14. Synthesis of Ecosystem Developments

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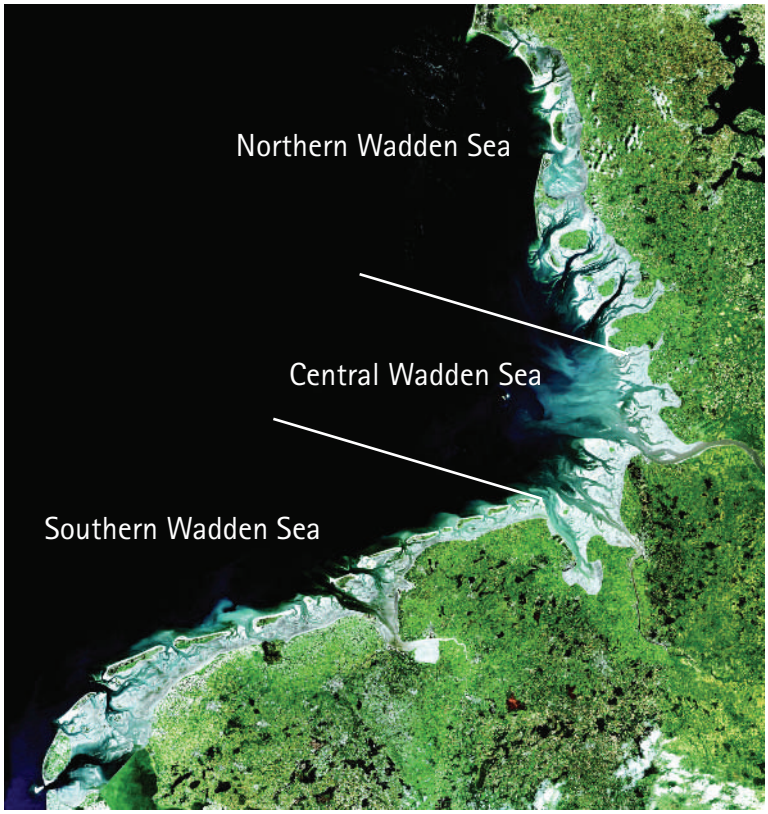

Figure 14.1:
The Wadden Sea divided into three sub-regions.

14.1 Introduction

The preceding chapters of this Quality Status Report have been structured very much according to the ecological targets as formulated in the Wadden Sea Plan of 1997 with chapters 1 and 2 providing an update of the trilateral conservation policy and legislation together with an overview of the various human activities that – the one more than the other – act as pressures against the natural processes in the Wadden Sea ecosystem. The report describes and evaluates recent developments in order to guide further management decisions. In this chapter, we present an overview written from an ecosystem perspective, summarizing the major trends and events, focusing on geographical differences within the system, on its dynamics and productivity. In doing so, we hint at priorities for a further development of targets, monitoring and management.

14.2 Some trends and events

Coastal ecosystems such as the Wadden Sea are subject to continuous and ongoing change, never attaining final equilibrium when considered in a long time frame. There are trends in sea level, water currents, climate or nutrient supply, interspersed by particular events such as a severe winter in 1995/1996, three very warm summers in a row from 2001 to 2003 facilitating the spread of introduced Pacific oysters, and two disastrous Phocine Distemper Virus epizootics in 1988 and 2002 each of which halved the harbour seal population. Seagrass beds are beginning to recover. A sign of high habitat quality may be that breeding populations of Mediterranean and great black-backed gulls as well as spoonbills have been able to expand their range in the Wadden Sea. On the other hand, there seems to have been a recent decline of migrant birds on tidal flats in most parts of the Wadden Sea.

14.3 Management

Superimposed on such trends and events are attempts by the authorities responsible for an integrated environmental management, aiming for - as far as possible - a natural status of the Wadden Sea ecosystem, as agreed in the Trilateral Wadden Sea Plan, Stade 1997. Management was successful in the last decade. Riverine loads of nutrients and several pollutants have declined further. Many artificial salt marshes are gradually developing natural structures. Almost all cockle fishery has been stopped to reduce disturbances of the benthic system and to improve food resources for mollusc-feeding birds. The harbour seal population seems to be in a viable state in spite of epidemics. A better protection of the moulting area of the

European shelduck population and of breeding colonies of little tern have been achieved.

However, there are also developments of an adverse nature or of which appropriate observations are lacking. Beaches, for example, still remain a critical habitat because of increasing human use in all seasons, affecting the breeding success of great ringed and kentish plover and possibly the recolonization of grey seals. Top consumers including humans are still exposed to pollutants. Hormone-disrupting substances may form a new threat. Some developments with interacting processes and confounding effects, such as reduced nutrient loads and their final effects on benthic productivity and carrying capacity for birds, are not sufficiently understood and it is not clear what management options should be chosen.

14.4 Geographical constraints

The Wadden Sea is a wide open system subject to processes originating from outside the region, and only partly amenable to current management. Examples are the increasing size of sea-going vessels entering the estuaries and the absence of juvenile cod because of overfishing and climate change in the northern Atlantic. In some cases research is needed to distinguish between internal and external causes as in the recently declining numbers of flatfish and of migratory wading bird species. The analyses of such cross-boundary developments as well as the corresponding management efforts have to be performed in collaboration with partners outside the Wadden Sea area. It should be kept in mind that the boundaries of the Wadden Sea ecosystem are far beyond those of the Wadden Sea Cooperation Area.

The persistent absence of large anadromous fish - salmonids and sturgeon - requires coherent restoration programs from upstream reaches of rivers through the estuaries into Atlantic waters. The observed spread far into the North Sea of seals tagged at the Wadden Sea coast necessitates studies of food availability and threats in an area beyond the Wadden Sea if the efficiency of protective measures within the Wadden Sea by the Seal Management Plan is to be evaluated.

In addition to external linkages, differences in developments between sub-regions within the Wadden Sea need more attention. For processes in the water, the perpendicular orientation of the southern versus the northern Wadden Sea coastline may be important. Exposure to wind and waves affects these two coastlines differently, most probably causing differences in exchange processes between the Wadden Sea and the adjacent North Sea. With respect to locations of major freshwater discharges (*e.g.* Rhine-Meuse, Weser, Elbe), sub-regions may need to be discerned. When also considering tidal range, a central Wadden Sea (from Jadebusen to Eiderstedt peninsula) with more than 3 m tidal range may be distinguished from the southern and northern sub-regions, which mostly have a smaller tidal range (Figure 14.1).

Accelerated sea level rise, especially increasing high tide level, is apparent in the northern but not in the southern Wadden Sea. Phytoplankton biomass in summer and nitrogen remineralization in autumn are about twice as high in the southern as in the northern Wadden Sea, indicating differences in eutrophication level. Intertidal seagrass beds declined until the 1990s in the southern but not in the northern Wadden Sea. Bivalve recruitment patterns differ conspicuously between Wadden Sea sub-regions. While the last good spatfall of blue mussels in the northern Wadden Sea dates back to 1996, several significant recruitment events have occurred recently in the eastern Dutch Wadden Sea. The causes of these geographical patterns are not known. A better understanding of differing processes and developments between sub-regions of the Wadden Sea is necessary for refining targets, and to adjust monitoring and management schemes accordingly.

Sub-regional differences not only occur in the water but also the dune vegetation differs substantially between southern and northern Wadden Sea islands. In the south, dune grassland and scrubs dominate while dune heath prevails in the north. These vegetational differences have divergent effects on the associated fauna and require different management approaches.

14.5 Morphodynamics

At a coast with a flat land fronting a shallow sea, slight changes in sea level, tidal range, storm frequency, currents and river runoff strongly affect morphodynamics and ecosystem processes. Consequently, the ecosystem is highly sensitive to man-made changes of shoreline shape and position, operation of freshwater sluices or dredging in estuaries to accommodate larger sea-going vessels. Some human interferences inhibit natural morphodynamics while others facilitate dynamics beyond natural rates (Figure 14.2).

In the Wadden Sea, the most fundamental inhibitor of natural morphodynamic adjustments to sea level rise is the dike line along the mainland coast, constructed and maintained to provide pro-

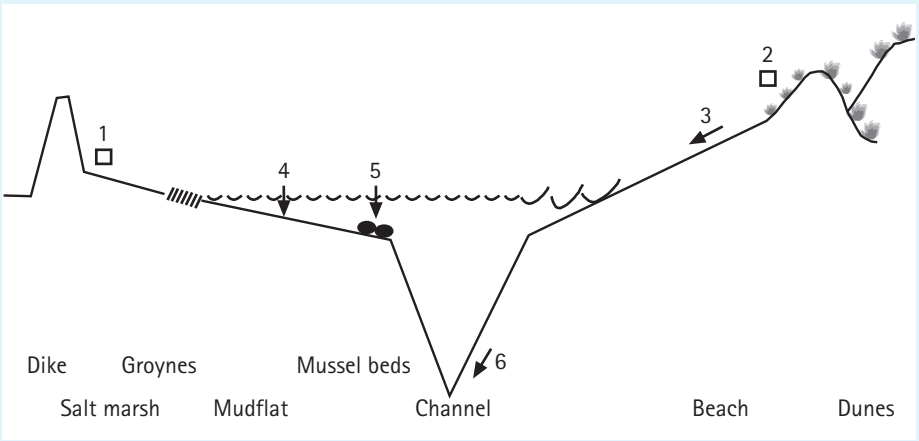

Figure 14.2: Human interference inhibiting and facilitating natural morphodynamics. 1: salt marsh confined between dike and groynes, 2: dune stabilization, 3: nourishment of beaches and foreshore, 4: decreasing fine particle deposition on intertidal flats, 5: dredging and bottom trawling by fishery, 6: deepening of channels for shipping.

tection against flooding. Salt marsh succession is truncated at the upper end by a dike. Pioneer vegetation at the lower end usually requires protection by brushwood groynes in order to develop. Between dikes and groynes the vegetation is ageing. The further the level of a salt marsh has grown upward through sediment deposition during spring and storm tides, the more conspicuous is the receding cliff at its seaward side. Where this progressive edge erosion occurs close to a dike, it is soon stopped by revetments made out of stone or asphalt. Dynamic development has then ceased altogether.

Many birds use salt marshes and wet meadows for breeding. Several breeding wader species, however, including black-tailed godwit, dunlin and ruff are declining and some have become nearly extinct. They depend on the quality of salt marshes and meadows, which obviously has been inadequate for the demands of these species during the last decade. This may not be related to morphodynamics but more to other habitat management decisions. Except for some tips of sandy islands, dune dynamics are usually inhibited by a combination of planting marram grass and of airborne eutrophication, which facilitates a dense grass cover. This stabilization allows for permanent housing or road infrastructures in or close to dune areas and leads to a dominance of late successional stages in vegetation.

Artificial facilitation of morphodynamics occurs where beach erosion is compensated by sand replenishments. Although this measure is a better environmental practice than traditional hard defences, it results in a higher rate of change in beach and foreshore morphology because beaches are set back by sand nourishments to an earlier state of succession. Furthermore, disturbance and instability are imposed at sand extraction sites as well.

Three processes may give rise to a sandier Wadden Sea at the expense of silty or muddy flats. On tidal flats adjacent to a dike and fronting a straight coastline, sediment stability and mud deposition is decreasing with sea level rise. This conclusion is based on grain-size distributions and modeling. Such a gradual process towards a more sandy Wadden Sea has far reaching consequences for all benthic organisms living on nearshore mud flats as well as for the crustaceans, fish and birds which forage there. Morphodynamics are also facilitated in the lower intertidal zone and subtidal bottoms. This is caused by dredging or trawling for bivalves, shrimp or flatfish and may prevent recovery of sabellarian reefs. In addition, removal of blue mussel beds or the maintenance of mussel bottom cultures are inhibiting mud deposition and promote mobile sandy bottoms.

In estuaries, the continuous dredging of one major channel which has to accommodate ever larger vessels initiates sediment instability. The deeper the channel, the higher the inshore migration of sand to restore the previous depth and the faster the currents flushing through. On the other hand, former side channels become silted as in the Ems and Weser estuaries.

The desire for morphological stability at the shore and in dune areas on the one hand, and the facilitation of sediment dynamics in the intertidal zone and below on the other, are both in conflict with the target for natural morphodynamics. Some mitigation is possible. Good examples are the cessation of artificial drainage and

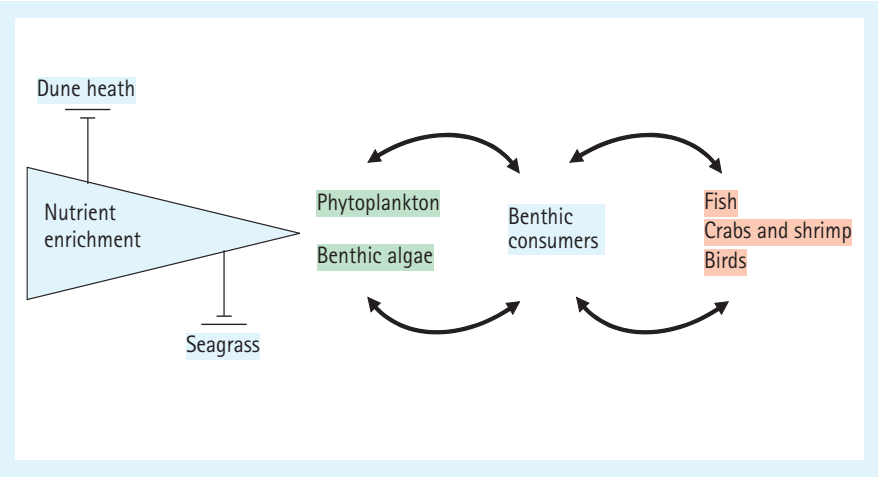

Figure 14.3: Effect chain of nutrient enrichment in the Wadden Sea area: Inhibiting dune heath and seagrass, facilitating phytoplankton and benthic algal growth, and these create reciprocal interactions with various groups of consumers.

a moderation of livestock grazing on mainland salt marshes, the end of mechanical cockle dredging or agreements to save intertidal mussel beds from exploitation in large parts of the Wadden Sea. However, there is still a wide potential for restoration and mitigation, particularly along shorelines to avoid hard sea defenses.

14.6 Productivity

The Wadden Sea is praised for its great productivity, serving as a nursery for North Sea fish and as a turntable for large flocks of migrant birds (Figure 14.3). Nevertheless, some of its characteristic plants such as seagrass flourish best under oligotrophic conditions and heath vegetation in the dunes is threatened by eutrophication. Thus, high productivity should not be a general aim for all habitats. The tidal area of the Wadden Sea is to be regarded as a eutrophication problem area with a phytoplankton production exceeding natural background conditions.

Presumably, the peak of riverborne eutrophication was passed in the 1990s. Nutrient inputs from land are decreasing. Phytoplankton biomass is decreasing in most parts of the Wadden Sea. Green algal mats on intertidal flats have never again reached the massive coverage of the early 1990s, and seagrass beds are recovering. In spite of this, total nitrogen concentrations in rivers debouching into the Wadden Sea are still about 7-8 times higher than the assumed background values, and estuaries have lost most of their primordial filter and retention capacity.

In contrast to coastal regions with more stagnant waters, strong water currents and waves in the Wadden Sea have prevented large-scale oxygen deficiencies. Instead, benthic suspension and deposit feeders were supplied with more food than there would have been without eutrophication. Predation by juvenile shrimp and crabs on recruits of bivalves has limited their abundances in the lower intertidal zone. This predation pressure is particularly effective when winter conditions remain mild, leaving less prey for fish and birds. Other confounding effects have been exploitations of cockles and blue mussels. Increased numbers of introduced American razor clams, slipper limpets and Pacific oysters may take their place or enlarge the suspension feeder component. All of these introductions seem to be less accessible to predators than native molluscs. It is not known whether these introduced filter feeders have already affected phytoplankton biomass.

In a recreational area such as the Wadden Sea, the goods and services of an ecosystem are disproportionately measured by the abundance of large-sized or otherwise conspicuous consumer species. In the water there are no signs of recovery for once common sturgeon, salmon and rays. At the bottom, native oysters and reefs of sabellariid worms did not recover either. Most bird populations which were severely affected until the 19th century have benefited from cessation of egg collecting and hunting as well as from protecting breeding and roosting areas. This process of bird recovery is still under way for some bird species and also applies to seals. One may wonder how many top consumers the Wadden Sea ecosystem can provide with sufficient food.

While herbivorous birds seem to be on the safe side, there are indications that mollusc-feeding birds such as common eider, oystercatcher, knot and herring gull have suffered from food shortage, particularly in the Dutch Wadden Sea. It cannot be ruled out that this shortage has been caused by the mussel and cockle fishery. A further prob-

lem for mollusc-feeding birds may arise when recruitment failures in bivalves become more frequent as winters continue to be rather mild.

Whether a further reduction of nutrient supply will eventually result in food shortage for top consumers is unclear because of the many alternative pathways in the food web. Effects of the changed nitrogen-phosphorus ratio have not yet become apparent. Anyhow, anoxia or harmful algal blooms are not likely to increase under the present level of eutrophication.

14.7 Conclusion

The present Wadden Sea is a particular habitat problem area and still deficient in a number of charismatic species which once lived in this region. This is mainly the result of various pressures exerted by human activities. Relevant issues for the future are also an increasing impact of introduced species, the consequences of sea level rise and an assumed trend towards sandier sediments. Precaution requires the further reduction of the release of technogenic toxic substances and the prevention of the release of novel ones. The need for balancing the reduction of nutrient enrichment deserves to be critically assessed. Future management of the natural values of the European Wadden Sea should be better tuned to the apparent differences between subareas as well as taking into account the cross-boundary relationship between this system and the influences from large river catchment and offshore areas.