HELCOM Ecological Objectives for an Ecosystem Approach

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Introduction

The Regional Seas Conventions work for the protection of marine and coastal environments in 18 regions of the world. In the Baltic Sea area the Helsinki Commission (HELCOM) co-ordinates implementation of the Helsinki Convention. The convention has the aim to prevent and eliminate pollution in order to promote the ecological restoration of the Baltic Sea area and the preservation of its ecological balance (HELCOM 1992).

The HELCOM and the joint HELCOM/OSPAR Ministerial Declarations of 2003 put explicitly a new management concept, the ecosystem approach to the management of human activities (Ecosystem Approach), at the centre of HELCOM work (HELCOM 2003; HELCOM & OSPAR 2003). The joint declaration commits the parties to apply and further develop the measures necessary to implement an ecosystem approach by 2010.

In the Ecosystem Approach the state of the ecosystem itself is used as a measure by which to identify, plan and implement management actions needed to combat pollution from all sources and to promote protection, as well as sustainable use and development, of the environment. This differs from earlier sector-by-sector approach.

In Ecosystem Approach the present, or projected, state of the whole ecosystem is defined by comparing measured, or forecasted, level of selected indicators to target levels representing good, but not necessarily pristine, state. Progress in defining the overall state, or -using more popular wording- *health*, of the ecosystem eventually determines the success of this approach.

The HELCOM 2003 Bremen declaration invites HELCOM to develop and apply objectives and appropriate indicators of the eutrophication status which express “good quality status” as stipulated in the EU Water Framework Directive (WFD) (Anon. 2000), but covering the whole Baltic Sea Area (HELCOM 2003).

The declaration states further that this approach should be harmonised with other similar international activities, such as the WFD adopted for the inland and coastal waters of the EU Member States, and the proposed European Marine Strategy (EMS)(Anon. 2005).

The aim of this document is to describe the emerging HELCOM Baltic Sea assessment system based on Ecological Objectives presently merged into the HELCOM Baltic Sea Action Plan. The results are an example of a way to begin implementing Ecosystem Approach, and defining ecosystem health, in a regional sea. The relation of this drafted HELCOM assessment system to similar concepts in other international initiatives such as Convention of Biological Diversity (CBD, (1992), European legislation (WFD as well as the emerging EMS) will be discussed.

Foundations of an ecosystem assessment system

HELCOM adopted a stepwise approach in developing a system consisting of a vision, strategic goals, regional objectives and indicators with target levels. The main aim has been to lay the foundations of a hierarchical assessment system where higher levels can be seen as indices integrating the underlying scientific measurements (Figure 1).

Figure 1*. Stepwise approach to define good ecological status.*

The last two steps (4 and 5 in Figure 1) needed in order to unambiguously define good ecological status, quantitative indicators and targets, are not within the scope of this article. This substantial work will be completed by experts in each specific field. For eutrophication this work is already past its pilot phase (HELCOM *in press*).

In the adopted system the *Vision* describes overall ambition, *Strategic Goals* define major topic areas (e.g. eutrophication), *Ecological Objectives* describe central characteristics of a healthy sea (e.g. clear water) in a simplified way, *indicators* on the other hand exactly define a quality assured method to measure and present the ecological state (e.g. summertime Secchi depth). Finally the *targets* define the indicator value representing acceptable deviation from historical background levels (reference levels) for the given indicator and given geographical area.

A common vision was drafted in order to integrate the aims of HELCOM with several national, international as well as European conventions and policies. The 2004 Meeting of the Helsinki Commission adopted the overall vision: *Healthy Baltic Sea environment, with diverse biological components functioning in balance, resulting in a good ecological status and supporting a wide range of sustainable human economic and social activities* (HELCOM 2005).

This vision names bio*diversity* in the spirit of CBD as well as *good ecological status* in the spirit of the WFD as essential components of the healthy Baltic Sea. The aim to reach *ecological balance* in the Baltic environment is included in the 1992 Helsinki Convention text and echoes the consensus reached at the United Nations Conference on Environment and Development (UNCED 1992). The vision statement emphasises also one of the ultimate reasons for HELCOM efforts to protect the Baltic Sea environment: its socioeconomic value interpreted in the widest possible sense (including social values).

The Baltic Sea ecosystem has been recognised by HELCOM as being threatened by four major human activities: 1) eutrophication caused by excessive inputs of nutrients, 2) health problems caused by inputs of hazardous substances, 3) pollution by maritime activities, and 4) loss of biodiversity caused by the aforementioned issues as well as direct extraction of biomass mainly in the form of fishing (HELCOM 2003). The Vision forms a conceptual basis in which the defined concerns can be related to "*diverse biological components functioning in balance*" i.e. biodiversity as depicted in Figure 2.

Four strategic goals were adopted to reflect these four main themes of concern under the management mandate of HELCOM (Figure 3). The strategic goals aim at the Baltic Sea unaffected by eutrophication, its life undisturbed by hazardous substances and maritime activities carried out in an environmentally friendly way, all making possible the favourable status of the Baltic Sea biodiversity.

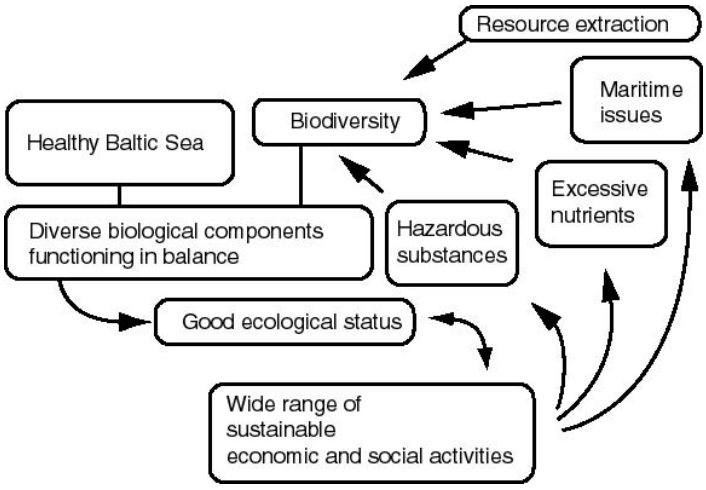

***Figure 2**. Schematic picture of the interlinkage between the vision and the main anthropogenic pressures on the Baltic ecosystem under management by HELCOM.*

In addition to the three ecological goals, HELCOM aims to ensure that all maritime activities are carried out in an environmentally friendly way (Figure 3). Specific human activities, such as maritime activities including shipping, affect often the Baltic ecosystem in multiple ways. For shipping this includes non-indigenous species introductions, exhaust nitrogen emissions and risks of accidents and oil spills.

Fish stocks are an integral part of Baltic fauna and will in this system be assessed under the strategic goal for biodiversity. Fisheries as such have traditionally been managed by others than environmental protection organisations; commercial fisheries management (e.g. setting quotas) is for this historical reason not explicitly part of HELCOM mandate. However, fish stocks of commercial and recreational interest, as well as environmental effects of fisheries, have been traditionally and naturally included in the HELCOM periodic assessments.

Selecting objectives

A common set of ecological objectives, defining further the hierarchical system described in Figure 1 will be used to communicate central ecosystem characteristics to a wider community. Therefore it is important to include topics of common interest in an assessment system. The aim is to make assessments more concrete and interesting for environmental managers and general public without reducing their scientific value. Topics such as toxicity of food, sizes and stocks of recreationally valuable fish, clarity of water, well-being of species like seals and eagles are concrete and widely interesting. If not presented in a proper way such parameters as nutrient concentrations, or abundances of microscopic species, are usually less interesting for the public even if ecologically important.

The objectives presented in Figure 3 are a result of a combined consensus achieved with large number of experts representing science and management. As many of the processes operating in the marine environment are not well documented, with eutrophication as an exception, the selection is to some degree subjective.

Biodiversity

The strategic goal for protection of nature and biodiversity is the “favourable conservation status of the Baltic Sea biodiversity”. The Ecological Objectives related to this goal are divided into landscape/seascape level, community level and species level, reflecting the CBD, focused on levels “within species”, “between species” and “of ecosystems” (Figure 3).

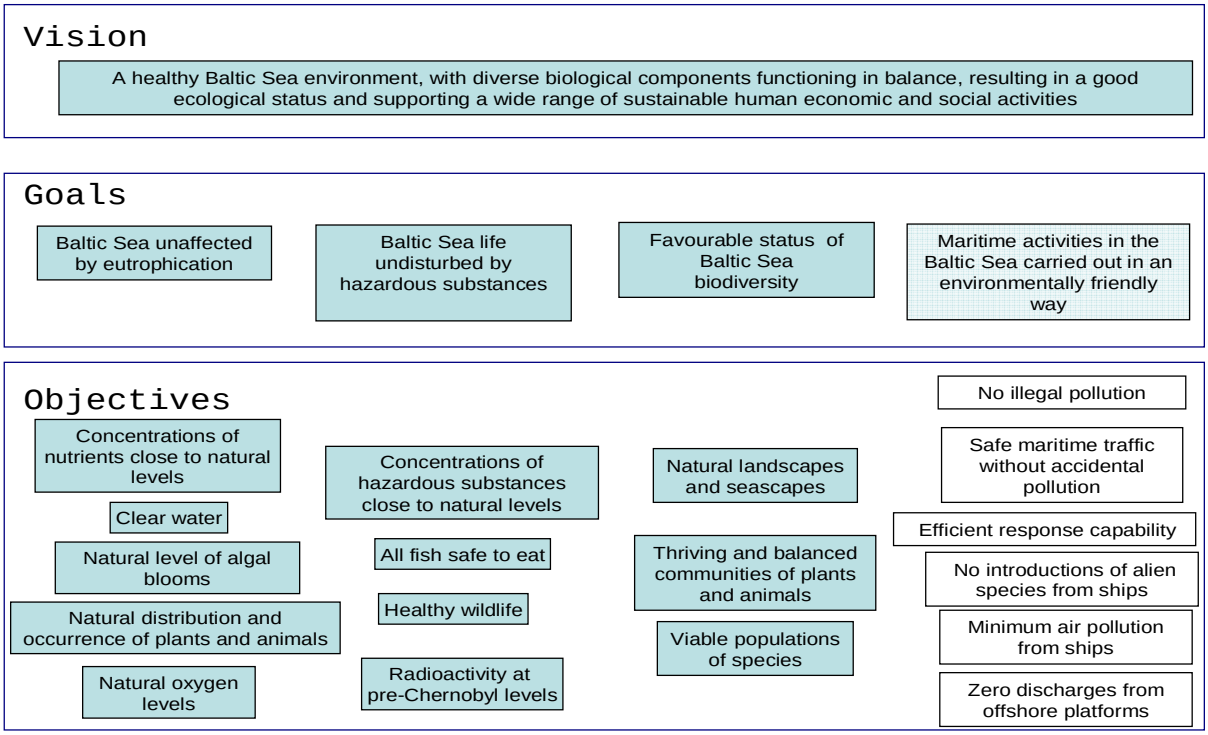

***Figure 3**. General outline of the HELCOM assessment system. For each Objective a number of indicators with target levels have to be agreed upon. In order to have objectives for all HELCOM main issues of concern the project has also developed management objectives for maritime activities. As maritime issues are a pressure acting on, and not an ecological state of, the marine environment the maritime objectives are coloured white.*

All Objectives under the other three Goals, pertaining to eutrophication, hazardous substances and maritime activities, are also relevant to biodiversity as described in Figure 2.

Biodiversity or biota in general, in the Baltic Sea is affected by a number of human pressures including nutrient inputs, hazardous substances inputs, alien species inputs as well as resource extraction (Figure 4).

The objective **natural landscapes and seascapes** underlines the importance of diverse coastal and marine landscapes, associated ecosystems, processes and cultural values. The Baltic Sea Protected Area (BSPA) network is set up in a way to comprehensively cover different ecosystems and landscapes. Thus the implementation status and the ecological coherence of the network can be used as tools to assess the level of protection afforded to coastal and marine landscapes.

Thriving and balanced communities of plants and animals are essential for the favourable status of the Baltic Sea biodiversity. Changes in the structure of communities have cascading effects on their associated species and the ecological function of the ecosystem. For example, changes in plankton communities can have effects on entire food chains including fish stocks. Algal blooms fuelled by eutrophication are expressions of decreased diversity in the phytoplankton communities but also affect other pelagic and benthic communities. Many communities have key or habitat building species, such as bladder wrack (*Fucus vesiculosus*) and eelgrass (*Zostera marina*) that can be used as indicators of their associated communities.

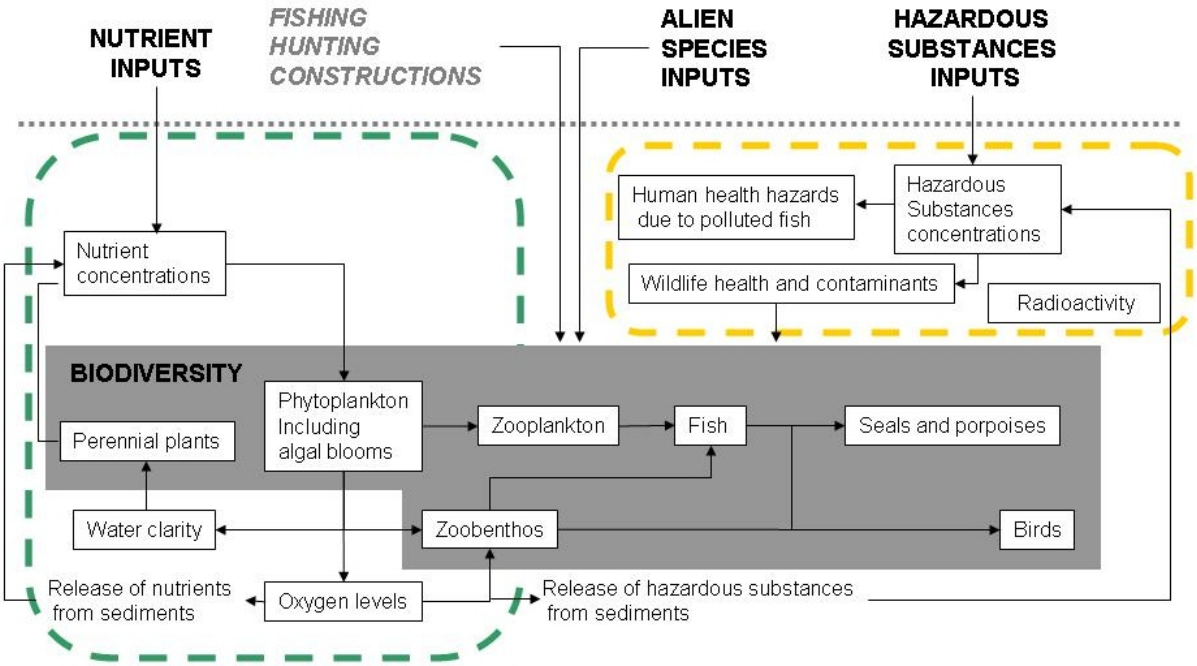

***Figure 4**. A general model presenting interlinkages in the proposed system of Ecological Objectives. The topics in boxes are represented specifically by one or several Objectives. The Biodiversity topics are presented by the grey area, these presented compartments are to be assessed in the three levels of seascape, community and species. Assessment of fish, seals & porpoises and birds is partly done species by species -the others mainly on the community level.*

Both natural ecosystems and balanced communities are reliant on **viable populations of species**. A viable population consists of a successfully breeding, healthy population that is able to maintain itself and perform its functional role in the community and ecosystem. The population trends of certain species, such as the seals, white-tailed eagle, salmon and cod are well known due to long-term studies, and can be readily assessed.

Threatened and declining species in the marine environment are generally difficult to monitor but the ecosystem changes resulting from eutrophication and toxification of the environment may result in an increasing number of local declines or even extinctions. Introduction of non-native species is another threat to the Baltic biodiversity which is difficult to manage by the available methodology, ballast water treatment may be one way to stop the present influx of alien species (Figure 3).

Eutrophication

Eutrophication assessment can rely on well documented conceptual models such as the European framework for eutrophication assessment (EC JRC/BSC/HELCOM 2004) used as the starting point for defining the objectives for eutrophication described in Figure 3.

It is widely accepted that **concentrations of nutrients** in the Baltic Sea have increased in most sub-basins during the last century resulting in an eutrophied ecosystem.

The clarity of seawater is integrating many of the concrete effects of eutrophication. The decrease in **water clarity** during the 20th century is a result of increased planktonic primary production, including intensification of **phytoplankton blooms,** and has resulted in changes in vertical **distribution** perennial macroscopic algae and vascular plants. In addition, clear water is a property which is easily understood by everybody. The increased sedimentation of organic matter has increased oxygen consumption in the sediments resulting in **oxygen depletion** even in shallow bottoms, leading to marked changes in benthic zoobenthic **communities** and fish.

Hazardous substances

Heavy metals and organic pollutants have been released into the Baltic Sea often in low concentrations. Many substances are observed only when they are accumulated in the food chain and when special concern is raised for e.g. human health risks. Sometimes the only way to detect the impact is through applying biological effects monitoring, referring both to traditional observations of top-predator reproduction disorders and to novel biomarker methods. Therefore both **hazardous substances concentrations** and their biological effects to **wildlife health** have been included in the HELCOM ecological objectives (Figure 3 & 4).

Fish is the pathway of concentrations of hazardous substances from the environment to humans, eventually affecting our own health. In order to preserve the commercial and cultural value of Baltic Sea fishing **all fish should be safe to eat** by humans, but naturally also by wild predators.

Radioactivity is a somewhat special and separate topic apart from the other hazardous substances. Radioactivity originating from the 1984 Chernobyl accident is approaching natural levels according to monitoring.

Interlinkages

In the previous chapters as well as in Figure 3, the Ecological Objectives are described separately under the four strategic goals. The system should not, however, be treated as consisting of four separate vertical blocs since there are a number of horizontal links between different Ecological Objectives (Figure 4). A prime example is biodiversity which is affected by a multitude of human actions and is directly linked to eutrophication, hazardous substances and maritime activities: thriving and balanced communities are connected to algal blooms as well as introduction of alien species, viable populations of species can not be achieved without having healthy wildlife or natural levels of oxygen.

Finalising the assessment system

Ecological Objectives are to be assessed by using specific, and more numerous, indicators. Some objectives, such as clear water and natural nutrient concentrations can be assessed with one or few indicators while some objectives may need several indicators, especially such as healthy wildlife and the objectives under biodiversity. The basic approach is to use indicators which are based on existing monitoring programmes.

These indicators should be provided with target levels and require consensus on the data collection, data validity and applied statistical methods. They should also be representative to the area in question, be easy to interpret correctly as well as match the interest of the target audience. Most importantly the indicators should be provided with target levels reflecting good ecological status.

The development of a coherent set of ecosystem assessment indicators for the Baltic Sea is a major task for future activities within HELCOM. Presently ca. 20 annually updated indicator fact sheets are available in the HELCOM website and are in the process of being equipped with target levels or limit values. HELCOM report “Development of Tools for Assessment of Eutrophication in the Baltic Sea” (HELCOM *in press*) has already drafted assessment criteria for the different sub-basins of the Baltic Sea. Together with data from the HELCOM COMBINE monitoring program these criteria make assessment of the eutrophication status of the Baltic possible. Similar activities defining pristine levels and acceptable deviations from these levels for indicators of hazardous substances and biodiversity are needed to cover the Ecosystem Approach.

Management action: why assessments are needed?

Finalising the objective-indicator-target system described here is only the first step in moving towards the ecosystem approach to management of human activities. Emphasis should be put on producing clear advice on what should be done (and how) to remedy the situation. Finally this advice should be implemented in concrete management action. Ecosystem Approach presents a challenge both to science and management.

From science Ecosystem Approach requires that information on complex ecosystem interactions, acting over large spatial and temporal scales, is presented in a concise and clear manner. In Ecosystem Approach the exact definitions of the good status of the ecosystem should be scientifically justifiable. Monitoring data combined with ecosystem models provide a way to identify and quantify required reductions in relevant anthropogenic pressures to reach target levels of indicators and the Ecological Objectives which they define. In the HELCOM Thematic Assessment on Eutrophication (HELCOM 2006), the operational modelling tools have been used to provide first estimates of the required reductions in nutrient inputs to reach sub-regional target levels in water clarity.

For management the challenge is to accept good ecological status as a starting point in defining the measures, e.g. the quantity of needed reductions in nutrient inputs to reach the ecological objectives. The actual extent of implemented actions, determining e.g. the time-frame to reach the good status, is a value judgement and will be decided upon according to political will and available resources.

HELCOM system of Ecological Objectives and other international approaches

The Ecosystem Approach has been endorsed within the context of the CBD as a means to deliver the objectives of the Convention in practice (CBD/COP 5 2000) and is the central concept in the WFD and EMS (Table 1).

The CBD aims to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level (CBD/COP 6 2002). The CBD 2010 target was subsequently endorsed by the Johannesburg World Summit on Sustainable Development (WSSD 2002).

As described in Figure 4 biodiversity is in the core of the described HELCOM approach. The emerging indicator based assessment system enables the regional assessment of the Baltic Sea marine biodiversity, i.e. the status of Baltic Biodiversity when compared to CBD 2010 targets. Measuring states of eutrophication and hazardous substances pollution as well as biodiversity directly in this system provide a means to address pressures affecting the Baltic Sea biota.

In addition to identifying a flexible framework of globally relevant goals, sub-targets as well as indicators for immediate testing the 2002 CBD Conference of the Parties invited Parties and Governments to develop national and/or regional goals and targets, and, as appropriate, to incorporate them into relevant plans, programmes and initiatives, including national biodiversity strategies and action plans.

European environmental legislation reflect the recognised importance of ecosystem approach. For coastal areas under jurisdiction of the EU member states such an indicator-based assessment system as described in this article is presently emerging with the implementation of the Water Framework Directive (WFD), defining a desirable state of the water environment by quantitative target levels. Specific ecological elements are listed under the WFD, with topics comparable to the Ecological Objectives described in this article. The work done in the context of the WFD will define good ecological status in the coastal areas of the EU member states.

For the European offshore areas the legal basis for developing such a classification system is presently at a preparatory stage. The European Marine Strategy, as well as the proposal

for a European Marine Framework Directive, approved by the European Commission in October 2005 point towards delineation of regional “targets” for environmental work and aiming at good environmental status of European seas by 2021. When the assessment system drafted by this project is developed further to operational status by agreeing on indicators and target levels, it serves as material for such ecological targets in the Baltic Sea.

The European Commission proposal for a Marine Strategy Directive lists in its Annex II a number of essential characteristics which should be used in the initial assessment, determination of good environmental status and in monitoring the marine areas falling under the Directive proposal. Even if the formulations in the Annex II of the proposed Marine Strategy Directive are not very exact the described topics are covered by the HELCOM system of Ecological Objectives.

Table 1. *Comparision between the WFD (Anon. 2000) Quality elements, other EC legislation in force such as the Habitats (Anon. 1992) and Birds (Anon. 1979) Directives , as well as the proposed topics listed in Annex II of the proposed European Marine Strategy Directive (Anon. 2005)*

HELCOM Ecological Objective	**Convention on Biological Diversity 2010 Goals**	**WFD Elements (Other EC legislation than WFD in parenthesis)**	**Marine Strategy Directive proposal (Annex II) characteristics**
Natural seascapes and landscapes • Implementation of ecologically coherent MPAs	Goal 1. Promote the conservation of the biological diversity of ecosystems, habitats and biomes	(Protection of Natura 2000 habitats)	Predominant habitat types Special habitat types Special areas
Thriving and balanced communities of plants and animals +Distribution of plants and animals e.g. • Plankton communities • Invertebrate bottom fauna • Macroalgae & vascular plant communities • Fish communities Natural levels of algal blooms	Goal 1. Promote the conservation of the biological diversity of ecosystems, habitats and biomes	Composition, abundance and biomass of phytoplankton & frequency and intensity of blooms Composition and abundance of macroalgae & angiosperms Diversity and abundance of benthic invertebrate fauna & presence of disturbance sensitive taxa Composition and abundance of fish fauna, especially disturbance sensitive species	Biological communities, e.g. • Phytoplankton • Zooplankton • Invertebrate bottom fauna • Fish populations
Viable populations of species e.g. • Seals • Fish stocks • Birds • Threatened & declining species	Goal 2. Promote the conservation of species diversity Goal 3. Promote the conservation of genetic diversity	(Habitat Directive annex species, Common Fisheries Policy fish stocks)	Population dynamics, natural and actual range and status of: • marine mammals • seabirds • other species • non-indigenous species
Concentrations of nutrients close to natural levels Clear water Natural oxygen levels	Goal 7. Address challenges to biodiversity from climate change, and pollution	General: Transparency, thermal conditions, oxygenation, salinity & nutrients	Nutrient enrichment
Concentrations of hazardous substances close to natural levels All fish safe to eat Healthy wildlife Radioactivity	Goal 7. Address challenges to biodiversity from climate change, and pollution	Priority pollutants & other pollutants discharged in significant quantities	General state of chemical pollution

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