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Guidance on the Application of the Ecosystem Approach to Management of Human Activities in the European Marine Environment

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Contents

1 Introduction

This report is an input to the development of the European Marine Strategy (EMS). It was written by a core group established jointly by ICES and the European Commission and has been subject to wide stakeholder consultation in one of the working groups set up to support the development of the EMS process – the Working Group on Ecosystem Approach to human activities (EAM).

The report is directed at the Governments of countries participating in the Marine Strategy, including Member States as well as non-EU countries bordering the regional seas shared with the Community. The audience is also the European Commission and the Marine Conventions responsible for conservation and protection of the marine environment, and the scientific community. The core group worked during 2003–2004 with the following members:

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Drafts of the report were commented on at meetings of the Working Group on Ecosystem Approach to human activities (EAM):

16–17 December, 2003	Brussels
18 March, 2004	Brussels
5 May, 2004	Brussels
15 July, 2004	End of e-mail consultation

The report was also discussed at a Stakeholder Conference, arranged by the European Commission and held in Rotterdam 10–12 November 2004. The Conference concluded that the current guidance on Ecosystem Approach covers all relevant notions required to start work at regional levels. The Conference also endorsed an approach with objectives supported by indicators, limits, reference points, and targets as the appropriate approach for operationalising an Ecosystem Approach. Finally, the Conference concluded that the guidance on the Ecosystem Approach is an integral part of the European Marine Strategy necessary to make it operational, and a key mechanism to support delivery of sustainable development.

Based on the general support from the participants at the Conference, it was recognized that the report warranted wider dissemination and might be used for guidance outside the geographical scope of the European Marine Strategy.

2 Aims and scope

The aim of this guidance is to support the development and implementation of the Ecosystem Approach to the management of human activities in the European marine environment. The guidance addresses the general issues underpinning the management of human activities in all regions and at all scales. It outlines an approach on how to achieve the benefits and environmental conditions sought through the implementation of the Ecosystem Approach to the management of human activities, and hence on how to obtain sustainable development. It offers a practical guidance on how to reach established visions, strategic goals, and associated objectives.

Common principles will underpin the effective implementation of the Ecosystem Approach, and will apply to the planning and the management in all regions. There are many

formulations of management principles within the Ecosystem Approach, and the points below, for instance, draw on the Malawi Principles. The proposed principles are:

1. Management should be based on a shared Vision and requires stakeholder engagement and participation;
2. Planning and management should be integrated, strategic, adaptive, and supported by unambiguous objectives and take a long-term perspective;
3. The geographic span of management should reflect ecological characteristics and should enable management of the natural resources of both the marine and terrestrial components of the coastal zone;
4. The management objectives should be consistent with the requirement for sustainable development and reflect societal choices. They should address the desired quality status of the structure and dynamic functions of the ecosystem;
5. Management should be based upon the precautionary principle, the polluter-pays principle, and the prevention principle. Best Available Technologies (BAT) and Best Environmental Practices (BEP) should be applied;
6. Management should be supported by coordinated programmes for monitoring, assessment, implementation, and enforcement and by peer-reviewed scientific research and advice and should make the best use of existing scientific knowledge.

While the guidance addresses directly the quality or health of the marine environment it will stress the need to address all human uses of marine ecosystems. Human uses need to be pursued through setting and achieving social and economic objectives for these uses. Such objectives will have to be set at regional or national level, as will the principles that highlight that good governance will have to form an integral part of the institutional framework for the Ecosystem Approach. While guidance on setting objectives for human uses and governance will not be provided here, it is stressed that all objectives need to reconciled, so that they can be pursued and achieved together. This reconciliation will be important at every level, but will have particular importance at the regional scale where implementation and programme delivery will occur.

In various forms, the proposed strategic goals and objectives have long been goals of management of most human activities, so moving to the Ecosystem Approach is an evolutionary step, not a revolutionary one. However, the Ecosystem Approach highlights the need to approach the goals systematically and in a coordinated manner. Looked at this way, two deficiencies in the *status quo* are apparent.

(1) First, the existing policy instruments operate largely independently. In moving to the Ecosystem Approach there is a clear need to address interactions and cumulative effects among:

   a) multiple uses of marine ecosystem components;
   b) multiple impacts of most human activities, including land-based activities;
   c) multiple policy instruments used to manage the uses.

   Most sectoral policies address diverse uses, impacts, and major ecosystem components like fish, seabirds, water quality, and habitat features separately. One of the major challenges for the implementation of the Ecosystem Approach to human activities is to create the appropriate institutional framework to deliver the integration and coherence required to achieve the goals and objectives. The benefits that result from developing such a framework will be larger than the sum of the individual payoffs for each sector.

(2) Second, the concept of a ‘healthy’ ecosystem needs to be reconciled across sectors and policy instruments. For example, a ‘healthy’ ecosystem from the perspective of chemical contamination might be an ecosystem with no contaminant loading (un-impacted), while a ‘healthy’ ecosystem from the perspective of fishery managers is

one that is impacted until the fishery provides the maximum sustainable economic and social benefits to society. This highlights the need for a forum in which different societal sectors with different values can express their values and reach a common description of what they want management to achieve. While this document mainly provides guidance on the delivery of strategic goals in relation to the environmental pillars on a regional scale, there is a strong and direct relationship between policy framework (visions, goals, and objectives) and regional implementation.

Regional implementation will be supported by ecological objectives that are consistent with the Vision and strategic goals. The management measures needed to meet ecological objectives will be determined by operational objectives. Operational objectives are specific and tractable objectives that can be achieved through the application of a management measure. For each operational objective, there will be associated indicators and reference points. This guidance document explains the process of setting ecological objectives and operational objectives, their ideal properties, how they interact, and how they support the Ecosystem Approach at any spatial scale.

The guidance aims to support the development and implementation of the Ecosystem Approach to the management of human activities. It addresses the general issues underpinning the management of human activities in all regions and at all scales and contains:

- A review of the concept of 'ecological status'
- A description of the Ecosystem Approach
- Recommended criteria for selecting objectives, indicators, limits, and targets
- Recommendations for management methods and structures that underpin the Ecosystem Approach
- Recommendations for assessment, monitoring, and scientific research
- Recommended methods of measuring progress towards implementation

This document provides higher-level guidance and recommendations relevant to the development and implementation of the Ecosystem Approach in the European marine environment. It does not attempt to present a comprehensive review of all ongoing proposals on the development of the Ecosystem Approach in Europe. In further developing an Ecosystem Approach to the management of human activities in the European marine environment, it will be necessary to take account of the existing frameworks of indicators/ecosystem objectives (e.g. the Ecological Qualities (EcoQ's) and Ecological Quality Objectives (EcoQO's) concept developed within Marine Conventions such as OSPAR). Although we do not expect every ongoing initiative to follow precisely the guidelines laid out here, it will be necessary to ensure the general intercompatibility of all those initiatives, with each other and with the conceptual approach underlying this guidance.

3 Ecological status

Humans have affected European marine ecosystems for hundreds of years. Some of these effects have been sustainable and have not compromised the options for future generations to benefit from the full range of goods and services that ecosystems provide, or the capacity of the ecosystems to respond to environmental change. Conversely, other impacts have not been sustainable and have led, for example, to species depletions or extirpations, fish stock collapse, or the degradation of ecosystem processes. The overriding objective of a European Marine Strategy is to ensure that all human activities are sustainable and that its vision and strategic goals are reached.

Ecological status is an expression of the quality of ecosystem structure and function. Ecological status varies naturally in response to drivers like climate, but human impacts also affect the ecological status of ecosystems, sometimes profoundly. Ecological status is good when human activities are sustainable, as defined above. Good ecological status does not imply that human impacts are not detectable, since some degree of effect is unavoidable whenever humans take benefits from the range of goods and services that ecosystems provide. However, when ecological status is good, the human impacts are still reversible, so any other mix of ecological goods and services could also be taken, should societal needs or values change. In the context of the European Marine Strategy, ecological status would be good when the targets for all indicators that underpin the Strategy have been met, moderate when all precautionary limits were avoided, and poor if any precautionary limits were not avoided.

4 The Ecosystem Approach

4.1 The concept

The Ecosystem Approach is embedded in the concept of sustainable development, which requires that the needs of future generations are not compromised by the actions of people today. The Ecosystem Approach puts emphasis on a management regime that maintains the health of the ecosystem alongside appropriate human use of the marine environment, for the benefit of current and future generations.

The Convention on Biological Diversity (CBD) defines the Ecosystem Approach as "a strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way", and the ecosystem can be defined as "an interacting complex of living communities and the environment, functioning as a largely self-sustaining unit." Humans are part of the ecosystem.

To provide the greater specificity for the purposes of the European Marine Strategy the Ecosystem Approach could be described as 'a comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of the marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity.' This description clearly places humans as part of natural ecosystems, and stresses that human activities in these ecosystems must be managed so that they do not compromise ecosystem components that contribute to the structural and functional integrity of the ecosystem.

The application of the Ecosystem Approach in the marine environment must take account of the linkages between the terrestrial and marine environment and recognise that actions on land can affect the marine environment. Decisions on appropriate management actions will need to take into account environmental variation and natural change.

The Ecosystem Approach strives to ensure that those human activities and demands that have an actual or potential impact on the marine environment are managed effectively. The Ecosystem Approach does not require control of the natural processes of ecosystems; only that these must be considered in managing human activities. The Ecosystem Approach to management is based on a long-term perspective, and highlights the dependence of economic and social sustainability on ecological sustainability. Ecological sustainability will be achieved by setting and achieving ecological objectives that protect ecosystem structure and function from serious or irreversible harm. Economic and social objectives should be met without compromising ecological objectives. Achieving the appropriate balance between ecological, economic, and social objectives requires that ecological objectives, and the associated operational objectives, should be set on geographical scales comparable with economic and social objectives.

Common principles will underpin the effective implementation of the Ecosystem Approach, and will apply to the planning and the management in all regions. Guidance on the key ecological factors that should be considered when translating these principles into ecological objectives and operational objectives is provided in Annex 1.

4.2 Management regions

The Vision, the strategic goals and objectives, and the principles should apply to the marine environment as a whole. This means that the area in question should include all waters under national jurisdiction including coastal waters and will, in some sea areas, also include waters outside national jurisdictions.

The Marine Strategy will be implemented at many scales, ranging from local to pan-European. The application of the Ecosystem Approach requires ecological objectives, operational objectives, indicators, targets, and limits that can be applied at all these scales. However, if there are activities taking place outside the area of implementation with impacts inside the area then these must be taken into account when defining actions to avoid or remediate impacts. Whereas some ecological objectives could be the same in all areas or at all geographical scales, such as the ambition to limit harmful substance to levels that do not threaten the health of the ecosystem including humans, other ecological objectives and associated operational objectives would apply at scales ranging from local to regional.

Since the Marine Strategy will be implanted at many scales, to achieve consistency it will be necessary to identify individual management regions for which ecological and operational objectives will be defined. Ecosystem boundaries are typically based on biological and physical processes. The boundaries of the management regions should therefore be primarily based on biogeographic and oceanographic features. By doing so, management regions will be characterised by similarity in biogeographic and oceanographic characteristics among sites within the same management regions. This enhances the opportunities to pursue management objectives in consistent and orderly ways within each region. The process of identifying appropriate boundaries between regions should also take account of existing political, social, and economic and management divisions, since this is likely to reduce conflicts and inconsistencies in the management process and increase the probability of meeting ecological objectives. However, it is recognised that boundary problems cannot be totally avoided, given the ongoing changes in patterns of human activity and the environment, as these are subjected to changes over time as well as variation in human behaviour.

When selecting management regions, some of the biogeographic characteristics to consider will include the composition of faunal communities and patterns of primary production. Appropriate physical oceanographic characteristics to consider include depths, basin morphology, tidal and ocean currents, temperature, or degree of seasonal stratification. Identification of management regions should also take account of the links between the marine and terrestrial environment, including patterns of land use and distribution and density of human populations. Appropriate human activities may be fisheries, mineral extraction, energy, and shipping.

5 Objectives, indicators, limits, and targets

5.1 Qualities of good objectives

Unambiguous ecological and operational objectives are needed to underpin the implementation of the Ecosystem Approach. Ecological and operational objectives will be required at all scales, from local to regional to ecosystems. At all scales, effective ecological and operational objectives should be SMART:

(1) **Specific**. Objectives should clearly specify the state to be achieved and be interpreted unambiguously by all stakeholders.

(2) **Measurable**. Good objectives should relate to measurable properties of ecosystems and human societies, so that indicators and reference points can be developed to measure progress towards the objective.

(3) **Achievable**. Good objectives should not conflict. Within an effective management framework, it should be possible to achieve all objectives. Good objectives should describe a state of the ecosystem, including the position and activities of humans within it, which accurately reflects the values and desires of a majority of stakeholders.

(4) **Realistic**. Good objectives will be implementable using the resources (research, monitoring, and assessment and enforcement tools) available to managers and stakeholders. Good objectives should reflect the aspirations of stakeholders, such that the majority of stakeholders will strive to achieve them and ensure sustainable development.

(5) **Time bound**. There should be a clearly defined time scale for meeting objectives.

The process for identifying objectives must be inclusive and consultative. Objectives will be set at many geographic scales, apply to many types of ecological, social, and economic properties, and be used by many types of governance systems. The capacity to set and address ecological and operational objectives will differ between different areas based on the differences in factors such as the available scientific knowledge, the human activities in the areas, and the threats present. Reconciliation of economic and social objectives with ecological objectives will pose different challenges in different management regions. It is therefore appropriate to apply different ecological and operational objectives in different circumstances.

To ensure that the groups of objectives set in different management regions are compatible at all scales of governance, objectives must relate upward (geographically and in terms of governance bodies) without conflicts and contradictions, and relate downward without gaps or inefficiencies.

5.2 Indicators, limits, and targets

This section sets out a process for developing the indicators, limits, and targets associated with the operational objectives. Indicators are needed to monitor the progress being made towards meeting operational objectives and to guide management decision-making. Indicators may describe ecosystem state, activity-specific ecosystem properties, or impacts.

5.2.1 Indicators

Effective indicators should have the following properties:

(1) **Measurable**. Indicators should be measurable in practice and in theory. They should be measurable using existing instruments, monitoring programmes, and analytical tools available in the regions, and on the time-scales needed to support management. They should have minimum or known bias, and the signal should be distinguishable from noise.

(2) **Cost-effective**. Indicators should be cost-effective because monitoring resources are limited. Monitoring should be allocated in ways that provide the greatest benefits to society and the fastest progress towards sustainable development.

(3) **Concrete**. Indicators which are directly observable and measurable rather than reflecting abstract properties which can only be estimated indirectly are desirable. This is because concrete indicators are more readily interpretable by the diverse stakeholder groups that contribute to management decision-making.

(4) **Interpretable**. Indicators should reflect properties of concern to stakeholders, and their meaning should be understood by as wide a range of stakeholders as possible. Public understanding of the indicator should be consistent with its technical meaning.

(5) **Grounded in theory**. Indicators should reflect features of ecosystems and human impacts that (according to well-accepted peer-reviewed scientific theory) are relevant to the achievement of operational objectives. They should not be based on theoretical links that are poorly defined or validated.

(6) **Sensitive**. Trends in the indicator should be sensitive to changes in the ecosystem properties or impacts, which the indicator is intended to measure.

(7) **Responsive**. Indicators should be responsive to effective management action and provide rapid and reliable feedback on the consequences of management actions.

(8) **Specific**. Indicators should respond to the properties they are intended to measure rather than to other factors, and/ or it should be possible to disentangle the effects of other factors from the observed response.

Few indicators will have all the properties listed above, and thus several indicators with complementary properties may be needed to provide strong and effective support for management decision-making. In selecting indicators, it is important to ensure compatibility among indicators so that they do not provide conflicting information for managers or provide the same information in several different ways and thus obscure overall patterns. This issue becomes even more important when an evaluation of the ecological state is based on the integration of several indicators – to derive a higher-level indicator.

The properties highlighted here refer primarily to indicators of ecosystem state. Various institutions have developed other types of indicators, and indicators for pressure and response may also be needed to fully support management decision-making. It is not the purpose of this document to deal with these types of indicators even though the properties listed might apply to these indicators as well.

5.2.2 Limits and targets

For indicators to support decision-making, managers need to know the values associated with specific ecosystem states. These values are known as reference points. Reference points that might support ecosystem-based management include those for the unexploited ecosystem (or component), target reference points associated with the favoured state of the ecosystem (as a trade-off between environmental, social, and economic benefits), and limit reference points which, if exceeded, indicate that the ecosystem will be subject to serious or irreversible harm or that society has driven the ecosystem to a state where it does not want to go. As estimates of indicators contain measurement error, precautionary reference points may be used to guarantee a high (preferably specified) probability that the limit reference point is not exceeded. Indicators must be assessed regularly in relation to reference points, to identify changes in the status of the system.

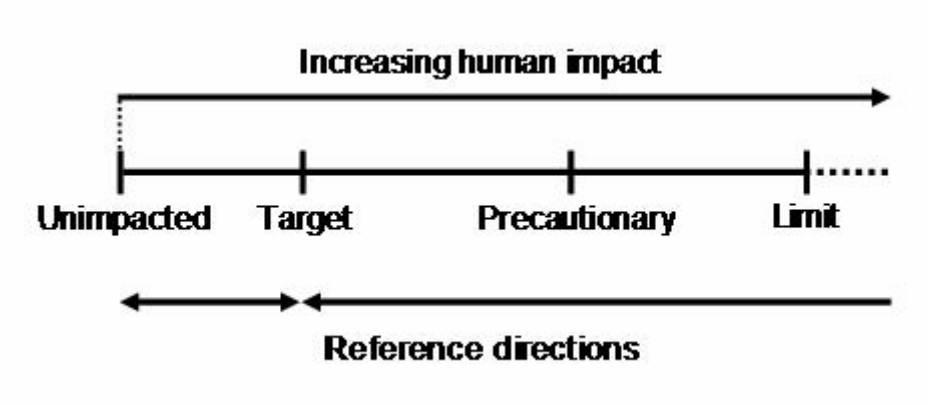


Figure 1. The relationship between target, limit, precautionary, and unexploited reference points.

For contaminants, reference points may be set to zero, or to the lowest detectable concentration, reflecting a wish to remove from the marine environment harmful substances that provide no ecological, social, or economic benefits. Reference points that take account of the unexploited situation may be appropriate for assessing the overall impact of fishing, because it is important to avoid the "shifting baseline syndrome", where baselines set with a short-term perspective represent an increasingly impacted state over time. However, this does not imply that the management objective is to perpetuate the unexploited state. Society often deems some impacts acceptable, given the social and economic benefits that fisheries can provide. Ultimately, setting a management objective is a societal issue, though science can provide commentary on the consequences of setting different objectives, and how to meet them.

6 Management

6.1 Adaptive management

Decision-making for management relies on the assumption that we can predict the effects of management actions. Decision-making should preferably be supported by scenario studies with quantitative predictions. This ability relies on how well we can quantify the effects of management actions and hence on the availability of proper data and a good understanding of the major processes controlling the ecosystem components affected by management action.

However, scientific knowledge is always incomplete, and the extent to which it is incomplete will vary among regions and for different ecosystem components. Therefore, managers will rarely be in a position to use formal rule-based management frameworks to implement the Ecosystem Approach.

The Ecosystem Approach should also take account of the natural variability in marine ecosystems and management should recognise that ecosystems are dynamic. This implies that management frameworks will not be static, but continually reassessed and updated as circumstances change.

The alternative to rigid and inflexible management frameworks is adaptive management, and adaptive management is part of the Ecosystem Approach. Adaptive management requires less stringent assumptions about scientific understanding of ecosystem processes but requires an ability to predict the trend and general magnitude of the effects of management actions. Managers would be guided towards the achievement of the operational objectives, and hence the ecological objectives and strategic goals, through a series of adjustments of the management measure in response to system reactions.

Adaptive management is a form of learning by doing, with structured feedback and decision-making. The adaptive approach uses the ecological indicators to support the operational objectives, and requires that monitoring and assessment are of sufficient accuracy, precision, and frequency to ensure that the effects of management measures can be evaluated in a timely manner, and adjusted as necessary.

In order to make adaptive management efficient, the indicators should provide rapid and reliable feedback on activities and management measures. Limit or target points will often have to be set with limited knowledge and re-evaluated and revised regularly as learning-by-doing provides more and better information. In the longer term even the ecological objectives and operational objectives may need to be refined to reflect new knowledge of relationships and impacts.

6.2 Management structures

Management is most effective when the entities being managed, whether institutional, corporate, or individual can be identified directly and, in this way, jurisdictional responsibility for management is clear and unambiguous. This ideal situation is not often encountered, even when managing a single economic sector.

The Ecosystem Approach creates new challenges for management. Individual actors will become accountable for a wide range of direct and indirect impacts on marine ecosystems. Consequently, they may have to deal with an even wider range of regulatory authorities, and respond to a variety of management instruments, often some legally binding and others voluntary. Relevant authorities should try to coordinate themselves in order to facilitate the involvement of individual actors in this process.

The Ecosystem Approach requires that more components of marine ecosystems are taken into consideration in management and are protected from human activities, even if they lack direct economic or cultural significance. This situation creates a risk that mitigation measures considered necessary to support one aspect of the Ecosystem Approach may actually cause greater harm to some other part of the ecosystem. Hence any suite of management measures must be carefully coordinated and checked for compatibility before implementation. Management should recognise the potential significance of cumulative impacts in all decisions and actions, and consider both direct and indirect impacts.

The complexities of the Ecosystem Approach will require that management should be better integrated across agencies, economic sectors, and levels of government, to ensure both policies and practices are mutually compatible. The selection of appropriate management regions (see Section 4.2) will help with this integration as the appropriate scale will help diverse agencies to coordinate their activities effectively.

6.3 Management tools

There is a need for appropriate instruments to manage human activities in a way which is consistent with the operational objectives, and hence the ecological objectives and strategic goals. Different types of management tools are described below:

(1) **Input controls**. Management measures that influence the *amount of a human activity* that is permitted. These include controls on emission levels of contaminants, on fishing capacity and activity, on numbers of tourists, and on vessel sizes or numbers in shipping.

(2) **Output controls**. Management measures that influence the *degree of perturbation of an ecosystem component* that is permitted. Controls include nutrient input limits for land-based activities, limits of concentration of contaminants in water, sediment, and biota, allowable catches and bycatch limits in fisheries, tonnage allowances in sediment

extraction, regulation of coastal development, tourism, and ballast water exchanges rules for shipping.

(3) **Spatial and temporal distribution controls**. Management measures which influence *where and when an activity is allowed to occur*. These include regulations for the localisation of industrial installations, closed areas for fisheries, defined shipping lanes for transportation, and zoning and marine protected areas for regulation of multiple uses.

(4) **Integrated planning tools.** These are not management *measures*, but are tools to ensure that management is coordinated. Coordination can be achieved by using integrated planning mechanisms that ensure that management actions complement each other both across multiple human activities and diverse ecosystem effects. Integrated planning tools include strategic environmental assessment, integrated coastal zone management, and systems of spatial planning**.** It is important that these Integrated Tools take full account of land-based activities that affect marine ecosystems.

(5) **Remediation tools**. Management tools which guide human activities to restore damaged components of marine ecosystems. These include clean-up operations on polluted sites, recovery plans for species at risk and for depleted fish stocks, and shoreline restoration programmes for damaged habitats.

(6) **Economic incentives.** Management measures which make it in the economic interest of those using the marine ecosystem to act in ways which help to achieve the ecological objectives for the ecosystem, rather than pursue selfish goals. Eco-certification schemes and economic sector-based instruments such as the FAO Code of Conduct have both contributed to placing fisheries in a broader ecosystem context. Such tools have the potential to integrate the planning and management of other human activities as well.

Open communication between institutions dealing with the management and the various stakeholders is important in order to ensure that management actions are optimized. Furthermore, the awareness among stakeholders can be improved by proper information about the potential threats and the management tools to be used.

All of the tools described above require enabling policies in order to be implemented effectively. For many tools, existing policies provide an effective basis for management action. For example, mechanisms of the International Maritime Organisation provide a basis for input controls and spatial controls in marine transportation; the Common Fisheries Policy provides a basis for input, output, and spatial distribution controls of fisheries, and the Habitats (92/43/EEC) and Water Framework Directives (2000/60/EC) provide a broad policy basis for input, output, and spatial distribution controls on many human activities. Annex 2 provides additional information on instruments available in the EU, organised thematically (biodiversity, hazardous substances, eutrophication, etc.).

There are gaps in the existing policy instruments. For example, the ability to regulate tourism is not well covered by either input or output controls. Also, the policy basis for implementing many of the integrated planning tools could be strengthened, and windows created and strengthened for the coordination of planning and management of land-based activities with regard to their impacts on marine ecosystems. Likewise, many of these policy instruments have been adopted at the largest spatial scales, but their success depends on effective translation at regional and local scales. The evaluation and management of the long-term consequences of the implementation of these instruments on other sectors and on the marine environment is a condition for the adoption of an Ecosystem Approach based on the precautionary principle.

Management is often based on incomplete knowledge. Planning tools thus have a particularly important role in understanding how multiple uses of the marine ecosystem can proceed with the smallest practical impacts. Incomplete knowledge also means that all of the tools, but particularly planning tools, also need to be adaptive, so the policy instruments must ensure

that management can respond rapidly as new information is acquired. Finally, it is important to build support that ensures compliance with both the spirit and the letter of any management decision; otherwise all efforts may be undermined.

7 Assessment, monitoring, and scientific research

Assessment, monitoring, and scientific research will be required to support the Ecosystem Approach. They are required to provide a sound scientific basis for identifying ecological objectives and associated operational objectives, selecting indicators, and identifying reference points. They are also required to provide regular evaluations of ecosystem status and to assess the values of indicators in relation to reference points. The capacity for supporting science will vary regionally and the selection of indicators, limits, and targets to support the achievement of the operational objectives should be sensitive to regional capacity for support.

The science available will almost always be perceived as incomplete, particularly in the most sensitive or contested areas. The resources should focus on where risks are highest, and the science advice provided should be clear about sources and magnitudes of risks and uncertainties. Managers will have to make best use of incomplete advice and apply the precautionary principle when the advice is uncertain about consequences of human activities.

Policy-setters and managers should interact with scientists at an early stage in the process to form tractable questions and requests for advice, so the scientific community can address the questions asked and ensure that the answers will support management. In addition, managers implementing the Ecosystem Approach should liaise effectively with scientists involved in planning and coordinating monitoring or assessment programmes. Through this liaison, managers and scientists should identify opportunities for joint and more cost-effective monitoring activities from the same platforms, or multiple uses of existing monitoring programs.

Advice should be clear, direct, and relevant to the needs of the entire governance process. Advice should come from scientifically reliable sources and should be delivered by processes which are open to external scrutiny. The advisory processes should also be uncompromising in their rigour and objectivity. Nonetheless, there is growing acknowledgement that there are many sources of sound information on status and trends of the properties being assessed and of hypotheses about the causes of trends in the assessments. Thus the scientific advisory process should be able to draw in and consider the ecological knowledge of resource users and those living close to the ecosystems being assessed, without compromising the objectivity, rigour, or credibility of the ultimate advice.

8 Applying the Ecosystem Approach at a regional scale

The Ecosystem Approach can be applied by following a seven-step process:

8.1 Step 1. Scoping the current situation

Regional implementation requires description of the starting conditions for management within the Ecosystem Approach. This has four components:

(1) **Evaluate the ecosystem status**. This is a science-based activity, using the best information and practices available. It requires a description of the ecosystem, based on the best available knowledge of ecosystem structure (species and size compositions, spatial distributions, population trends, etc.), function (productivity, predator-prey linkages, energy flows), and environmental quality (contaminants, nutrients, physical destruction of the habitats, etc.). For many regional seas, ecosystem status evaluation is already undertaken periodically, for example by the Marine Conventions.

(2) **Evaluate relevant ecosystem policies**. This is a policy-based activity, drawing together regional policies and legal instruments that define limits (and sometimes targets) for ecological and environmental health such as the Community Directives and Regulations.

(3) **Compile inventory of human activities**. This is a socio-economic activity, to create an inventory of what human activities occur within the marine ecosystem, at what rates, and where. It also inventories the land-based human activities which impact marine ecosystems. For many regions economic activities by sector are reported periodically. However, these regional reports would have to be augmented with human uses which may have high societal value, but possibly low direct economic consequences.

(4) **Evaluate relevant economic and social policies**. This is a policy-based activity, drawing together the economic and social strategies such as the Sustainable Development Strategy, regional development plans, regional economic activity reports, and other policy-like expressions of the uses which society wishes to make of marine ecosystems. In addition, the economic costs and benefits of other services provided by the ecosystem need to be evaluated.

8.2 Step 2. Contrasting with the Vision

The current situation, as described by scoping (Step 1) should be contrasted with the Vision *"we and future generations can enjoy and benefit from biologically diverse and dynamic oceans and seas that are safe, clean, healthy and productive"*.

It is likely that discrepancies will be found between the current situation and the situation described in the Vision. Where the discrepancies are in ecosystem status, they are addressed through taking an Ecosystem Approach to management, as developed in this document. Where the discrepancies are in social or economic benefits, they must be addressed through economic and social development agencies, which are not considered in this document. However, their link to the Ecosystem Approach must not be lost, as the relevant management will always be underpinned and constrained by the requirement for sustainability.

8.3 Step 3. Identifying important ecosystem properties and threats

Ecosystems have many properties, and realistic Ecosystem Approaches to management can only evaluate and make management decisions based on tractable subsets of these properties. The scoping of the current situation will identify ecosystem properties of particular importance, e.g. biodiversity features, species at risk of loss, species supporting economic industries such as fishing or eco-tourism, or keystone species. Ecosystem components impacted by past or current human activities will also be identified when the properties that have been identified are contrasted with the Vision. Cross-tabulation of the properties and components identified in Steps 1 and 2 with the major human activities impacting the marine ecosystem will allow all threats to important components of ecosystem structure, function, or environmental quality to be identified. The cross-tabulation will also highlight areas where additive or synergistic impacts of human activities might be expected.

8.4 Step 4. Setting ecological objectives

Based on the analysis of ecosystem properties and threats (Step 3), ecological objectives can be set. The complete set of ecological objectives should be reviewed to ensure that, together, they provide adequate coverage of the valued ecosystem components and threats, while being tractably small in number. Gaps and redundancies should be identified and addressed at this stage. Likewise the suite should be reviewed in a science context to ensure that all the ecological objectives are inter-compatible, so they can be achieved together. Those setting the social and economic objectives for uses of the regional seas should crosscheck their objectives for compatibility with the ecological objectives at this stage as well. Iterative revisions may be

necessary before full reconciliation of ecological, economic, and social objectives is achieved and Step 5 can be undertaken.

8.5 Step 5. Deriving operational objectives with indicators and reference points

The process for translating ecological objectives to operational objectives was described in Section 5.2. The linkage to ongoing monitoring and assessment is also important at this stage, but the process in Steps 3 and 4 should ensure that indicators are identified on the basis of need.

It is likely that structural ecosystem properties will feature more prominently in the operational objectives than will functional ones. This is not because they are more important, but because they are more tractable to measurement, and more directly tied to management actions. When the suite of operational objectives, indicators, and reference points has been assembled, they should be examined together relative to the Vision. If the targets were being achieved on all the operational objectives, would the resultant ecosystem match the Vision? If not, some gaps have been left in Steps 1–4, and the full process should be reviewed for comprehensiveness, as well as practicality. Revisions or additions may be needed.

8.6 Step 6. Ongoing management

Once the suite of operational objectives, indicators, targets, and limits have been adopted, the management tools (Section 6.1) are applied to continually move the ecosystem closer to the targets and further from the limits. Monitoring and reliable assessment of current status of the indicators is particularly important in this phase of the Ecosystem Approach. Success will also depend on adaptive responses to discrepancies and to new information about ecosystem status, human activities, and their interactions.

8.7 Step 7. Periodic updates

Although progress on the individual operational objectives should be evaluated regularly, a piece-meal approach to assessing progress on the Ecosystem Approach is inherently self-contradictory. Scoping of the current situation (Step 1) needs to be repeated at intervals, to review ongoing changes in ecosystem status that may be influenced substantially by processes such as climate change. Only by comparing the changes in ecosystem status and human activities, over time and in relation to the Vision, strategic goals, and ecological objectives, is it possible to determine whether the Ecosystem Approach to management has been implemented successfully (see Section 9).

Such periodic re-evaluations also allow the effects of inevitable and often unforeseeable natural variability in ecosystems to be considered in management. Environmental changes may require adjustments to the ecological objectives, even if the Ecosystem Approach has been implemented. Similarly, changes in social and economic conditions may result in changes to human activities affecting the marine ecosystem, whether the social and economic objectives have been changed explicitly or not. Periodic updates allow changing societal needs to be reconciled with changing ecological conditions.

Finally, each periodic update provides an opportunity for new scientific knowledge to be incorporated into the Ecosystem Approach. Where possible, of course, new knowledge is applied as quickly as it becomes available. However, because the suites of ecological objectives and the operational objectives must function well together, there can be sound reasons for not changing them very frequently. Periodic revisions allow for the updating of the entire system, keeping practice as close to the state of knowledge as possible.

Examples of setting ecological objectives, operational objectives, indicators, and targets for contaminants and eutrophication are provided in Annex 2.

9 Measuring progress towards implementation

When the seven-step process for applying the Ecosystem Approach at a regional scale is followed, then the extent of progress towards implementation can be measured using the following tests. The Ecosystem Approach would be considered as fully applied when all tests have been passed.

1. Have management regions with unambiguous boundaries been defined and have responsibilities for the management of all activities at all scales been identified?
2. Has the current status of the ecosystem been described and contrasted with the Vision?
3. Have the properties of the ecosystem and the associated threats been fully documented and likely additive or synergistic threats identified?
4. Have ecological objectives and operational objectives with appropriate properties (SMART) been identified and agreed in all regions, based on an inclusive and consultative process?
5. Have all incompatibilities of ecological objectives, operational objectives, and scales of management been identified and rectified?
6. Have indicators, limits, and targets been established for each operational objective and are they inter-compatible?
7. Have sufficient management tools to support the operational objectives been identified and put in place?
8. Will all proposed management tools be effective in supporting the ecological objectives and operational objectives of management and are the management methods coordinated and compatible?
9. Has a process for providing quality-controlled supporting science been established, and is there a clear route by which the science is fed into the decision-making process?
10. Is the science advice supported by adequate monitoring and assessment and are the monitoring and assessment procedures also quality controlled?
11. Has a process for management feedback and decision-making been established and will it ensure ongoing compatibility of management methods?

10 Definitions used

Bias – The difference between the estimated and the true value of a parameter. Measures which are ACCURATE have low bias.

Habitat of a species – An environment defined by specific abiotic and biotic factors, in which the species lives at any stage of its biological cycle.

Indicator – A variable, pointer, or index of a phenomenon. Indicators can reflect the status and changes of well-defined parts of an ecosystem, derived from observations, normally from monitoring programmes.

Limit reference point – The point/value of the indicator to be avoided, since it is associated with a high risk of serious and irreversible harm to ecosystem.

Natural habitat – Terrestrial or aquatic areas distinguished by geographic, abiotic and biotic features, whether entirely natural or semi-natural.

Objective – Used without modifier “objective” can refer to ecological, economic, and social objectives.

Ecological objective – An objective that relates to ecosystem health, structure, and/or function.

Operational objective – An objective with sufficient specificity that it is supported by an indicator and an associated target or reference direction.

Precaution. – Different disciplines make different distinctions among the words 'Precautionary Principle' and 'Precautionary Approach', so use can depend on context. The concepts in common among the uses of "precaution" are that a) decision-making should be highly risk averse when dealing with the threat of harm that is serious or difficult to reverse, and b) scientific uncertainty should not be a reason to delay the risk averse actions motivated in a). In the context of these guidelines, it is assumed that the best practice should be applied for each discipline.

Precision – The expected scatter of values around the true value. Noisy measures have low precision.

Reference point – A specific value of an indicator associated with a particular objective. The types of reference points that can be used to support the Ecosystem Approach are described in Section 4.2.

Sensitive – The magnitude of response of any indicator to a change in the system.

Sustainable exploitation – The exploitation of a resource in such a way that the future exploitation will not be prejudiced and that it does not have a negative impact on the marine ecosystems.

Target reference point – The point/value of the indicator associated with the state of ecosystem that best meets the goals of society, while ensuring that the human uses are sustainable.

Uncertainty – In colloquial meaning, uncertainty relates to how much is unknown about a system. In technical use, particularly for risk management, it is the probability distribution of a variable (ecosystem measure or model parameter) across the range of values which the variable can assume.

Annex 1: Key ecological factors to be considered when addressing Principles

Objectives will be set at many geographic scales, for many types of ecological, social, and economic properties and by many types of governance system. In this Annex we provide guidance on the key ecological factors to be considered when translating the principles into ecological objectives and operational objectives.

Principle	Issues underpinning principle	Associated ecological issues
1. Management should be based on a shared vision and requires stakeholder engagement and participation	1a. Management should be based on shared visions and development of objectives should involve all stakeholders	1a(i) Ecological and operational objectives and targets for all user groups have to be intercompatible. This requires that the states of ecosystems consistent with achieving the objectives and associated reference points are known and that an appropriate forum to achieve intercompatibility is available. 1a(ii) Stakeholders have to be very well informed about the ecological implications of pursuing their sector visions and objectives. This requires effective mechanisms for science – stakeholder communication.
	1b. Management should seek to increase public awareness	1b(i) Public understanding of ecological objectives, operational objectives, and Indicators should match their technical meaning.
	1c. Management should promote good governance and wide stakeholder participation	1c(i) Science assessment and advisory processes must be inclusive of traditional / experiential knowledge, and operate in an open, transparent manner.
	1d. Adoption of ecological objectives should be based on societal choice, being aware of the responsibility for the protection of the marine environment	1d(i) Conservation limits for ecosystem properties affected by human impacts must be set before societal and economic expectations are translated into social and economic objectives. 1d(ii) Setting reference limits for protection of the marine environment is a scientific and technical task for expert groups, where “expert” is broadly defined to make full use of “traditional / experiential ecological knowledge” that is subject to an appropriate process of quality assurance. 1d(iii) It is possible to set reference limits for properties that ensure the protection of the marine environment, even when there are no corresponding targets for those properties.

		1d(iv) To ensure the protection of the marine environment it is necessary to measure the impacts of human activities on important ecosystem properties, whether each property is of social interest or not. 1d(v) To ensure that social choices are expressed as ecological objectives and operational objectives it is necessary to measure the benefits from human activities in marine ecosystems, whether the benefit can be linked to a property of ecological importance or not.
2. Planning and management should be integrated, strategic, adaptive, and supported by unambiguous objectives and take a long-term perspective	2a. Management of human activities should take a long-term perspective	2a(i) To be sustainable human uses have to be robust to occurrence of periods of low productivity, and not dependent on always encountering the "average" condition. 2a(ii) Where there are multiple activities affecting a resource, sustainability needs to measured on the time-scale of the activity with the longest lasting impacts.
	2b. Management should be responsive	2b(i) Management must be able to respond quickly to the inherent variability in marine ecosystems. 2b(ii) Many ecosystem properties have a certain degree of internal resilience. This may mean that unsustainable activities will not result in immediate changes to associated indicators. However, when the indicator does start to change, resilience may already be low, and failure to take swift and effective management action might result in significant ecological harm. 2b(iii) The Ecosystem Approach will always require suites of management objectives. Effective management must always attend to those objectives most at risk of failure, even if many objectives in the suite are being met.
	2c. Quality status as well as the dynamic functions of the ecosystem should be addressed	2c(i) Setting reference points requires setting targets for ecosystem properties as well as human impacts. This requires knowing the capacity of an ecosystem, or the state that an ecosystem must be in, for various uses to be supported. 2c(ii) Setting reference points requires identifying states of the ecosystem that are considered degraded. Some of these states can be identified on scientific and technical grounds. Others may be identified on social or cultural grounds. It is important that the basis for the identification is stated. 2c(iii) There is an asymmetry between reference points set on the basis of dynamic functions (which may be ecologically determined limits) and those set on the basis of quality status (which may be socially determined limits). The former cannot be violated without broad negative consequences for the ecosystem. Violations of the latter may affect quality of life, real or perceived, but have no wider direct repercussions for the ecosystem itself. Reference points for quality status can be set higher than corresponding reference points for dynamic functions, but not lower – where "higher" means a more natural or less impacted state, not necessarily a larger number.

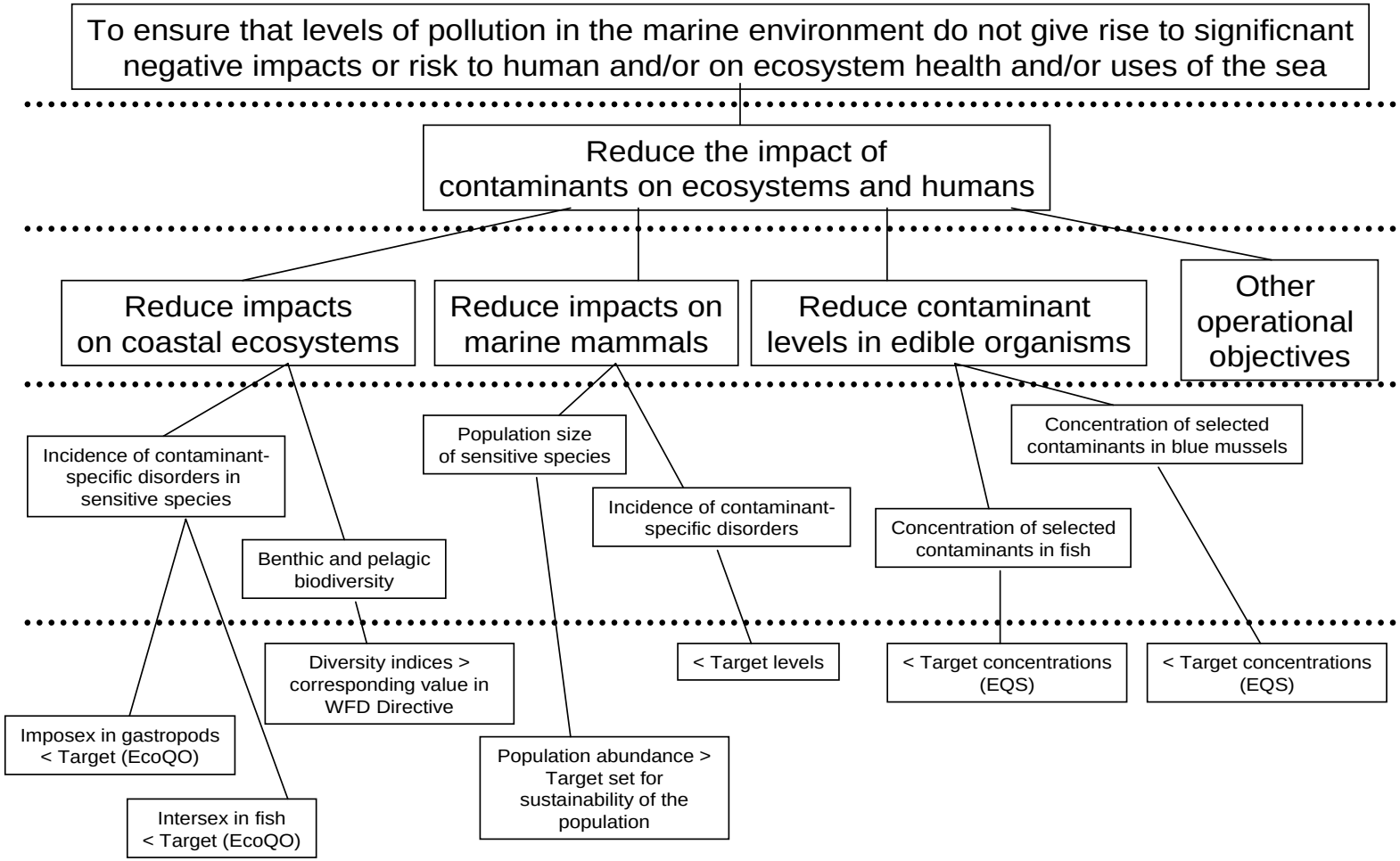
3. The geographic span of management should reflect ecological characteristics and should enable management of the natural resources of both the marine and terrestrial components of the coastal zone	3a. Ecosystems are dynamic; their attributes and boundaries are constantly changing, as are the patterns of human use.	3a(i) Patterns of both spatial and temporal variation in ecosystem properties need to be measured and taken into consideration when setting objectives. 3a(ii) For effective monitoring of achievement of objectives, it is necessary to determine which ecosystem and social/economic properties are stable enough for meaningful evaluation of status relative to reference points, and wherever possible to frame the objectives accordingly. 3a(iii) The approach requires the definition of local and regional boundaries. This should be done on empirical grounds, which are documented fully, so both the management boundaries and the scientific basis for them can be reviewed periodically. 3a(iv) It is essential to obtain periodic feedback through regular and rigorous status evaluation, using those properties for which objectives are set. 3a(v) Human activities take place on a variety of spatial and temporal scales. Thus cumulative impacts and interactions may need to be assessed on several scales, to allow the activities to be adjusted / tuned on scales appropriate to the activity, but with consequences appropriate to the scale of the interactions.
4. The management objectives should be consistent with the requirement for sustainable development and reflect societal choices. They should address the desired quality status of the structure and dynamic functions of the ecosystem	4a. Management should focus on the conservation and recovery of ecosystem structure and function rather than just maintaining degraded ecosystems	4a(i) Marine ecosystems around Europe have been used by humans for centuries. Therefore even the longest available time-series used to assess the status of the ecosystem may not reflect the true extent of human impacts. 4a(ii) Not all causes of ecosystem degradation are local, so management action may be required in other regions to address local issues. 4a(iii) In ecosystems which are severely disturbed, or in which phase shifts have led to alternate ecosystem states, small reductions in human impacts may not be sufficient to achieve sustainability. In these cases, major changes in patterns of human activity may be warranted to ensure that the ecosystem can provide long-term benefits to society.
	4b. Sustainable human use and ecological values should be central to establishing objectives	4b(i) To achieve sustainability of human impact, it is necessary that appropriate technical experts determine the state(s) of the ecosystem which must be maintained in order that the desired human uses can be sustained. 4b(ii) Targets and limits for valued ecological components should be set based on risks assessment, historical information, or theoretical analysis. In all cases, the justification must be fully peer-reviewed and documented.

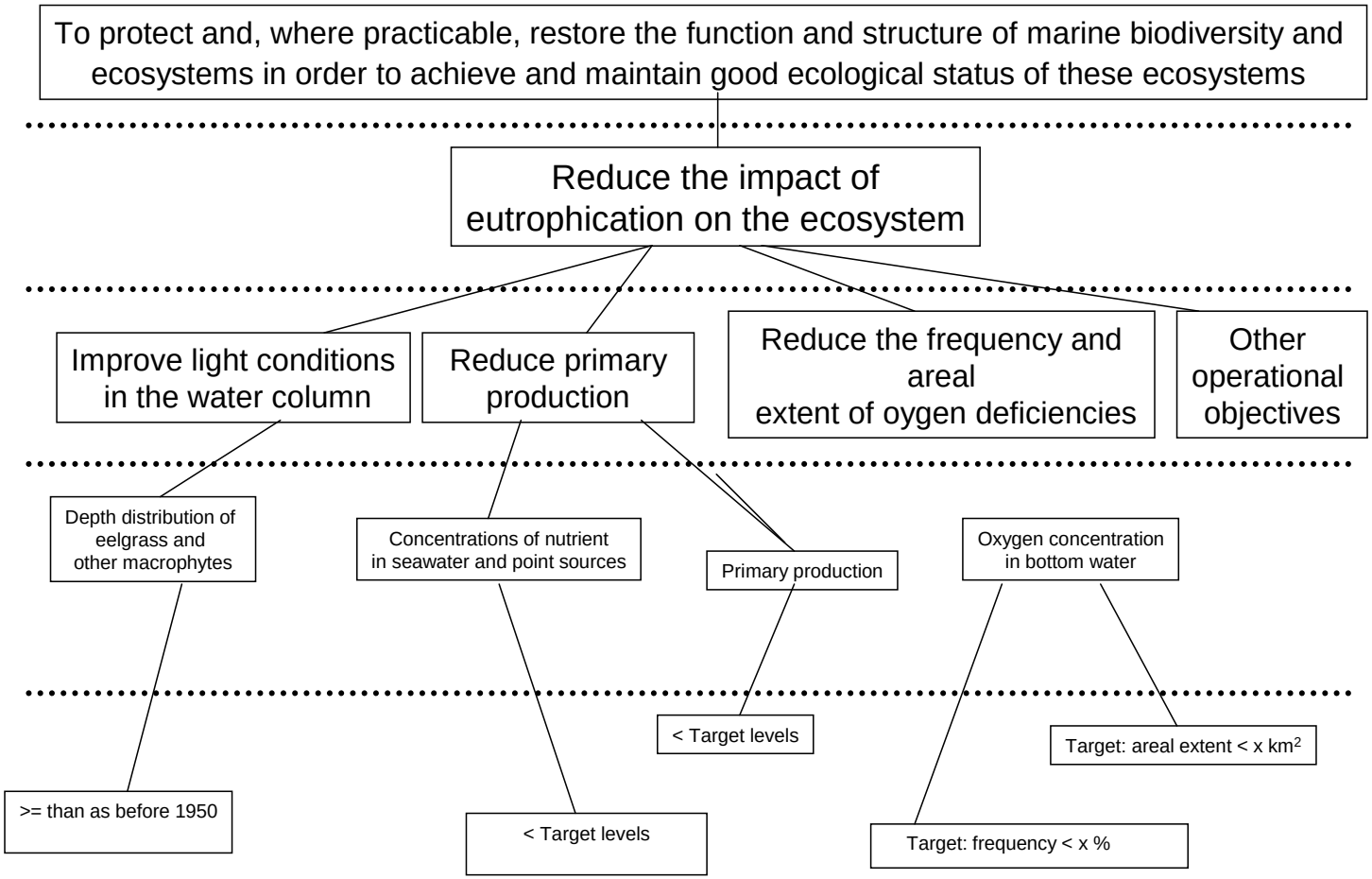
		4b(iii) Societal values should be considered when setting targets and limits, but the technical aspects of setting objectives and benchmarks should be separated from dialogue and consultation about the societal values.
5. Management should be based upon the precautionary principle, the polluter-pays principle, and the prevention principle. Best Available Technologies (BAT) and Best Environmental Practices (BEP) should be applied	5a. Management should be precautionary and risk averse	5a(i) During periods of above-average ecosystem productivity, the scale of human-use activities should not be allowed to ramp up in any ways that would be difficult to reverse when conditions become more typical. 5a(ii) Human impacts which result from the use of spatially distributed resources should be managed to allow realistic recovery times for those resources. 5a(iii) When recovery is needed to achieve sustainability, human impacts should not recommence until substantial progress on recovery has been made. 5a(iv) Where there are multiple activities affecting a resource, sustainability of each use requires considering how effects of the activities interact, and how consequences may accumulate over time.
6. Management should be supported by co-ordinated programmes for monitoring, assessment, implementation and enforcement, and by peer-reviewed scientific research and advice and make the best use of existing scientific knowledge	6a. The infrastructure should be robust to environmental variability and change	6a(i) The natural variability of marine ecosystems includes occasional occurrences of change in status which are large, abrupt, and very difficult to predict. Monitoring must be vigilant for indications of such changes, and management must respond to such signs swiftly. 6a(ii) Where objectives, targets, and benchmarks set for the protection and conservation of the marine environment are comparable, assessments should address them in a comparable way. 6a(iii) Different assessments covering (parts of) a sea region should be consistent for that region. 6a(iv) Assessments should be scientifically sound and aimed at the broadest level of acceptability possible in such a way that they can be used by other organisations. 6a(v) Information on the marine environment should, to the fullest extent possible, be shared to facilitate the production of assessments.
	6b. Management should be based on best available scientific knowledge, continued learning, and indicator-based monitoring and assessment	6b(i) Regular, rigorous, and impartial assessments of indicators must be structured into the overall management process. 6b(ii) For precautionary, risk averse management, serious or irreversible harm has to be defined so that limit reference points can be set. This has important implications for indicator selection.

		6b(iii) For precautionary, risk averse management, it must be possible to conduct risk assessments on the indicators. This has important implications for indicator selection. 6b(iv) For precautionary, risk averse management, management systems must be designed to react swiftly and effectively to scientific advice when conservation actions are required. 6b(v) To be adaptive and allow continued learning, the links of assessment results to management actions must be direct and effective.
	6c. Scientific advice should be impartial and subject to rigorous quality control	6c(i) To develop management based on the best available scientific knowledge, assessment and advisory bodies must have participation by the full range of professional scientific opinions in all relevant fields, operate impartially and by consensus. 6c(ii) The capacity for providing supporting science and quality control will vary regionally and this should thus be reflected in the selection of indicators and targets to support the objectives, rather than adopting indicators that are supported by science without appropriate quality control.

Annex 2: Two examples (contaminants and eutrophication) of setting ecological objectives, operational objectives, indicators, and targets for two different strategic goals.

The five vertical levels in the diagrams reflect (top–down): 1. Strategic goals; 2. Ecological objectives; 3 Operational objectives; 4. Indicators; 5. Targets




To protect and, where practicable, restore the function and structure of marine biodiversity and ecosystems in order to achieve and maintain good ecological status of these ecosystems
Reduce the impact of eutrophication on the ecosystem
Improve light conditions in the water column
Reduce primary production
Reduce the frequency and areal extent of oygen deficiencies
Other operational objectives
Depth distribution of eelgrass and other macrophytes
Concentrations of nutrient in seawater and point sources
Primary production
Oxygen concentration in bottom water
< Target levels
Target: areal extent < x km2
>= than as before 1950
< Target levels
Target: frequency < x %

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