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Integration of ecological and fisheries objectives through indicator development

R.L.P. Lanters and E.L. Enserink

Limit and target reference points are used to define management measures for target species within the framework of the precautionary approach. This seems insufficient to meet the demands of ecological objectives. A further integration of fisheries and ecological objectives should be achieved. Currently the status of the North Sea ecosystem is sub-optimal for fisheries and nature. Fisheries yields are below their potential due to overfishing and ecosystem properties are largely influenced by the high levels of fishing effort. This situation calls for a joint action, management measures which restore fish stocks and preserve the natural environment.

Recent the development of ecological indicators has been pursued in The Netherlands. They were developed as part of an evaluation tool to assess the ecological status of the North Sea and the ecological effects of human activities. Results of this study can be used to define operational ecological objectives. Shared economic and ecological indicators are considered to be important. Indicators developed by fisheries science may also serve as ecological indicators. Further research on indicators beyond the single species level is needed to meet ecological demands. Examples of some new ecological indicators are presented. Communication between managers, politicians and scientists proved to be crucial to identify shared goals and explicit differences in perception. Concepts integrating socio-economic and ecological objectives such as the Catch per Unit of Effort (CPUE) will be studied further.

Keywords: communication, ecological objectives, indicators

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Introduction

The introduction of the precautionary approach in fisheries management is meant to achieve sustainable fisheries and reduce the effects of fishing activities on the ecosystem (FAO, 1995). Currently the approach is practically implemented by defining limit and target reference points for commercial fish stocks and the development of restoration and action plans when limit reference levels are exceeded. Such an approach may result in a reduced in fishing effort and overall effects of fishing activities. Although this is a promising development, it is seriously doubted whether this is sufficient to protect the ecosystem (ICES, 1998). Commercial species are by their nature often highly productive components of the ecosystem. Reducing their abundance through fishing may have particularly great impacts on the dynamics of the food web. Also, just because they often are less productive, non-targeted species can be much more vulnerable to mortality caused by fishing than many commercially important species. In March 1997 the Intermediate Ministerial Meeting on the integration of fisheries and environmental issues was held in Bergen, Norway. The North Sea Fisheries and Environmental Ministers stressed that the further integration of fisheries and ecological objectives should be elaborated through the implementation of an ecosystem approach in management practices. How such an integration can be achieved remains unclear, since the operational level of current fisheries and ecological objectives differs considerably.

General objectives of the Common Fisheries Policy, as stated in Council Regulation (EEC) No. 3760/92, with respect to the ecosystem are *'rational and responsible exploitation on a sustainable basis'* and *'taking account of its implications for marine ecosystems'*. Similar formulations are used in ecological objectives (Hewison, 1993). Such general objectives are interpreted as long term goals. Short term goals for fisheries, i.e. levels of Total Allowable Catch and fishing mortality rates, are well defined whereas such operational targets for the North Sea ecosystem are missing (Workshop Ecosystem Approach, Oslo 1998). This certainly hampers balancing economic and environmental demands.

As fisheries depend on the state of marine ecosystems, it can be concluded that to a certain extent fisheries management and nature conservation pursue the same objectives (Marchant, 1998). An example is given in Figure 1. The main challenge is to detect management measures that serve both demands. Further development of ecological indicators facilitates identification of mutual and dissimilar objectives between fisheries and ecology.

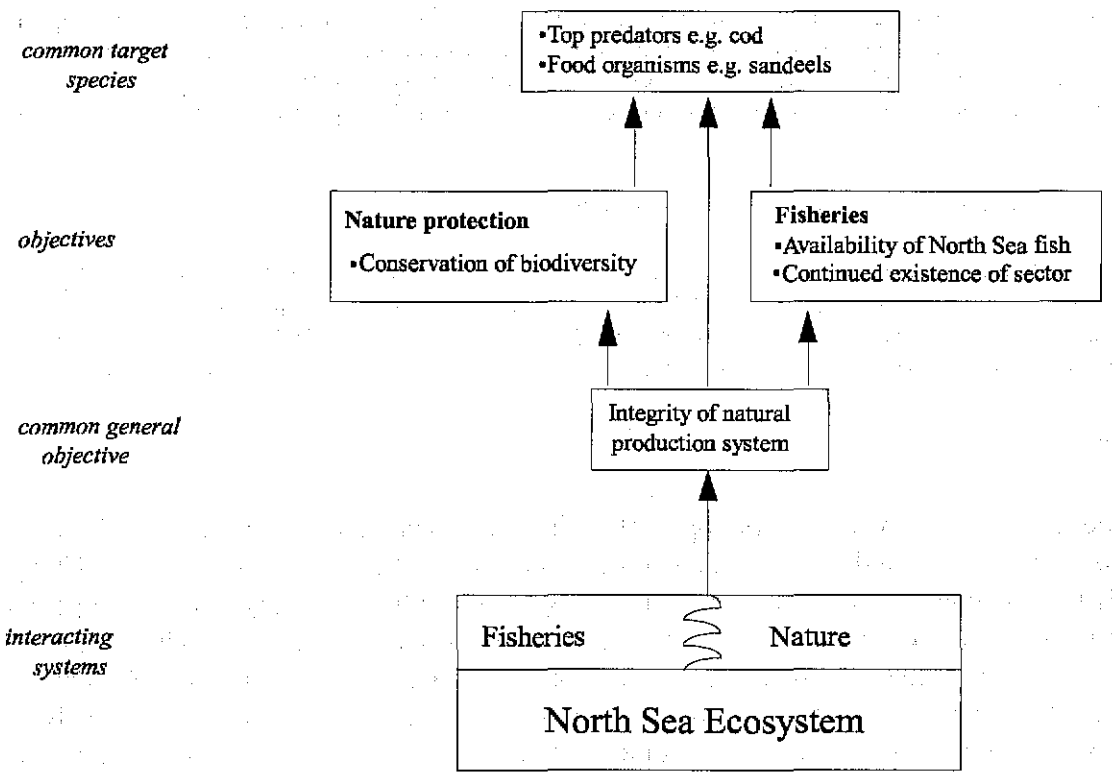

Figure 1 Identifying mutual indicators between fisheries and ecology through comparison of common objectives (after Bergman *et al*, 1997).

In 1996 a pilot study started in The Netherlands to further develop ecological indicators for the North Sea. The goal of this project, which is named GONZ (Dutch acronym for Indicator Development North Sea), was to develop an evaluation tool for assessment of the ecological status of the North Sea, and evaluation of the effectiveness of Dutch integrated management policies. For this purpose the tool should enable assessment of the ecological effects of human activities on the ecology of the North Sea. In order to create sufficient basis, both scientists and policy makers were involved in the process of developing such a framework.

In this paper the general framework of GONZ will be explained. Attention is given to the role of scientists and policy makers. In the discussion the contribution of the project to development of quantitative ecological objectives and their use in fisheries management is evaluated.

The GONZ project

The aim of the GONZ project is to deliver a framework for the positioning of ecological indicators along the line of Dutch policy themes. The project didn't start from zero since a similar evaluation tool, the AMOEBA approach (Ten Brink et al, 1991), already existed. Here, single key-species are used to assess the state of the ecosystem. Based on scientific reasoning a set of species was chosen that was considered to be directly affected by human activities. In general, the AMOEBA approach served the policy makers very well because it gives an easy to understand and uniform picture of the ecological status of the North Sea (Figure 2). However, at the same time another assessment method was developed for nature conservation, that focused on ecological processes. As new policy items arose, e.g. biodiversity and sustainable use of the North Sea, it was decided to combine the best of both approaches into a new method.

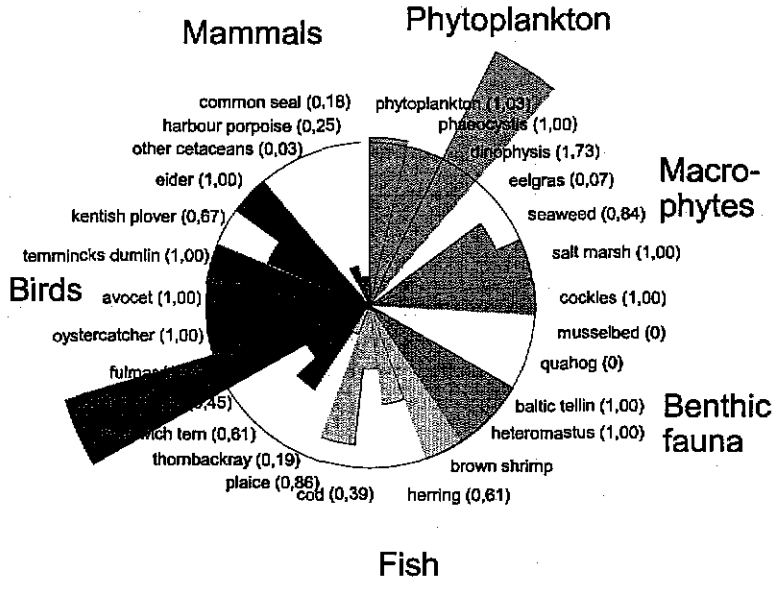

Figure 2 Assessment of the ecological status of the Dutch part of the North Sea in 1996 with the use of the AMOEBA approach. The circle represents the target level for each indicator. Measured levels are superimposed.

Instead of the bottom-up approach (from science to policy) that was used for the AMOEBE, the GONZ project used a top-down approach (Figure 3). Firstly, the main ecological objectives for the North Sea were identified, followed by a selection of the indicators necessary to evaluate the effectiveness of these policy issues. This turned out to be a sound, but tough approach. In first instance, policy makers could only define their goals in general terms, i.e. sustainability, preservation of biodiversity, and healthy ecosystem. They were unable to translate these goals into practical and quantitative objectives without the help of scientists. The iterative process of discussion in workshops and reading and rewriting conceptual frameworks finally resulted in a broadly accepted method for defining and

structuring indicators that are related to the main policy issues for nature and water management of marine ecosystems.

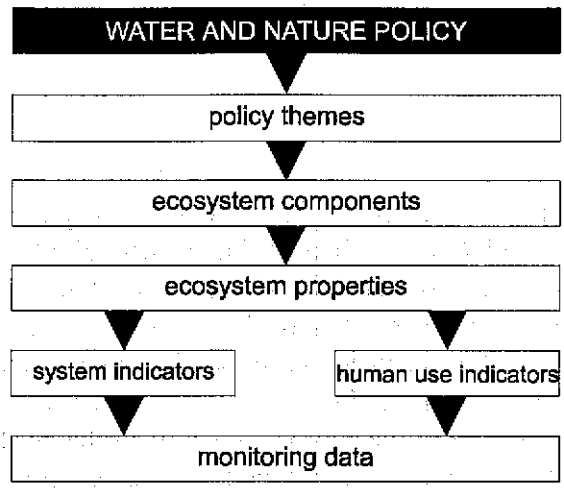

Figure 3 Top-down approach in the development of an evaluation tool in the GONZ project.

The final construction of the evaluation tool is straightforward. The main policy themes are biodiversity and ecological processes, which are connected to ecosystem properties through the most profound ecosystem components (Table 1).

Table 1 Structure of the GONZ asssessment framework for evaluation of water and nature policy. Ecosystem properties are measured by indicators.

Policy Theme	**Ecosystem Component**	**Ecosystem Quality**
biodiversity	species	single species reference points (numbers, distribution-pattern or mortality)
		diversity indices for major species groups
	communities	community metrics for plankton, benthos and fish
	ecotypes	area of specfic ecotypes
ecological processes	productivity	production rates at primary, secundary and tertiary level
		decomposition
	foodchain	bulkfood organisms
		top predators
		complexity foodchain
		trophic structure benthic and fish community
	hydro- en morfodynamics	area of dynamic ecotypes

Each ecosystem property can be measured by one or more indicators. Science is now challenged to define the most sensitive and informative indicator(s) for each ecosystem property. Single species indicators are already fairly elaborated. For instance, spawning stock biomass and fishing mortality rates of fish species are common goods. In this phase of the GONZ project community metrics and productivity seem the most promising areas where a new generation of indicators can be developed. Theories on foodchain properties, although judged important by policy makers, seem insufficiently developed to yield operational indicators at short notice.

To deal with both assessment of the state of the ecosystem and effects of human activities, two sets of indicators are proposed. Indicators for ecosystem health and human function overlap to a large extent. As an example, duration of algal blooms seems a good descriptor of ecosystem development as well as an indicator for the ecological impact of eutrophication (Figure 4). Another good example is the development of the share of large fishes (>25 cm) in the total catch weight in the Dutch Sole Net Survey (Figure 5). More than 80% of the 53 proposed system indicators is also used as an indicator for the effects of human pressures. In addition, 70% of the 40 proposed human use indicators is directly or indirectly connected to fishing, thereby reflecting the importance of this activity. The overlap shows that ecological aspects of human use cover many components of the ecosystem.

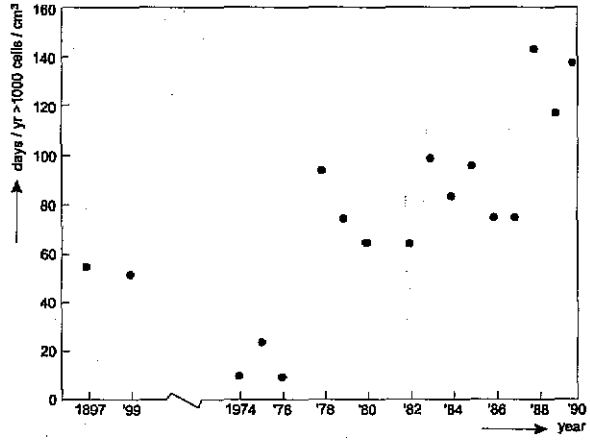

Figure 4 Variations in the duration of algal blooms in the Marsdiep (area between the Dutch coast and the Wadden Sea). Blooms occur when algal levels exceed 1000 cells per cm3 (source: Cadee, 1992).

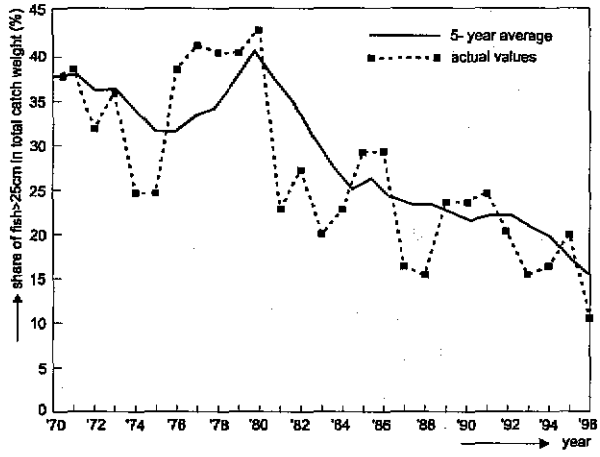

Figure 5 The share of fishes >25 cm in the total catch weight in the Dutch Sole-Net-Survey between 1970 and 1996 (Data source Netherlands Institute for Fisheries Research).

In GONZ a new generation of indicators will be given a chance to prove themselves as measures which provide additional information beyond the single species level. Of these just two examples were given. The framework of GONZ is still in an early stage and only few indicators have been defined properly. The Dutch government will continue the development of this framework. Managers, scientists and policy makers agree on the merits of the process, which intensifies the discussion between science and politics.

Discussion

The framework constructed within the GONZ project is restricted to the Netherlands and is still in a preliminary stage. However some general features may be of use for the development of indicators in the international community. The intense communication between policy makers, managers and scientists was one of the major benefits of the GONZ project. De Jong (1998) analyzed the development of ecological quality objectives in the Wadden Sea. One of the main problems in quantifying ecological objectives is the inverse relation between management usefulness and scientific credibility. This was experienced also in the GONZ project. De Jong (1998) proposed a strategy of adaptive management where the communication between interests groups involved is essential to guide the process. This is similar to the iterative process between politicians and scientists in the GONZ project. Managers were forced to explicit the choices they have to make in day to day management and scientists had to translate their knowledge to the level of indicators.

The use of single species reference points is not sufficient to measure biodiversity or ecological processes. Indicators beyond the single species level are needed. Community metrics e.g. mean weight or length in ground fish assemblages, seem promising. Next to being a worthy piece of science they may also be very illustrative. Although the theory of size spectra is still further developed (ICES, 1998; Gislason & Rice, 1998), a fairly simple but elegant indicator as the share of large fishes in the total catch (Figure 5) formed the burden of proof for some Dutch politicians and managers that changes at the community level do take place, probably as a consequence of the continuous high fishing pressure.

It became clear that some of the indicators used within fisheries management may also serve as system indicators. Fisheries science has the advantage of being a leading field in marine research. Fisheries scientists possess long term data from landings and surveys which can be used to analyze long term trends. For non-commercial species and other ecosystem properties long term datasets are not available or scarce. Scientific knowledge of processess in marine ecosystems is still in an early stage. A solution could be to make better use of fisheries data in ecosystem research.

Since ecosystem management in the North Sea is only possible through the regulation of human activities, international fora such as European Commission are confronted with the socio-economic effects of ecological objectives. This means that in the end management comes down to a political decision. Even if it is possible to define operational ecological objectives the political choice of measures still remains. Ecological indicators can help this decisions by clarifying the effects of policy decisions and reduce uncertainties about the ecological effects. An increase in the contribution from scientific research to environmental and fisheries management is therefore necessary (Marchant, 1998). From the GONZ project it becomes clear that such a process will benefit from an active attitude of the managers and policy makers. A future step would be the integration of socio-economic and ecological indicators in one framework. Some concepts seem promising. For instance, the measure of the catch per unit of effort directly relates to the state of the ecosystem as well as the costs and investments needed for the fishing industry to keep up their profits (NRLO, 1997).

The development of indicators is not easy and we expect that it will take a long time (if ever reached) before new instruments can be used. Meanwhile ecosystem quality should be properly safeguarded through the application of the precautionary approach.

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