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# METHODOLOGIES FOR SETTING TARGETS RELATING TO ECOLOGICAL OBJECTIVES, TO FURTHER THE ECOSYSTEM APPROACH IN THE MEDITERRANEAN SEA

**Delegates are kindly requested to bring their documents to the meeting**

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## 1. Background

The nations sharing the Mediterranean Sea recognize that an ecosystem approach to conserving natural marine heritage and protecting vital ecosystem services requires systematic planning, and that this planning is most effective when done in a cooperative and coordinated manner at regional, subregional, and national levels.

The Mediterranean countries which are parties to the Barcelona Convention have thus articulated a systematic process for moving towards more effective, ecosystem-based management. The Ecosystem Approach entails countries participating in a seven step process:

1. Articulating a vision for the Mediterranean Sea and coastal areas.
2. Establishing clear strategic goals for the process.
3. Undertaking an initial assessment to determine ecosystem properties, ecological status and pressures, as well as to identify gaps in information.
4. Setting ecological objectives based on the above assessment, to reflect priorities coherent with an ecosystem approach to management.
5. Identifying indicators and targets related to those objectives.
6. Setting up a monitoring plan to ensure that progress towards an Ecosystem Approach is indeed being made.
7. Developing issue-specific or area-specific management plans.

During the 15th Meeting of the Contracting Parties (January 2008), the above roadmap was approved, as was the following Ecological Vision (Decision IG 17/6):

“A healthy Mediterranean with marine and coastal ecosystems that are productive and biologically diverse for the benefit of present and future generations”

Decision IG 17/6 also established the strategic goals aimed for with the Ecosystem Approach process:

i. To protect, allow recovery and, where practicable, restore the structure and function of marine and coastal ecosystems thus also protecting biodiversity, in order to achieve and maintain good ecological status and allow for their sustainable use.
ii. To reduce pollution in the marine and coastal environment so as to minimize impacts on and risks to human and/or ecosystem health and/or uses of the sea and the coasts.
iii. To prevent, reduce and manage the vulnerability of the sea and the coasts to risks induced by human activities and natural events.

To reach these goals, countries have agreed to review existing programmes and develop plans for management that will be more effective and efficient than historically. Representatives of the countries party to the Barcelona Convention have, with MAP guidance, committed to the Ecosystem Approach process (known as ECAP in shorthand), and the region is well on its way to becoming a model for effective management worldwide.

At this point in time, assessments have been completed for the four subregions agreed to by the Contracting Parties, and an integrated assessment has been developed following the adoption of a specific Table of Contents that covers all relevant issues and themes. This integrated assessment, conceived with the purpose of determining priorities for implementing

an ecosystem approach to management, has been useful not only in providing a broadbrush look at the overall status of the Mediterranean and varying conditions within its four subregions, but also in highlighting information availability and needs going into the future. The assessment also provided an important foundation for the 2012 State of the Mediterranean Coastal and Marine Environment Report, which for the first time attempts to take a holistic look at human pressures on marine and coastal systems in order to steer the region towards an Ecosystem Approach.

Countries have also examined, discussed, and adopted Ecological Objectives, Operational Objectives, and Indicators that capture the key ecosystem processes and integrated functioning of the Mediterranean's coastal and marine ecosystems.

The region-wide progress has been to some extent catalyzed by policy developments in the European Union. Shortly after the Decision IG 17/6 was adopted, in June 2008, the European Commission established the Marine Strategy Framework Directive (MSFD) charging Member States to take the necessary measures to achieve or maintain good environmental status in the marine environment by the year 2020 at the latest. According to the Directive Member States marine strategies shall apply an ecosystem-based approach to the management of human activities, and it is these activities which have catalyzed action around determining objectives, setting targets, and developing quantifiable goals for management.

While the Mediterranean ECAP process responds to the prevailing ecological and management situation in the Mediterranean, and therefore does not necessarily need to follow the current EU efforts to determine Good Environmental Status (GES) through the use of the eleven descriptors provided by the MSFD, MAP can assist in harmonizing work done under ECAP with the work EU member States are obliged to do under the MSFD. In addition, because all of the obligatory steps in the ECAP process (outlined above) have the goal of determining how management can be improved and integrated, as per the Ecosystem Approach, it is necessary to also find ways to link the monitoring, research, and management done in the coastal zone under the rubric of integrated coastal zone management (ICZM), and similar efforts in watersheds done under the guidance of the Water Framework Directive, with the more traditional marine-focused work of MAP. There is much opportunity to do all of these things by building on the monitoring and research (and management) already being undertaken by Mediterranean nations, as part of their obligations under the Barcelona Convention and its protocols.

MAP proposed and tested a methodology that could be used to determine ecological objectives for the Mediterranean – one that is in complete harmony with the MSFD Descriptors but is tailored for the scale and circumstances of moving towards an Ecosystem Approach within the Mediterranean region. This methodology interprets each Descriptor and casts it as a Mediterranean-relevant Ecological Objective. In some cases Descriptors have been merged, amended, and added to reflect the priorities that have emerged in the ECAP Assessments.

The set of eleven Ecological Objectives outlined for ECAP (see Table 1) aims at enhanced harmonization and integration amongst all the above-mentioned processes. ECAP Ecological Objectives are directly related to, but at the same time adapt, the MSFD descriptors. The

Reference Document provided for the Workshop “Decision IG.20/4 Implementing MAP ecosystem approach roadmap: Mediterranean Ecological and Operational Objectives, Indicators and Timetable for implementing the ecosystem approach roadmap” describes these Ecological Objectives, Operational Objectives, and Indicators, MSFDand the timeline of the ECAP process.

## 2. Methodologies for Setting Targets

The setting of targets for environmental protection is practiced in a wide variety of ways, at differing scales, targeting different sorts of objectives. Targets are defined by the EU as “a qualitative or quantitative statement on the desired condition of the different components of, and pressures and impacts on, marine waters in respect of each region or sub-region” (EC MSCG 2011). Environmental targets should be stated in a measurable and quantifiable manner (see Annex 1). Under the Marine Strategy Framework Directive, countries have been advised that the definition of a target is always closely linked to an indicator and an indicator can only be assessed in relation to its target threshold.

A target can either be set in terms of biodiversity status or in terms of the pressure. For example, for the population status of a seabird species that is particularly sensitive to gillnet fisheries the respective target can be a measurable population size or the magnitude of the pressure acting upon it. In Mediterranean-wide discussion, five over-arching issues need to be considered:

1) whether a more qualitative or more quantitative approach for determining goals is desired;
2) the degree to which targets reflect the ideal environmental conditions (including, if necessary, restoration potential) or rather focus on individual pressures and acceptable levels of pressure;
3) whether or not current conditions can be taken as baseline for determining targets, such that management would aim to maintain the status quo (as opposed to suggesting priorities for restoration);
4) what the scope and scale of the area being assessed to see if targets are being met or exceeded should be; and
5) how Ecological and Operational Objectives can be integrated across all elements of the coastal and marine ecosystems to achieve an ecosystem approach, using indicators and targets that link to one another.

Below are illustrative examples that touch upon these considerations. These are not provided as models for ECAP, but to demonstrate the spectrum of approaches to target-setting, from the highly qualitative to the more quantitative. Subsequently, these approaches are then contrasted to the emerging work of the European Union under the Marine Strategy Framework Directive. It must be noted that to date there is no true Ecosystem Approach framework for describing environmental targets and for using the information coming out of monitoring of indicators to steer Ecosystem Based Management, at least not at the very large regional scale and international arena that exists in the Mediterranean – thus ECAP is paving the way for other regions, not following their lead.

**Examples of Ecosystem Approaches, Indicators, and Targets**

Evaluating status and condition of marine and coastal ecosystems and measuring management efficacy in relation to set targets or descriptions of ideal environmental conditions can be done in a number of ways, depending on what the objective of evaluation or assessment is, and what the data availabilities are (or could be, once improved monitoring is put in place). One example of target-setting and related assessment is the state of the U.S. environment reporting done periodically by the John Heinz Center, using national monitoring of core indicators, each undertaken by different federal agencies. Another example is outlook reporting done by the Great Barrier Reef Marine Park and World Heritage site, and the related but more expansive Australian State of the Environment Reports and scorecards. Numerous European countries are developing methodologies for determining GES under the MSFD, though all these efforts are works in progress and it is too early to derive lessons learned.

In the US example, the non-partisan non-governmental think tank known as the H. John Heinz III Center for Science, Economics, and the Environment has developed a framework for reporting on the state of the U.S. terrestrial, freshwater, and marine ecosystems. The goal of producing periodic reports, using key indicators and qualitative targets, is to identify what the nation most needs to know about its ecosystems in order to conduct enlightened policy debate (Heinz Center 2002). According to the Heinz Center, the analysis involves using a succinct set of strategic indicators, rather than characterizing every aspect of the environment or the ecosystems of particular regions. These strategic indicators serve as meaningful reference points for broad-ranging policy discussions, complementing rather than replacing, existing reporting frameworks developed for particular management, regulatory, or scientific needs (Heinz Center 2002).

It is important to note that the Heinz center reporting focuses on the state (or condition) of the nation's ecosystems, rather than identifying the stresses (pressures) that might be changing ecosystems, and of analyzing the effects of actions taken by governments, private individuals, or businesses to reduce those stresses (Heinz Center 2008). Indicators reflect degradation of ecosystems and/or loss of services; the desired state or target condition is one in which the environmental conditions across all indicators remains unchanged or improves. Monitoring data are synthesized to present a picture of whether the specific condition is maintained, on a decreasing trend, or on an increasing trend; no target thresholds are ascertained.

For oceans and coasts, these coastal habitats (wetlands, reefs, seagrasses, and shellfish beds) and shoreline types (beach, sand, mudflats, steep cliffs, wetlands and mangroves) are tracked for the following sorts of environmental red flag conditions:

- ✓ Areas with oxygen depletion
- ✓ Contamination in bottom sediment
- ✓ Coastal erosion
- ✓ Sea surface temperature
- ✓ At-risk native marine species

- ✓ Non-native species
- ✓ Unusual marine mortalities
- ✓ Harmful algae
- ✓ Bottom disturbance
- ✓ Chlorophyll concentrations
- ✓ Declines in commercial fish and shellfish landings or populations
- ✓ Contaminants in seafood
- ✓ Recreational water quality

The target for oceans and coasts is avoidance of increases in these red flag conditions – scoring is relative and qualitative, but the entire nation's waters are assessed rather than specific sites or subregions. While many of these parameters of environmental quality are being monitored in national programs around the world, the thing that is unique to these efforts is that all these features are tracked simultaneously in an ecosystem-based manner, and that the target levels (idealized environmental condition, either or averted degradation or of restoration) reflect the optimal conditions for all associated ecosystems.

Similar ecosystem-wide, multi-value assessments have been done in Australia, at both the national and sub-national level (at the scale of the Great Barrier Reef Marine Park, one of the largest and most complex managed areas in the world). A recommendation of the 2006 Review of the *Great Barrier Reef Marine Park Act 1975* (DEH 2006) was to prepare a five-yearly Outlook Report for the Great Barrier Reef. The aim of the Outlook Report is to provide a regular and reliable means of assessing performance in an accountable and transparent manner.

The Report (GBRMPA 2009) assesses the state of the Great Barrier Reef ecosystem's environmental, social and economic values, examines the pressures and current responses, and considers the likely outlook or future conditions, given current trends. For each of the assessments required under the *Marine Park Act 1975*, a set of Assessment Criteria are used to determine an overall grade for each Assessment Criterion, based on a series of grading statements.

This approach has been developed specifically for the Great Barrier Reef Outlook Report to meet the legislative requirements (GBRMPA 2009). It is intended that future Outlook Reports will follow the same process so that changes and trends can be tracked over time. As in the US Heinz Center example, the Outlook Report presents a comprehensive and frank assessment of the current state of the environment and its likely future, while not offering recommendations for solutions to the issues raised [the 2009 Outlook Report identifies climate change, continued declining water quality from catchment runoff, loss of coastal habitats from coastal development and a small number of impacts from fishing and illegal fishing and poaching as the priority issues reducing the resilience of the Great Barrier Reef].

Assessments include biodiversity (populations of key species and extent of critical habitats); ecosystem health (physical processes such as ocean currents, cyclones and wind, freshwater inflow, sedimentation, sea temperature, sea level and light; chemical processes such as nutrient cycling, pesticide accumulation, ocean acidity and salinity; ecological processes such as microbial processes, particle feeding, herbivory, symbiosis, reef building, competition, connectivity; and current state and trends of outbreaks of disease, introduced

species and pest species); and commercial and non-commercial use (commercial marine tourism, defense activities, fishing, ports and shipping, recreational use excluding fishing, scientific research, and traditional use of marine resources). These assessments consider the full range of specific threats listed in Annex 2.

Risks were assessed according to likelihood (almost certain, likely, possible, unlikely, rare), and scale of potential impact (catastrophic, major, moderate, minor, insignificant). Targets in this case are to have impacts so reduced that they are rare (or non-existent) and if they do occur, cause negligible impacts.

Multiple risks are considered together in the outlook reporting (GBRMPA 2009). However, the Great Barrier Reef Marine Park Authority states that the future cumulative effects of all use and the ecosystem-level impacts are poorly understood and that overall trends of use of the Great Barrier Reef are difficult to predict because each use is shifting at different rates and in response to different drivers.

Even though the Great Barrier Reef Marine Park is quite large (larger than many Mediterranean countries), this ecosystem approach process is still confined to the sub-national scale, and all activities take place under the rubric of a single management agency. In contrast, the government of Australia has also embarked on State of the Environment reporting at the national level, looking at conditions and trends in various aspects of the environment and assessing each as “very poor”, “poor”, “good” or “very good” (ASEC 2011). The State of the Environment report also indicates how much confidence exists in the grade given, and the trends. These indications are needed because the national monitoring was not designed with an Ecosystem Approach in mind, and the data collection is either inconsistent or unsuitable to “grading” in some areas.

The characteristics which are assessed in Australian State of the Environment reporting are given in Annex 3. Targets, taken cumulatively across all the features, are to score “very good” in all categories, with high confidence in both grade and trends. The establishment of this reporting system is influencing the way the Australian government will undertake national monitoring, much in the same way that the ECAP may positive influence data collection amongst the Mediterranean countries.

The efforts of the US and Australia are rather qualitative approaches that contrast with the more quantitative approach being adopted by some European countries under the Marine Strategy Framework Directive. Discussions around OSPAR and HELCOM Regional Seas provide good examples. In the OSPAR region, the ICG-COBAM identifies a fixed list of pressure categories and a priority set of pressure categories, according to their degree of relevance (impact) to biodiversity (OSPAR 2011). OSPAR has focused on a prioritized list of pressures to provide cumulative pressure distribution/intensity information (preferably as GIS data layers) for future use in the assessment of biodiversity descriptors of GES.

To prioritize pressures at a coarse level, three or four relative ranks (high, medium, low, minimal) provide sufficient guidance. For this, the QSR pressure categories were scored according to their impact on eight ecosystem components (marine birds, cetaceans, seals, fish, rock and biogenic reef habitat, coastal sediment habitats, shelf sediment habitats, deep-sea habitats) across the five OSPAR regions. The OSPAR Commission tracks 8 broad sets

of pressures, including 1) climate change, 2) eutrophication, 3) hazardous substances, 4) radioactive substances, 5) offshore oil and gas development, 6) fishing, 7) emerging uses (wind farms, mariculture), and 8) loss of species and coastal and marine habitat.

In providing input for the determination of GES under the MSFD, OSPAR has suggested an establishment of ranking of pressures or threats, by subregion. Their initial relative ranking is provided in Table 2 below.

Table 2: Ranked list of pressures for the OSPAR regions, based on assessments of eight ecosystem components (output of 2009 Utrecht workshop)

**Summary - total impact per Region**

| | | I | II | III | IV | V |
|---|---|---|---|---|---|---|
| Climate change | Climate change | 20 | 12 | 7 | 10 | 16 |
| Hydrological pressures (local) | Temperature changes (local) | 2 | 2 | 2 | 2 | 1 |
| | Salinity changes (local) | 2 | 2 | 2 | 2 | 1 |
| | Changes in water flow, wave action & emergence regime (inshore/local) | 2 | 2 | 2 | 2 | 1 |
| Pollution & other chemical pressures | Contamination by hazardous substances | 8 | 8 | 7 | 8 | 5 |
| | Radionuclide contamination | 0 | 0 | 0 | 0 | 0 |
| | De-oxygenation | 3 | 7 | 4 | 4 | 0 |
| | Nitrogen & phosphorus enrichment | 6 | 6 | 5 | 4 | 1 |
| | Organic enrichment | 5 | 7 | 4 | 4 | 1 |
| Other physical pressures | Electromagnetic changes | 1 | 1 | 1 | 1 | 1 |
| | Litter | 5 | 5 | 4 | 5 | 5 |
| | Underwater noise | 3 | 3 | 3 | 3 | 2 |
| | Barrier to species movement | 3 | 3 | 3 | 3 | 0 |
| | Death or injury by collision | 3 | 3 | 3 | 3 | 3 |
| Habitat changes | Siltation rate changes | 4 | 10 | 6 | 6 | 4 |
| | Habitat damage | 12 | 20 | 11 | 11 | 9 |
| | Habitat loss | 15 | 8 | 7 | 10 | 7 |
| Biological pressures | Visual disturbance | 0 | 0 | 0 | 0 | 0 |
| | Genetic modification | 0 | 0 | 0 | 0 | 0 |
| | Introduction of microbial pathogens | 2 | 2 | 2 | 2 | 2 |
| | Introduction of non-indigenous species & | 8 | 8 | 7 | 6 | 6 |
| | Removal of species (target & non-target) | 16 | 24 | 13 | 13 | 11 |

The descriptors collected in the EC MSFD address 11 unique classes of threat, and GES targets will center on the abatement of minimization of those threats, tracked using the indicators agreed in the Commission Decision 2010/477/EU on criteria and methodological standards on Good Environmental Status of marine waters. Still to be decided are questions of where assessments will take place – across all waters of the country in question, or in sub-regions.

Another question, which relates to the efficacy of the Ecosystem Approach, is how GES across all descriptors will be determined. In other words, good status for any single descriptor may be set, but may need to be amended as descriptors are considered in tandem. Targets can describe general conditions related to each Ecological or Operational Objective, but in most cases, threshold limits will also need to be articulated, so that ecosystem changes can be assessed as robustly as possible.

## 3. Targets for ECAP

It is broadly recognized that the Ecosystem Approach to management of marine areas is an effective one for increasing the resilience of marine ecosystems to the myriad climate change-related pressures. Ecosystem-based adaptation strategies provide a cost-effective way to reduce vulnerabilities to climate and other large scale changes.

Given that capacities to undertake monitoring, scales of assessment regions, and nature of the pressures and impacts occurring simultaneously in each country's coasts and marine waters are all so diverse, a common methodology for establishing targets should be one that is attainable for all parties to the Barcelona Convention, yet steers the region towards more effective management. For this reason, a combination of qualitative and quantitative approaches that use an established baseline against which to track changes, with a focus on each of the Ecological Objectives and their associated Operational Objectives and Indicators, is likely preferable to intensive quantitative determinations of optimal environmental conditions across all features of these ecosystems. It may be that such a system will need to be phased in, since some Operational Objectives are more mainstreamed than others and where existing monitoring can support determinations of whether targets are being approached, these are likely to be first on line.

For some Ecological Objectives, acceptable levels of change (or degradation) are already agreed in protocols to the Convention. For instance, the SPA Protocol lists both vulnerable species and key habitats; loss of these species or habitats is to be avoided. Similarly, the Pollution Protocol identifies key contaminants; the EU and certain states have established standards for some of these pollutants which should not be exceeded. The GFCM determines acceptable limits of catch for managed species; these could constitute one basis for Ecological indicators having to do with commercial fish exploitation as well as food web integrity.

The discussion around how to establish GES under the MSFD (see EC 2011 papers) are informative and can serve to support arguments in favor of either state-focused or pressure-focused target levels, as well as discussions about whether targets should be qualitative and

relative, or quantitative and absolute. It is interesting to note that some European countries (Netherlands, Spain, UK) define GES in a qualitative manner focused on each Descriptor while others (Germany and France) describe GES quantitatively at the level of specific indicators (EC Working Group on Economic and Social Assessment 2011). Regarding the setting of targets, the EU countries show little commonality across many of the targets, and many reflect a mix of pressure, state, impact, and management effectiveness limits.

For the purposes of ECAP, each Ecological Objective could be reviewed and discussed vis a vis acceptable levels of change. Discussion should also center on whether trend targets or ideal conditions are preferable, as has occurred in discussions of the GES (see Leverett and Crane 2010). In some ways the ECAP process is already constrained by the choice of indicators – but this is a positive constraint in that the indicators are all measurable, and the targets can focus on either periodic relative rating or grading (as in the case of Australia) or trends away from the ideal (as in the US case).

**ECAP Ecological Objectives**

Each Ecological Objective agreed at the 2012 COP Meeting in Paris (Decision 4 UNEP(DEPI)/MED IG.20/4 Annex II) is discussed individually below, with possible options for setting targets. This discussion is not meant to be comprehensive but rather exemplary.

Ecological Objective 1 states “Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions”. Obviously it would be impossible to track the biodiversity at all levels in all areas, hence selected species and habitats should serve as indicators. In order for this element of the ecosystem characterization to serve as a useful parameter to monitor for an Ecosystem Approach, it is important that the approach is multi-species and multi-habitat. Most national tracking of biodiversity monitors population size and distributions of key vulnerable or threatened species, such as those occurring on Red Lists or in Endangered Species laws. For the Mediterranean, the species listed in Annex II and III of the SPA and Biodiversity Protocol of the Barcelona Convention could serve as the basis for a pared down indicator list. Selection among those species could be on the basis of representing all functional groups, as is being suggested by the UK for determination of GES (Leverett and Crane, 2010).

For habitat cover and condition, the list of 27 habitat types provided by RAC/SPA could again serve as a basis for indicator monitoring; again, a pared down list that achieves representativeness across broad categories of habitat types (perhaps based on general aspects of substrate -rocky, coralligenous, soft bottom - and location – coastal, nearshore, offshore) would be more feasible than tracking condition in all habitat types, but this is a topic for discussion. The special case of rare habitats provides additional monitoring opportunities for biodiversity condition. Candidate habitats include biocoenosis of infralittoral algae (facies with vermetids or trottoir), hard beds associated with photophilic algae, meadows of the sea grass *Posidonia oceanica*, hard beds associated with Coralligenous biocenosis and semi dark caves, biocoenosis of shelf-edge detritic bottoms (facies with *Leptometra phalangium*), biocoenosis of deep-sea corals, cold seeps and biocoenosis of bathyal muds (facies with *Isidella elongata*), upwelling areas, fronts and gyres.

Even in the case of biodiversity, where previous regional discussions and agreements have focused the management spotlight on key habitats and species, it will be easier to focus on pressures causing the loss of biodiversity rather than the state of biodiversity across all ecosystems. Nonetheless, for target determination, some triangulation on collective species and habitat status will likely be necessary. One clear threshold is the condition in which no species are lost or extirpated (an objective agreed to under the SPA Protocol of the Barcelona Convention). A similar target could be stipulated for key threatened habitats. Beyond this, countries will need to discuss and agree to thresholds regarding population size, age classes, and sex ratios for key species and habitat extent for key habitats.

Ecological Objective 2 states "non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem". An obvious option for a target related to this EO is no further spread of invasives (for non-indigenous species already present in the Mediterranean) and no increases in their population sizes, no transformation of introduced species into invasives (i.e. preventing introduced non-indigenous species from becoming invasive and causing ecological damage), and no new introductions of potentially invasive species. The difficulty here is that while tracking existing alien species may be relatively easy, anticipating the introduction and then tracking the spread of species new to the Mediterranean may be problematic. As with some other features of the environment, countries will be able to supplement their own monitoring programs with the periodic assessments being done by academic institutions, research institutions, and non-governmental organizations, some of which have developed early warning systems for invasive species.

Ecological Objective 3 deals with commercial fisheries exploitation and states "Populations of selected commercially exploited fish and shellfish are within biologically safe limits, exhibiting a population age and size distribution that is indicative of a healthy stock". The choice of indicator species for collecting information for Ecological Objective 3 should be derived from fisheries targeting species listed in Annex III of Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (species whose exploitation is regulated) and the species in the GFCM Priority Species list (http://www.gfcm.org/gfcm/topic/166221/en). Choice of indicators should cover all trophic levels, and if possible, functional groups, using the species listed in Annex III of SPA and/or, as appropriate the stocks covered under regulation (EC) No 199/2008 of 25 February 2008 concerning the establishment of a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy.

In the context of the MSFD, the European countries have addressed GES determinations differently. Most EU countries have focused on Maximum Sustainable Yield (MSY) across all managed fisheries as at least one large part of GES EC WG ESA, 2011). Age and size class structure is a bit more difficult, and most EU countries are examining trends for a small subset of fisheries as part of GES related to this descriptor. For the Mediterranean, the target for this Ecological Objective could be quantitative for managed species, since fisheries data are being collected by countries and databases maintained by GFCM – at least for stock size. Regarding age class assessments, the determinations on what constitute ecological optimal age and size classes should rely on guidance from GFCM and FAO, as appropriate; in the absence of this guidance, Mediterranean countries could focus on trends in age and size class as part of the fisheries exploitation-related target.

Ecological Objective 4 states as a goal that “alterations to components of marine food webs caused by resource extraction or human-induced environmental changes do not have long-term adverse effects on food web dynamics and related viability”. Most scientific assessments done in other regions or countries for the purpose of guiding policy that do consider food webs rely on qualitative targets or on trends, to the extent that trends in food web integrity can be efficiently tracked. For instance, countries like the US have experimented with applications of indices of biotic integrity, with *a priori* threshold levels. Where quantitative targets have been used, as is being discussed in the UK (see Leverett and Crane 2010), the productivity of key species in each trophic level is being discussed as an indicator, with possible targets of ‘no downward trends in productivity’. The DEFRA workshop also discussed setting targets having to do with percentage thresholds for specific size classes of key species, absence of jellyfish blooms, limits on by-catch of selected threatened species, among others. As this is a particularly complicated and multi-faceted objective, the Mediterranean countries will need to agree on a small subset of parameters which are both common to all the countries and feasible to monitor. The agreed indicators for this Ecological Objective in the Mediterranean can be used simultaneously to develop targets that reflect both optimal productivity at different trophic levels, and trends in relative abundance (proportion) of both habitat-forming taxa and species with high turnover rates.

Ecological Objective 5 is stated thus: “Human-induced eutrophication is prevented, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters”. The target condition for eutrophication should be relatively straightforward – eutrophication is relatively easy to monitor. But the situation is somewhat complicated by the changing dynamics of marine systems in light of climate change, and the difficulty in determining what levels of eutrophication are ‘normal’ in any particular temperature, precipitation, and physical oceanography regime. Pressure indicators (in this case, nutrient input levels) may be easier to monitor, with thresholds that can be ascertained, than impact indicators. However in an Ecosystem Approach the absolute levels of nutrients are less important than the impacts, including hypoxia, harmful algal blooms, impaired health of seagrasses, etc. The discussions and workshops focused on the eutrophication descriptor of the MSFD have raised the possibility of different targets (and GES) for problem and non-problem areas. One proposal is to have the target for non-problem areas be no increases in nutrient concentrations, while in problem areas a decreasing trend is the proposed target (EC MSCG 2011).

The condition and functioning of the seafloor is addressed in Ecological Objective 6, which states “Sea-floor integrity is maintained, especially in priority benthic habitats” (e.g. coastal lagoons and marshes, intertidal areas, seagrass meadows, coralligenous communities, sea mounts, submarine canyons and slopes, deep-water coral and hydrothermal vents). For the purposes of ECAP, the determination of what constitute these priority areas is key. As with eutrophication, target levels could be based on pressures (e.g bottom fishing, dredging activities ,sediment disposal, seabed mining, drilling, marine installations, dumping and anchoring, land reclamation, sand and gravel extraction), with threshold levels – by size of ecological footprint, for instance -- to be determined. Impact monitoring and the associated setting of targets having to do with minimizing impact, will be more difficult.

Ecological Objective 7 describes dynamics of water flows, as a result of bottom topography and currents, worded as “alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems”. In general the targets around this Ecological Objective will

likely be quantitative, relating to reference conditions (e.g. *existing hydrographical conditions in a sub-area at year x*...). As with other Ecological Objectives, the question of scale comes into play. Targets could be set in an iterative fashion, or they might be set differently at different scales. Spain, for instance, has opted to consider Descriptor 7 on hydrographic conditions at two scales simultaneously: on the small, site-level scale for evaluating (and minimizing) impacts of construction activities, and at the national scale, in national assessments.

Ecological Objective 8 concerns coastlines, coastal landscapes, and coastal ecosystem dynamics and health. The Ecological Objective 8 is described as “the natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved”. Focusing on erosion and the mitigation or avoidance of erosion is one facet of this Ecological objective. Another is land use – though the targets associated with his are difficult to imagine, as the ‘normal’ condition is that land uses change over time, as a result of population growth and urbanization, shifts in agriculture, and market forces creating demand for space. One proxy for looking at land use and how its changes might negatively impact coastal seas is to look at amount of non-porous surfaces and shoreline hardening (beach armouring, placement of seawalls, etc.). By setting a target of no net increase in non-porous surfaces, and combining this with either threshold determinations for erosion or trends in erosion, much of the coastal dynamics could be captured.

Pollution is encapsulated in Ecological Objective 9, which states “Contaminants cause no significant impact on coastal and marine ecosystems and human health”. This broad objective encompasses many different impacts originating with a diverse set of pressures, ultimately affecting not only ecosystems but also human health (through contamination via seafood consumption as well as exposure through recreational activities). For the most egregious of these contaminations, a target of no increase might be justifiable. (Similarly, the target could include avoidance of pollution effects from catastrophic events.) For less dangerous contaminants, targets could focus on trends away from baseline conditions.

Marine litter and its impacts are addressed in Ecological Objective 10: “Marine and coastal litter do not adversely affect coastal and marine environment”. This may appear to be the one of most easily quantifiable set of indicators, however existing monitoring programs are not sufficient to generate the data needed to determine if trends in marine litter (abundance and distribution) are increasing or decreasing, except in those beach areas where monitoring has been done for some time. Targets in pelagic areas will likely focus on trends as opposed to absolute quantities of litter or their impacts on ecosystems and species (with the exception of impacts on seabird species, since this information is more readily available – OSPAR countries, for instance, are investigating whether plastics in the gut of fulmars could be a good indicator for litter in the pelagic environment). Spain is concentrating its target determinations on sources of litter, as opposed to distribution of litter and potential impacts.

Ecological Objective 11, the final Ecological Objective agreed by the Mediterranean countries, concerns noise, and is stated as “Noise from human activities cause no significant impact on marine and coastal ecosystems”. The science of determining the impacts of noise on individual species or taxonomic groups is still in its infancy, thus the focus for this Ecological Objective will likely be on the pressure values. In Europe, countries have focused on impulse sounds, with some countries proposing acceptable levels of impulsive noise that are quantitative (e.g. Belgium and Germany), while others are more qualitative tracking

(France, Spain, Sweden and the UK all propose establishment of a noise registry. For continuous sound, targets will likely need to be focused on trends in shipping noise.

## 4. Scale, Site Selection, and Integration of Monitoring to Determine if Targets are Being Met

When undertaking the sort of systematic assessment that institutes the ECAP process requires, other spatial scales may be used to identify what will be monitored (i.e. location for monitoring, in addition to periodicity of monitoring), by ecology, ecological impacts (pressures), or response. Certain drivers can be of international and global scale (e.g. IMO regulations, EU directives, climate change) while others occur on a smaller scale (e.g. national legislation, localised pollution, fisheries impact on a particular stock). For marine waters, investigation of pressures will include adjacent watersheds or even the whole drainage basin of the Mediterranean Sea. The choice of scale is an important issue: national scale monitoring and reporting is of course preferable but the regional scale may be more feasible. Regardless of which Ecological Objective is being considered, it may make sense to aim for national level monitoring but through a phased approach that focuses subregionally to begin, reflecting how data are being collected already under the various obligations states have to protocols of the Conventions (as well as to the MSFD, the WSFD, and to international agreements such as the Convention on Biological Diversity). Piloting subregions according to considerations of feasibility will allow countries to launch ECAP monitoring and evaluation of how they stand relative to targets as soon as possible, with the eventual aim of scaling up to the national level.

Even with consensus being reached on the question of scale, the related question of where data coming from agreed indicators will be collected in order to periodically ascertain if targets are being approached is an open one. Determination of where, and how often, data are collected using the priority indicators will be made possible by analysis of the specific ecosystems present, the human uses of and anthropogenic impacts on these ecosystems, and a systematic and objective process for determining priorities. For European countries, GES can be determined nationally, regionally, or sub-regionally, and these processes under the MSFD will complement (and in some cases catalyze) the efforts of non-European nations. GIS will prove to be important as countries take the commonly developed Ecological Objectives and prioritize them within their own regions, establishing monitoring and research regimes that derive information on the conditions and trends in their coastal and marine ecosystems. It is unlikely that GES or periodic assessments under ECAP will reflect a pristine status, since most areas of the Mediterranean are impacted in one way or another, or – as in most cases – multiple ways. Setting targets (and GES determinations) should therefore steer countries towards priorities for restoration, not just maintenance of *status quo*. In general, quantitative targets can be set for indicators when reference data exist; in the absence of reference data, trends information will have to suffice (see, for instance, HELCOM's working group paper on targets (HELCOM CORESET 2011).

Finally, an unresolved question that underlies both the ECAP and the MSFD processes revolves around how the targets will be integrated to get at a true ecosystem approach. The totality of targets across all eleven Ecological Objectives should reflect the collectively determined desired condition of marine and coastal environments throughout the

Mediterranean. But the whole must be better (if not greater) than the sum of the parts: in other words, the key to the ecosystem approach and ecosystem-based management is that priorities reflect the big picture, and the determination of limits of acceptable change are made with all change in mind– and the ways these changes influence each other and the working of the ecosystem as a whole.

Integrating information across all Ecological Objectives will allow assessment of whether the overall target condition (or GES) is being met. If all Ecological Objectives are deemed to have equal weight, then no weighted ranking system needs to be put in place. However, as in the case of how to evaluate conditions relative to targets when more than one indicator exists, priorities will need to be identified, within each Ecological Objective in regards to the parameters serving as indicators, and among Ecological Objectives as well. For instance, Mediterranean countries might collectively decide that one Ecological Objective is a lower priority than other; this sort of relative prioritization may lead to a weighting system that will allow for integrated assessment of targets. It is also possible that the priorities in one region differ from those of the next. Nonetheless, an overall positive assessment is one in which no limit of acceptable (or unavoidable) change is exceeded. That said, some change in each of the features described is inevitable – the key will be to come to agreement over what level of change across all features is acceptable, at the national level, and across the region as a whole. Integrated targets should be chosen that achieve the strategic goals laid out in the ECAP process, in order to achieve the collective vision for the Mediterranean to which all countries aspire.

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## Annex 1. MSFD Assessment Terminology (adapted to the EU COM draft decision acc. to Art. 9) Draft 06.07.2010

**Indicator**

Given the complexity of biodiversity, both in its range of character and the number of aspects (criteria) which contribute to an assessment of state, it is common practice to use a set of indicators to assist in monitoring and assessment programmes. These help limit the number of parameters that need to be monitored to those which can most effectively represent wider functional and structural aspects of the ecosystem and simplify its complexity. Where possible, indicators should closely respond (in space and time) to a particular anthropogenic pressure and hence be linked to respective management requirements. The assessment of environmental state provided by one or more indicators should allow inferences to be made on the wider state of biodiversity components in that ecosystem. State means the actual (measured or otherwise assessed) environmental condition (e.g. of a species, species group, assemblage, community or habitat) in a given geographical area. The assessment of state can be derived by direct measurements of the particular biodiversity component (state indicators) or indirectly by measuring the prevailing anthropogenic pressures (pressure indicators). In this latter case, impacts of these pressures on biodiversity must be known. Indicators have been widely evaluated by various ICES Expert Groups, and there are several criteria that need to be considered when trying to determine the utility and applicability of an indicator.

**Criterion**

A criterion is an aspect of biodiversity that can be assessed using a set of indicators. For example, the criterion “population size” can be assessed by monitoring and assessing the indicators population abundance or population biomass. A criterion can also represent an anthropogenic activity or pressure, such as physical damage of the seabed indicated by the extent of the seabed significantly affected by human activities.

**Parameter**

A parameter is a measureable single characteristic of a species or habitat (e.g. number of individuals, biomass in g/dry weight, particle diameter in mm).

**Indices and metrics**

An index/metric is a more or less complex measure that represents the aggregated measurement of several different criteria, mostly across different biodiversity components. In ecology, they are frequently used to inform on the amount of variety in a given area/time. The degree of variety can be assessed on various levels, e.g. at the level of species, genes or habitats. Most commonly, biodiversity is measured on the level of species.

**Target**

A target is a qualitative or quantitative statement on the desired condition of the different components of, and pressures and impacts on, marine waters in respect of each region or sub-region. For each, a specific task arises from environmental objectives and that must be defined and met in order to achieve those environmental objectives. Environmental targets should be stated in a measurable and quantifiable manner. The definition of a target is always closely linked to an indicator and an indicator can only be assessed in relation to its target threshold. A target can either be set in terms of biodiversity status or in terms of the

pressure. For example, for the population status of a seabird species that is particularly sensitive to gillnet fisheries the respective target can be a measurable population size or the magnitude of the pressure acting upon it.

## Annex 2. Details of the Great Barrier Reef Marine Park Risk Assessment (from GBRMPA 2009)

The forty one threats or pressures considered in the risk assessment are listed on the box below.

Anchoring on coral by small vessels
Artificial barriers to riverine and estuarine flow (e.g. dams, weirs, breakwaters and gates)
Boat strike leading to death in species of conservation concern
Clearing or modifying wetlands, mangroves and other coastal habitats
Climate change induced altered ocean currents
Climate change induced altered cyclone activity
Death of discarded species during fishing or collecting
Dredging and dumping of spoil
Extraction of detritivores by fishing (e.g. prawns and sea cucumbers)
Extraction of filter feeders by fishing (e.g. scallops)
Extraction of herbivores by fishing
Extraction of lower order predators by fishing (e.g. coral trout)
Extraction of top order predators by fishing (e.g. sharks)
Fishing in unprotected fish spawning aggregations
Grounding of large vessels
Grounding of small vessels
Illegal fishing or collecting (foreign or domestic)
Incidental catch during fishing of species of conservation concern
Increasing sea temperature
Ingestion of or entanglement in marine debris causing death in species of conservation concern
Introduction of exotic species and diseases from aquaculture operations
Introduction of exotic species and diseases through use of imported bait
Introduction of exotic species and diseases through vessel ballast water discharge
Introduction of exotic species and diseases through vessel hull fouling
Large chemical spill
Large oil spill
Nutrients from catchment runoff
Ocean acidification
Outbreak of coral disease
Outbreak of crown-of-thorns starfish
Outbreak of *Drupella* species
Pesticides (including herbicides) from catchment runoff
Physical impacts of fishing
Physical impacts of snorkeling and diving activity
Poaching and illegal harvesting of species of conservation concern
Sea level rise
Sediments from catchment runoff
Small chemical spill
Small oil spill
Traditional hunting of species of conservation concern
Waste discharge from a vessel (including litter and sewage)

**Annex 3. Australian State of the Environment Reporting (from Australian State of the Environment Committee (2011), Australian State of the Environment 2011 report, Independent report to the Australian Government Minister for Sustainability, Environment, Water, Population and Communities)**

**Assessment summary 6.1—State and trends of quality of habitats for species**

| Component | Summary | Assessment grade | | | | Confidence | |
|---|---|---|---|---|---|---|---|
| | | Very poor | Poor | Good | Very Good | In grade | In trend |
| Gulfs, bays, estuaries, lagoons | South-east, south-west and east regions heavily degraded in many places; north region in very good condition | | | — | | ● | ◒ |
| Beaches | South-west and north regions in very good condition | | | — | | ◒ | ◒ |
| Fringing reefs—corals, intertidal and subtidal, of coast and islands | East region in very poor condition | | | — | | ● | ◒ |
| Seabed inner shelf (0–50 m) | South-east and east regions in poor condition | | | — | | ◒ | ◒ |
| Seabed outer shelf (50–200 m) | South-east and south-west regions in poor condition | | | — | | ◒ | ◒ |
| Seabed, shelf break and upper slope (200–700 m) | South-east region in very poor condition | | | | — | ◒ | ◒ |
| Seabed lower slope (700–1500 m) | South-east region in poor condition | | — | | | ● | ◒ |
| Seabed abyss (>1500 m) | Abyss depths in very good condition in all regions | | | | — | ◒ | ◒ |
| Water column, shoreline (0–20 m), not estuaries | East region in poor condition | | | ↙ | | ● | ◒ |
| Water column, inner shelf (20–50 m) | East region in poor condition | | | | ↙ | ◒ | ◒ |
| Water column, outer shelf (50–200 m) | All regions in good or very good condition | | | | — | ◒ | ◒ |
| Water column offshore (>200 m) | All regions in good or very good condition | | | | — | ◒ | ◒ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mangroves | East and south-east regions in poor condition | | | ⊟ | | ● | ● |
| Seagrasses | East and south-east regions in poor condition | | | | ⊟ | ◒ | ◒ |
| Algal beds | East and south-east regions in poor condition | | | | ⊟ | ● | ◒ |
| Coral reefs (<30 m) | North-west and north regions in very good condition | | | ⊟ | | ◒ | ◒ |
| Deepwater corals and sponges (>30 m) | North and east regions in very good condition | | | ⊟ | | ◒ | ◒ |
| Bryozoan reefs | Only assessed in the south-east region | | ⊟ | | | ◒ | ◒ |
| Canyons and shelf break | South-east region in poor condition | | | | ⊟ | ◒ | ◒ |
| Seamounts (>1000 m rise from sea floor) | East region in poor condition | | | ⊟ | | ◒ | ◒ |
| Offshore banks, shoals, islands | Only assessed in north-west and east regions | | | ⊟ | | ◒ | ◒ |
| Regionally unique features | Assessed 60 individual habitat features that occur primarily in only one region | | | | ⊟ | ◒ | ◒ |

**Recent trends**

Improving

Stable

Deteriorating

Unclear

**Confidence**

Adequate high-quality evidence and high level of consensus

Limited evidence or limited consensus

Evidence and consensus too low to make an assessment

**Grades**

**Very good**: All major habitats are essentially structurally and functionally intact and able to support all dependent species

**Good**: There is some habitat loss, degradation or alteration in some small areas, leading to minimal degradation but no persistent, substantial effects on populations of dependent species

**Poor**: : Habitat loss, degradation or alteration has occurred in a number of areas, leading to persistent, substantial effects on populations of some dependent species

**Very poor**: There is widespread habitat loss, degradation or alteration, leading to persistent, substantial effects on many populations of dependent species

**Assessment summary 6.2—State and trends of species populations and groups**

| Component | Summary | Assessment grade | | | | Confidence | |
|---|---|---|---|---|---|---|---|
| | | Very poor | Poor | Good | Very Good | In grade | In trend |
| Sharks and rays | East, south-east and south-west in poor condition for some species (e.g. east coast population of grey nurse sharks) | | | — | | ◒ | ◒ |
| Whale sharks | South-west in very poor condition | | ↙ | | | ◒ | ◒ |
| Great white sharks | Condition continues to decline in the east | | ↗ | | | ◒ | ◒ |
| Tuna and billfish | Condition very poor in the south-west and continuing to decline | | | — | | ◒ | ◒ |
| Southern bluefin tuna | Condition very poor and stable | — | | | | ● | ● |
| Outer shelf (>50 m)—demersal and benthopelagic fish species | Condition improving in all regions except the north-west, where the condition is generally stable but the worst areas continue to decline | | ↗ | | | ◒ | ◒ |
| Inner shelf — demersal fish species | South-east in good condition and improving | | ↗ | | | ◒ | ◒ |
| Slope—demersal fish species | Only south-east was assessed | | ↗ | | | ◒ | ● |
| Mesopelagic fish species | Only east and south-east were assessed | | | | — | ◒ | ◒ |
| Small pelagics—inner shelf | South-east and south-west were assessed, with condition improving in the south-west | | | — | | ● | ◒ |
| Inner-shelf reef fish species | South-west, east and south-east were assessed, and are all in poor condition | | — | | | ◒ | ◒ |
| Inner shelf—invertebrate species | East and south-east in poor condition | | | — | | ◒ | ◒ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Outer shelf and inner slope—invertebrate species | South-east in poor condition | | | — | | ◒ | ◒ |
| Shoreline and intertidal species | East in poor condition and declining | | | — | | ◒ | ◒ |
| Seabirds—resident | South-east in poor condition | | | — | | ◒ | ◒ |
| Seabirds—migratory | South-west in very poor condition | | ↙ | | | ◒ | ◒ |
| Hard coral species | East and south-east in poor condition | | | — | | ● | ◒ |
| Mangrove species | East and south-east in poor condition | | | — | | ◒ | ◒ |
| Seagrass species | East and south-east in poor condition | | | — | | ◒ | ● |
| Dune and saltmarsh plant species | East in poor condition and declining | | | — | | ◒ | ◒ |
| Dugongs | East in poor condition | | | | — | ◒ | ◒ |
| Turtles | North and east in poor condition (greater understanding in east region) | | — | | | ◒ | ◒ |
| Sea snakes | East in very poor condition and declining | | | | ↙ | ◒ | ◒ |
| Crocodiles | Populations increasing | | | | ↗ | ● | ● |
| Dolphins and porpoises | Populations generally stable, although some are declining in the east and south-east | | | — | | ◒ | ◒ |
| Baleen whales (not including humpbacks) | Condition and trends are poorly understood for some species, but recovery occurring generally | | — | | | ◒ | ◒ |
| Humpback whales | Condition in the east and south-east remains very poor and stable | | | ↗ | | ◒ | ◒ |
| Toothed whales | Condition and trends are poorly understood | | — | | | ◒ | ◒ |
| Fur seals | Assessed only in the south-west and east | | ↗ | | | ◒ | ◒ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Australian sea lions | Assessed in the south-west |  | | | |  |  |
| Seahorses and allies (families Syngnathidae, Solenostomidae) | Assessed in the south-west and south-east | | | |  |  |  |
| Regional features | Assessed nine species or population features that principally occur in only one region | | |  | |  |  |

| | | | | |
|---|---|---|---|---|
| **Recent trends** | Improving | Stable | **Confidence** | Adequate high-quality evidence and high level of consensus |
| | Deteriorating | Unclear | | Limited evidence or limited consensus |
| | | | | Evidence and consensus too low to make an assessment |

**Grades** **Very good**: All major habitats are essentially structurally and functionally intact and able to support all dependent species

**Good**: There is some habitat loss, degradation or alteration in some small areas, leading to minimal degradation but no persistent, substantial effects on populations of dependent species

**Poor**: : Habitat loss, degradation or alteration has occurred in a number of areas, leading to persistent, substantial effects on populations of some dependent species

**Very poor**: There is widespread habitat loss, degradation or alteration, leading to persistent, substantial effects on many populations of dependent species

**Assessment summary 6.3—State and trends of ecological processes**

| Component | Summary | Assessment grade | | | | Confidence | |
|---|---|---|---|---|---|---|---|
| | | Very poor | Poor | Good | Very Good | In grade | In trend |
| Connectivity—spatial/physical disjunctions | South-east has been significantly affected | | | | ⊟ | ◒ | ◒ |
| Connectivity—biological, migration, flyways | South-east in poor condition and continues to decline | | | ↙ | | ◒ | ◒ |
| Connectivity—recruitment, settlement | Variable across the regions, improving in some and declining in others | | | ⊟ | | ◒ | ◒ |
| Connectivity—genome structures, genetic adaptation | Knowledge base very limited and condition hard to assess | | | ⊟ | | ◒ | ◒ |
| Nesting, roosting and nursery sites | Knowledge base very limited and condition hard to assess | | | ⊟ | | ◒ | ◒ |
| Feeding grounds | Whale feeding grounds significantly affected by human activities in the south-west and north-west | | | ⊟ | | ◒ | ◒ |
| Trophic structures and relationships | South-west and north-west are in poor condition, substantially affected by historical and ongoing fishing | | | ⊟ | | ◒ | ◒ |
| Water column, pelagic productivity | Good to very good in all regions | | | | ⊟ | ◒ | ◒ |
| Benthic productivity | Good to very good in all regions | | | | ⊟ | ◒ | ◒ |
| Reef building | Condition poor in south-east | | | ⊟ | | ◒ | ◒ |
| Symbiosis—fish, corals, molluscs | Knowledge base very limited and condition hard to assess | | | | ⊟ | ◒ | ◒ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Predation | Condition of the worst areas very poor in the south-west and north | |  | | |  |  |
| Herbivory processes | Declines observed in the east | | | |  |  |  |
| Filter feeding | Condition poor in the south-east | | | |  |  |  |
| Microbial processes | Knowledge base very limited and condition hard to assess | | | |  |  |  |
| Regional features | Assessed four ecological process features that principally occur in only one region | | |  | |  |  |

**Recent trends**

Improving

Stable

Deteriorating

Unclear

**Confidence**

Adequate high-quality evidence and high level of consensus

Limited evidence or limited consensus

Evidence and consensus too low to make an assessment

**Grades**

**Very good**: There are no significant changes in ecological processes as a result of human activities

**Good**: There are some significant changes in ecological processes as a result of human activities in some areas, but these are not to the extent that they are significantly affecting ecosystem functions

**Poor**: :There are substantial changes in ecological processes as a result of human activities, and these are significantly affecting ecosystem functions in some areas

**Very poor**: There are substantial changes in ecological processes across a wide area of the region as a result of human activities, and ecosystem functions are seriously affected in much of the region