Chapter 4
The sea

The free bodies of water contain the world's most extensive ecosystems. On the other hand, there are far fewer plant and animal species in the sea than on land. This is because the class of terrestrial creatures that boasts the greatest number of species, the insects, has not been able to colonise the sea.

Of Denmark's total sea area of about 105,000 km², 43,000 km² (which corresponds to Denmark's land area) has a depth of less than 30 m. The Danish waters are in the zone of transition between the Baltic Sea, one of the world's largest bodies of brackish water, and the salt water of the North Sea. The conditions of life of plants and animals are thus made difficult, e.g. by the fact that the salinity of the water can vary considerably over short distances; see Box 4.1.

Thus, as the sea around Denmark constitutes a highly variable ecosystem, the sea bed, for instance, is the habitat of a number of ecologically precious and unique plant and animal colonies that range from brackish water that is almost fresh to colonies that require water with a high salinity. This variation is augmented by the great variation in the structure and dynamics of the sea bed.

Box 4.1

Danish waters - a large estuary

Because of the enormous quantities of fresh water that enter it at a rate that exceeds the rate of evaporation from its surface, the Baltic Sea ejects a stream of brackish water (low salinity)through the Danish waters. On its way to the North Sea, this water encounters a stream of salt water flowing in towards the Baltic Sea from the North Sea and Skagerrak.

At the point at which these two streams meet, the lighter stream of brackish water from the Baltic Sea flows over the heavier, salty North Sea water, which is therefore pressed down along the bottom in the deep parts of the inner Danish waters. This results in great variation in the salinity, which generally increases according to the depth and to how far north we travel in Danish waters. In individual parts of the sea, the salinity also varies according to the season and prevailing meteorological conditions.

The peculiar distribution patterns of bodies of water of differing salinity exert an influence on a number of other very important ecological conditions. This applies, for instance, to temperature, nutrient-salt content, production of plant plankton and the oxygen content of the water column.

Such conditions are typical of estuarine waters, for which reason the Danish waters can, from the ecological standpoint, be said to resemble an estuary.

Box 4.2

Eelgrass - a water quality indicator

Eelgrass, or grass wrack, grows in silt or sand in shallow waters, where rhizomes and roots help to bind the material of the sea bed. It can withstand relatively high variations in salinity and temperature but is sensitive to reductions in the amount of light and, therefore, to shading and increasing depth. With the exception of the west coast of Jutland, eelgrass is widespread along the Danish coasts and fjords today.

Eelgrass in Europe and the USA was destroyed by disease during the period 1932-1934. By 1941, this disease had reduced the growth of Danish eelgrass to 500 km², which was only about 7% of its earlier extent. The disappearance of the eelgrass allowed wave action to erode the soft sea bed. Although eelgrass began to spread gradually in the course of the 1940s, it did not regain its previous coverage, partly because of the erosion of the sea bed.

The eelgrass started to recede again in the 1960s. This time, the cause was the increasing quantities of nutrient salts discharged into the sea, which resulted in an increase in the reproduction of plant plankton and the growth of filamentous algae which, in turn, shaded out the eelgrass.

Because of its vulnerability, eelgrass has been used as an indicator of water quality in coastal waters. When the Action Plan on the Aquatic Environment was adopted in 1987, the intention was to improve the growth conditions, for instance, of eelgrass. This action plan has not yet had any noticeable effect on the distribution of eelgrass.

(Source: Ministry of the Environment 1990d, Sand-Jensen, Borum and Duarte, 1994.)

Our many, more or less enclosed fjords and coves also have their own characteristic nature types in their transition zones between salt and fresh water.

The impact of human activities, such as fertilisation and fishing, can lead to more or less permanent changes in the variation of species and the numbers in which they appear. On the other hand, man's discharging of environmental poisons can endanger individual species as well as entire groups of animals.

Physical and chemical conditions

Together with the salinity of the water, the character of the surface of the sea bed (rocky to silty), mobility of sediment (sedimentation and erosion) is decisive for the plant and animal colonies that can live on the sea bed.

Due to its attenuation of light, the depth of the sea is significant to the distribution of vegetation. Different planktonic and epiphytic algae can also obscure the light, with concomitant degradation of the living conditions of sea-bed vegetation.

Sea currents affect the physical and chemical aspects of life in the sea - the chemical aspects through salinity, nutrient-salt content and oxygenation - the physical aspects through temperature, stratification, turbulence and transport, together with the spreading of flora and fauna. Large variations in the salinity of the water has resulted in the evolution of different ecotypes and assemblages of species.

Status and trends

Flora and fauna

Marine biodiversity has traditionally been studied in the higher links in the food chain, i.e. especially in the case of fish species of commercial significance, birds and certain marine mammals.

Another general tendency in the establishment of our scientific knowledge has been that it has mainly focused on the individual species and their occurrence and, to a lesser extent, on the way in which species live. We also lack knowledge of the marine nature types and their geographical distribution.

Bottom vegetation

The distribution of plants on the sea bed is a useful indicator of the cleanliness of sea water. During this century, the depth

Box 4.3

Algae

Algae comprise the predominant group of marine plants. This group includes the large, perennial algae - commonly known as seaweed - that grow on rocks, hard, solid substrates and other material on the sea bed, and the microscopic algae that live as plankton in free bodies of water. The numbers of species of large algae in Danish waters is estimated at about 450 but the true number of microscopic algae in unknown.

Just as terrestrial plants, algae need sunlight in order to perform photosynthesis. The clarity of the sea water and nature of the sea bed substrate are therefore decisive to the distribution of the sessile algae. Today, the depth limit for algae is considered to be 25 m in Danish waters.

Algae need nutrient salts for producing photosynthesis products. However, the increased discharge of such salts into the sea in recent decades has meant that microscopic plankton algae that have a short reproduction cycle in periods of warm calm weather, reproduce rapidly, resulting in mass efflorescence. Poisonous plankton algae, which occur through mass efflorescence, are often observed in eutrophicated areas of the sea.

Since biomass production during such mass efflorescence exceeds the consumption capacity of the next level in the food chain, bacteriological decomposition becomes predominant. Bacteriological decomposition is accompanied by the consumption of oxygen.

The decomposition of algae takes place mainly in free bodies of water, where the constant agitation counteracts oxygen depletion. The disintegrating bacteria and algae decompose in the same manner on the sea bed, with the concomitant consumption of oxygen. During parts of the year, the supply of oxygen to the sea bed is meagre or absent and areas in which there is an increasing supply of organic particles will suffer from oxygen depletion, followed by the efflorescence of sulphur bacteria (paper-white crust) and the death of the sea bed.

Oxygen depletion and the occurrence of paper-white crust reduce the fauna of the sea bed (benthos) and modify its species and age assemblages. In turn, this modifies the food supply of other links in the food chain and, due to the different food supplies of the two species, has resulted in the increased occurrence of dab and areduction in the plaice population, for instance.

limit of bottom vegetation has generally moved closer to the shore, so that the area of distribution has become smaller. The living conditions of several of the species that are dependent on the bottom vegetation have been impaired or destroyed. Eelgrass is the predominant bottom plant in many coastal waters; see Box 4.2.

The cause of the decrease in the bottom vegetation's depth limit is the increased discharge of nutrient salts that is also responsible for the increased quantity of plant and animal plankton which, in turn, reduces the amount of light in the sea; see Box 4.3.

Conversely, an increase in the depth limit has been observed in a few areas in recent years, probably as the result of a reduction in the discharge of nutrient salts and organic material.

Fish and benthic fauna

Only a small part of the Danish fish population is of socio-economic significance. Our knowledge of the condition of fish populations and benthic fauna is concentrated mainly on the species that are of commercial interest. But even in the case of the species that are of commercial interest our knowledge, for instance, of the spawning waters and biology of the fry, is extremely limited.

During the course of the 1980s, great reductions were observed in the catches of such important commercial species as plaice and Norway lobster. These two species have in common the fact that they live on or near the sea bed. The reduced catches of these species appear to be related to the frequent periods of oxygen depletion in the inner Danish waters that result from the increased discharging of nutrient salts. Frequent oxygen depletion has also resulted in a reduction in the growth of such flat-fish as sole, plaice and dab. Similarly, oxygen depletion has caused a change in benthic fauna in favour of the small, fast-growing creatures, and the mass death of benthic fauna has been observed in certain areas.

Conversely, such fish as herring and sticklebacks, which live at the surface and benefit from the increased plankton production, have increased. The increase of the herring in the Baltic Sea is probably due to the decline of the cod, which lives partly on herring.

To safeguard the biodiversity of our marine fish species and benthic fauna we must map our knowledge of the assemblage and distribution of species and relate it to nature types for foraging, reproduction and growth. Only in this way can we obtain the information needed for the appropriate control and regulation of the fishing industry.

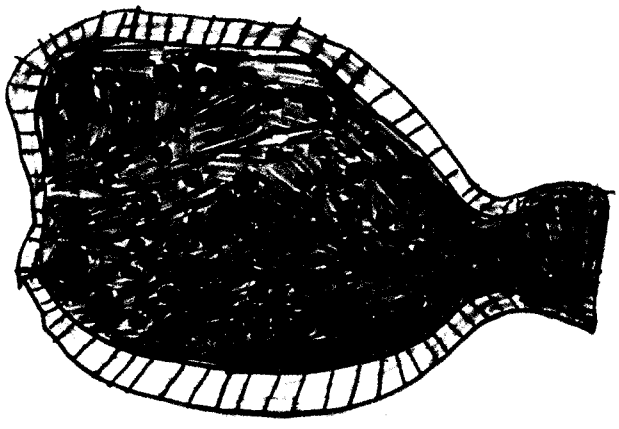


Fig. 4.4
Birds in particular need of protection that pass the winter in, or migrate through, Danish waters.

Name	Population estimates *(minimum and maximum)	Estimated percentage of the North-West European population
Scaup duck	3.000 - 39.000	7 - 20%
Common eider	538.000 - 797.000	20 - 38%
Grey lag-goose	30.000 - 47.000	33%
Mute swan	34.000 - 59.000	19 - 33%
Pink-foot goose	24.000 - 31.000	100%
Brentgoose	30.500 - 3.500	100%
Red-throated diver	12.500 - 39.000	29 - 90%
Whooper swan	12.000	50%
Common scoter	225.000 - 555.000	28 - 69%
Goosander	8.800 - 21.400	7 - 17%
Red-breasted merganser	8.300 - 15.000	8 - 15%

* The maximum and minimum population sizes reflect in part the uncertainty from one year to another inherent in counting aquatic birds and, in part, the fact that these birds stay in Danish, Swedish or German waters, depending on the conditions of wind, weather and ice.
(Source: Jensen, 1993; Jørgensen, Madsen & Clausen, 1994.)

Birds
The Danish waters are one of Europe's most important winter refuges for several species of marine bird.

The shallow waters are highly productive and form the base of the food chain for an extremely rich assemblage of marine birds, even when considered on the international scale; see Fig. 4.4. The inner Danish waters are of great international significance as a winter refuge for many birds. The various marine biotopes attract different species of bird. Thus, the common eider forages especially on mussel beds, whereas the swan forages on populations of eelgrass.

Most of the marine birds that appear in Danish waters are migratory birds that spend the summer in the north and north-east of Europe. Many hundred thousand marine birds gather around Denmark, especially in the winter half of the year, and some of them take advantage of the large plant growths, benthic fauna and mussel beds in the shallow waters. Other marine birds spend most of their time on the open seas, where they live on small fish, crustaceans, etc.

The marine birds that occur in large numbers are various types of diving duck, swan, Alcidae, diver, grebe and cormorant. In the case of some species, such as the brentgoose from Svalbard, most of the population spends the winter in Denmark. Of other species, such as the common scoter and red-throated diver, over 90% of the North-West European population spends the winter in Danish waters; see Fig. 4.4.

The birds are endangered when the very shallow waters disappear, for instance, because of damming. Oil spills at sea and disturbances due to shooting are other serious threats to the birds. Moreover, the natural balance and mutual competition between species of marine bird can be affected by the industrial disposal of fish refuse at sea.

Mammals
Only three species of breeding marine mammal are to be found in Danish waters, i.e. the common porpoise, the common seal and the grey seal, of which the grey seal has only recently been observed as occurring in Danish waters.

Various large whales, such as the sperm whale and killer whale, are regularly observed in Danish waters.

Marine mammals are extremely sensitive to the impact of man. Environmental poisons, unintentional trapping in fishing nets and various forms of disturbance ashore, especially in the breeding season, are the most serious threats.

Environmental impact
Denmark has 7,300 km of coastline and no Dane lives further than 50 km from the sea. Thus, the sea is of special significance to the Danish culture and life style and is the object of many widely-varied interests.

However, our waters are also vulnerable since many of the sea's organisms live at or near the limit of the natural environmental factors that they can withstand. The effects of man's impact can, thus, easily become a factor critical to the preservation of biodiversity, especially at the local level.

Alien species can be introduced through oyster cultivation or via ships' ballast water. This can mean that alien species can become established locally and then spread so that they eradicate or infect native species.

Nutrient salt input
The greatest impact on the biodiversity of marine areas has been the intensifying input of the nutrients nitrogen and phosphorus (eutrophication), which has resulted in a serious imbalance in marine ecosystems; see Box 4.3.

Agriculture is the primary source of *nitrogen* input. The addition of nitrogen fertilisers to Danish agricultural soil has doubled over the past thirty years.

As far as *phosphorus* is concerned, the primary source has been domestic and industrial waste water. However, the discharge of phosphorus has dropped dramatically in recent years, cf. the Action Plan on the Aquatic Environment below.

Environmentally hazardous substances
These are substances that are toxic, bioaccumulable (concentrate in living tissue) or persistent (degrade only slowly). They include the heavy metals and substances that are alien to the environment.

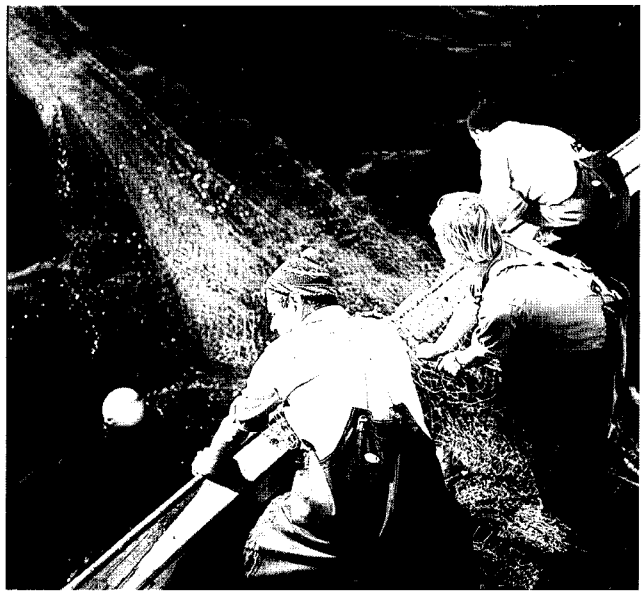
The harmful effects of environmentally hazardous substances have manifested themselves to a significant extent. High concentrations of the heavy metals (cadmium, lead and mercury) and other environmentally hazardous substances (DDT and PCB) have been ascertained in fish and benthic fauna. In recent years, however, a general decline has been observed in some of the environmentally hazardous substances monitored, primarily due to legislation that has been enacted since 1970.

It has, thus, proved feasible to control the loading on the marine environment that derives from certain clearly defined sources, through imposing conditions on the discharge of waste water and through the general regulation of chemical substances and products. The real problem is, however, the large deposits that have accumulated in the sediment of the sea bed through the sins of earlier times and which will have a continued impact for many years to come.

Another problem is the diffuse loading due to environmentally beneficial substances which are included in many products in circulation in society and which end up in the marine environment sooner or later. Finally, our waters are loaded by discharges from other countries.

We lack precise knowledge of the quantities of environmentally hazardous substances that are discharged, how they

spread and how they affect biodiversity. We know most about the occurrence of heavy metals, whereas we know very little about the occurrence and effects, for instance, of pesticides and the sex-hormone-like substances (such as oestrogen) that are to be found in a wide variety of products and that are suspected of causing sterility in birds, fish and human beings.



Oil pollution

Oil spills from shipping present a serious threat, especially to Danish marine birds. Although Denmark has so far been spared major oil catastrophes, the lives of several hundred thousand marine birds, according to certain estimates, have been lost over the last 10 to 20 years as a result of oil spills. It is, however, extremely difficult to carry out assessments of this nature, probably because most of the dead birds do not drift ashore. Danish waters are some of the most intensively trafficked waters in the world while, at the same time, they are narrow and difficult to sail, which only increases the risk of oil catastrophes.

Fisheries

The large quantities of fish taken by commercial fisheries from the sea's ecosystem affect fish populations in various ways.

In combination with other factors, the improvement of fishing efficiency has resulted in population reductions of unintentional and unsuitable proportions in the case of certain heavily used species. First and foremost the average age and size of the fish have dropped. There is also the risk of a shift in the natural balance between the sea's fish species as a result of the different species' commercial interest. Sea farming, mussel cultivation and the release of fry can also result in various changes in the surrounding ecosystem, changes in the gene pool and in the spreading of fish diseases and parasites.

Bottom trawling and mussel dredges can injure plant and animal life on the sea bed. Such dredging activities probably constitute a threat, e.g. to the perennial seaweed growth. Similarly, fishing nets constitute a danger to porpoises, seals and marine birds, which can drown in the nets.

Extraction of raw materials

The shallow areas of the sea that are less than 20 m deep contribute significantly to the approximately 5 million m^2 of marine material (sand, gravel, pebble gravel and stone from the sea bed) that is used annually in Danish construction activities. Together with shoals and reefs in the open waters, the shallow coastal and fjord areas include some of the most productive ecosystems in Danish waters and are the spawning and nursery areas of fish and the foraging areas of marine birds.

The pumping of sand and pebble grav-

el also results in removal of the flora and fauna that live in the pumping area. At the same time, fine-grained material can be spread and subsequently deposited on the sea bed. Pumping causes the immediate reduction or modification of the available food supply of birds, fish and marine mammals wherever it takes place. However, its impact is generally local and, in certain cases at least, it is possible to re-establish the sea-bed environment in just a few years.

The impact and significance of the spreading and subsequent depositing of fine-grained material depends on the composition of the surface sediment in the surrounding environment. Such spreading and depositing is considered to constitute the greatest environmental hazard in gravel, pebble-gravel and stone areas, where the flora and fauna are not adapted to such sedimentation.

The administration of raw-materials dredging is, therefore, a balance between society's need for raw materials and our consideration for marine biodiversity.

Land reclamation and construction activities

Many shallow coastal areas have been dammed, drained and converted into arable land. However, in view of the increasing efficiency and excess productivity of modern agriculture, there can hardly remain any need for the continued expansion of Danish arable land.

The construction activities that take over areas at sea include landfill, damming, coastal defence installations, bridges, cables, pipelines, sea farming and marine wind power generators. Such installations are typically tied to the ecologically important shallow waters and protected fjords and bays.

Open-air activities

The sea and coast hold an enormous attraction for people, which can in itself constitute a threat to marine biodiversity. The noise of motor boats and jet-skis, and even the more peaceful activities of surf boards and rowing boats, can disturb birds, seals and porpoises in their resting, foraging and breeding areas. One vital preventive instrument here is the dissemination of information to the population on the living patterns of these animals and the consequences to them of disturbances.

Current protection performance

Combatting pollution

The Environmental Protection Act requires a *waste water permit*, issued by either the county council or local council, for every discharge of waste water into watercourses, lakes or the sea. Such permits specify the precise conditions of discharge, including the substances to be discharged and to what extent. The State monitors the state of the aquatic environment in areas of open sea, whereas the county councils monitor states in coastal and fresh waters. The local councils supervise discharges from small-scale enterprises.

Dumping at sea is prohibited according to the Act on the Protection of the Marine Environment. However, permission can be obtained to *deposit* bottom material that has been dredged up elsewhere, typically in connection with the cleaning or dredging of harbour basins and fairways - although not when polluted materials are involved.

Without the permission of the Ministry of Environment and Energy, such depositing must not be carried out of less than 6 m, in marine bird protection sites or in areas designated as protected under the EC Habitats Directive.

Action Plan on the Aquatic Environment

The *Action Plan on the Aquatic Environment* was adopted in 1987. The goal of this plan is to reduce the discharge of nitrogen and phosphorus into the aquatic environment by 50% and 80%, respectively, in part through improved waste

water treatment and reduction of the total fertiliser consumption of agriculture. In parallel with the Action Plan on the Aquatic Environment, the *Action Plan for the Development of Sustainable Agriculture*, which was adopted in 1991, also aims to reduce the input of nutrients into our waters. The measures taken in relation to agriculture as a result of these plans are discussed in more detail below.

The goals of the Action Plan on the Aquatic Environment, for reducing the input of nutrients from point sources, especially sewage treatment plants and industrial discharges, have almost been attained. This means that the input of phosphorus into the aquatic environment has dropped dramatically.

Nitrogen, in contrast to phosphorus, is the limiting factor in the marine environment, which means that the reduction in the quantity of phosphorus discharged does not immediately benefit the marine environment. As there has been no reduction in the quantity of nitrogen discharged by agriculture, the quantity entering our waters remains at the same level as prior to implementation of the Action Plan on the Aquatic Environment in 1988. The quantity of nitrogen entering the marine environment is also dependent on prevailing meteorological conditions.

Protected areas

The following groups of protected area have been designated with a view to protecting *national natural assets or natural resources*:

- nature conservation areas and nature

Figur 4.5
111 EC Bird Protection Areas in Denmark.

reserves;
- wildlife reserves, including seal reserves;
- scientific reserves;
- areas in which the extraction of raw materials is prohibited;
- areas protected against fishing;
- Ramsar Sites and EC Bird Protection Areas designated by the EU;
- EC Habitat Areas designated by the EU (from mid-1995).

The Ministry of Environment and Energy can protect parts of our territorial waters through conservation orders laid down in ministerial orders in accordance with Section 51 of the Nature Protection Act. At present 16 areas, of widely varying size and for a variety of reasons, have been protected in this way. The protection of land areas can also cover the adjoining shallows of our territorial waters when special interest is attached to these areas.

The work done by the Ministry of Environment and Energy on the *protection of marine waters* was laid down in an action plan in 1992. This states, for instance, that it is the task of the central environmental authorities to influence special legislation in the individual ministries, so that more attention is paid to considerations of nature conservation.

In 1977, Denmark ratified the *Ramsar Convention* On Wetlands of International Importance Especially As Waterfowl Habitat. 27 *Ramsar Sites* with a total area of 7,400 km″ have been designated, 25 of which include marine areas covering a total of almost 6,000 km″.

EU Protection Areas (SPA) have been designated pursuant to the EC Bird Protection Directive of 1979, which obliges member states to protect the habitats of a number of specific bird species. 111 EC Bird Protection Areas, which also include the 27 Ramsar Sites, have been designated and 51 of these protection areas apply to areas in our territorial waters. Of the total area of about 9,600 km″, the marine areas comprise by far the greater part, with an area of over 7,000 km″; see Fig. 4.5.

The Ramsar Sites and the EC Bird Protection Areas are subject to a set of independent protection provisions pursuant to the Executive Order of 1994 on the demarcation and administration of these areas. The scope of this executive order will be extended to include the EC Habitat Areas mentioned below.

Wildlife reserves

It is possible to introduce restrictions concerning public access and hunting when designating *wildlife reserves* in pursuance of the Act on Hunting and Wildlife Management.

A number of "green" organisations have proposed expansion of the existing *network* through the establishment of about 60 new *reserves where hunting is prohibited* in 46 Danish EC Bird Protection Areas. The aim is to give aquatic birds better foraging and resting areas.

In this connection, the Ministry of Environment and Energy has drafted an action plan for the establishment of new reserves and is now engaged on laying out the areas in cooperation with the relevant organisations.

EC Habitat Areas

A directive on the conservation of nature types and wild plants and animals (the EC Habitats Directive) came into force on 5 June 1994. The obligations of this directive correspond to the obligations of the EC Bird Protection Directive. Where the latter is intended to preserve European birds and their habitats, the EC Habitats Directive aims to protect the other groups of European animal - mammals, amphibians, reptiles, fish and invertebrates, plants, habitats and nature types.

The central goal of the directive is to assist in safeguarding the biodiversity of member states. The most important instrument here is the designation of protected areas, which is aimed at the

maintenance or restoration of a satisfactory state of conservation for the nature types and habitats of the species specified in Lists I and II of the directive. Together, the designated areas shall comprise a network of EC Habitat Areas in member states - the so-called "NATURA 2000" network.

Many of the areas will either be at sea or connected to the sea.

The regional authorities, "green" organisations, institutes of higher education, museums and various experts will all be involved in the designation of EC Habitat Areas in Denmark. The final proposal will be discussed and negotiated with all of the above, before it is sent to the Commission of the European Community.

Constructions and utilisation of raw materials

As a result of the State's sovereignty over our territorial waters, *constructions* in these waters require permits from the Ministry of Transport. Special construction acts will normally be passed in the case of major constructions, such as bridges and tunnels. The construction of trading ports requires permission in pursuance of the Act on Trading Ports and a construction act will occasionally be passed in special cases.

An EIA (Environmental Impact Assessment) pursuant to the EU directive on the assessment of environmental impact is mandatory in the case of major harbour constructions for ships of over a certain tonnage. The same applies if it is desired to locate a construction in the Wadden Sea region or in areas designated under the EC Bird Protection Directive or EC Habitats Directive, or where such construction can be detrimental to these areas or cause disturbances that can have significant consequences to the species for which the areas have been designated. In other cases the question of an EIA is decided on the basis of a review of the case in hand.

Constructions used in prospecting for and extracting oil and natural gas and for the dredging of fairways and harbour basins require the permission of the Ministry of Transport, which consults with the Ministry of Environment and Energy.

Prospecting for, and *extracting sand, gravel and stone, together with other raw materials*, from the sea bed must be granted approval in accordance with the act on raw materials and can only be carried out with the permission of the Minister of Environment and Energy. There is a prohibition against grab dredging from the sea bed in EC Bird Protection Areas. All raw materials extraction projects in progress in these areas will be phased out.

Fishing

The regulation of fishing and *the protection of fish populations, crustaceans and*

molluscs is carried out pursuant to the acts on freshwater fishing and sea fishing and through EU regulation of fishing. This specifies for individual fish species minimum size restrictions, close seasons and maximum quantities. These restrictions are implemented through regulations governing fishing vessels and the design and use of fishing equipment.

There are restrictions on the use of net equipment in and along rivers and streams, along the coast and on trawling in coastal areas and certain sections of fairways with a view to *protecting migratory fish*. Similarly, there are restrictions on fishing for shellfish in the Wadden Sea and the Liim Fjord.

The EU adopted a new, ten-year, basic regulation on fishing and aquaculture in 1992, for the purpose of ensuring the sustainable use and development of marine-biological resources, with consideration for the need for protecting the total ecosystem.

The EU has subsequently adopted a development programme for fishing capacity that contains requirements on limiting fleet capacity or the number of *sea days*, i.e. the number of days on which sea fishing is carried out.

The Nordic environmental and fishing ministries have decided to draft a strategy for increasing the degree of consideration for the environment in the fishing sector, so that the ministers can reach a decision on this topic during 1995.

At the global level, it has been decided that a behaviour codex for responsible fishing be drafted under the auspices of the FAO, with a view to ensuring sustainable use and development of the sea's living resources. Moreover, the UN has started negotiations on a global convention on the protection of migratory fish populations.

Forthcoming efforts

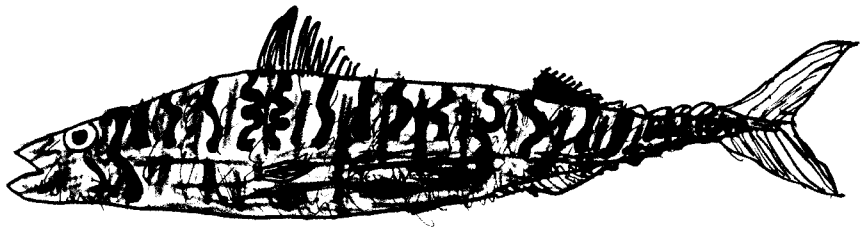
Accumulation of scientific knowledge

Our extensive utilisation of the sea means that we often intervene in its ecosystems without knowing enough about the consequences of our actions. We must increase the body of scientific knowledge of the biological processes and conditions involved, so that we can attain a position from which we can institute sufficiently preventive and restorative measures against the vitiation of biodiversity.

Hitherto, the body of scientific knowledge on biological conditions in the sea is mainly the result of research conducted in limited fields or areas, as decided by the interests and fields of work of the individual researchers or research institutes. In particular, it has been concentrated on the occurrence and distribution of species of flora and fauna, and rather less on their mutual interaction.

We lack a scientific basis on which we can classify the sea into nature types and diverse societies and on which we can carry out detailed mapping of their distribution, as we have succeeded in doing on the terrestrial area. Our knowledge of the significance of the various types of sea bed to the establishment of societies of plants and animals is still insufficient.

Much data has been collected, e.g. on nutrient salts, the growth of plankton



algae and the occurrence of benthic flora and fauna in Danish waters, in connection with the planning of watercourse quality, and as a part of the monitoring programme of our Action Plan on the Aquatic Environment. However, this data is still spread around the individual monitoring and research instances. Thus, centralised coordination and concentration of the acquired data is still lacking and should therefore be encouraged.

Research programmes conducted under the "Sea '90" project have carried us a step further in our knowledge of the dynamics of nutrients, although the biological effects of these substances at the species and society levels are still less known. However, efforts are being made to improve this situation under the auspices of the Strategical Environmental Research Programme.

Future research programmes in the field of biology should concentrate on research into the sea's ecological balance and the sustainable use of biological and raw-material resources. This should, for instance, be expressed in the establishment of a better foundation for consequence analyses in a broad sense and, thus, a better foundation for a goal-oriented protection programme.

Scientific advice in the field of fishing should be based to a greater extent on a knowledge of the total ecosystem, and given in such a way that our knowledge of species that are not used commercially and on the interaction between fish populations is taken into account in administration. To this end, there is a special need for better illumination of spawning conditions and fry biology for a number of species of fish.

There is a need for increased knowledge of the effects of fishing equipment on the sea bed and on how the undesired capture of birds, marine mammals and other species can be avoided.

Finally, there is a need for increasing the body of knowledge on the effects of the release of fish on the biodiversity of the sea and on the spreading of parasites and fish diseases, etc.

Our targets for the future state of the sea should include a description of the desired state and development and of the external conditions that will decide whether or not we can attain our goals. This demands, for instance, the drafting of criteria for assessing the state of marine nature types and trends and quality criteria for the biodiversity that we wish to maintain/restore in the sea.

In order to ensure a basis that is sufficient for future efforts, we must intensify the acquisition of scientific knowledge on trends and variations in the hydrological and sedimentological processes in the sea and coastal waters.

Criteria for protected areas

There exists a large number of different areas of interest alongside the protection areas that actually have legally binding protection status (nature reserves, Ramsar Sites, EC Bird Protection Areas and the forthcoming EC Habitat Areas). These areas have been planned according to differing criteria and are, or have been, of varying practical significance.

Expanded knowledge of the various nature types in the sea will make it possible to coordinate the differing interests in the protection and use of resources and to plan possible new protection areas on the basis of coherent biological and socio-economic interests.

Nature restoration of dammed areas

Dammed shallow sea and fjord areas constitute a total of about 33,000 ha, or 15%, of our original coastal areas (fjords and bays); also, about 180 islands and islets have disappeared. A part of these areas is today marginal arable land, where there is still potential for nature restoration that could restore them to the marine state.

Only a few projects of this type have been carried out so far and efforts towards this end should be reinforced.

Restoration of marine nature
No nature restoration has hitherto been undertaken in our territorial waters. The hard sea bed is, however, of special significance to biodiversity, and the removal of stones from stone reefs has meant the loss of habitats vital to plants and animals.

However, we lack an overview of the damage and an assessment of the needs and practical opportunities for, and appropriateness of, undertaking marine nature restoration including, for instance, the construction of artificial reefs. The Danish Ministry of Agriculture and Fisheries is currently drafting a project on this in cooperation, with the Ministry of Environment and Energy.

Prevention at source
We Danes have believed that *"the sea covers all traces"* - that we could "thin" our way out of pollution through the supposition that Nature herself would finally create an acceptable balance. However, we were long ago compelled to realise that this supposition was untenable in the long run.

The challenge of the future is to prevent the occurrence of pollution and other injurious influences. This can be achieved, e.g. by the use of cleaner technology, recycling, reducing the use of artificial fertilisers, ending the use of environmentally hazardous substances, improving methods of waste disposal and by generally including consideration for marine biodiversity in our commercial utilisation of the sea. *The precautionary principle* should be our guiding light.

Satisfaction of goals of Action Plan on the Aquatic Environment
As has been mentioned above, the increased discharge of nutrients must be considered the most serious influence on the natural biological and ecological balance of our waters. In the latest report of results obtained through the monitoring programme of the Action Plan on the Aquatic Environment, it is concluded that nitrogen leaching is still at the same level as it was in the 1980s.

It is likely that the measures taken so far in compliance with the plan will have some effect over the coming years. The same applies to the set-aside scheme under the EU Common Agricultural Policy (CAP) and the new subsidisation schemes for environmentally oriented agriculture.

However, the National Environmental Research Institute report entitled *Environment and Society* (1994) considers that the Action Plan on the Aquatic Environment, together with agricultural reform, will temporarily bring about an annual reduction in nitrogen leaching of about 50,000 tons of nitrogen. This is not sufficient to attain the goal of the Plan of reducing total discharges by 50%. Against this background, the National Environmental Research Institute concludes that additional measures must be taken if our goals are to be attained.

International efforts
While the pollution problems in our coastal areas have first and foremost been created by our own discharges, an improvement in the aquatic environment of the open waters requires that our neighbouring countries also make a considerable effort.

Within the framework of the international marine conventions, in the EU and in cooperation with the Nordic countries, Denmark will continue to work to focus the spotlight on the above-mentioned principles for a national effort, holistic orientation and prevention through the use of the best available technology.

Sustainable use of fishing resources
The EU fishing policy was revised in 1992. A main objective added at that time was that we must ensure the future protection and preservation of living marine resources and promote the responsible utilisation of them on a sustainable

basis and with consideration for the marine ecosystem and socio-economic conditions. This objective is expressed in the EU's preservation, control and research policy. It is also a consequence of the Maastricht Treaty that consideration for the environment shall be integrated into all sector policies, including our common fishing policy.

The strategy for the sustainable utilisation of fishing resources is based on both national and international laws and regulations. Apart from fishing quotas, the principles of the protection measures adopted encompass a large number of technical conservation measures, for instance, concerning the selectivity of fishing equipment, restriction of the fishing effort and increased supervision. Moreover the need is also confirmed for specifying new administrative strategies based, for instance, on models that take into account the interaction between species.

In the field of research, a declaration concerning joint fishing research has been adopted under the auspices of the EU, in which is emphasised the need for achieving better basic data for fishing research and in which higher priority is assigned to research on ecological and socio-economic conditions. This declara-

Box 4.6

The Wadden Sea

The Wadden Sea covers 10,000 km² of the shallows and tidal coast that stretch from Den Helder in Holland to Blåvandshuk in Denmark. This area has high biological productivity and is of great significance as a nursery area for North Sea fry. It lies on the East-Atlantic flyway and is essential as a resting place for 6 to 12 million birds - including more than 50 species.

Together with the adjacent parts of our territorial waters to the south of Blåvandshuk, the Danish part of the Wadden Sea was declared a ***wildlife reserve*** *in 1979, protected as a* ***nature reserve*** *in 1982-1983 and designated a* ***Ramsar Site*** *and* ***EC Bird Protection Area****. With its approximately 1,125 km², the Danish part of the Wadden Sea is the largest individual area to be protected in Denmark.*

In 1982, Denmark entered into co-operation at the ministerial level with Holland and Germany on the preservation of the Wadden Sea's nature, with international nature protection agreements as the basic point of departure. This initiative was the result of an increasingly unfortunate environmental impact and our cooperation includes continuous reporting of the status of the Wadden Sea, environmental trends and the planning of future action areas.

In 1991, the three countries entered into an agreement (within the framework of the Bonn Convention) on the protection and administration of the Wadden Sea's population of the common seal. A number of measures were also adopted for restricting diking and mussel fishing, oil prospecting and extraction, together with a ban on the hunting of migratory birds.

A common monitoring programme for seal and birds has been initiated and it will be expanded into a nature and environment monitoring programme over the coming years. A common framework for future administration in the three countries of the Wadden Sea is in preparation, as is an application that seeks to place the Wadden Sea on the UNESCO ***World Heritage List.***

tion will be expressed in specific research programmes in the fishing field.

Future extraction of raw materials

The Raw Materials Act makes it possible to locate raw materials extraction at special extraction sites. In future, the designation of extraction sites will be based on an overall assessment of raw materials interests, fishing interests and nature interests.

The pumping of pebble gravel and sand in water less than 6 m deep will be limited pursuant to the *Action plan for future extraction of raw materials from Danish waters*. With the exception of current activities, which will be wound up over the next few years, the extraction of raw materials is prohibited in EU bird sanctuaries.

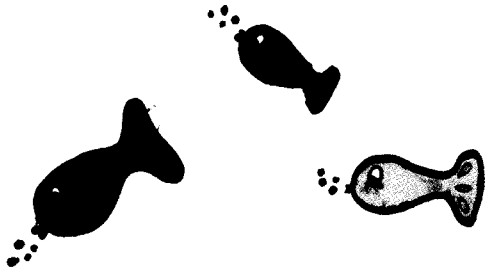
Notice was given in 1989 that grab dredgers' general permits would expire in 1999. Grab dredging is prohibited in EC Bird Protection Areas. In compliance with the raw materials action plan, grab dredging will be restricted to special areas and, in general, only where the depth is exceeds 6 m.

Environmentally sensitive waters and international shipping

In 1993, the Commission of the European Community asked its member states to designate environmentally sensitive areas (ESA) from the standpoint of shipping in their coastal and territorial waters. Denmark designated all of the inner Danish fairways, the Danish part of Skagerrak and the Wadden Sea and its adjoining waters as ESAs in 1993. This was done against the background of the country's long coastline, its extensive, highly productive shallows and the extremely large number of aquatic birds that stay in these waters for shorter or longer periods; see Box 4.6.

In 1994, the EU member states were urged at a joint Council meeting for ministers of transport and the environment, under the auspices of the International Maritime Organisation (IMO), to ratify a number of conventions intended to promote safety at sea.

The member states and Commission of the European Community were also urged to increase their endeavours towards the protection of environmentally sensitive waters, to assess the risk that shipping constitutes towards their coastal areas, to assess current safety measures in relation to ESAs and to give priority to the preparation of proposals and standards that are sufficiently comprehensive for the whole of the EU.



Denmark wishes to promote these initiatives towards the global stipulation of rules governing safety at sea and pollution caused by shipping which, considering the international character of shipping, should be carried out under the auspices of the IMO.

In combination with the constantly increasing flow of shipping, the great biological differences between different parts of the sea can endanger the biodiversity of marine environments. Organisms that are not, themselves, capable of spreading from one area to another can be spread by ships that load ballast water in one place and discharge it in another. Shipping can thus threaten local marine environments through the introduction of alien species. At its general assembly in 1994 and under the auspices of the IMO, the IUCN (of which Denmark is a member) adopted a recommendation (No. 19.47) to study and implement various measures and legal instruments for controlling the discharging of ships' ballast water.

Target areas

- Increasing our knowledge of marine biodiversity from the standpoint of:
  - identifying and demarcating the different marine nature types;
  - the development of indicators of the state and trend of the sea's nature types;
  - identifying factors influencing biodiversity;
  - specifying future quality criteria for our targets for marine biodiversity, on the basis of information obtained from the indicators.
- Integrating consideration for the preservation of biodiversity into the management of fisheries by:
  - expanding the scope of scientific advice given to the management of fisheries to include a knowledge of consequences to the total ecosystem;
  - specifying a new management strategy that takes into account the inter action between species (multi-population models);
  - implementing strict supervision of the release of fish, with a view to preventing genetic homogenisation and the spreading of fish diseases;
  - reducing significantly the unintentional capture of birds, marine mammals and endangered species;
  - assigning higher priority to research into the impact of fishing on marine ecosystems.
- Develop cohesive criteria for the designation of different protection areas in the marine environment.
- Apply the precautionary principle in order to restrict the discharge of polluting substances and environmentally deleterious influences on the sea, through the continued encouragement of:
  - a preventive effort in all sectors that use the sea and its resources;
  - a corresponding preventive effort on the part of the countries that contribute to the pollution of Danish territorial waters, including work at the in ternational level to sharpen the requirements on environmental safety and pollution, both from land-based sources and shipping.
- Determining the need for nature restoration of the sea, including the need for constructing artificial reefs.
- Increasing the nature restoration of hitherto dammed areas.