being. The environmental quality objectives describe the quality or state of the Swedish environment that needs to be achieved for long-term ecological sustainability. The fifteen quality objectives rest on five fundamental values. Sustainable development shall promote human health, preserve biodiversity and other natural values, safeguard the cultural environment and its historical values, guarantee the long-term productive capacity of ecosystems and ensure efficient use of natural resources.

Sector responsibility

Environmental sector responsibility implies that authorities, companies and other organisations in various sectors of society must take responsibility for environmental issues within their area of operation. This was established as an important approach in Swedish environmental policy in Government Bill 1987/88:85: *Environmental policy for the 1990s*. Sector responsibility has been developed and strengthened throughout the 1990s. It has also gained international recognition, for example at the 1992 UN Conference on Environment and Development in Rio de Janeiro. Government Bill 1997/98:145, *Swedish Environmental Quality Objectives – an environmental policy for a sustainable Sweden*, enjoined the sector authorities with a special responsibility for implementing sustainable development. This implies that the authorities and agencies are responsible for driving ecologically sustainable development efforts forward, particularly within their sector. If sector authorities develop their own objectives, these must be based on the national quality objectives including their interim targets and strategies.

The Swedish EPA, the National Chemicals Inspectorate, the National Board of Fisheries, the Swedish Maritime Administration, the Swedish Board of Agriculture, the Geological Survey of Sweden (SGU) and the Swedish Metrological and Hydrological Institute (SMHI) are the central administrations whose activities are of significance for the marine environment. In its environmental quality objectives, the Government has designated certain authorities as responsible for specific objectives. The Swedish EPA, for example, is responsible for the *Balanced marine environment, sustainable coastal areas and archipelagoes* and *Zero eutrophication* objectives. The National Chemical Inspectorate is responsible for the *Non-toxic environment* objective. This does not relinquish other authorities from their responsibility for the environmental objectives and sustainable development within their area of operation. In its Bill of 2000/01 (2000/01:130), the Government makes the assessment that sector responsibility must be developed further to constitute an efficient mechanism for the achievement of the quality objectives. The core issues that have been identified as critical are the delimitations between the sectors, their mandates and role distribution.

3.3 Weaknesses in the current management system

A lack of implementation and analysis

"A point has been reached in history when we must shape our actions throughout the world with a more prudent care for their environmental consequences. Through ignorance or indifference we can do massive and irreversible harm to the earthly environment on which our life and well-being depend".

The introduction to the Declaration of the United Nations Conference on the Human Environment at the Stockholm Conference in 1972 is just as relevant today as it was 30 years ago. This was a trailblazing conference and much of today's environmental work has its origins in the processes launched at that time. The Commission on the Marine Environment considers it important to underline the fact that a number of principles in the Stockholm Declaration constitute the basis of the Commission's proposal for a new management system.

Principle 2: The natural resources of the earth, including the air, water, land, flora and fauna and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations...

Principle 7: States shall take all possible steps to prevent pollution of the seas by substances that are liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea.

Principle 21: States have... the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

The Stockholm Declaration also underlined the necessity for worldwide cooperation in order to protect the environment. This played a significant role in the establishment of the United Nations Convention on the Law of the Sea (UNCLOS). Global environmental efforts led to the UN Conference on Environment and Development in Rio de Janeiro in 1992. A number of environmental agreements originate from Rio, including the Convention on Biodiversity, the ICCP (International Climate Change Panel) and the UN Fish Stocks Agreement. The world summit was also the catalyst for a number of important initiatives on the regional

and global level, including Agenda 21, which in the Baltic Sea region became Baltic 21.

Prior to the UN World Summit on Sustainable Development in Johannesburg in 2002, a review of what had happened since the Rio summit was carried out. The report presented in Johannesburg emphasised the importance of an efficient implementation of the agreements entered into over the last ten years. Concerning the marine environment, the implementation of initiatives such as the UN Fish Stocks Agreement, the UNEP Global Plan of Action and instruments linked to the IMO (Articles 29-34) was emphasised.

Many of the agreements drawn up since 1972 have not been properly implemented. If all these agreements were conformed to, the environment would be substantially better preserved and protected. But it is not just global processes that have been insufficiently implemented. Over the last 10-20 years, many Swedish committees have presented proposals for measures to improve the marine environment. In accordance with recommendations from HELCOM and OSPAR, the Government has, for example, decided on various measures. If all these had been implemented and the precautionary principle applied, the current state of the marine environment would be considerably better. Hence, it is not primarily a lack of good proposals for measures, but the problem rather lies in such measures not being implemented. Below are a few examples of the lack of implementation and analysis which hampers efforts to protect the marine environment.

Shipping

The problem with shipping, especially when it comes to the oil issue, is the lack of compliance with international regulations. After having taken years to prepare, the MARPOL Convention constitutes a comprehensive system aimed at limiting operational discharges from sea vessels. Despite this, the lack of compliance with the convention means that the marine environment is still being polluted by illegal discharges. Another example is the Baltic Sea Strategy, which was adopted within the framework of HELCOM in 1996.

In 1997, the IMO adopted an appendix to the MARPOL Convention concerning air pollution, the so-called Annex VI: Prevention of Air Pollution from Ships, that limits the sulphur

content of bunker oil to 4.5 per cent (the global average sulphur content in marine oil has already been reduced to 2.7 per cent). The Baltic Sea area applies even stricter regulations and is classed as a sulphur control area, where the sulphur content must be less than 1.5 per cent. Six years on, the annex has still not come into force since only eight countries (Sweden, Norway, Denmark, Singapore, The Bahamas, The Marshall Islands, Liberia and Bangladesh), that collectively make up 26 per cent of world trade tonnage, have ratified it. Fifteen countries, making up 50 per cent of world tonnage, must ratify the annex before it can come into force.

Fisheries

The aim of the European common fisheries policy (CFP) as regards use of the marine environment is “to protect and preserve living marine resources, promote its sustainable use and to minimise the impact of fishing on marine ecosystems”. A decision has also been taken to bring fisheries into line with the precautionary principle adopted in the Rio Declaration of 1992. In 1995, the UN Food and Agriculture Organization began developing a code of conduct for responsible fisheries. One of the most important components of the code is a list of guidelines which concern the application of the precautionary principle.

Knowledge as to the complex system that includes fish, their surroundings and exploitation is incomplete (see Section 6 *The research requirement*), but it is not this lack of knowledge that is the primary cause of the current situation concerning marine fish resources. With existing knowledge, it would have been possible to regulate and manage fisheries to ensure long-term sustainability if there had been sufficient political will and ability. The Swedish Ministry of Finance’s report, *Fish and Fiddling – goals, means and muscle in fisheries policy*, establishes that Sweden has lacked clear political management in the issue of efficient use of fishery resources. The report shows that a number of interests utilise the fishery resources but despite this the way they are managed benefits only a few of the actors.

There has also been a lack of implementation of decisions aimed at adapting fisheries to the biological resources available. The precautionary principle is having no impact and there is a lack of compliance with FAO’s code of conduct for responsible fisheries,

which states that measures are to be taken when fish stocks have reached levels that are under biologically safe limits. Instead decisions have been taken over the course of many years to increase catch quotas (TACs – total allowable catches) in excess of those that biologists recommend.

The action plan for Baltic Sea fisheries, which was approved by the IBSEFC (International Baltic Sea Fishery Commission) within the framework for Baltic 21, contains a number of long-term aims for the fisheries sector. One such aim is to promote the preservation of biodiversity and sustainable use of ecosystems. These are commendable aims, but yet fisheries still lead to large by-catches of small fish. By-catches of non-commercial fish species, sea-birds, seals and porpoises are substantial and constitute a major threat to some of these species.

Scientific research and knowledge in the area of fish and fisheries goes unheeded. Moreover, the knowledge of professional fishermen and anglers is not being heeded either. Coastal fisheries off the east coast of Canada discovered and warned against decreasing catches of cod at an early stage and anglers and others in Sweden have since the middle of the 1980s been claiming that the cod is declining in the Baltic and North Sea.

The same measures have been proposed over the last decade to improve the situation in the EU but there is still a considerable lack of implementation concerning fisheries policy. All signs indicate that the modern professional fishing industry is heading for the rocks, which will have a major impact not just on ecosystems but also on the remaining professional fishermen that are left, anglers and hence on our coastal areas and archipelagos.

Toxic substances

Existing knowledge about toxic substances is not being applied sufficiently to combat known problems. The problems associated with the negative properties of many chemical substances have been known for a relatively long time, but it is only now that we have begun to approach the problems systematically; e.g. through Sweden's new chemicals strategy and the interim targets of the *Non-toxic environment* quality objective. Despite these relatively recent initiatives to adopt a more general approach to chemical

substances, measures are still insufficient to combat several substances which we know to be toxic.

PCB has been known since the 1950s, but there are still insufficient measures aimed at reducing levels of PCB and dioxins, in order to abolish dietary restrictions on fish caught in the Baltic. Instead, new toxic substances and deepened understanding about the impact of such substances on the environment result in the need to impose even more dietary restrictions. In Section 2.4 *Toxic substances*, some of the difficulties and shortcomings were presented when facing current emissions and the use of chemical substances.

A study in the United States on the extent of our knowledge regarding chemicals used in large volumes indicated a few years ago that a mere 7 per cent of the substances on the American market fulfilled the minimum requirements which the OECD countries feel are necessary. There was no knowledge at all as to the possible environmental impact of 43 per cent of the substances. Regarding chemicals, it is not just a lack of implementation that has led to the current state of affairs but also serious shortcomings in our understanding. For example, we have little knowledge about the quantities of various substances in products, treatment plants and other sources that actually reach the environment and what impact they have on the marine environment. One reason for this lack of information is that manufacturers have no obligation to report the environmental impact of chemical substances. But even in cases where we know what the environmental effects are, society is still not able of taking care of and restricting these substances.

Eutrophication

Under an agreement at the second North Sea Conference in 1987, nitrogen discharges to the Baltic Sea and North Sea were to decrease by 50 per cent during the period 1985-1995. This target has been reiterated through decisions taken within OSPAR. Within HELCOM, Sweden has undertaken to reduce anthropogenic nitrogen discharges to the Baltic Sea south of the Åland Sea by 50 per cent during the period 1985-2005, which is equivalent to a 40 per cent decrease from 1995 onwards. Reporting from HELCOM indicates that only Estonia and Latvia have reached the target,

mainly due to the cessation of agricultural production. Sweden and Finland have the furthest to go before fulfilling their undertakings.

In addition, things are complicated by the fact that there is no uniform international system to follow up and evaluate the effects of implemented measures. HELCOM guidelines for the reporting and compilation of environmental impact data are, for example, not applied by the countries around the Baltic Sea. Compilations are hence not comparable between countries, which means it is impossible to determine what the effects of implemented measures are. Both land-based and off-shore environmental monitoring as well as continuous environmental analysis must be better coordinated and harmonised in order to improve comparability and the quality of the data.

Disharmony in marine environment efforts

The sector responsibility for the environment and sustainable development is the backbone of Swedish environmental policy and a necessary pre-condition if the environment is to be considered as part of all decisions taken within the various sectors.

Despite the benefits of the sector responsibility, the Commission on the Marine Environment is of the opinion that it has not led to any noticeable improvement in the marine environment.

Responsibility for activities that have a direct or indirect impact on the sea is divided among several government ministries and authorities, all of which have different agendas and objectives. The objectives for each area of operation respectively have often been clearly specified by the central government. Reporting by sector authorities is therefore based on the relevant correlation between the objectives and their level of achievement, but there is no overall analysis of the effects. The National Maritime Administration, for example, does not have the task of analysing the impact of oil spills on sea-birds. The National Board of Fisheries does not analyse the environmental impact of a new sea-vessel subsidy or the effects of reduced cod stocks on other components of the ecosystem. Authorities report the impact of their own activities based on set objectives, and there is no comprehensive, collective analysis carried out by the commissioning ministries. The disharmonious efforts to promote the marine environment are further exacerbated by poor dialogue and coordination among the various stakeholders,

scientists and authorities. Environmental protection is all about changing and stimulating human behaviour. Considerable changes in prevailing attitudes will be needed.

The Commission on the Marine Environment concludes that an integrated and comprehensive approach needs to be adopted, in which all actors help to analyse the problems and participate in decision-making. Only then will the negative trend in the marine environment be reversed.

Good management of the marine environment means protecting and preserving efficient marine ecosystems through well considered and well controlled human activities within the limits of nature's systems. Human activities that impact the marine environment include a large number of actors. Successful management necessitates a balance being struck to promote common interest rather than to benefit only a few actors within certain sectors. This balance must have a real impact on management. The management of an international, public resource is further complicated by the fact that many issues need coordinated international measures. Both national and international cooperation is required, adapted to suit the eco-systems, catchment areas and sea-basins.

It has been decided by the central government that sustainable development is an overall aim. This means that political decisions must be formulated so that they take long-term economic, social and ecological consequences into consideration. The ecological dimension of sustainable development has yet to be put on the same footing as the short-term aspects of the economic and social dimensions. This is probably due to several reasons. For example, the economic and social consequences are more obvious and attention is not always been paid to the complex relationship between cause and effect in the field of environment. Changes in the environment often only manifest themselves after several decades. Another important reason is that the value of ecological systems cannot not be easily quantified in monetary terms.

The Commission on the Marine Environment believes that the disharmony in marine environment protection must be resolved through concrete action. The Commission therefore draws the conclusion that an overarching body is needed that is both responsible for overall analysis and striking balances between the sectors by implementing cross-sectoral decisions.

The sustainability secretariat that will be established at the Prime Minister's Office to coordinate government policy for sustainable

development can, according to the Commission on the Marine Environment, create the prerequisites for a more holistic approach and better coordination within the Government Offices. The Commission will come back with proposals for how the disharmony can be resolved and how cross-sectoral cooperation can be developed in Section 5, *A national marine strategy*.

3.4 European marine strategy

The European Commission communication on a common marine strategy (COM 2002:539) emphasises the importance of a holistic approach aimed at the preservation, sustainable use and fair distribution of marine ecosystem resources.

The EU marine strategy aims to be innovative and shall help to achieve a holistic approach, better coordination and long-term measures. The strategy is being developed in consultation with the relevant stakeholders and will be based on existing structures.

The Commission on the Marine Environment feels, however, that the pan-European marine strategy is marred by two shortcomings. Despite the fact that the communication provides for sustainable use of marine resources, it does not specifically state that fish constitute an integrated component of the ecosystem. In one of the strategic measures proposed (Action 3), the Commission pledges to continue its efforts to adjust the fishing effort and capacity in line with long-term management plans to secure sustainable harvest of fish resources and to propose measures to reduce discards (e.g. fish that are less than the minimum catch size and must be thrown overboard) of fish and other organisms, incidental by-catches and impact on habitats. In their current wording, the actions focus only on fisheries and not on the biological resource. Fish are a central component in the ecosystem and the threat to stocks must therefore be seen from a biological perspective. The current proposal, however, leaves the management of fish as a biological resource outside the marine strategy.

The other shortcoming concerns the aim of efforts to combat eutrophication in European seas (Action 9). A number of measures to restrict nutrient emissions from the air, shipping, treatment plants, etc., are mentioned. However, the effects of a possible agricultural reform in candidate countries are not mentioned. The risk is that the European agricultural policy may benefit the build-up of

intensified farming which could increase eutrophication in the Baltic Sea considerably. Agriculture's contribution to eutrophication is not mentioned at all among the proposed actions. The current wording suggests that the ecosystem approach is not an integral part of the Commission's work. Short-term social and economic interests still have the whip hand over the need to reconstruct and preserve ecosystems in the long term.

The prevailing situation in the European seas is indeed alarming. It is just a matter of time before marine ecosystems change so much that a return to naturally functioning systems is rendered impossible. In the long run, the productive capacity of the seas is under threat. By applying the ecosystem approach, these changes can be limited and possibly prevented. The European marine strategy risks being developed without clear provisions concerning the two most significant cornerstones of a better marine environment – fish, one of the most important components of marine ecosystems and eutrophication, one of the most serious threats to them. The strategy proposal highlights the importance of the work being based on an ecosystem approach, but it seems to be restricted by the management structure, i.e. that fish and other marine environment issues are managed separately.

The EU's proposal for a common marine strategy exhibits a lack of analysis, where the biological prerequisites for sustainable use are subordinate to the decision-making structures. Hence, the impact of agriculture and fisheries cannot be fully evaluated.

Sweden must endeavour to ensure that the European marine strategy is developed, with the ecosystem approach as its guiding principle. In turn, this shall lead to e.g. fisheries management being combined with environmental protection so that the relevant marine regulations and directives are integrated (e.g. the Habitat Directive should be applied to all activities that have an impact on marine and coastal areas). The Commission on the Marine Environment wishes to emphasise the importance of Sweden placing Swedish national experts on committees etc., where strategically significant issues are discussed in the European Commission. It is important to develop a strategy for the participation of Swedish experts in expert groups that are closely linked to the marine environment work taking place in the European framework. The opinions presented by the experts must have political support. The participation of experts in expert groups and of government ministries in negotiations in the Council of Ministers' working

groups is insufficiently coordinated. This must be achieved so that the experts have the chance to be involved and influence the wording of the proposals based on political priorities.

3.5 A comparison between the air quality convention and marine convention

The Commission on the Marine Environment has considered the various experiences gained from national and international environmental protection. The regional marine efforts within the Helsinki Convention can be compared to another similar regional process, air quality work within the UN Convention on Long-Range Transboundary Air Pollution (LRTAP). The Helsinki Convention and LRTAP were designed at approximately the same time, but the results differ considerably.

During 1988, the Swedish Government negotiated legally binding international undertakings as part of air quality efforts in order to restrict emissions of nitrogen oxides (NO_x). In the same year, the Government undertook to achieve a 50 per cent reduction in nitrogen emissions to the Baltic Sea within HELCOM. The commitments under LRTAP were by no means as far-reaching as those under HELCOM but they were legally binding. A more cautious start has produced more long-term effects since the measures have actually been implemented.

There seems to be four essential differences between marine environment protection and air quality work. The first lies in the scientific consensus which is considerably greater when it comes to air quality. This is helped by a broad, solid scientific base made up of models and meteorological calculations which clearly illustrate how pollution is transported, where it ends up and what impact it has. Based on the acidification or eutrophication sensitivity of the different areas, critical loads (limits for what nature can tolerate) have been established. These load limits have then been used to set up effect-based environmental targets for emission reductions. Protecting the marine environment has on the other hand focused on the collection of monitoring and research data and its interpretation, often within one particular scientific discipline in an attempt to analyse trends. There are few overarching models that link flows, relationships and measures together. This leads to difficulties in analysing the effects of implemented measures, for example,

from both an ecological and a socio-economic perspective. The gap is considerable between various disciplines, ecologists, oceanographers, chemists, economists, legal experts, etc., who analyse effects on the marine environment. This is caused by a lack of uniform coordination, evaluation and interdisciplinary analysis. In addition, there is a large gap between the research community and the industries who use the sea.

The second difference lies in the absence of clear, quantitative, effect-based objectives. The objectives of air quality work have been based on how the ecosystem functions and this has been an integral part of both the national efforts made in trying to achieve the quality objectives and the work done within various international organisations. Sweden has consistently and persistently advocated that it should be the sensitivity of the Swedish ecosystem for acidifying substances that determines the international commitments in the EU acidification strategy and the UN LRTAP Convention. This has helped generate political support for the work. Concerning the marine environment, the situation is complicated by the difficulty involved in linking measures to effects. To reconcile this difficulty, the Ecological Quality Objectives (EcoQOs) project within the OSPAR and North Sea initiative has been started but is not yet up to speed. During 2003, HELCOM will look into which EcoQOs would be suitable to develop for the Baltic Sea.

The third difference lies in the flexibility that characterises the air quality strategy which has helped paved the way for common decisions on measures. The commitments that have been negotiated in the air quality field have basically been overarching requirements to achieve certain aggregate emission levels based on set targets. But the measures that each country needs to implement in order to achieve these have not been regulated in detail. It has instead been left up to each individual country to decide how to achieve the best possible cost-efficiency. How the commitments are distributed among the countries has been calculated in order to, in simple terms, achieve the greatest possible environmental gain at the lowest total cost. For some countries, the requirements are higher if they have incurred serious environmental damage by certain substances and if emission reductions can be achieved relatively easily. The scope for developing flexible national measures to tackle the problem has contributed to the positive results.

The fourth difference lies in the strength of a legally binding instrument. The fact that the signatories to the treaty within the LRTAP Convention consented to a legally binding agreement, has motivated them to analyse the proposed commitments very thoroughly and formulate clear-sighted positions. To have a binding effect, the recommendations of HELCOM and OSPAR must be transposed into national legislation. Currently, this formal process only happens sporadically. Often, recommendations are adopted that are already accommodated within the framework of national environmental efforts. Seldom do recommendations imply more national funding of commitments and measures. In addition, since recommendations are not binding, they will probably gain insufficient support. The countries obviously have a moral responsibility to treat recommendations in earnest. But today, when there is a plethora of different agreements in the environmental field, it is probable that provisions that are basically just guidelines will take a back seat in favour of those with which countries really do have to comply.

This comparison clearly indicates four important components that are missing from marine environment protection: consensus and cooperation among authorities, the research community, industry and other stakeholders; joint effect-based objectives that are an integral part of both national and international work; flexibility to be able to implement cost-effective measures within relevant sectors on a national level and legally binding agreements. The Commission on the Marine Environment concludes that making makeshift repairs to the current system is not enough if we are to bring about sustainable use of marine resources.

Management of the sea and current decision-making structures must change both nationally and internationally. A new form of management must be intersectoral and be able to handle complex relationships. International decision-making structures must be changed to allow the relevant states autonomy to decide how the sea is to be protected. A strategy should be established for how the work is to be carried out.

