The Ecosystem Approach of the Convention on Biological Diversity

German Case Study
on the lessons learned from the project
"Ecosystem Research Wadden Sea"

Report

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Summary

It has increasingly become accepted in recent years that ecosystems can only be managed sensibly if they are perceived and protected in their entirety. To this end, 12 principles for an ecosystem approach and 5 points of operational guidance have been elaborated in the framework of the Convention on Biological Diversity. They have not been applied to a marine ecosystem as yet. The "Ecosystem Research Wadden Sea" of 1989-1999 provides an appropriate case study for the practicality of these principles, because its integrative approach largely corresponds to the ecosystem approach.

Principle 1: The objectives of management of land, water and living resources are a matter of societal choice

Intensive publicity is an insufficient foundation for implementing management actions in a national park. Stakeholders whose economic interests are affected must be involved in the preparation of the management concept at an early stage (e.g. by the formation of working groups), particularly since the implementation of precise measures often requires the stakeholders' practical experience. When dealing with controversial and complex topics, it is advisable to employ independent mediators capable of formulating proposals to reconcile diverging interests. Decisions must be taken in a cooperative manner, because an ecosystem can only be protected effectively with active support from the local population; decisions must be binding, thus enabling stakeholders and conservation agencies to plan for the future.

Principle 2: Management should be decentralized to the lowest appropriate level.

Decentralized structures make it possible to involve local stakeholders in the management of the region, and they help to take the local characteristics of the ecosystem into consideration. They also serve to convey proposals to the upper management levels. Effective management of an ecosystem meshes decentralized with centralized approaches in order to tune local interests to the general interests of society. If comprehensive research projects are conducted, it is advisable to form a steering committee that will delineate the practical requisites of the management to the participating scientists and explain the rationale of the research program to the population (see also guidance point 5).

Principle 3: Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.

Ecosystems are interlinked; this necessitates a corresponding linkage between research and management activities in different ecosystems. The management of each individual ecosystem requires an understanding of the large-scale ecological, economic and

social interactions between ecosystems. Therefore, sensible management is only possible with correspondingly comprehensive scientific research and international cooperation.

Principle 4: Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context

It is necessary to explain to stakeholders and consumers that sustainable use of natural resources (e.g. in fisheries) is only possible from an ecological perspective. To ensure sustainability, the access to the resource (e.g. mussels) may be regulated by licenses subject to fees. An "ecolabel" for products obtained by sustainable means can help to illuminate the ecological background and to render price increases acceptable. Tourism has special significance in ecosystems, due to its conflict potential and economic importance. A socio-economic monitoring can provide a database to diminish conflicts in managing the competition for space between tourism and nature conservation. It is also advisable to internalize the resulting ecological costs ("nature tax"), since tourists are demonstrably willing to pay for nature conservation activities.

Principle 5: Conservation of ecosystem structure and functioning ,in order to maintain ecosystem services, should be a priority target of the ecosystem approach.

The protection of the structure and functioning of an ecosystem (protection of processes) can be attained best in unexploited zones; priority for closure should be given to the areas with the greatest ecological importance. Sectoral steps, such as seasonal closures, seasonal bans on certain activities, and technical regulations can also serve to reduce anthropogenic impacts on exploited areas. The functioning and structure of ecosystems are threatened by the exchange of species, which is increasing on a worldwide scale ("McDonaldization"). Steps are required to abate the introduction of alien species, and a normative catalog classifying introduced species as ecologically and/or economically acceptable, dubious, or critical, is needed. Management actions need to reflect the results of relevant research.

Principle 6: Ecosystems must be managed within the limits of their functioning.

This principle should be abolished and integrated either into the 5th Malawi principle or into the 1st operational guidance point.

Principle 7: The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.

The terms "spatial and temporal scales" should be defined to discriminate between local and regional objectives. Protected areas should have adequate dimensions, cor-

respond to natural spatial structures, and include the typical habitats of the ecosystem. Each subunit of the ecosystem should include unexploited sectors. Zoning concepts must protect the most sensitive areas; in some cases it might be best to accord a temporary protection status, subject to later revision. Long-term plans must be implemented in intermediate steps agreed upon with stakeholders and nature conservation groups. Many conservation objectives are attainable by small-scale, small-term, and seasonal steps, as long as the regulations are sufficiently flexible in space and time.

Principle 8: Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.

The objectives of long-term ecosystem management can be communicated by means of "strategic visions". This includes: a) a mobilization strategy to publicize ecological issues and place them on the political agenda; b) development of communication structures between interest groups; c) finding a consensus between the groups involved, possibly including compensation of economic losses suffered by certain stakeholders.

Principle 9: Management must recognize that change is inevitable.

The rationale for this principle needs to be more specific with regard to avoidable and unavoidable change in ecosystems. Developments resulting from the effects of natural processes are basically acceptable. Changes due to local anthropogenic impacts (exploitation) must be minimized as far as possible. Changes due to indirect anthropogenic factors (climate change, introduction of alien species) need to be investigated before implementing appropriate management actions. Global developments such as climate change can only be checked by measures undertaken on an international scale. Changes brought about by species alien to the ecosystem are largely immune to local management. It is advisable to conduct a local monitoring for introduced species, as well as steps to reduce introductions (in the case of marine ecosystems, e.g. by controls of ballast water). Belated control of introduced species appears impracticable.

Principle 10: The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.

Ecosystem management requires legally binding agreements on protection and exploitation of natural resources. Binding regulations can serve to implement restricted access zoning concepts and closed seasons and catch limits, and to manage the sustainable exploitation of resources by means of technical specifications. One

important example is the management of the mussel fishery in Schleswig-Holstein. Voluntary catch limitations enacted for economic reasons may equally serve to protect the ecosystem, e.g. in the shrimp fishery. To reduce conflicts between recreational uses and conservation goals, recreational areas and ecologically sensitive spaces should be delimited explicitely. This can be assisted by guidance of tourist activities and by information of the public ("inducements instead of prohibitions"), as well as by local contact persons and the widespread presence of park wardens.

Principle 11: The ecosystem approach should consider all forms of relevant information, including scientific, indigenous and local knowledge, innovations and practices

and

Principle 12: The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

These two principles need to be more specific. The management of any ecosystem can profit from the application of informal knowledge held by stakeholders and the local population. The Wadden Sea experience shows that conflicts arise if management decisions are not understood by the population and some stakeholders feel a threat to their interests. The formation of permanent or ad hoc working groups, e.g. in the planning of protected zones, can reduce these conflicts. Management actions should be accompanied by independent investigations, and subjected to review and possible modification. The results of individual research projects should be complemented by the knowledge of stakeholders and the local population. The ecosystem's functional relationships and processes must be explained to the people who work and live in it. In a succession of many small steps, an aggressive public relations program and an application of adaptive management strategies provide a chance to protect, maintain, and to some extent restore the typical natural processes in an ecosystem.

Guidance point 1: Focus on the functional relationships and processes within ecosystems.

An understanding of the functional relationships in ecosystems is improved by:

Establishment of unexploited reference areas and of comprehensive monitoring programs.

Establishment of decision-making bodies that continuously evaluate new information and adapt monitoring programs and management actions accordingly.

Construction and constant adaptation of ecosystem models.

Precautionary measures to reduce the introduction of alien species; environmental impact assessment prior to any cultivation of new animals and plants (including new cultivars and genetically modified organisms).

Guidance point 2: Enhance benefit-sharing.

With regard to enhanced sharing of the benefits of biological diversity, three recommendations can be derived from the Ecosystem Research Wadden Sea:

Introduction of an ecolabel for natural resources that are exploited in a sustainable way.

Establishment of special monitoring and management programs on exploited stocks, funded out of the profits of the users of the resource.

Introduction of a "nature tax" (see Principle 4) on tourist activities in the ecosystem and use of the funds for public information and for steps to minimize possible impacts.

Guidance point 3: Use adaptive management practices.

Adaptive ecosystem management requires:

Studies on the causes of ecological change, to complement monitoring programs; this research should be linked more closely to the administrative agencies, so that scientific results can be imparted more directly to the political and socio-economic system.

Establishment of a socio-economic monitoring (see Principle 4).

Introduction of new methods for the sustainable and equitable exploitation of natural resources, e.g. by co-management; constant cooperation between stakeholders, conservationists and scientists to reconcile diverging interests.

Intensive public relations campaigns and acceptance improvement programs, conducted by trained personnel in collaboration with nature conservation groups, to publicize the ecological relationships in the ecosystem and to illustrate its sensitivity and vulnerability.

Guidance point 4: Carry out management actions at the scale appropriate for the issue being addressed, with decentralization to the lowest level, as appropriate.

Decentralized structures foster the involvement of local stakeholders in regional management. In the case of general issues that require solutions at an international level, decentralized management helps to describe and abate regional and local effects. Despite the need for centralized guidelines, it is usually essential that concrete actions be undertaken at the local level. Effective management is therefore characterized by a combination of centralized guidelines and decentralized flexibility of implementation.

Guidance point 5: Ensure intersectoral cooperation.

The decisions of intersectoral international agreements, such as the Trilateral Cooperation on the Wadden Sea, should be made legally binding. The potential funding agencies for intersectoral research projects should be involved in the planning and organization of the program. Research projects should consist of a staggered preliminary phase and a principal research, evaluation and synthesis phase, with intersectoral coordination between scientists and administrations. The funds for intersectoral projects should be channeled through a central agency.

Contents

1. Introduction

The 1998 Malawi Conference of the Parties to the Convention on Biological Diversity adopted 12 principles and 5 operational guidances for an ecosystem approach to ecosystem management (Malawi principles). “The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way” (Decision V/6 of the CBD) and is intended to serve as an integrated concept for implementation of the Convention on Biological Diversity. It is based on existing concepts such as the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), the Ramsar Convention on wetland protection and the Interagency Ecosystem Management Force of the USA (cf. TemaNord 1998, Annex II). Discussions of the management of biodiversity and the natural environment have increasingly focused on the ecosystem approach (Aricò 1998), even though the term has not yet been defined clearly and there is no consensus on its meaning (Aricò 1998, WBGU 2000). Various experts have criticized the concept for being too theoretical (e.g. Jones 1998). The 5th Conference of the Parties, held in Nairobi in May of 2000, decided to re-examine the concept with the help of case studies, and to collect data on the practicality of the Malawi principles. The case studies are to be evaluated by the SBSTTA.

The ecosystem approach has been employed in managing terrestrial areas, e.g. in agriculture. Application of the concept to the marine environment has also received considerable attention, particularly with respect to fisheries (cf. TemaNord 1998, Pope & Symes 2000). Because of their size, however, marine ecosystems are more difficult to manage than terrestrial and freshwater ecosystems (Pope & Symes 2000). It has not yet been attempted to implement the 12 Malawi principles and the operational guidance of the ecosystem approach in a project in the marine sector. Apart from the fact that they have been adopted only recently, this is mostly because the principles of the ecosystem approach require specification for marine areas (TemaNord 1998).

The “Ecosystem Research Wadden Sea” of 1989-1999 represents an adequate case study for the ecosystem approach of the Convention on Biological Diversity, because Wadden Sea management is subject to a variety of jurisdictions, as the region extends across three nations, and across three federal states within Germany. The concept and initiation of the “Ecosystem Research Wadden Sea” project predate the Convention on Biological Diversity adopted at the Conference of Rio in 1992, and were therefore not conceived along the lines of the ecosystem approach. Nevertheless, the integrative approach of the “Ecosystem Research Wadden Sea” largely corresponds to the ecosystem approach and may thus serve as a case study on its applicability to a marine area.

The objective of this interdisciplinary project was to obtain a better understanding of the structures and functions of the ecosystem, in order to provide a better approach toward its conservation and management. The project was designed to develop environmentally compatible methods of exploitation, and it was included by UNESCO in its

MAB (Man and Biosphere) program. Scientific results obtained during its implementation supplied constant input to conservation and management concepts even while the research work was in progress (Stock et al. 1996, GESAMTSYNTHESE Vol. 1-3, 1999). The Ecosystem Research Wadden Sea thus provided scientific information that can be used to elaborate the ecosystem approach of the Convention on Biological Diversity.

The three countries bordering on the Wadden Sea – the Netherlands, Germany and Denmark – have coordinated their national Wadden Sea conservation programs at government conferences held regularly since 1978. The basis of this trilateral cooperation is the "Joint Declaration on the Protection of the Wadden Sea" adopted in Copenhagen in 1982. In 1987 the "Common Wadden Sea Secretariat" was established for the purpose of preparing the government conferences. The principle adopted at the 1991 conference, "… to attain a natural and sustainable ecosystem in which natural processes may occur undisturbed" (Esbjerg Declaration, CWSS 1992), is in agreement with the goals of the ecosystem approach of the 1992 Convention on Biological Diversity. This principle must invariably collide with the interests of certain stakeholders. Management of marine coastal ecosystems needs to reconcile traditional exploitations and economic interests, such as fisheries and tourism, with the sometimes opposed objectives of nature conservation. The attempt to consider and harmonize very different interests provokes debates and disputes in an intricate political and social context.

The various stakeholders and the general public know about the natural environment and the necessity to protect it. At the same time, however, competition for the exploitation of marine resources is increasing. With respect to the management of the Wadden Sea, political institutions have abandoned any attempt to take isolated decisions without consulting and involving the stakeholders. This is due to experiences such as the protests that erupted during the public discussion of the amendment of the National Park Act in Schleswig-Holstein.

Anthropogenic impacts on the Wadden Sea may be caused by:

- fisheries
- tourism
- agricultural use of salt meadows
- coastal protection installations
- ship and air traffic
- oil drilling
- laying of cables and pipelines
- military activities.

Only the first four factors are considered in this report, because the Ecosystem Research Wadden Sea was not concerned with the other uses.

The present assessment is mainly based on the final reports of the Ecosystem Research Wadden Sea:

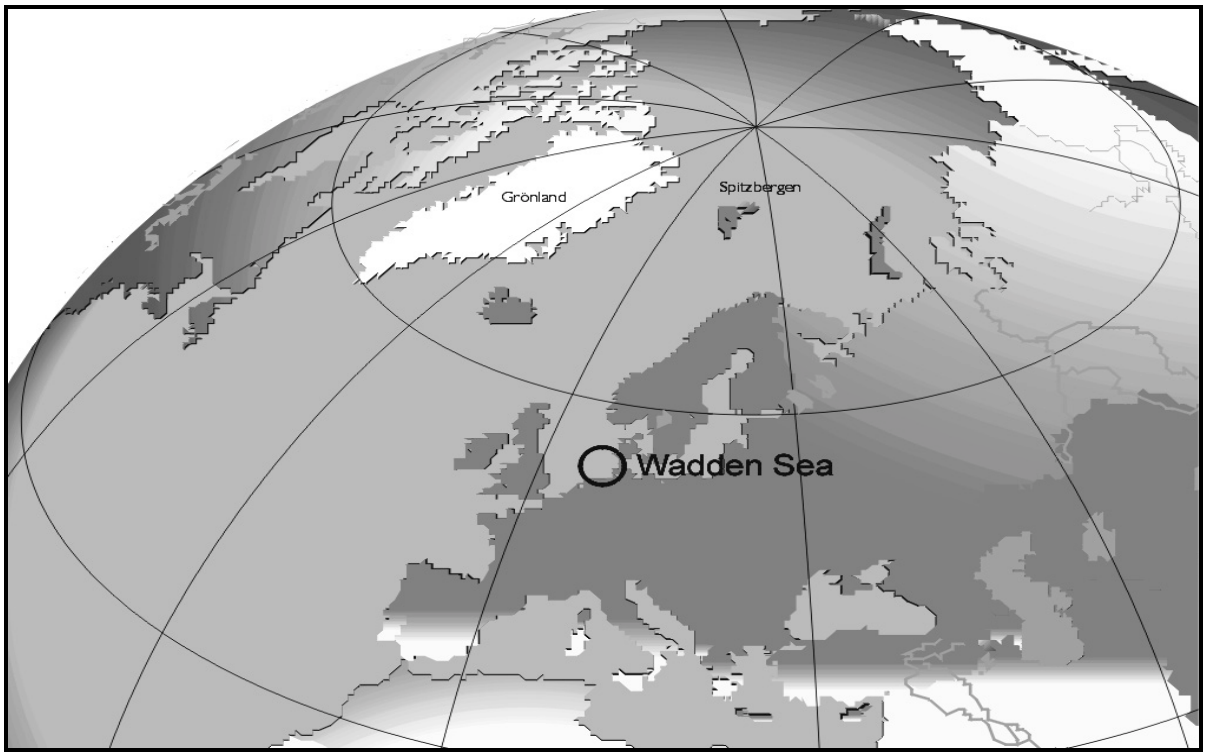
- volumes 1-3 of the final evaluation (*Gesamtsynthese*; 1999);
- final reports of the applied and basic research components of the Ecosystem Research Schleswig-Holstein Wadden Sea (Stock et al. 1996, Gätje & Reise 1998);
- final reports of the applied and basic research components of the Ecosystem Research Wadden Sea of Lower Saxony (Dittmann 1999);
- final reports of various projects, and thematic reports;

as well as experiences made by the final evaluation committee (*Synthesegruppe*) of the project.

2. The Wadden Sea ecosystem

The European Wadden Sea is a shallow coastal region shaped by the tides. It has an average width of 10 km and extends along 450 km of coastline from Den Helder in the Netherlands across the coast of Germany to Skallingen in Denmark. About 70% of its area is in the German sector. In its present form, the Wadden Sea is a recent post-glacial ecosystem about 5000-7000 years old, and it constitutes the largest such area worldwide. The Wadden Sea is an ecotone forming a transition from the open sea to the mainland and therefore consists of an association of biotopes:

- The supralittoral or spray zone (dunes and salt meadows which are only flooded intermittently at high tidal levels),
- The intertidal (tidal flats covered by water twice daily),
- The subtidal (tidal creeks and channels permanently covered by water).



The species and communities of the Wadden Sea are adapted to its adverse conditions and interlinked with the neighboring terrestrial and marine ecosystems. The high productivity of the Wadden Sea forms a basis for the recruitment of North Sea fish stocks, and it is a prerequisite for its function as a turntable on the East Atlantic Flyway. Thus, the Wadden Sea is a component in ecological structures extending from the Arctic to South Africa.

In contrast to terrestrial and freshwater systems characterized by structures of long duration, the Wadden Sea ecosystem is shaped by highly dynamic processes. In addition to continuous and periodic changes on various temporal and spatial scales (such as daily tides, and sediment turnover), the system is affected by stochastic events of irregular periodicity, such as storm surges and ice winters. The Wadden Sea ecosystem has a great ability for self-organization and is characterized by resilience, i.e. the system is capable of returning to an initial state following a disturbance (Dittmann 1999). The natural “disasters”, such as ice winters and storms causing enormous fluctuations in the animal and plant populations, are a typical feature of the ecosystem and a prerequisite of its great dynamism. Thus, the evolution of any given site in the Wadden Sea is highly variable and unpredictable (Reise 1994). This is particularly true in the marine sectors, compared to habitats more terrestrial in character, such as the salt meadows.

No other ecosystem has a species inventory similar to that of the Wadden Sea. The biological diversity is high: some 30 biotopes contain about 4800 marine and semi-terrestrial species, or 5% of the 95,000 animal and plants species in central Europe

(Heydemann 1998). One may encounter some 2000 species in the tidal basin of List alone, excluding micro- and meiofauna (Gätje & Reise 1998).
Among the various biotopes in the Wadden Sea, the salt meadows have the highest species diversity. They constitute only 3% of the surface area, but contain nearly half of the plant and animal species. Many of these species are endemic, living exclusively in this sector. No other central European ecosystem has a higher number of animal species than the salt meadow, with a species density per unit of area up to 900 times higher than the North Sea (Heydemann 1998).
The biological diversity of the Wadden Sea can be placed at risk by overexploitation, e.g. fisheries and tourism, but also by changes in the species spectrum resulting from the introduction of alien species. The biotopes at risk and the flora and fauna of the Wadden Sea are reviewed by Nordheim et al. (1996) and Stock et al. (1996).

3. The integrative concept of the Ecosystem Research Wadden Sea

The Wadden Sea is particularly worthy of protection, because it has far-reaching links to other ecosystems, and because it is the largest natural or near-natural landscape that remains in Europe, along with the high mountain region. For centuries, however, the Wadden Sea has been subject to human influence such as the construction of dikes for land reclamation, and in recent decades it has been impacted further by increasing inputs of nutrients and pollutants, as well as various uses such as fisheries, navigation and tourism. It is declared environmental policy to preserve the characteristic features of the Wadden Sea. Therefore, transnational activities for its protection and management are now discussed regularly at the trilateral conferences of the Dutch, German and Danish governments.

3.1 Objectives

A new type of interdisciplinary project was developed in Germany in the 1980s for the purpose of analyzing the impacts and the limits of stress tolerance in ecosystems, and to propose steps for the preservation of the natural foundations of human existence. The novelty in this approach is that social scientists and economists participate in the investigation of the ecosystems to assist in evaluating anthropogenic impacts on the environment. This approach thus refers a socio-economic system to the natural system of animal and plant communities (biotic foundations), and non-living environmental factors such as geomorphology and local climate (abiotic foundations). The socio-economic system is superimposed upon the natural system in the spaces settled by humans.

The “Ecosystem Research Wadden Sea” of 1989-1999 is one of several ecosystem-oriented interdisciplinary projects on important landscapes, which employ social scientists and economists to participate in the analysis of the interactions between anthropogenic effects and the natural system. The projects are designed to provide directly applicable solutions for administrative agencies and environmental policy even while they are still in progress (Leuschner 1989). The Wadden Sea project consisted of an applied and a basic research component. The applied research was funded by the federal states of Schleswig-Holstein and Niedersachsen, and to a smaller extent by the state of Bremen and the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety. The basic research was funded by the Federal Ministry of Education and Research.

The objectives of the project were:

- To obtain a fundamental understanding of the interactions between humans and the natural environment in the Wadden Sea.
- To provide at an early stage information helping to solve or reduce existing environmental problems in the Wadden Sea.
- To develop criteria for the assessment of the ecological status of the Wadden Sea.
- To develop monitoring strategies.
- To provide tools for the protection and management tasks of the national park administrations.

3.2 Research focus

The basic research in Lower Saxony (ELAWAT = *Elastizität des Ökosystems Wattenmeer* – elasticity of the Wadden Sea ecosystem) dealt with the question “stability through variability?” and was focused on the following issues (Dittmann 1999):

- patchiness and temporal variability of the flora, fauna and chemistry of the sediments;
- distribution of seabirds;
- recolonization of areas destroyed either experimentally, or by ice winters.

The corresponding component in Schleswig-Holstein (SWAP = *Sylter Wattenmeer Austauschprozesse* – exchange processes in the Wadden Sea of Sylt) was focused according to Gätje & Reise (1998) on:

- transformation of matter and transport of matter and organisms in the Wadden Sea;
- exchange of plankton, and of particulate and volatile matter with the North Sea, the land and the atmosphere.

The focus of applied research in Lower Saxony was:

- investigation of the population dynamics of mussel beds;
- study of anoxic sediment areas ("black spots");
- development of monitoring strategies for benthic organisms, fishes and crustaceans;
- investigation of contaminants in the food web;
- socio-economic situation of the fisheries.

The corresponding component in Schleswig-Holstein was focused according to Stock et al. (1996) on:

- mapping of the distribution of pollutants, benthic organisms, eelgrass meadows, fishes, crustaceans, seals, seabirds and human activities;
- construction of a geographic information system to analyze the data for planning and management purposes of the National Park Agency;
- impacts caused by the shrimp and mussel fisheries;
- effects of disturbances upon seals and upon resting and breeding birds;
- impacts of intensive grazing on the salt meadows;
- socio-economic system of the national park region.

Ecosystem management according to the guidelines of the Convention on Biological Diversity must take into account the characteristics of the region and the specific features of the ecosystem in question, to ensure its conservation and sustainable exploitation by the local population and other stakeholders. The necessity of managing the system in a flexible manner was taken into account during the planning and implementation of the Ecosystem Research Wadden Sea. An overview of the German ecosystem research program and of the "Ecosystem Research Wadden Sea" is provided in GESAMTSYNTHESE Vol. 3 (1999).

4. Evaluation of the Ecosystem Research Wadden Sea and recommendations on the further elaboration of the ecosystem approach

The Ecosystem Research Wadden Sea has substantially improved our understanding of the interrelationships between human activities and ecological processes in the region (GESAMTSYNTHESE Vol. 1-3, 1999), thus creating an essential foundation for effective conservation of this complex and dynamic ecosystem. The current Wadden Sea management makes use of many of the project's results. This chapter investigates the extent to which the principles of the ecosystem approach of the Convention on Biological Diversity, i.e. the 12 Malawi principles and the operational guidance, are being implemented in the management of the Wadden Sea. The assessment is based on an evaluation of the results of the Ecosystem Research Wadden Sea and includes recommendations for a further elaboration of the ecosystem approach of the Convention on Biological Diversity.

4.1 The 12 Malawi principles

Principle 1: The objectives of management of land, water and living resources are a matter of societal choice

Background

The Wadden Sea is comprehensively protected by national laws and international agreements, and in the German sector it has almost in its entirety been provided with the highest protection status, that of a national park. The Wadden Sea is also a protected area in the sense of international agreements such as the Ramsar Convention on wetland conservation, the EU Bird Conservation Directive, and the EU Flora-Fauna-Habitat Directive.

The countries bordering on the Wadden Sea – the Netherlands, Germany and Denmark – have concluded steps for the protection of the Wadden Sea at trilateral meetinGesamtsynthese held regularly since 1978. The stated objectives of the National Park Acts are the conservation of species and biotopes, as well as the undisturbed continuation of natural processes. The principal objective of trilateral cooperation is the conservation of the natural dynamics in the Wadden Sea, i.e. the abatement of human impacts on the processes that occur there (CWSS 1992). Exemptions from the rule are foreseen for actions that protect the interests of the people living in the region, particularly their economic activities. To specify the ideal of protecting the natural dynamics of the Wadden Sea, so-called "ecotargets" have been defined by the trilateral cooperation (CWSS 1995). Ecotargets are indicators of the principal structures, functions and processes in the Wadden Sea, as well as of the essential anthropogenic activities and impacts.

The management of the national parks needs to consider the economic and cultural interests of the local population. Therefore, traditional activities, such as fisheries, have to be tolerated (e.g. National Park Act of Schleswig-Holstein of December 1999). Many of the people that live in the Wadden Sea region are "indigenous" in a general sense. Their forebears have settled there for centuries, and they have built dikes for land reclamation, making the area inhabitable and useful for agriculture. But land reclamation has dramatically changed the ecosystem. Only a societal decision-making process can determine which human influences on the ecosystem can be tolerated, and which need to be minimized or banned (Stock et al. 1996). In a system as complex and dynamic as the Wadden Sea, decisions such as these require a great deal of research, as well as the utilization of the practical experience and knowledge of the people who are economically active in the ecosystem.

Assessment

The protected status of the Wadden Sea is the result of societal choice. To attain the ideal of an undisturbed evolution of nature, concepts for the management of nature conservation and exploitation in the national park need to be based on conservation assessments, comparisons between the actual situation and the ideals, and analyses of controversial issues (Stock et al. 1996, 1999). The practical implementation, however, can only be done in agreement with the stakeholders. The initially strong public opposition to the theoretical concepts shows that management decisions can only become effective if the overwhelming majority of those affected concludes that the management of the ecosystem is equitable (as called for in the rationale to the 1st Malawi principle).

It can become difficult to find a consensus when certain interest groups demand the introduction of controversial steps at the expense of others, e.g. an establishment of no-take zones and reference areas that may result in losses of income to the fishery. The implementation of the results of the Ecosystem Research Wadden Sea particularly created conflicts between conservationists and fisheries – as had already been the case in the establishment of especially protected zones in the Dutch Wadden Sea (van der Zwiep 2000) – because the agencies responsible for the administration of the Wadden Sea (not only the national park administrations) had falsely assumed that intensive public relations campaigns would suffice to bring about an acceptance of theoretically founded decisions.

According to the ecosystem approach, trade-offs between fisheries and conservation are a prerequisite of sustainable fisheries; this is not limited to thew Wadden Sea (Pope & Symes 2000, Symes & Pope 2000). Conservationists are increasingly prepared to accept the continued existence of fisheries in the Wadden Sea. In the fisheries, which represent the principal exploitation of natural resources in the Wadden Sea, the need for sustainable management is increasingly understood. Sustainability in the exploitation of the stocks, however, is often hindered by the inefficacy of national and regional

management instruments for the enforcement of environmental regulations. This will soecifically require a novel fisheries policy at the European level, because fisheries management is until now concerned more with the short-term stability of the fishing industry than with sustainability (short-term safeguarding of employment and income, instead of resource protection).

This illustrates the intricacy of "societal choice" in ecosystem-oriented management. In many, and possibly in most cases, implementation of the ecosystem approach may be easier. But if the management institutions are unwilling or incapable of explaining to the population concerned that the protected region is being managed equitably, the resulting conflicts may set back the efforts of nature conservation by years.

Recommendations

The first of the Malawi principles emphasizes that the objectives of ecosystem management are subject to societal choice. Competition between groups wanting to exploit the ecosystems and efforts to improve their conservation is increasing, especially in densely populated regions such as central Europe. The experience of the Ecosystem Research Wadden Sea shows that explications of the natural processes in the ecosystem and of the objectives of its management are not a sufficient foundation for the implementation of certain actions. Those groups, in particular, whose economic interests are affected, must be involved in the preparation of concepts even before decisions are taken, in order to ensure their active support for the conservation activities.

In some countries, when controversial policies need to be undertaken (and not just in the case of environmental issues) it is customary to form working groups made up of government officials, independent experts and representatives of the various interest groups, in order to reduce (emotionally charged) public debates and attain a consensus acceptable to the society even before formal decisions are taken by government institutions. One example for the succesful integration of very different interest groups is the 25-year strategic plan for the Great Barrier Reef in Australia (Cansfield-Smith 1998), which has been accepted by all stakeholders as a framework for long-term planning, management, exploitation, education and research in the area of the Great Barrier Reef.

In the management of the Wadden Sea, working groups could be formed to deal with specific topics (e.g. agriculture, fisheries, coastal protection, tourism), and they could meet at the local, regional or interregional level, depending on the issue. This has been practiced in Schleswig-Holstein for some time, and it makes sense not just as a democratic formality. The decisions to be taken not only deal with theoretical concepts; they always include concrete steps which may be impossible to carry out without the know-how of the practitioners (in fisheries, for instance, in cases dealing with technical details of permissible gear or with the precise delimitation of no-take zones). In very controversial issues involving complicated negotiations, it is advisable to employ inde-

pendent mediators who will more probably be able to assess the various interests impartially and make proposals to help overcome contradicting standpoints.
Public relations activities and fundamental discussions on the objectives of ecosystem management (scientific, conservationist and ethical arguments) are a prerequisite and a basis of the management. But specific decisions must be arrived at cooperatively, because the ecosystem can only be protected effectively if the corresponding concept enjoys at least the passive support of the local population. The decisions resulting from the discussions need to be made legally binding, to permit long-term planning by stakeholders and conservation agencies.

Principle 2: Management should be decentralized to the lowest appropriate level.

Background

The Ecosystem Research Wadden Sea was essentially coordinated by decentralized steering groups attached to the national park administrations. These steering groups were designed to guarantee the communication and cooperation between scientists from different disciplines. The regulation of nature conservation issues was conducted in a decentralized manner by the national park administrations of the federal states. This helped to take into account the characteristics of the various subregions.
On the other hand, issues concerning the Wadden Sea as a whole, such as the design of a standardized monitoring procedure for the entire region (the "Trilateral Monitoring and Assessment Program", TMAP) were decided at the international level.

Assessment

The Ecosystem Research and the current management of the Wadden Sea show that decentralized administration is sensible and practicable (GESAMTSYNTHESE Vol. 3). It is the purpose of decentralized management to take into consideration the ecological characteristics or "individual" features of the region. The national park administrations concerned with conservation issues were also responsible for implementing the Ecosystem Research Wadden Sea. The steering groups in the conservation agencies provided a direct link between scientists, and national park managers.
It was one of the tasks of the steering groups to coordinate the environmental policies of the ministries at the state and federal levels as well as the need for practical solutions on the part of the management with the work conducted by the scientists. The two steering groups in Schleswig-Holstein and Lower Saxony differed in their ability to act. The National Park Agency of Schleswig-Holstein is an upper level conservation agency and an administration with executive powers, and advises the Minister directly. The National Park Administration of Lower Saxony is an upper and lower conservation agency constituting a branch of the Weser-Ems district government.
Decentralized management is a prerequisite for involving the stakeholders in local problem-solving. Examples are the management of the salt meadows and the establish-

ment of reference areas: one of the results of the Ecosystem Research Wadden Sea was the reduction in the extension of salt meadow areas subject to grazing, in order to meet the ideal of a salt meadow largely free of anthropogenic influence (NPA 2000). Proposals to establish an unexploited reference area in Schleswig-Holstein caused serious disputes between various interest groups. The public debates were channeled towards the relevant offices of the National Park Agency, thereby involving the stakeholders in question (fisheries and tourism) in the decision-making process.

In the case of general problems that can only be solved on an international level, decentralized management can serve to describe and abate regional or local effects. This is exemplified by the mussel fishery, the activities of which are largely determined by the international market. Decentralized actions have little effect on the market, as it is mainly subject to EU jurisdiction. Nevertheless, the Ecosystem Research Schleswig-Holstein Wadden Sea has resulted in regulations that could only be implemented at the regional level, such as the collection of license fees from the mussel fishermen by the state government and their use for a regional mussel monitoring and management program; other regional actions include the closure of the core zone of the national park to mussel cultures and the long-term reduction in area of the cultures, as well as the fishermen's participation in the management of the fisheries. These are constructive examples of an implementation of the ecosystem approach.

Recommendations

The Wadden Sea experience shows that decentralized structures serve to involve local stakeholders in regional management. The efficacy of decentralized management can be enhanced by various steps, such as the establishment of institutionalized working groups and the appointment of local mediators in case of conflicts (see principle 1). This helps to achieve solutions appropriate to local conditions.

In conducting comprehensive research projects, it is advisable to form a steering committee – as was done in the Ecosystem Research Wadden Sea – to delineate the practical requirements of the management to the scientists and the local population. The steering groups should be granted definite responsibilities.

The capabilities of regional management are limited when overriding factors have an important influence on the ecosystem (see above, mussel fishery, and Trilateral Monitoring and Assessment Program) or when broad environmental policy is in opposition to certain management objectives. In cases such as these, the possibilities for regional management must be used to the fullest extent, even if only partial solutions can be accomplished. On the other hand, decentralized structures need to be used to propel solutions to urgent problems toward the central authorities. This provides the best possibility for local stakeholders to invest their knowledge and actively influence the resolution of important management issues. Effective management requires interlinking the decentralized with the centralized approach. This is the best way to tune local interests to the broader interests of society, as called for in principle 2.

Principle 3: Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.

Background

Each ecosystem interacts with other ecosystems, and the management of one invariably affects the others. In the case of the Wadden Sea, these links are not limited to the adjacent marine and terrestrial ecosystems. Two examples:

Salt meadows have great importance as resting grounds for migrating birds. The extension and exploitation of the salt meadow areas mainly depend on management decisions. The management of the Wadden Sea thus affects ecosystems in the Mediterranean, western and southern Africa, and the Arctic.

The shrimp fishery (and the flatfish fishery in the Netherlands) can reduce the numbers stock of juvenile fish in the North Sea. On the other hand, the discards returned to the sea provide additional food to some components of the food web (seabirds and benthic organisms). Reducing the catch and bycatch of the shrimp fishery can therefore lead to shifts in the trophic relationships between species, modify the species spectrum, and diminish the populations of seabirds in the Wadden Sea. This may again affect adjacent ecosystems, e.g. by changing the food web in the North Sea due to changes in fish stock size.

Assessment

This principle has far-reaching implications for ecosystem management. However, it can only be taken into consideration adequately if the ecosystem managers are fairly well-informed with respect to the interactions of "their" ecosystem with other ecosystems. Resulting management decisions can be simple or complicated, as the above examples show.

The management of the salt meadows is a relatively simple and positive example of the consideration of the interests of other ecosystems. Results of the Ecosystem Research served to manage the salt meadows in a way that would leave enough resting space for migrating birds, and breeding places for wading birds, gulls and terns, as well as feeding areas for herbivorous geese and ducks. Priority is accorded to the preservation of these areas and to the successive reduction of their exploitation (about 10% of the salt meadow area must continue to be exploited for sod for coastal protection purposes). As a side-effect, these actions contribute to the conservation of migrating birds and the protection of processes in distant ecosystems.

The management of the shrimp fishery is more complicated. There are no quota regulations and fishermen are allowed to make as many trips as they desire (Neudecker 2000). Moreover, there are no binding regulations to employ methods that protect juvenile fish. It is presently impossible to estimate the consequences of the removal of juveniles for the North Sea fish stocks. A collapse of the stocks is not expected, parti-

cularly since the shrimp fishermen adhere to a weekly catch limit in order to stabilize market prices. This voluntary limitation reduces bycatch quantities, helping to protect the fish stocks and other ecologically valuable systems (Neudecker 2000). Binding regulations for the permanent protection of the fish stocks are desirable nevertheless. On the other hand, a decrease in discards will remove the principal source of food of some seabird populations. The effects of such an action on the ecosystem are unappraisable at present.

In addition, economic interactions may equally cause effects in distant ecosystems. In the case of the shrimp fishery, catch limitations might increase the demand for shrimp from abroad. Considering that 70% of the mangrove forests of Ecuador have been destroyed to create shrimp cultures, this would amount to a further export of environmental problems to the Third World.

Recommendations

The interactions between ecosystems necessitate correspondingly organized research and management, which must consider economic and social relationships in addition to the ecological ones. It must also be kept in mind that activities undertaken in other ecosystems affect the system in question (see below, principle 5). In the Wadden Sea ecosystem as an ecotone, i.e. a system with many connections to adjacent ecosystems, this concerns, e.g., the inputs of nutrients and contaminants from rivers, the North Sea and the atmosphere, as well as that of organic matter from North Sea phytoplankton blooms such as *Phaeocystis* (foaming algae) und *Coscinodiscus* (cause of the "black spots" in 1996, i.e. extended anoxic sediment areas in the East Frisian Wadden Sea).

How can it become possible to recognize and manage interactions between ecosystems? Compilation of the knowledge needed for integrated management will often require exhaustive scientific investigations, including in areas far away from the ecosystem in question. The consideration of the interests of other ecosystems will remain a challenge to ecosystem managers, however. Solutions will depend on corresponding international cooperation, such as that taking place in the conservation of migrating birds.

Principle 4: Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem management program should:

a) Reduce those market distortions that adversely affect biological diversity;
b) Align incentives to promote biodiversity conservation and sustainable use;
c) Internalize costs and benefits in the given ecosystem to the extent feasible.

Background

Ecosystem management must take the economic interests of the local population into account. Tourism and fisheries are important economic activities in the Wadden Sea region. Both activities are subject to various economic pressures.

Tourism achieves considerable economic benefits by the use of the ecosystem, and it is an essential economic foundation of the Wadden Sea region. According to the results of the Ecosystem Research Wadden Sea, tourism accounts for about 20% of the per capita income, attaining more than 50% in some communities (Stock et al. 1996).
The shrimp fishery is to be maintained, due to its socio-cultural and economic importance (GESAMTSYNTHESE Vol. 1, 1999). However, the survival of many of the enterprises is threatened by the costly modernization of the boats and the increasing competition from shrimp cultures abroad. The exploitation of mussels consists of an extensive culture of seed mussels; its economic situation appears stable at present. In the past, insufficient consideration of the economic interests of the fisheries caused protests against the management of the Wadden Sea (see remarks on principle 1).

Assessment

This principle mentions to possible market distortions, such as may arise out of state subsidies, which can make it profitable to engage in economically dubious activities that damage biological diversity. Moreover, management should hold the parties that cause environmental damages liable for the resulting costs. Subsidies and alternative land use concepts are of minor importance in the Wadden Sea region. Economic pressures may nevertheless impinge upon environmentally safe resource exploitation.
In the case of the shrimp fishery, for instance, it had been thought that economic constraints (declining incomes due to falling prices and costly investments in modern craft) might result in a higher fishing effort, leading to economic and biological overfishing of the Wadden Sea and North Sea stocks (Temming & Temming 1991). A recent study has not confirmed these worries (Neudecker 2000), because the voluntary catch limits introduced in 1998 have a positive ecological effect (cf. principle 2).
In the case of mussels, overexploitation of the natural populations appears impossible from the viewpoint of the fishery, despite the massive decline of the intertidal stocks, because the fishery for seed is restricted to subtidal areas colonized almost exclusively by mussel spat (i.e. there is practically no bycatch) at densities that would entail nearly total mortality in the absence of any fishery (Seaman & Ruth 1997). Conservationists, however, regard the mussel fishery as critically as the shrimp fishery, because – among other points – there are no data on the possible effects of the creation of culture plots. The mussel stocks in the Wadden Sea of Schleswig-Holstein have been protected by management actions since 1996 (cf. remarks on principles 7 and 10).
In the case of tourism, ecosystem impacts - which would ultimately also damage the business - can be caused by an overuse of sensitive zones (e.g. salt meadows and dunes). As a result of the socio-economic studies on the Wadden Sea region, tourist activities are now guided towards certain areas, while the access to ecologically sensitive sectors is restricted or denied (GESAMTSYNTHESE Vol. 1, 1999).

Recommendations

No particular recommendation on a reduction of market distortions can be derived from the Ecosystem Research Wadden Sea, since these hardly play a role in the region. Sustainable fisheries require a reduction in landings, and this will result in higher prices to consumers. An ecolabel for ecologically safe fisheries products could help to illuminate the ecological background and render a price increase acceptable. The introduction of such a label is being planned in cooperation between a company engaged in offshore fisheries (Unilever) and an NGO (non-governmental organization), the World Wildlife Fund for Nature (WWF). A similar procedure is being followed to promote sustainable logging practices. The Forest Stewardship Council awards its FSC label for tropical wood produced in an environmentally safe manner. Economic management principles could be applied in the shrimp fishery to accelerate the introduction of environmentally safe fishing methods (bycatch reduction) or to protect the stocks if the current voluntary catch limitations are abolished (cf. principle 3). All fisheries should be evaluated with regard to the possibility of subjecting the access to the resource to licensing for a fee, as has been practiced in the Wadden Sea mussel fishery for some years (cf. principle 2).

Tourism is an important economic factor having special significance in ecosystems because of its conflict potential. Tourism should be developed with a view to creating as few conflicts with nature conservation as possible. If limits of ecological acceptability are reached, development should focus on improving the quality rather than increasing the quantity of recreational use. This can only be done successfully if the necessary decisions are based on a reliable set of data acceptable to all stakeholders. A permanent socio-economic monitoring is a recommendable way to create such a database. Socio-economic variables provide specific information on the recreational use of the ecosystem, and they improve the reliability of decision-making in conflict situations. Interdisciplinary monitoring could consist of three modules (cf. Feige & Triebswetter 1997):

- A socio-economic baseline monitoring that continuously provides quantitative data on the entire region.
- A visitors and acceptance monitoring that provides qualitative data on the attitudes and activities of the visitors and of the local population in the national park.
- A conflict monitoring on specific controversial issues.

A socio-economic monitoring program is now being conducted in Schleswig-Holstein (Gätje 2000) and its surveys have yielded important information on tourist behavior and its ecosystem effects. The program provides basic data for management decisions, e.g. on the further construction of wind power generators on the coast. It is advisable to include parameters on reactions of species to recreational activities, e.g. flight reactions in breeding birds and mammals. Internalization of the environmental costs of tourism (“nature tax”) has often been discussed, but pertaining regulations are applied

with reticence by the institutions responsible. Public relations activities should focus on the discrepancy between the fact that such a fee is not being collected, although tourists are demonstrably willing to pay for nature conservation activities.

Principle 5: Conservation of ecosystem structure and functioning ,in order to maintain ecosystem services, should be a priority target of the ecosystem approach.

Background

The conservation goal of the Wadden Sea national parks – defined at the 6th trilateral government conference by the ideal of "undisturbed development as far as possible" (CWSS 1992) – coincides with the principle stated above. The objective is to conserve the natural dynamics in the ecosystem, as a corollary to the conservation of species and habitats. This concept has been termed "protection of processes", and it is defined as the conservation of the functioning of the natural balance to enable the regulating, synthesizing and degradation processes in the ecosystem to occur in accordance with local biotic and abiotic conditions. Several Ecosystem Research projects dealt with the interactions between humans and nature, and with the practical implementation of process protection in the ecosystem (see the remarks in chapter 2).

Assessment

The Wadden Sea continuously undergoes changes mediated by hydrodynamic, geomorphological and biological processes. Therefore, the objective cannot be to conserve the present status, much less to re-create a defined former situation. Protection of the structures and functioning of an ecosystem requires a continuous availability of information on its condition, i.e. research and monitoring, as they are indeed being carried out in the Wadden Sea.

The results of the Ecosystem Research Wadden Sea confirm that the protection of natural processes is more important for the long-term conservation of the ecosystem and its biodiversity than a protection of individual species or areas. The ecological approach to nature conservation, i.e. the unbiased scientific description of an ecosystem or of condition, complements the protection of individual species on which conservation has been focused in the past (Prilipp 1997; cf. principle 9: change is inevitable in ecosystems and their management).

Anthropogenic impacts, however, prevent a consistent protection of processes. In the Wadden Sea, there is a general consensus not to question necessary coastal protection activities or the location of the principal dikes, even though coastal protection and dike construction have eliminated entire habitats, e.g. extended brackish water zones. The proposal to remove the dikes at some small sectors (provided that the population is protected from storm surges) is a matter of controversial debate in the Netherlands as well (de Jong 1999). According to Gätje & Reise (1998) this would create a heterogenous flooded landscape with retention areas that would recreate various former struc-

tures and functions of the Wadden Sea, enhancing ecologically and economically sustainable development.

Undisturbed occurrence of natural processes could not be guaranteed even if all human activity were to cease in the protected area, because anthropogenic activities in other areas would still impact ecosystem functions (in the Wadden Sea, for instance, by the introduction of alien species via ballast water and aquaculture). Ecosystem managers might be tempted to undertake steps to restore a condition defined as desirable (in accordance with the formulation in the rationale to this principle, "… restoration of these interactions and processes"). Such an approach would be questionable, however, and various authors consider it impossible (cf. e.g. Daan 1998, see remarks on principle 9).

Recommendations

Comprehensive protection of processes is possible only in unexploited zones (e.g. reference areas in the Wadden Sea). The creation of unexploited areas of adequate size should therefore be one of the goals of ecosystem management (cf. comments on principles 1 and 7), giving priority to ecologically important sectors (in the Wadden Sea, e.g. tidal basins and salt meadows; cf. comments on principle 2).

In areas subject to exploitation, process protection should focus on an abatement of anthropogenic impacts (e.g. a reduction in the quantity of bycatch in the shrimp fishery; cf. comments on principle 4). Reduction of impacts can be achieved by sectoral measures, such as seasonal closures, seasonal bans on certain activities, technical standards (fishing gear, agricultural practices), and in fisheries by catch limits and minimum size regulations as well. These steps must be enacted in a legally binding manner, by agreement with the stakeholders if possible (cf. principle 1).

Furthermore, practical steps must be taken to minimize the effects of anthropogenic activities outside of the ecosystem (in the Wadden Sea, e.g. to reduce nutrient and pollutant inputs). The functioning and structures of ecosystems are also at risk from the worldwide exchange of species, which increasingly homogenizes species assemblages ("McDonaldization"). Two precautionary actions are advisable regarding Decision V/8 of the Conference of the Parties to the Convention on Biological Diversity:

- The elaboration of a normative catalog for each ecosystem, to classify each newly introduced alien species as ecologically and/or economically acceptable, dubious, or critical.
- The implementation of steps to reduce introductions of alien species (e.g. treatment of ships' ballast water).

The elucidation of functioning and structures in an ecosystem and an insight into the limits of its functioning (cf. principle 6) are prerequisites for its conservation. Unexploited zones must therefore remain accessible to research, and management actions being undertaken or planned need to be reviewed in light of the research results. This requires adequate guidelines for the interpretation of the data produced by research and

monitoring activities, as well as adequate procedures for the implementation of management decisions.

Principle 6: Ecosystems must be managed within the limits of their functioning.

Background

In light of its very general form, principle 6 is quite correct, as it merely states that ecosystem management needs to consider the limits of sustainability.

Assessment

The declarations contained in this principle and its rationale are already included in the other Malawi principles (e.g. remarks to principle 6). As called for in the rationale of this principle, the management of the Wadden Sea reflects "limits to ecosystem functioning" due to "temporary, unpredictable and artificially maintained conditions" (in the Wadden Sea, for instance, ice winters are unpredictable events, and dikes represent artificially maintained conditions; cf. principles 1 and 5). The same applies to the request that "management should be appropriately cautious", which is only a repetition of the precautionary principle.

Recommendation

Malawi principle 6 should be eliminated and included in principle 5 or in operational guidance point 1.

Principle 7: The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.

Background

The entire Wadden Sea has been declared a "trilateral Wadden Sea cooperation area" placed under protection across national boundaries by the three bordering countries, the Netherlands, Germany and Denmark (see the introduction). Its seaward limit is the international 3 n.m. border, which has now been enlarged by a marine mammal sanctuary extending to the 12 n.m. border. About 3% of the Schleswig-Holstein national park is an unexploited reference area. In the mussel fishery, agreements have been concluded providing for spatial (no-take zones) and temporal limitations (closed seasons; cf. remarks to principles 3 and 4). The conservation of migrating birds accounts for the geographical dimensions cooperation with foreign nature conservation institutions.

Assessment

Brief localized disturbances are usually avoidable, e.g. by small-scale protection measures such as closing off breeding areas of birds in recreational zones. A concept of visitor guidance can serve to concentrate visits at selected points, thus controlling and diminishing disturbance.

The introduction of sustainability requires time. The mussel fishery concept in Schleswig-Holstein (cf. principle 2) is being implemented gradually in consensual steps that give the fishermen time for an economically viable adaptation (reduction of the area of the culture plots). There is no such concept in the shrimp fishery; temporal catch limitations are merely based on economic arrangements, and not on ecological conditions or requirements (cf. principle 3).

The term "appropriate time scales" includes time limits on management actions, pending a review of their efficacy and possible changes in the ecosystem in the course of time (cf. principle 9). The term also implies a consideration of seasonal phenomena, e.g. by conservation steps limited to the summer months. This is the most sensitive period in many species, as it constitutes the breeding and molting season of various birds and seals.

The protected areas of the Wadden Sea are large enough to permit natural processes to occur, and a large part is no longer subject to exploitation: in Schleswig-Holstein, this includes the entire intertidal zone, a reference area and small sectors closed to the mussel fishery; in Lower Saxony, it is about one-third of the intertidal. The reference area in Schleswig-Holstein does not conform to the aims of the 1991 Esbjerg Declaration (CWSS 1992), however, because public quarrels led to a political decision that ignored scientific advice. The present reference area does not satisfy the spatial requirements (Gätje et al. 1998; cf. remarks to principle 1) and the necessary historical data series and other information, e.g. on its biodiversity, are lacking as well. The new reference area will hardly be able to supply the results that conservationists had hoped for, such as information on natural and anthropogenic change in the ecosystem. The space requirements of a reference area could be fulfilled by a tidal basin as the smallest spatial subunit containing all of the ecologically relevant subsystems, biotopes and habitats. The sectors originally recommended by the park administration would have been adequate as reference areas (Gätje et al. 1998), and they would have made it possible to improve the protection of ecosystem processes without affecting essential coastal protection activities such as improvements to dike installations.

Recommendations

The terms "spatial and temporal scales" need to be defined clearly, to discriminate between local and regional objectives, and between short-, medium-, long-term, and seasonal actions.

The processes occurring in the Wadden Sea have very diverse spatial and temporal dimensions ranging from narrowly localized ephemeral chemical processes to permanent changes affecting the entire Wadden Sea, such as the sea level rise expected to result from global warming. Management according to the principle of a protection of processes (cf. principle 5) has to consider the spatial and temporal scales associated with each process. Specially protected areas must have adequate size, conform to natural structures of the landscape, and include a coherent and representative array of habitats

typical of the ecosystem, i.e. the delimitation should encompass as many different habitats as possible. Each subunit of the ecosystem should have unexploited sectors, and particularly sensitive areas must be placed under protection by appropriate zoning concepts. If zoning concepts give rise to social conflicts, then it is advisable to establish temporary sanctuaries such as unexploited reference areas (cf. principle 10), and to review their extension and their boundaries together with the stakeholders at a later date (cf. principle 5).
Long-term goals must be implemented in short steps. This requires binding agreements between stakeholders and conservationists, permitting both sides to plan for the future cf. principle 1).
Conservation objectives are partly attainable by small-scale, short-term or seasonal steps. Birds, for instance, often change their breeding and resting grounds from one season to the next. To account for such features, protective regulations should be implemented with flexibility.

Principle 8: Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.

Background

The fundamental objective of management for sustainability in the Wadden Sea is to maintain the natural dynamics and the functioning and structures of the ecosystem (cf. principle 5) with as little anthropogenic impacts as possible, and to conserve the natural resources permanently.

Assessment

This principle is sensible and stated clearly. Attempts by stakeholders to achieve quick economic gains from an exploitation of natural resources often interferes with long-term goals of ecosystem management. The Wadden Sea management experience, however, shows that it is possible to implement long-term aims one step at a time.
In the Wadden Sea of Schleswig-Holstein, the Ecosystem Research led to actions to balance mussel conservation and exploitation, e.g. unexploited zones and a stepwise reduction in culture plot areas (cf. principles 2 and 10). The gradual reduction of grazing in the salt meadows, designed to conserve the biodiversity of the Wadden Sea, is also implemented step by step, as leases that run out are not renewed. In addition, visitor guidance in the national parks, designed to conserve and restore ecologically sensitive areas, is being introduced stepwise in accord with the stakeholders.

Recommendations

Long-term objectives can only be attained in a dialogue with the stakeholders and with the help of an appropriate long-range information strategy. The managers need to con-

vince the stakeholders (with the help of mediators, if necessary) that adequate exploitation of the ecosystem, maintaining its functioning and protecting the long-term interests of the stakeholders themselves as well, can only occur in a sustainable manner. One way to propagate the objectives of foresighted ecosystem management is by formulating "strategic visions", as recommended in a recent study on "wise use" of the Dutch Wadden Sea (Verbeeten 2000).

According to her research, strategic visions that serve to improve the stakeholders' understanding of the present state of the ecosystem can lead to negotiations on regulations for exploitation and conservation of the ecosystem. If the stakeholders are firmly involved, they may well come to accept certain goals that meet the interests of all participants. Strategic visions thus fulfill several functions: They promote research and the introduction of acceptable standards, they help to create an organizational structure oriented towards defined goals, and they motivate all stakeholders to participate in the discussion of conservation and exploitation of the ecosystem. The proposal to introduce "strategic visions" consists of three components (Verbeeten 2000):

- A "mobilization" strategy: ecological issues need to be publicized and placed on the political agenda.
- A structure of communication between the various stakeholders must be built.
- A consensus must be found between stakeholders, including possible (financial) compensation of those user groups that suffer economic losses.

Principle 9: Management must recognize that change is inevitable.

Background

The Wadden Sea ecosystem will in the future continue to be affected by anthropogenic impacts that are immune to local management.

Global climate change may, for instance result in a rise in sea level with a higher frequency of storm surges and higher inputs of energy that cause the intertidal areas to dwindle; this could furthermore eliminate specialized members of the flora and fauna. Nutrient and pollutant inputs from rivers and the atmosphere, and inputs of organic matter from phytoplankton blooms due to eutrophication (e.g. of the foam-producing alga *Phaeocystis*, and of the cause of "black spots", *Coscinodiscus*), can hardly be influenced by the management of the Wadden Sea (cf. principle 5). The same holds true for the possible introduction of alien species, e.g. from aquaculture or with the ballast water of freighters (cf. principle 5).

Assessment

This principle is especially applicable to an ecosystem that is as variable as the Wadden Sea. Future changes in the Wadden Sea may not only result from alien species introductions and global climate change, but from the constant increase in tourism as

well. The management must take these developments into account, even if it is incapable of controlling them.

The issue of species introductions is a good case in point with regard to future changes in ecosystems, particularly as there is hardly a biotope in the world that remains unaffected by this problem. The composition of the flora and fauna of the Wadden Sea has undergone increasing changes during the past few decades, mostly due to shifts in the frequency of indigenous plant and animal species (Reise et al. 1989, 1994, Herrmann et al. 1998). Some species have disappeared (e.g. the European oyster) or have become rare, others (e.g. some seabird species; cf. principle 3) have increased considerably. Introduced species could restructure the ecosystem in the future; the Pacific oyster, for instance, is able to form reefs such as have never existed before in the Wadden Sea (Seaman & Ruth 1998).

The factors that promote a spreading of alien species and the changes these may cause are hardly predictable. Increasing ship speeds, e.g., shorten the duration of ocean passages, increasing the chances of survival of larvae in ballast water. This leads to accelerated rates of immigration into marine ecosystems, unless technical control of the ballast water is introduced. Current monitoring programs do not record alien species, and it is hardly known whether and how they may affect key ecosystem functions. The question whether alien species increase or decrease the species diversity of an ecosystem, e.g. by expelling indigenous species, is only answerable on a case by case basis.

No disastrous consequences of species introductions have been dectected so far in the Wadden Sea. It is therefore difficult to explain the necessity of protective actions. Studies conducted elsewhere, however, show very clearly that species introductions may cause dramatic ecological change. Some parts of San Francisco Bay are today inhabited exclusively by introduced species, and this has grave consequences for the functioning and structure of the ecosystem as a whole (Cohen & Carlton 1995).

Recommendations

The statement that “change is inevitable” is correct. The rationale to this principle, however, includes statements indicating that management should attempt to prevent change from occurring. The rationale needs to be formulated more precisely with respect to the avoidability and inevitability of change in ecosystems:

- Developments resulting from the action of natural processes on the system have to be tolerated on principle and may be guided or promoted by the management (principle 5).
- Changes that are a direct consequence of local anthropogenic impacts (in the Wadden Sea, e.g. pollution and exploitations such as tourism and fisheries) need to be minimized (principles 4, 5 and 6).
- Changes due to indirect anthropogenic factors (e.g. climate change and species introductions) require a precise evaluation before management decisions are undertaken. The steps to be taken will differ greatly between ecosystems.

Effects of possible climate change are not clearly detectable in the Wadden Sea as yet, in contrast to other ecosystems. First, it would be necessary to record such changes precisely (e.g. sea level rise, precipitation, temperatures). In the case of the Wadden Sea, limited local action, e.g. improvement of coastal protection, is presently the only possible response to a rise in sea level. As a rule, actions to eliminate the causes of global climate change require international cooperation, e.g. in global climate summit meetings.

Regarding the possible impacts of alien species, it would first be advisable to expand current monitoring programs for the purpose of recording species immigrations. In addition, steps should be undertaken to minimize the introduction of species (in marine ecosystems, e.g. by a cooperation with engineers and shipping companies to improve ballast water controls). This is also largely beyond the reach of local management. Ulterior controls and the elimination of alien species once they have been introduced appears impossible in marine ecosystems at present, and it is hardly practicable in terrestrial ecosystems as well.

Principle 10: The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.

Background

This principle mostly concerns ecosystems subject to intensive exploitation, such as areas with massive logging, or areas where indigenous wild and cultivated plants are at risk from monocultures of introduced cultivars. This does not apply to the Wadden Sea; an example for the implementation of the principle in the Wadden Sea is the management of the salt meadows and mussel beds, the exploitation of which has been restricted. In the tourist industry, the visitor guidance program fulfills the same function.

Assessment

The intended balance between conservation and use of biological diversity primarily concerns the flora and fauna of the salt meadows as well as the seabirds, and to a smaller extent marine mammals, eelgrass beds, mussel beds, and *Sabellaria* reefs (structures built by tube-dwelling polychaetes). Reduction of grazing on salt meadows leads to an increase in the numbers of rare and endangered species, particularly of plants that are sensitive to cropping and trampling, as well as insects associated with these plants. The reduced use of salt meadows also helps to conserve rare bird species.

The recent establishment of a sanctuary for marine mammals off Sylt also helps conserve the biodiversity. The same aplies to the closure of areas with eelgrass beds to the mussel fishery, and of areas with *Sabellaria* reefs to the shrimp fishery.

A good example for the regulation of conservation and use of biodiversity is the management of the mussel stocks (cf. principle 2). The steps undertaken range from a complete closure of some areas (cf. principle 8) to the use of mussels from culture plots

and the – restricted – exploitation of wild beds. In the Dutch Wadden Sea, the fisheries on intertidal mussel and cockle beds is ceased whenever food for seabirds becomes scarce, e.g. after a severe winter. In the German part of the Wadden Sea, the fishery on cockles, whose stocks are subject to great fluctuations, has been banned for several years now to guarantee the food supply for seabirds, and because the use of hydraulic dredges might cause environmental damage. It became possible to enact these regulations by mutual agreement after conservationists and fishermen both gave up maximalist demands.

Despite the wealth of information produced by the Ecosystem Research Wadden Sea, we often still lack the basic scientific data to create a balance between conservation and use. Often the consequences of management are not understood, because stakeholders and the public are poorly informed with respect to hardly accessible marine habitats, and damages inflicted there often remain unnoticed for a long time. At the same time, successful conservation steps resulting from restrictions in use, e.g. the restoration of habitats and the reduction of the pressure on non-target bycatch species, often go unnoticed as well.

Impacts from tourism can be revealed by socio-economic studies, and abated by appropriate steps (cf. principle 4). In the Wadden Sea, investigations comparing recreational activities with ecological data have been conducted in a rather random and uncoordinated fashion until now. It is not possible to apply these data to other regions (GESAMTSYNTHESE Vol. 1, 1999, Frederiksen 2000). First steps toward a coordinated socio-economic monitoring are now being undertaken in Schleswig-Holstein (cf. principle 4).

Recommendation

Guidelines for the conservation of the ecosystem require a careful decision-making process based on an appropriate dataset, as well as binding rules negotiated between the ecosystem management and the principal stakeholders. Binding regulations (cf. principle 5) can serve to enact a zoning concept with access restrictions, as well as closed seasons, catch limits or technical measures for an environmentally compatible exploitation of resources.

One example is the mussel management (cf. principle 2). Similar agreements on ecologically safe exploitation are equally desirable for the shrimp fishery, which is virtually exempt of regulations and only limited by the draft of the boats. Although this fishery is presently subject to voluntary catch restrictions that function as a conservation measure (cf. principle 3), binding regulations reflecting ecological requirements are needed for the case when the voluntary restrictions no longer apply.

Regarding the recreational use of the ecosystem, talks between the local population, stakeholders, interest groups and administrations should be conducted on the basis of socio-economic surveys. To reduce conflicts between recreational activities and conservation proposals, recreational areas and ecologically sensitive spaces should be de-

limited in an explicit manner that can be appreciated by the tourists (cf. principle 4). An effective system of tourist guidance can help to avoid conflicts. It would require public education at zones with access restrictions (e.g. information panels, according to the motto "inducements instead of prohibitions"), as well as blanket coverage by a national park service having local contact persons.

Principle 11: The ecosystem approach should consider all forms of relevant information, including scientific, indigenous and local knowledge, innovations and practices,

and

Principle 12: The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

Background

These principles were taken into consideration during implementation of the results of the Ecosystem Research Wadden Sea, as a wide spectrum of scientists and interest groups were involved in the decision-making process. Actions affecting the Wadden Sea as a whole are decided in consultation between the Netherlands, Germany and Denmark (cf. principle 1).

Assessment

It appears dubious to state ecosystem management objectives in such vague terms, as management should be based on concrete, quantitative and representative indicators of the ecosystem effects of human activity. The principles of the ecosystem approach reflect the lack of consensus on the implementation of the concept (Aricò 1998). The ecosystem approach is only an instrument to persuade the largest possible number of interest groups to support the widest possible range of conservation goals.

Nevertheless, the Wadden Sea experience shows that aims stated in such general terms represent a first step toward a consensus between nature conservation, science, political institutions and the relevant interest groups, because their vagueness constitutes a basis for negotiations. Thus, the ecotargets – the quality objectives of the "Trilateral Monitoring and Assessment Program" (TMAP) – contributed to the development of methods and aims for the monitoring, evaluation and management in the Wadden Sea, despite their imprecise formulations (de Jong 1998).

The objectives of the Convention on Biological Diversity – conservation, sustainable use, and equitable sharing of benefits from genetic resources – are only attainable step by step and in concordance between the relevant interest groups, whereas decisions that have been arrived at in discord usually cause lasting irritation (cf. principle 1). In the discussion of the results of the Ecosystem Research Wadden Sea, it was attempted to involve the knowledge and the interests of public officials (representatives of the

counties and communities, and of interest groups from agriculture, hunting, sports, and nature conservation), in order to create a win-win situation for all participants. This corresponds to the call of the ecosystem approach that management decisions be coordinated with the needs and the knowledge of the interest groups affected.
Despite the initial problems in the implementation of the results of the Ecosystem Research Wadden Sea, they provide a management experience that is applicable to other sectors. This is the case, for instance, in the writing of new regulations on the mussel fishery in Schleswig-Holstein, which was arrived at in agreement between the different interest groups, as postulated in the Malawi principles (cf. principles 1, 2 and 10).

Recommendations

These two principles consist of very vague and almost identical statements. They should therefore be united to form a single principle. They also need to be more specific to become applicable to the concrete situations in different ecosystems.
A consideration of the complicated context of managing biological diversity requires – as stated by the two principles – the involvement of all persons affected and the use of every available information, including the practical knowledge of the users and the local population. This knowledge is usually not recorded in writing and only available from the practitioners. In fisheries, for instance, this may concern detailed information on certain sectors of importance to the delimitation of reserved zones, or technical know-how on fishing gear improvement. The management of any ecosystem can profit from the use of such informal knowledge.
The Ecosystem Research Wadden Sea has shown that serious conflicts arise if management decisions are not understood by the local population and if some stakeholders feel their interests are threatened. This necessitates belated crisis management that binds forces unnecessarily and may ultimately not yield the desired results. An establishment of permanent working groups, e.g. in planning closed areas or in the implementation of large-scale actions, can avoid such conflicts (cf. principle 1). Working groups can also be created on an *ad hoc* basis in the case of urgent issues or unexpected problems.
Management guidelines should be complemented by independent scientific investigations and reviewed periodically, so that actions that have been decided can be modified or canceled if the need arises. The scope of ecosystem research projects should not be too broad, and rather consist of a framework concept amenable to further development in the course of the project. Interdisciplinary research projects should have a staggered initiation phase consisting of fundamental investigations on ecosystem structure (e.g. mapping), to provide a base for later studies on ecosystem processes. Other advisable measures are a monitoring program with a socio-economic component, the establishment of reference areas (cf. principle 5), and the application of remote survey methods and mathematical models.

Comprehensive ecosystem research projects should conclude with a final evaluation that integrates the results of the separate studies and the knowledge of stakeholders and the local population, and that explains the functional relationships and processes in the ecosystem to the people who live and work there. Management decisions should be made legally binding. The use of this knowledge, an aggressive public relations campaign, and an application of adaptive management practices, implemented in a succession of many small steps, provide a chance to protect, maintain, and to some extent restore the typical natural processes in an ecosystem.

4.2 The five points of operational guidance

Guidance point 1: Focus on the functional relationships and processes within ecosystems.

Background

Precise knowledge on the functioning and structures of ecosystems is an essential prerequisite for their sustainable management. The improvement of knowledge on ecosystem processes called for in the explanation to guidance point 1 was one focus of the basic and applied investigations of the Ecosystem Research Wadden Sea (cf. chapter 2 and principle 5):

- Processes and mechanisms of importance for the long-term conservation of the Wadden Sea. To this end, spatial and temporal distribution patterns were studied along with the effects of disturbances and the stability of the Wadden Sea, in order to assess its resilience (i.e. the system's ability to revert to the original state after a disturbance). These investigations showed that the Wadden Sea is subject to great variability, and that it is impossible to determine reference conditions for highly dynamic ecosystems (Dittmann 1999).
- Exchange of matter with the mainland, the North Sea, and the atmosphere. These investigations focused on the transformation of matter, and on the quantification of the import and export of matter and organisms, to determine the Wadden Sea's function as a source of, or sink for, dissolved and particulate matter. The results made it possible to calculate the role of the Wadden Sea in the balance of matter of the entire coastal region, and to assess the long-term trends (Gätje & Reise 1998).

Assessment

This guidance point names an important shortcoming in the management of ecosystems to date, namely that it is often undertaken in ignorance of the processes affecting the biological diversity. Natural processes are often too intertwined to be predictable. The resilience of ecosystems is often poorly understood as well. Two examples:

- "Black spots" in which the macrofauna was exterminated by sulfide, became widespread on the tidal flats in 1996; contrary to the opinion of most experts, the areas were recolonized very rapidly (Oeschger 1997).
- A distemper virus epidemic strongly reduced the seal populations in the late 1980s; the populations are now greater than before the epidemic (TSEG 2000).

Extraordinary events hardly subject to management may thus occur in ecosystems. Therefore, it makes sense to obtain a better knowledge on the functional biodiversity, as stated in this guidance point.

At the same time, "ecosystem management has to be carried out even in the absence of such knowledge". In this case, sustainable management is only possible along the lines of the precautionary principle. In the past, for instance, aquaculture of non-indigenous species was often conducted in coastal ecosystems without precautions against eventual environmental impacts. In the German Wadden Sea, it has been decided not permit any new oyster farms beyond the one that has been operating since 1985, because information is insufficient to assess the ecological consequences.

Recommendations

Recommendations for the improvement of the knowledge on the functional relationships in the ecosystem to be derived from the Ecosystem Research Wadden Sea are:

- Establishment of unexploited reference areas (cf. principles 5 and 7) and of comprehensive monitoring programs to create long-term data series on the condition and variability of the ecosystem. Investigations should be based on reliable indicators of the variables to be determined. The indicators serve, a) to assess changes in the functioning and the processes in the ecosystem; b) to discriminate between natural and anthropogenic effects.
- Creation of decision-making bodies that continuously evaluate new information to adapt monitoring programs and management accordingly. These institutions have to ensure that the ecosystem is managed sensibly even with respect to issues on which knowledge is insufficient.
- Construction and continuous adaptation of ecosystem models. Temporal and spatial scenarios and budgets can be created from periodic local measurements, improving the understanding of all processes and their interactions. Modelling should equally serve to analyse the resilience of ecosystems and to identify the causes of possible decreases in biodiversity. Questions as complex as these can only be elucidated by long-term interdisciplinary investigations.
- It is advisable to undertake precautionary steps to restrict alien species introductions into ecosystems (cf. principle 5). Any cultivation of new animals and plants (including new cultivars and genetically modified organisms) must be preceded by an environmental impact assessment to determine the ecological effects.

Guidance point 2: Enhance benefit-sharing

Background

Direct economic exploitation of the biological diversity in the Wadden Sea is basically restricted the stocks of mussels and shrimp, which are in a general sense freely accessible resources. Apart from that, the biodiversity in the Wadden Sea also forms the basis of income generated by the continuous increase of tourism.

Assessment

Ecosystem management should consider the economic interests of the local population. There are few direct uses of biological diversity in the Wadden Sea, and an evaluation of this guidance point yields little information applicable to other ecosystems, in which a more equitable distribution of profits is undoubtedly of essential significance in implementing the ecosystem approach. One example is the destruction of mangrove ecosystems for shrimp cultivation; non-sustainable management eliminates the biological diversity in these areas. A comparably inequitable distribution of the benefits from the exploitation of natural resources is not expected in the Wadden Sea.

The challenge in the management of the Wadden Sea is to distribute the profits from all economic activities in the national parks in a way that makes funds available to conservation activities, as exemplified by the mussel management in Schleswig-Holstein (cf. remarks on principle 2). Changes in the economic framework (e.g. sinking income from the marketing of the resource) helped to conclude agreements on the management and conservation of the Wadden Sea ecosystem. The fishery thereby acknowledged its increasing responsibility for the production and management of the resources. The discussions on ecolabelling of mussels produced by environmentally safe methods, and of shrimp caught with little bycatch, point in the same direction.

The financial benefits of tourism, which generates about 20% of the income in the Wadden Sea region, are much greater than those of the fisheries, which produce about 1% (cf. principle 4). Surveys have shown that visitors are willing to give part of their expenditures to nature conservation activities, a so-called voluntary internalization. A majority of the persons and companies that profit directly from tourism are opposed to any such measure, however, so that its implementation is impossible at present.

Recommendations

With regard to enhanced sharing of the benefits of biological diversity, three recommendations can be derived from the Ecosystem Research Wadden Sea:

- Introduction of an ecolabel for natural resources exploited in a sustainable way (cf. principle 4).
- Establishment of special management programs to monitor the stocks of heavily exploited species, and funding of this measure from the profits of the users of the resources (cf. remarks on mussel management in principle 2).

- Introduction of a "nature tax" on the profits from recreational use of an ecosystem and investing of the funds into conservation activities and public relations programs to reduce the impacts of tourism (cf. remarks to principle 4).

Guidance point 3: Use adaptive management practices.

Background

Ecosystem processes are complex and unpredictable, therefore necessitating a flexible management capable of reacting to change. The explanations to this guidance point emphasize that ecosystem management has to be a permanent learning process. The experience of the Ecosystem Research Wadden Sea confirms the necessity of such an approach, particularly in an ecosystem as variable as that of the Wadden Sea. This is reflected by the concepts that have resulted from the Ecosystem Research Wadden Sea (Stock et al. 1996).

Assessment

The call for adaptive management presupposes an availability of continuous information on the condition of the ecosystem, i.e. appropriate environmental monitoring programs (cf. guidance point 1). One of the tasks of the Ecosystem Research was to supply the elements of such a monitoring program (cf. principle 5). Description and evaluation of the economic system is similarly important, and socio-economic issues were investigated by the Ecosystem Research Wadden Sea as well (Feige & Triebswetter 1997). The results have provided the basis of the socio-economic monitoring now being implemented in the Wadden Sea region of Schleswig-Holstein along with the environmental monitoring of ecological aspects (cf. principle 2 and 4). The difficulty of instituting adaptive management is evident in exploitations such as the fishery, the existence of which is not to be questioned according to the Malawi principles (see also GESAMTSYNTHESE Vol. 1, 1999). Wherever overexploitation cannot be identified reliably, management aims at instituting the precautionary principle with the help of specialists from the national park administrations and other government agencies as well as representatives of nature conservation and other stakeholders. The increasing acceptance of sustainable management on the part of the mussel fishermen makes it possible to act against the decrease of the wild mussel stocks in the Wadden Sea (cf. principle 2). In the Dutch Wadden Sea, a part of the bivalve stock is additionally reserved as food for seabirds in years of scarcity. The quantity is negotiated with the fishermen on a yearly basis, a flexible and adaptive procedure following the "co-management" model of an integration of fisheries and conservation interests (e.g. Jentoft & McCay 1995, Sen & Raakjaer Nielsen 1996).

The Dutch co-management of the mussel fishery is viewed with skepticism in the Ecosystem Research Wadden Sea, because the stakeholder group (i.e. the fishermen) manages the resource and carries out management actions itself (GESAMTSYNTHESE Vol. 1, 1999).

Recommendations

Monitoring programs should be accompanied by complementary ecological research on the causes of environmental change (cf. guidance point 1). It is advisable to link the ecological research more closely to the administrative agencies, enabling them to react more directly to unpredictable developments and events. This includes a socio-econo-

mic monitoring program to enable ecosystem managers to consider the attitudes of the local population and tourists (cf. principles 2 and 4).
Consideration of the use of new sustainable and equitable management methods such as co-management. Co-management of natural resources should involve all relevant interest groups and reflect conservation guidelines as well as economic interests. Continuous cooperation between users, conservationists and scientists is able to better harmonize the different interests.

Guidance point 4: Carry out management actions at the scale appropriate for the issue being addressed, with decentralization to the lowest level, as appropriate.

Background

The Wadden Sea is a diverse ecosystem, not only with respect to ist physical conditions and biological processes, but also with regard to ist exploitation. Uses must be assessed from case to case at various decision-making levels, depending on the area and type of activity. Issues such as local visitor guidance are decided in decntralized manner by the national park administrations, sometimes in accord with other institutions. Decisions concerning the Wadden Sea as a whole, e.g. the implementation of a standardized monitoring program, are subject to a complicated decision-making process. Decentralized discussions can, in a series of steps, lead to proposals for a national program, which is then discussed internationally at trilateral government conferences and harmonized with the proposals of the other countries bordering on the Wadden Sea (cf. principle 2).

Assessment

The experience of the Ecosystem Research and management of the Wadden Sea have shown the suitability of a decentralized ("bottom up") administration of large-sized preserves with regard to many issues, because such a procedure can better account for the ecological particularities of the region (cf. principle 2). This concerns issues such as visitor guidance, the regulation of grazing on the salt meadows, and the fisheries.
On the other hand, there exist complex issues where management actions affect other levels, e.g. global effects due to climate change or pollutant inputs (nutrients and contaminants).
Sometimes it may be difficult to institute management at the local or regional level. This is the case e.g. in the mussel industry, which is interlinked at the European level and controlled mostly by Dutch and British companies. The activities of the mussel fishery e.g. in Schleswig-Holstein may depend to a greater extent on production levels in Spain than on the productivity of the Wadden Sea cultures. Decisions on the quantity of mussels placed on the market may be taken in the Netherlands. Therefore, management must have a European (EU) component. The international character of the fishery is even greater in the case of other bivalves such as clams, *Spisula*, or cockles, *Cerastoderma*.
The shrimp fishery is internationalized as well, since Dutch companies are among the principal buyers. If any local management of the shrimp fishery comes into effect, it will need to consider the existing trilateral agreements on catch limitations.
On the other hand, fisheries management requires a decentralized component, because the fisheries are subject to the jurisdiction of the federal states and the fixing of precise regulations (e.g. borders of culture plots) requires a good knowledge of local condi-

tions. Also, surveillance of the activity of the boats, with the aid of a so-called "black box", only makes sense at the local level.

Recommendations

Decentralized structures can involve local stakeholders in regional management and help find solutions that reflect local characteristics. In the case of general problems that require solutions at the international level, decentralized management helps to describe and abate regional and local effects (cf. principle 2). The possibilities of local management are limited, however, when overriding policy goals are at odds with certain management objectives.

Effective management should combine centralized guidelines with decentralized flexibility of implementation. One example is the legal mandate to increase the area reserved for nature conservation. The law provides a general guideline that can only be implemented at the local level. Effective management should therefore merge the decentralized with the centralized approach as far as possible (cf. principle 2). Even though centralized guidelines are a necessity, it is usually imperative to carry them out decentrally at the local level.

Guidance point 5: Ensure intersectoral cooperation

Background

The Wadden Sea ecosystem extends across three countries, and across several federal states within Germany, necessitating intersectoral cooperation at the national and international levels. International cooperation is coordinated by trilateral Wadden Sea policy on the basis of the "Joint Declaration on the Protection of the Wadden Sea" issued in 1982 (see the introduction). In Germany, Wadden Sea cooperation is coordinated by the national park administrations. The 1989-1999 Ecosystem Research Wadden Sea project was funded intersectorally by two federal ministries and three federal states.

Assessment

The fisheries in the Wadden Sea may serve as an example of the need for intersectoral cooperation (CWSS 1997). It is only beginning to be implemented. In the framework of the Trilateral Wadden Sea Plan, the three countries have agreed on steps to reduce the effects of the mussel fishery. The implementation of these decisions requires a participation of all relevant agencies, including the fisheries agencies, national park administrations, the Federal Research Center for Fisheries, and Dutch and Danish fisheries institutions. There is no effective regional and international cooperation as yet. The trilateral Wadden Sea cooperation appears to be the adequate coordinating institution. The necessary basis, e.g. the involvement of the fishery and the organization of the infrastructure (hiring of experts, information service, regular conferences) remain to be established.

Cooperation needs to be improved in other areas as well. The aim of salt meadow management, for instance, is "to protect salt meadows adequately, so that natural processes can occur in this habitat. To this end, all salt meadows are to be protected by law … and in consideration of the experiences of local concepts and actions, the best environmental practice is to be used for the conservation and development of the salt meadows" (CWSS 1997). There are at present different approaches in the three states. In Denmark it is permissible to graze salt meadows without restriction, in the Netherlands some restrictions apply, and in Germany attempts are made to increase the pro-

portion of ungrazed salt meadows. The Quality Status Report of the Wadden Sea recommends that salt meadow management conform to the aim of increasing the proportion of natural salt meadows (de Jong 1999). These plans should include common criteria and goals for a uniform management of the salt meadows in accordance with the Wadden Sea Plan: further promotion of reduced or terminated grazing, to adapt objectives regarding drainage issues, coastal protection, tourism, hunting and agriculture. The possibility to remove the dikes at summer polders, which has until now been only practiced in the Netherlands, should be evaluated in the entire Wadden Sea region.
The "Ecosystem Research Wadden Sea" project was funded intersectorally by several federal ministries and federal states. It consisted of subprojects on the Wadden Sea of Schleswig-Holstein and of Lower Saxony, and these were again subdivided into basic and applied components. The project was concluded with a final evaluation. The original plan to carry out the project in one piece could not be implemented as desired, for financial reasons, and because the agreements on a cooperation between the two subprojects were too vague. Moreover, the coordination effort demanded by the interdisciplinary cooperation organized in this interdisciplinary project had been underestimated. Despite these organizational shortcomings, the project in its intersectoral implementation was able to make an important contribution to the increase of the systemic understanding of the interrelationships between humans and nature in the Wadden Sea region (cf. GESAMTSYNTHESE Vol. 1-3, 1999).

Recommendations

The experiences of the international Wadden Sea cooperation illustrate the possibilities and limitations of cooperation based on a "Joint Declaration on the Conservation of the Wadden Sea". The agreements on trilateral Wadden Sea policy are non-binding declarations of intent. It is therefore advisable to examine whether the decisions on comparable international cooperation could be made legally binding. The conditions for intersectoral cooperation could be improved by concluding binding international agreements under international law.
The experiences of the Ecosystem Research Wadden Sea lead to the following recommendations with regard to planning and organizing future comparable intersectoral projects of this magnitude (GESAMTSYNTHESE Vol. 3, 1999):

- The potential funding agencies should be involved in the conception of the project in order to prevent a later need for improvements and modifications in cases where certain requirements of the funding institutions were ignored.
- A staggered preliminary phase to clear up questions regarding logistics, data management, application of models etc., before further foundations such as mappings, standardization of methods, or similar tasks are carried out in another step. This should be coordinated intersectorally as far as possible, between the scientists as well as between the participating agencies as funding institutions. The investigations themselves should be conducted in a principal research, evaluation and synthesis phase.
- The funds should be channeled through a central intersectoral institution (project management) if possible.

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