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Monitoring Guidance on Ecological Objective 01: Biodiversity

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Monitoring Guidance on Ecological Objective 01: Biodiversity

1. Introduction

The most widely agreed definition of biodiversity is the one found in the Convention on Biological Diversity (CBD)[1]: "the variability among living organisms from all sources including, inter alia, [terrestrial,] marine [and other aquatic ecosystems] and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".

The Mediterranean Sea, probably due to the many marine research stations set up within its bounds, is one of the most studied seas in the world. The most recent estimates of Mediterranean marine species, taken from compilations of former works, list approximately 17,000 marine species. However, estimates of marine diversity are still incomplete as yet—undescribed species will be added in the future. Diversity for microbes is substantially underestimated, and the deep-sea areas and portions of the southern and eastern region are still poorly known. In addition, the invasion of alien species is a crucial factor that will continue to change the biodiversity of the Mediterranean, mainly in its eastern basin that can spread rapidly northwards and westwards due to the warming of the Mediterranean Sea.

The Mediterranean Sea is a marine biodiversity hot spot. Biodiversity hotspots are characterized by both exceptionally high levels of endemism and critical levels of habitat loss, and it is thus on them that conservation efforts mainly focus. High endemism (20-30%), referring to species that live only in the Mediterranean, is another marked feature of marine biodiversity of the region.

This high biological diversity may be related to the specific geomorphological and hydrographical features of the Mediterranean basin, its geological history and its position as interface between temperate and tropical biomes that allow it to host both cold- and hot-affinity species.

The Mediterranean Sea's flora and fauna are differently distributed among its various basins: 87% of the known forms of life in the Mediterranean are present in the western Mediterranean, 49% in the Adriatic and 43% in the eastern Mediterranean. However, many species are present in two or three basins. Also, endemic species are more numerous in the western Mediterranean.

Temporal trends indicate that overexploitation and habitat loss have been the main human drivers of historical changes in biodiversity. At present, habitat loss and degradation, followed by fishing impacts, pollution, climate change, eutrophication, and the establishment of alien species are the most important threats and affect the greatest number of taxonomic groups. All these impacts are expected to grow in importance in the future, especially climate change and habitat degradation. The spatial identification of hot spots highlights the ecological importance of most of the western Mediterranean shelves (and in particular, the Strait of Gibraltar and the adjacent Alboran Sea), western African coast, the Adriatic, and the Aegean Sea, which show high concentrations of endangered, threatened, or vulnerable species. The Levantine Basin, severely impacted by the invasion of species, is considered endangered as well.

While a coordinated systematic monitoring programme for the components of biodiversity (providing systematic data for assessment) has not as yet been set up under UNEP MAP, the Contracting Parties to the Convention on the Protection of the Mediterranean Marine and Coastal Environment (Barcelona Convention) are required under the Specially Protected Areas and Biodiversity (SPA/BD) Protocol of the Barcelona Convention to establish inter alia

[1] http://www.cbd.int/

inventories and monitoring activities on the components of biological diversity. The programme of work of the Specially Protected Areas Regional Activity Centre (SPA/RAC) of MAP for the biennium 2012-2013 included providing assistance to countries to carry out field survey, monitoring and mapping of biodiversity as part of their obligations under the Strategic Action Programme for Biodiveristy (SAP BIO). As key activities are listed the mapping of seagrass meadows and other assemblages and habitats of particular importance for the marine environment in Mediterranean areas, the elaboration of an atlas of seagrass meadow distribution in the Mediterranean, the elaboration of a database on marine Mediterranean invasive alien species (MAMIAS), and strengthening the Mediterranean monitoring system for the key biodiversity components. As part of the process of adopting, updating and implementing regional policies, guidelines and plans necessary for the effective implementation of the Convention, Protocols and Strategies, the Contracting Parties to the Barcelona Convention and its Protocols invited the Secretariat, at their Seventeenth Ordinary Meeting (Paris, France, 8-10 February 2012),to assess the progress made in applying the SAP BIO and defining its options and new orientations at national and regional level over the coming years.

The Parties stressed the importance of taking into account the Ecological Objectives adopted for the Mediterranean under the EcAp process and the Aichi Biodiversity Targets adopted by the CBD in the new SAP BIO options. The new orientations, with a strong priority towards a monitoring component, were defined in 2013 (UNEP, 2013).

According to the EcAp, biological diversity is maintained when the quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. It covers the whole range of species, habitats and pressures in all Mediterranean marine regions (from coastal waters to open seas).Despite the increasingly important effort made by Mediterranean countries, there are as yet critical gaps in the information and data for many key components of Mediterranean marine biodiversity. Indeed, in a considerable number of Mediterranean countries, marine species and habitats remain little studied, while knowledge on species abundance and distribution, as well as conservation status is uneven.

2 Monitoring strategy

2.1. From ideals to pragmatics

It is not practical, possible or even necessary to monitor all attributes and components of biological diversity, throughout the region or sub-region. Therefore, a pragmatic approach needs to be adopted, aiming at using resources wisely and to maximise the information gathered to reflect the overall state of biodiversity (JRC, 2010). The relationship between environmental pressures and main impacts on the marine environment is taken into careful consideration when selecting where and what to monitor (An indicative relationship between pressures on the marine environment and main impacts is provided in Annex IV). The following strategy is recommended:

a. The assessment and monitoring programme should be orientated towards a risk-based prioritisation of the biological components, pressures and locations to be investigated;

b. An initial risk assessment considers the full range of pressures (activities) in a region/sub-region and identifies those which, by way of their intensity, duration and extent, appear to provide the highest risk to biodiversity (noting that this may not be suitable for assessing higher predators, where causal links to pressures may be weakly understood).

c. Best use is made of ongoing biodiversity monitoring programmes, bringing these together and integrating them, wherever possible, to meet the needs of assessments for this

Ecological Objective. Integration with other monitoring programmes, including for other Ecological Objectives, is also likely to be beneficial.

d. Consider using monitoring data collected for regulatory purposes (by industry or regulatory authorities) as part of the overall programme. This may require some adjustments to better suit the wider requirements and standards for this Ecological Objective and appropriate quality assurance.

2.2. Preparatory phase of the monitoring process

A number of preparatory tasks are needed, after which the monitoring process may be divided into a series of broad phases (JRC, 2010). The development of an overall approach to biodiversity monitoring is likely to be an iterative process, such that the sequence offered below may need adjustment to best suit particular circumstances in some regions/sub-regions and also to provide links and feedback between some tasks and phases.

Preparatory tasks:

Task 1: Collate human activity and environmental data;

Task 2: Identify biodiversity components present in the region or sub-region;

Task 3: Define ecologically-relevant assessment areas;

Task 4: Define reference state (conditions);

Further useful guidance on how to elaborate the steps described above is provided in Annex I.

In general the development of a monitoring programme for subsequent assessments should be based on a holistic understanding of the region or subregion to be assessed. Compiling relevant information in a Geographic Information System (GIS) is recommended to enable a spatial (and temporal) understanding of the relationship between human activities (which may be causing adverse pressures on the environment) and the characteristics of the environment, including its biodiversity.

2.3. Selection of monitoring locations

Carrying out monitoring for biodiversity under the EcAp is recommended to focus on so called “representative sites” the criteria for the selection of which would indicatively include the following:

- Where most information/historic data are available
- Where well established monitoring (in general, not only for biodiversity) is already undertaken
- Sites of high biodiversity importance and conservation interest (according to national, regional or international regulations)
- Where pressures to and risks to/effects on biodiversity are most strongly associated, following a risk based approach
- Expert opinion

When prioritising where to monitor, assessing the risk of impacts from pressures, based on distribution, intensity and frequency of human activities and the pressures they exert on the environment provides an important analysis on which to base the monitoring strategy and sampling programme.

The monitoring programme should consider the range of pressures which occur within an assessment area. Locations to be monitored should be prioritised to cover at least the following:

a. Areas of influence from anthropogenic activities which are expected to cause impacts upon biological diversity, with priority on the areas at highest risk:

i. High-intensity activities;

ii. Multiple activities;

iii. Areas where impacts may be particularly severe or long-term.

b. Areas considered representative of un-impacted (reference) conditions (i.e. not thought to be subject to, or impacted by, pressures):

i. Without pressure (as far as is possible within the assessment area);

ii. Representing the physiographic and hydrological conditions of the pressured areas identified in (a) (including the same community types or ecotypes).

Overlapping maps in a GIS will help give a holistic visualisation of the assessment area, the anthropogenic pressures acting upon it and locations of current monitoring programmes. This will enable informed decision-making on how to prioritise the areas to be considered for monitoring.

The degree, to which pressures occur in isolation or in combination and giving rise to cumulative impacts, will affect the intensity of impacts as well as their spatial extent and temporal development. Spatial and temporal scales of change will also vary according to the specific background conditions of each region or sub region.

2.3.1 Monitoring in marine and coastal Specially Protected areas

It is considered that monitoring in marine and coastal protected areas or Specially Protected Areas under the SPA/BD Protocol could serve several purposes:

- Based on the risk approach some marine and coastal protected areas may be designated as such because of the risk to be under high pressures requiring thus more intense monitoring;

- Other marine protected areas may be in remote areas only very slightly affected by pressures. Monitoring in these areas could be useful for determining reference conditions and/or defining GES for several indicators;

- Monitoring of marine and coastal protected areas in different protection status could also inform on the effectiveness of protection measures.

Contracting Parties should therefore consider monitoring in protected areas as an integral and important part of their monitoring strategies.

2.4. Defining what to monitor

2.4.1. Indicative list of habitat and species

At UNEP/MAP COP 18 (Istanbul, 2013) an indicative list of habitats to be considered for monitoring and assessment was adopted, to be elaborated further during the preparation of the EcAp integrated monitoring programme. This list was refined at the recent informal scientific expert biodiversity workshop held in April 2014, which was co-organized by the MAP Secretariat and EU MED Projects (PERSEUS, COCONET, DEVOTES and IRIS-SES), as presented in Annex II to this document. It is considered that “representative sites” as mentioned above would include a substantive number of the listed habitats.

In addition at UNEP/MAP COP 18 (Istanbul, 2013) an indicative list of species to be considered for monitoring and assessment was adopted, to be elaborated further during the preparation of the EcAp integrated monitoring programme. This list was refined with respect to seabirds and marine reptiles, at the recent informal scientific expert biodiversity workshop held in April 2014, which was co-organised by the MAP Secretariat and EU MED Projects (PERSEUS, COCONET, DEVOTES and IRIS-SES), as presented in Annex III to this document.

2.4.2 Identifying biodiversity components at risk

The information compiled on the distribution and intensity of pressures (actual or modeled), should be assessed in relation to the distribution of the biodiversity components in the assessment area to identify the components and locations likely to be at most risk of impact from human activities.

This evaluation should:

a. Identify those activities and pressures that are currently having, or could potentially have the greatest impacts on biodiversity.

b. Assess the degree of risk of impact from human activities (i.e. in terms of the intensity, frequency and extent of the pressure) on each component.

c. Use the results of a-b above, to compile a set of biodiversity components to be monitored and identify locations which represent a graduation from expected high impact to low or no impact.

d. For biodiversity components which do not or cannot be linked directly to known pressures, consider what level of further assessment and monitoring might be appropriate. For mobile species, there is likely to be a need for some state monitoring, as changes in state may occur for a variety of reasons which are often difficult to link directly to pressures from human activities.

From the selected biodiversity component the level of risk of the targets not being met should be assessed to give a prioritised set of components and criteria to be considered for monitoring, by:

a. considering each criterion in relation to the pressures known to occur in space and time;

b. the types of impact caused by the pressures.

For instance, the pressures on a particular habitat type may pose a range of risks to the condition of the habitat (its structure and species composition), but not threaten any reduction in overall extent or distribution in the assessment area. In such cases, monitoring may be focused on aspects of habitat/community condition.

2.5 Selecting indicators

2.5.1. Identify type of monitoring needed

<u>State and pressure monitoring</u>

Following the production of a prioritised list of those biodiversity components and geographical locations that should be included in a monitoring and assessment for Ecological Objective 1, the assessment of these components can be done through monitoring of the state of biodiversity, including the level of any impact from pressures, through monitoring of pressures as a proxy for assessing biodiversity state, or a combination of the two.

If monitoring of pressures is to be used, a strong causal link between pressure and biodiversity state must be established (existing scientific literature provide suitable documentation). If there is such a link, then measuring pressures may be a more cost-efficient approach and would provide direct evidence to inform management. Wherever possible, such pressure monitoring should be accompanied by state monitoring to demonstrate changes (improvements) in state resulting from reductions in pressures (as a consequence of measures taken); in this combined approach the state monitoring may only need to be at a reduced level compared with situations where no pressure monitoring is included.

<u>Types of state monitoring needed</u>

The types of state monitoring that may be needed should be linked to the criteria and the types of impact to which the component is subjected. A pragmatic stepwise approach should be taken to selecting monitoring parameters for the locations in question, based on knowledge of the following:

a. The range of biodiversity components present, or expected to be present, at the prioritized sampling locations;

b. The potential responses of the biodiversity component at those sampling locations to the pressures in the area;

c. The availability of suitable indicators for the above, with reference to international standards for monitoring, where these exist

2.5.2. Selection of indicators

The previous stages should lead to an understanding of which criteria need to be assessed (those at highest risk) in relation to targets and reference conditions for particular components. It is typical to do this by measuring specific aspects of the component (e.g. the length of fish, the composition of communities) and to analyse these measurements in particular ways (e.g. using certain metrics or indices) to provide a value for the assessment of state. The repeated determination of these metrics or indicators over time should allow trends in state and progress towards achieving targets to be evaluated.

The February 2014 Integrated Correspondence Group on GES and Targets (Integrated CorGest) of the EcAp process of the Barcelona Convention selected the following common indicators from the integrated list of indicators adopted in the 18th Conference of the Parties (COP18), as a basis of a common monitoring programme for the Mediterranean in relation to biodiversity:

1. Habitat distributional range

2. Condition of the habitat defining species and communities

3. Species distributional range (related to marine mammals, seabirds, marine reptiles)

4. Population abundance of selected species (related to marine mammals, seabirds, marine reptiles)

5. Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to marine mammals, seabirds, marine reptiles

The number of indicators needed for a biodiversity component will vary according to the range of risks (pressures) each faces, and also need to consider the available resources and the state of knowledge of appropriate indicators. As each combination of prioritised pressure/biodiversity component should be assessed, each such combination should have at least one indicator (although some indicators may serve several pressure/component combinations).

The indicators selected to fulfil this role should involve species and habitats that are identified as conservation priorities by existing Regional and International Conventions and Community legislation, as this will add value to monitoring for Ecological Objective 1 and make full use of existing monitoring effort. In addition, most point-sources of anthropogenic pressures have legally-binding monitoring and regulatory commitments.

In order to select the most appropriate indicators for a given component and assessment area, the following two questions need to be addressed:

a. Should the state of the component be monitored and assessed directly, or is it more cost effective to monitor and assess the pressure or pressures that impact upon it (where a strong causal link is established)?

b. Are there particular species and habitats/communities within each species ecotype or predominant habitat type that could act as a suitable surrogate for the state of the broader component?

2.6. Defining sampling techniques, strategy and periodicity

The distribution of biodiversity components and assessment of risks to their status from previous phases, together with the identification of suitable indicators, will inform the type of sample design needed, including its spatial and temporal resolution. Sampling strategies need to be devised to collect the evidence needed to assess state, bearing in mind the need to distinguish anthropogenic change from changes due to environmental and climatic variation. The level of evidence required is also likely to be linked to the requirements to relate any impacts found to particular activities and thus inform decisions on the need for management measures. Whilst prioritisation towards biodiversity components and locations most at risk is advocated, this should include sampling of locations considered to be in reference condition to facilitate interpretation of monitoring data and to enable understanding of changes in the wider environment.

2.6.1. Spatial and temporal scale consideration

Spatial scales

Within the overall frame of assessment at the region/sub-region scale, two key issues regarding scale need to be accommodated to facilitate assessments for this Ecological Objective:

a. The natural characteristics of biodiversity, in which species and their populations occur at a variety of scales and communities within habitats change in character according to the biogeographic region (i.e. for the same physical habitat, the species composition of the community changes with location as a result of oceanographic differences, primarily in water temperature and salinity);

b. The need for effective links to management responses, which are often associated with particular pressures (or multiple pressures), locations and administrative zones.

Whilst the overall assessment of GES is undertaken at the Marine Region level and the Sub-region level for the Mediterranean Seas it is recommended that:

a. A suitable set of ecological assessment areas is defined which can adequately reflect both the ecological scales exhibited by the biodiversity components in each region/sub-region and links to areas which are effective for management measures;

b. These assessment areas should generally be smaller than the sub-regions provided in the EcAp, in order to reflect the biogeographic trends at the community level and the population distribution patterns of many mobile species. Where species are very wide ranging and do not appear to have distinct populations, it may be appropriate to establish assessment areas which are larger than the sub-region, spanning regions if necessary.

c. The number of assessment areas in a region/sub-region should in principle be kept to a minimum, so as to not produce an overly complicated assessment process. The assessment areas should provide a series of nested (rather than overlapping) areas which facilitate aggregation of assessments, where appropriate, up to sub-region or region scales.

d. In order to achieve an ecosystem-based approach to management, the assessment areas should be defined according to hydrological, hydrographic, oceanographic and biogeographic criteria. Given the complexity of scales at which biodiversity operates (particularly mobile species), the assessment areas should represent relatively distinct ecological units, each reflecting distinctive oceanographic and hydrological characteristics within the region/sub-region (which in turn reflect differing biogeographic zones). . The systems developed for each sub-region should be of comparable scales and levels of distinction across the regions and sub-regions.

e. Contracting Parties should determine whether the ecological assessment areas needed for Ecological Objective 1 are also suitable for application with the other Ecological Objectives.

<u>Temporal scales</u>

Ecological variation occurs over a wide range of time-scales, particularly depending on life history characteristics of species (hours to decades), long-term fluctuations in climate and sometimes very long periods for community structure to re-establish following severe damage (10s-100s of years). The six-yearly assessments should be based on evidence (environmental and activity/pressures) which is updated at least once within the six-year assessment period; however the periodicity of evidence collection needed to adequately assess trends should be determined in relation to the life history characteristics, environmental and other factors which are, or may be, causing adverse impacts. It is likely that many aspects of biodiversity assessments will need further development of techniques and understanding of change in relation to both environmental factors and anthropogenic pressures. Distinguishing anthropogenic pressures from other drivers of change is a key issue for effective assessments and is likely to require more intensive (and frequent) monitoring, until the relationships are adequately understood and the periodicity of monitoring can reasonably be reduced.

On the basis of these considerations, it is recommended that:

a. The evidence (environmental, activity/pressure and management measures) used to make the six-yearly assessments of GES for this Descriptor is updated before each assessment is undertaken;

b. The periodicity of evidence collection is determined according to the rates of change in natural and anthropogenic influences in the Region/sub-region;

c. The periodicity of evidence collection is sufficient to distinguish the effects of anthropogenic disturbance from natural and climatic variability, and the need to determine progress against the programme of measures;

d. The frequency of sampling in relation to costs is carefully considered. Whilst the costs of more frequent sampling may be higher than initially desired, it may be more costly over the long term to sample too infrequently if this leads to the wrong conclusions, and a flawed and costly programme of measures based on an under-designed monitoring programme.

2.7 Methodology and standardization

Consistent methods for monitoring across a region/sub-region are required. Some methods are described by international standard guidelines, such as the International Standards Organisation (ISO) and the European Committee for Standardization (CEN) as listed in Annex V. Where suitable guidelines exist, these should be followed, provided they are appropriate for the objective of the monitoring (i.e. to assess the criteria in relation to the targets and reference conditions). Where these are not available, the operating procedures used should be compatible with methods described in the scientific literature for the relevant biological indicators or components. A detailed description of procedures should be developed by the participating laboratories, and as a minimum, standardised between collaborators across the subregion, for example during synergy with other ongoing monitoring and research efforts.

Large-scale inter-disciplinary and international networks such as MarBEF[2] have highlighted the need for assessing biodiversity at the scale of ecosystems rather than localised areas. All monitoring activities should if possible aim to contribute to such large-scale assessment systems covering the Regional Seas. To achieve this, methodology and approaches for the selected indicators need to be reliable, reproducible and as far as possible inter-comparable between operators across the Regional Seas.

Further information on methodological approaches for monitoring the components of biodiversity is provided in Annex V.

2.8. Quality control/ quality assurance

The following is modified from ISO 16665, applicable to all biological monitoring.

Quality assurance and quality control measures should be incorporated during all stages of sampling and sample processing programmes. These principles help to guarantee that all data produced are of a specified quality, and that all parts of the work are carried out in a standardised and intercomparable manner. All procedures should therefore be clearly

[2] www.marbef.org

described and carried out openly, such that all of the laboratory‘s activities can be audited internally and externally at any time.

The overall aim is to assure traceability and full documentation of samples and equipment from beginning to end from sampling, sample transport, offloading from survey vessel (where used), placement within and retrieval from a sample store to sample processing, reporting and final archiving.

For some biodiversity components such as benthic fauna, international quality assurance and/or ring-testing schemes are well established (e.g. BEQUALM). Some approved national schemes exist. For other components, there may be a lack of specific quality assurance schemes, in which case, appropriate modifications may be developed.

A quality assurance/quality control scheme should encompass the following:

a. training and training records;

b. traceability of work and samples;

c. standardised practices throughout;

d. calibration of sampling and sample processing equipment or procedures;

e. in-house and external audit, also referred to as Analytical Quality Control schemes;

f. literature updates;

g. reference or voucher collections (where specimens are collected; photographs or other documentation for non-destructive sampling).

3. Baseline Setting Approaches

Approaches to setting baselines are described below, based on OSPAR (OSPAR, 2012):

a. <u>Method A (reference state, with negligible impacts)</u> - Baselines can be set as a state in which the anthropogenic influences on species and habitats are considered to be negligible. This state is also known as ‘reference condition’.

b. <u>Method B (past state)</u> - Baselines can be set as a state in the past, based on a time-series data set for a specific species or habitat, selecting the period in the dataset which is considered to reflect least impacted conditions;

c. <u>Method C (current state)</u> - The date of introduction of an environmental policy or first assessment can be used as the baseline state. As this may represent an already deteriorated state of biodiversity, the associated target typically includes an expression of no further deterioration from this state.

In the application of these methods, it is important to take account of ecosystem dynamics and climatic variation as these processes may lead to change over time in, for example, the distribution of a species or the composition of a community. Because of this, the use of baselines (and targets set as a deviation from a baseline) should aim to reflect a state of biodiversity that is consistent with ‘prevailing physiographic, geographic and climatic conditions’ (JRC, 2010).

Method A - Baseline as a state at which the anthropogenic influences are considered to be negligible

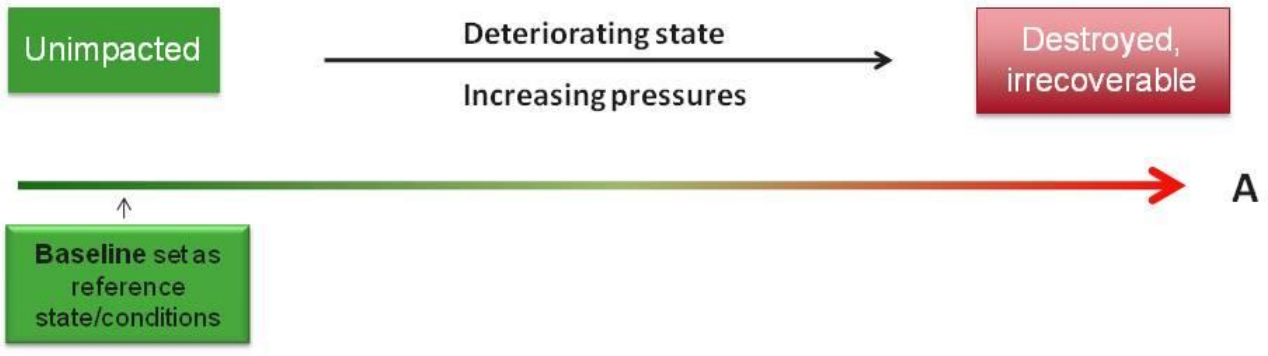

***Figure1**. Baseline method A – as a state at which anthropogenic influences are negligible (reference state).*

There are three options for setting baselines as a state at which anthropogenic influences are considered to be negligible (Figure 1). It is acknowledged that it is not possible to determine indisputably 'un-impacted' reference values either through modelling/historic data or through marine areas where human effects are currently minimal.

i. Existing reference state

The first approach is to use current information on species and habitats from areas where human pressure is considered negligible or non-existent (for example, in some marine protected areas). There may not be reference areas containing exactly the species or habitat for which targets need to be set, but it may be possible to use an analogous species or habitat.

This approach is a scientifically robust basis for setting baselines as it demonstrates reference conditions under current physiographic, geographic and climatic conditions. It is also a relatively transparent and comprehensible approach which can provide precise data on species composition and relative abundances. However, its robustness depends on the existence of areas of negligible impact containing species and habitats that are the same or very similar to those to be assessed under the EcAp. There are likely to be few genuinely un-impacted areas in the Mediterranean, although as marine protected area networks are further developed, more areas may ultimately be considered to be in 'reference state (at least for habitats and low mobility species).

ii. Historical reference state

The second approach is to use historical information to ascertain what a habitat/community or species population may have been like at a time when impacts from human activities were negligible. This information can be found in a variety of sources, such as historical accounts, old maps, fishing and whaling records, ship's logs, and archaeological information such as fish bone remains.

In the absence of present day reference state information, this method[3] offers a way to determine reference state of biodiversity but it is likely to yield mostly qualitative information on species composition and their abundance.

This approach provides a moderately scientifically robust basis for setting baselines, depending on the quality and quantity of the available data, as well as expert judgement used in the interpretation of that data. It is a comprehensible approach, but perhaps less transparent than Method Ai. The time involved in applying this approach depends on the degree to which existing research or data archiving programmes can deliver EcAp data needs. Climatic changes and ecosystem dynamics (e.g. predator-prey relationships) since the period used as a reference point needs to be built into any final definition of reference state.

iii. Modelling of reference state

A third approach to setting a baseline is one based on modelling[4] of reference states. This approach is closely linked to approach (ii), in that models depend on historic as well as current information to develop a theoretical state of un-impacted ecosystems under present climatic conditions.

As with approach (ii), the scientific robustness of this option has the potential to be moderate or even high, depending on the nature of the modelling exercise, and crucially on the quality of the data with which it is fed. It offers the possibility of introducing current and future climate scenarios, and their effects on biodiversity state. However, it is perhaps the least transparent or comprehensible of the three approaches. Another limitation of this approach is that of time. Unless existing programmes are underway that can deliver EcAp needs, new modelling work is not likely to take place within the required timeframes. However, it is an approach that could be considered as part of the future reporting round.

Method B - Baseline set in the past

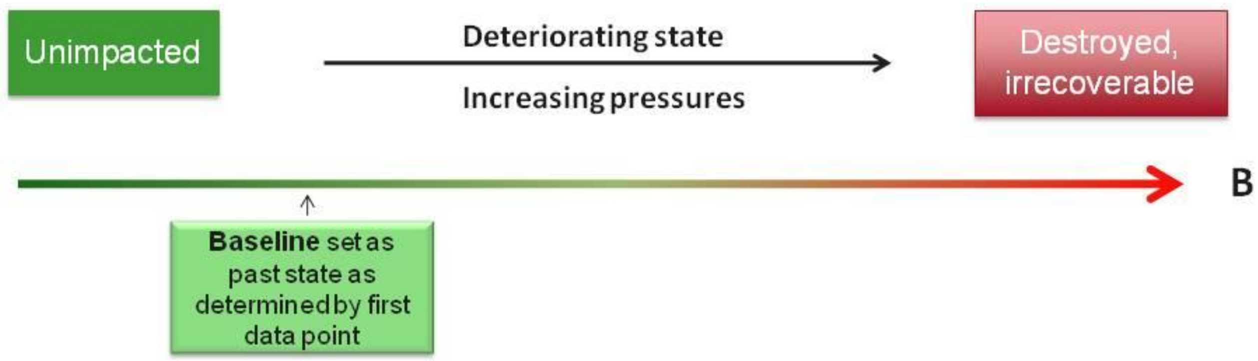

***Figure 2**. Baseline method B – as a state set in the past (often when monitoring first started).*

The second method is to set a baseline as a past state (Figure 2), based on a time-series data set for a specific species or habitat. Expert judgement is needed to select the period in

[3] The History of Marine Animal Populations (HMAP), which is the historical component of the Census of Marine Life (CoML), is a research project focused on this approach. Interpretation of changes in marine populations over the past 500-2000 years is providing researchers with a baseline that extends back long before the advent of modern technology, or before significant human impact on ecosystems.
[4] This type of ecosystem reconstruction modelling work is being developed within academia, such as at British Columbia, Dalhousie and Chicago Universities.

the dataset which is considered to reflect least impacted conditions; this may be the date of the first data point in a time series, provided this is considered the least impacted state of the time series. It is important to note that this first data point is not intended to represent an un-impacted/reference state, but simply when research or data recording on a particular species population or habitat began.

It is a robust approach in the sense that it is based on a time series of scientific data which should indicate how the state of a feature has changed over time; however, it can be limited by the quality and quantity of the data (for example, if the time series is rather short). It is straightforward and comprehensible, but resultant targets run the risk of being based on an already significantly impacted scenario. This is sometimes referred to as the 'shifting baselines syndrome'[5], where each generation at the beginning of their career redefines what it is they understand to be a 'healthy' marine environment, which may represent significant changes from the original state of the system.

Each time series needs expert evaluation to determine whether the first point/period (or some other point/period) in the time series is to be selected as the reference point, taking into account the changes in associated pressures over the time period and other relevant factors.

Method C - Current baseline

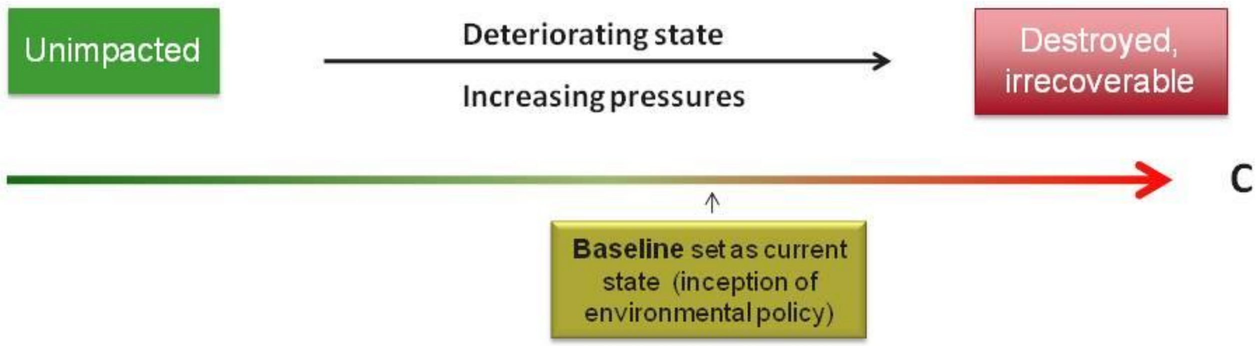

***Figure 3**. Baseline method C – as current state e.g. at inception of a policy or first assessment.*

Finally, baselines can be set as the date of inception of a particular environmental policy or the first assessment of state (Figure 3). This approach was used in the context of the Habitats Directive, where the date when the Directive came into force was used by many European countries as the baseline for favourable reference values[6]. This type of baseline is typically used with the objective of preventing any further deterioration from the current state; there can additionally be a target to improve the state from such a baseline (towards a reference state).

Although this approach is quick, practical and transparent, it is not scientifically robust as the current state may represent a wide range of conditions across Regional Sea waters. This

[5] As described by Pauly, D (1995) "Anecdotes and the shifting baseline syndrome of fisheries." Trends in Ecology and Evolution, 10(10):430.

[6] The favourable reference values of the Habitats Directive are, as a minimum, the ecological state when the Directive came into force. However, in the Article 17 guidance on assessment and reporting under the Habitats Directive it is acknowledged that historic data and expert judgement may also be used to help define these values.

approach could be appropriate where it is determined that GES has already been achieved and hence only requires “maintenance” under the EcAp. However, it is not considered appropriate where deterioration or degradation has already occurred. In addition, there is a significant risk of succumbing to ‘shifting baseline syndrome’ as described above. This method is generally more appropriate for use in setting baselines for pressures.

The use of expert judgement

Expert judgement can be used to supplement information that is available from the other methods, or allow disparate information to be brought together to provide an expert interpretation, for example on the types of species that might reasonably be expected to occur in a community. The application of expert judgement, should, where possible, follow predefined rules, such as:

- expert judgement needs to be scientifically sound and comprehensible for everyone concerned;
- an appropriate number of competent experts, preferably from a majority of Contracting Parties, needs to be involved;
- the applied procedure and the outcome need to be transparent and appropriately documented.

If the implementation of such rules cannot be guaranteed, the results of this expert judgement would not be reproducible and reliable, and should therefore be avoided. On this condition, reliance on expert judgement is most appropriate when combined with the other baseline-setting methodologies (particularly, method A), as opposed to being a distinct baseline-setting technique. Quality assessment through a panel of experts is always more preferable to using single expert judgement – confidence in the conclusions are likely to increase with the numbers of experts consulted.

4. Monitoring for the biodiversity common indicators

4.1. Elaborating habitat distributional range

4.1.1 Locating and assessing benthic habitats

The identification of habitat sites in marine areas away from the coast has to be based on more general geological, hydrological, geomorphological and biological data than is the case for coastal or terrestrial areas. Where the location of sub-littoral habitat types is not already known, they can be located in two steps using available data. Broad scale geophysical or oceanographic information is often available for large sea areas, and can be used as the first step in the selection of sites by helping to identify the location of potential habitats. Step two then involves focused information gathering or new surveys, directed to those specific areas where existing information indicates that a habitat type is present or is likely to be present. This approach is particularly useful for Contracting Parties with large sea areas and deep waters, where detailed biological information is likely to be sparsely distributed. Collation of data should involve examination of scientific archives and data from relevant academic, government, NGO, and industry stakeholders. This information can include historical charts of relevant seabed features and fishing grounds. The two steps involve:

1. Using available physical information mapped at a regional scale, such as modelled geological seabed data, bathymetric data, physical oceanographic data, navigation or naval charts (where they show seabed type), to predict the location of potential habitat type.

2. Refine and add to this information using more localised remote sensing datasets such as side scan sonar, acoustic ground discrimination system (AGDS) surveys, multibeam bathymetric survey, aerial photography or satellite images (for some habitats in very shallow water only, such as seagrass beds or maerl). Such remote sensed data will need to be validated in the field (ground truthed) by direct sampling of sediment and/or biota (grab/core sampling, diver survey, benthic trawls) or by remote observation (video, photography, ROV [Remote Operated Vehicle]). For more on these see Table A3 in Annex V and a review in Cogan et al (Cogan et al., 2007). The MESH Project has a developed a series of Recommended Operating Guidelines[7] to describe how best to use each technique in a marine habitat mapping.

As well as ground validation, data obtained from direct sampling will also be used to assess the biota of the habitat type directly.

Marine habitat survey and mapping has become increasingly common and widespread over the past 10-20 years, spurred on by both improvements in technology and the increasing demand for this type of information. Whilst the purpose for doing the mapping varies considerably (e.g. industry environmental assessments, conservation, fisheries, planning), the underlying techniques and type of data collected have a great deal in common. Habitat maps of the marine environment are required to provide a better understanding of the distribution and extent of marine habitats, both in particular protected areas and across the wider environment. Knowledge of the distribution and extent of marine habitats serves to establish sensible approaches to the conservation needs of each habitat and to facilitate better management of the marine environment through an understanding of how particular human activities are undertaken in relation to marine habitats.

With increasing pressure being put on our coastal and offshore marine environment through industry and leisure activities, new methods and technologies have developed in recent years to allow rapid site evaluation and appraisal. Such technologies include multi-beam echo-sounding, side-scan sonar and acoustic ground discrimination systems. These remote sensing techniques combined with ground-truthing techniques such as sediment grabs, camera tows and dredging can be used to create detailed habitat maps.

To fill gaps between small, detailed habitat maps broad-scale predictive habitat maps have been produced based on broad physical categories. The UKSeaMap 2010 project[8] has recently updated a seabed habitat map for the entire UK continental shelf area using this method.

Using a very similar approach, the EUSeaMap project[9] recently produced a seabed habitat map for over 2 million square kilometres of European seabed across the North, Celtic, Baltic and western Mediterranean seas. A similar exercise is currently being elaborated for the entire Mediterranean within the framework of the European Marine Observation and Data Network (EMODnet[10]) undertaking seabed habitat type and pressure mapping with a focus on protected areas that is expected to be completed in 2016.

[7] http://www.searchmesh.net/default.aspx?page=1915

[8] http://jncc.defra.gov.uk/ukseamap
[9] http://jncc.defra.gov.uk/euseamap
[10] http://www.emodnet-mediterranean.eu/project/

4.1.2. Evaluating the status of benthic habitat range

In order to evaluate the status of the range we need to look at two principal characteristics of the range, first at the size of the range in relation to the size of a favourable reference range and second at the range trend. A favourable reference range can be considered as the range within which all significant ecological variations of the habitat are included for a given biogeographical region and which is sufficiently large to allow the long term survival of the habitat. However, it should be noted that range is rarely the only parameter responsible for an overall assessment not being favourable as changes in range are invariably accompanied by changes in area of a habitat type. Estimates of trend for changes in habitat distribution are more likely to be statistically robust over more than an assessment cycle i.e. it is recommended to be carried out over two assessment cycles i.e. 12 years. The recommended period for assessing longer term trends is four assessment cycles (24 years).

The natural habitat range describes roughly the spatial limits within which the habitat occurs. It is not identical to the precise localities where a habitat permanently occurs. Such actual localities might for many habitats be patchy or disjointed (i.e. habitats might not occur evenly spread) within their natural range. Natural range as defined here is not static but dynamic: it can decrease and expand. Natural range can also be in an unfavourable condition for a habitat i.e. it might be insufficient to allow for the long-term existence of that habitat. When a habitat spreads naturally to a new area, this area has to be considered a part of the natural range. Similarly restoration or management of habitat areas can contribute to the expansion of a habitat and therefore its range.

4.1.3. Assessing individual parameters

Range is defined as ‘the outer limits of the overall area in which a habitat type is found at present. It can be considered as an envelope within which areas actually occupied occur.

The range should represent a parameter suitable for assessing the spatial aspects of the status. However the spatial component is also included in other parameters, namely ‘area’ for habitat types. The ‘range’ should be able to describe and detect changes in the extent of the distribution.

Range is a technical parameter allowing for assessing the extent and the changes in the habitat type. The range should be calculated based on the map of the actual distribution using a standardised algorithm. A standardised process is needed to ensure repeatability of the range calculation. A standardised process may consist of 2 steps:

1 Gap closure using a predefined set of rules specifying when two distribution points/grids will be joined together to form a single range polygon, and where an actual gap in the range will be left.

2 The polygons created by gap filling will be then fitted to environmental parameters to avoid the range covering areas which are not possible, for example the range of a marine habitat including terrestrial areas.

Contracting Parties can use their own methods to calculate ranges if their distribution data uses a grid close to 10x10 km^2. The main requirements are repeatability of the estimation and sensitivity to the spatial changes of the distribution.

Range should exclude major discontinuities that are natural i.e. caused by ecological factors. What is considered as a natural discontinuity is largely dependent on the ecological characteristic of the habitat type and the character of the surrounding landscape.

The choice of recommended gap distance corresponds with the definition of range as an envelope generalizing the distribution with major discontinuities excluded suitable to detect large scale changes in the distribution. A discontinuity of at least 40–50 km is suggested to be considered as a gap in the range. This value may be modified on the basis of an expert judgment, A range calculated with larger gap distances (40–50 km) is more sensitive to changes at the margins of the distribution and large scale changes within the outer limit of the distribution. On the other hand range calculated with smaller gap distances (20 km) is sensitive to small scale changes.

Generally, distribution data will be provided as presence on a 10 x 10 km grid. Technically the range will be calculated by filling in unoccupied grids between cells of distribution. A gap distance should be understood as the distance between two distribution grids, that will not be joined together to form a single polygon, component of range.

4.1.4 Setting the baseline and reference level

For each habitat type a baseline of the range has to be determined, as well as the natural range of the habitat type.

Reference state is recommended as the preferred approach to setting baselines for benthic habitats. To establish a baseline for this indicator, it is expected that information on the natural range of the habitat (based for example on historical data) will be needed. Where possible, information could be gathered using historical maps/data, and/or using information from undisturbed states within some Marine Protected Areas or areas with a very low level of disturbance. If the determination of reference state is not possible, then expert judgment should be used giving particular consideration to the current state. The approach for developing baselines should be applicable to all habitat types if possible as the methodologies will have to be standardized.

4.1.5 Setting GES boundaries

Further discussion will be needed to ascertain the GES boundaries applicable to this indicator. It is recommended that the target should be a deviation from a specified given baseline. As an example under the European Habitats Directive if more than 25% of the extent of the habitat is damaged (specific structures and functions including typical species) it is classed as ‘Unfavorable-Bad’. Additionally, a careful consideration of the level of resolution of the assessment and consideration of habitats of specific importance within representative sites (such as spawning or feeding grounds for mobile species) is recommended when applying, further developing or revising this indicator.

4.2 Elaborating the condition of habitat defining species and communities

4.2.1 Elaborating typical benthic species composition

The concept of “typical species” emerges from the relation of the conservation status of natural habitats to their long-term natural distribution, structure and functions, as well as to the long-term persistence of their typical species within the territory. Therefore typical species should be at a favourable conservation status (FCS) as a condition for their habitat to be in favourable conservation status (FCS). It is left to Contracting Parties to define lists of typical species and to set targets for their presence.

Typical species composition comprises both macrozoobenthos and macrophytes, depending on the type of habitat (i.e. macrophytes not in deeper aphotic waters).

Two different targets are covered under this indicator, which are (1) its implementation as a state condition indicator by using an unweighted list of typical species of the habitat's communities and (2) its implementation as a specific pressure indicator by including pressure-sensitive species. As this encompasses the use of different methodological approaches, this indicator should be considered as a general concept, covering different specific indicators.

4.2.1.1.1 Parameter/metric

The selection of the relevant parameter and the development of metrics strongly depend on the selected habitat and its relationship to pressures. It has to be highlighted that the natural variability of species composition in space and time has to be considered when further developing the indicator.

For [unspecific] state condition indicators, a simple species list per habitat forms an appropriate parameter. The species inventories may differ locally even if the habitat is similar. The list of typical (and possibly character) species has therefore to be defined per habitat type with respect to a particular geographic area (bioregion); it should be updated every six years. Species included within these lists should contain two aspects:

- state reflection (by listing habitat-typical species of the community)
- pressure reflection (by including species specifically sensitive to the pressures to which the habitat is subjected)

Long-living species and species with high structuring or functional value for the community should preferably be included, but the typical species list can also contain small and short-living species if they characteristically occur in the habitat under natural conditions.

4.2.1.2 Baseline and Reference level

For baseline setting the use of current state might be inappropriate if the habitats actually underlie high human pressure and no reference sites are available. Use of past state may be most appropriate as the definition of a reference state of Mediterranean Sea habitats may be problematic.

4.2.1.3 Setting of GES boundaries / targets

The general target is to reach a ratio of typical and/or character species similar to baseline conditions of all regarded communities.

In case of using habitat specific species lists this might be implemented by setting a certain percentage value to define GES. This cut-off value has to be habitat-specific and regionally adapted in view of the natural variability of species composition by habitat type and bioregion; the list also needs to be adapted to the sampling [effort and] methodology to be used (e.g. video, grab). Therefore, the importance of exact descriptions for the used methodologies to ensure comparability and reproducibility has to be stressed. Also for verification of comparability, biogeographic regions with common species compositions in same habitats have to be identified in advance.

4.2.1.4 Spatial scope

This indicator is applicable in all regions. Typical species lists have to be developed on a sub-regional scale (or bioregion within each sub-region) for each biotope.

4.2.1.5 Monitoring requirements

The selection of typical species has already been carried out by i.e. several Contracting Parties for listed habitat types in order to fulfill the assessment requirements under the Habitats Directive. Additionally, the coastal area out to 1 nautical mile offshore is already covered by these Contracting Parties under the Water Framework Directive. Therefore the indicator is available for considerable benthic habitats within these areas and is already covered by monitoring and assessed using appropriate metrics. Already in 2009, the Meeting of MED POL experts on Biological Quality Elements (UNEP/DEPI/MED WG. 342/3) recommended the application of metrics developed and tested under the Water Framework Directive for use by all Contracting Parties. Elsewhere in other extensive broad habitat types in certain regions there may be development work required.

The required methods and effort strongly depend on the habitat type (and selected species) to be addressed. Large attached epibenthic species on hard substrates are preferably monitored using optical, non-destructive methods such as underwater-video. Endobenthic communities are sampled using standardized grabs or corers which are commonly used in marine monitoring programmes.

4.2.1.6 Resources needed

The list of required resources includes:

- Research vessels, suited to work from sublittoral to bathyal, depending on subregion;

- Adequate equipment (box core samplers, grabs, dredges, underwater camera systems etc) for sample collection from intertidal to bathyal;

- Laboratory infrastructure to analyse samples (e.g. microscopes, scales).

Qualified personnel, in particular experienced taxonomists, are required for both field and lab work to guarantee quality in sampling accuracy, consistency in the data over time, meaningful data analyses and interpretation of the results.

4.2.1.7 Further work

The following steps are essential for operationalization:

1. Identify existing Contracting Party species lists and check for consistency within biogeographical regions

2. Identification of typical and character species for remaining habitats / biogeographical regions, and re-evaluate species lists in six-year periods

3. Identification / definition of baselines for habitats and biogeographical regions

4. Clear description of required sampling methodologies and effort

5. Setting cut-off value to determine GES in remaining habitats/bioregions

4.2.2 Elaborating Benthic Biotic Indices

As marine benthic macrophytes (seagrasses and macroalgae) are mainly sessile organisms, they respond directly to the abiotic and biotic aquatic environment, and thus represent sensitive indicators of its changes. Seagrasses are key components of coastal marine ecosystems and many monitoring programmes worldwide assess seagrass health and apply seagrasses as indicators of environmental status.

Soft-bottom benthic invertebrates and seagrasses are traditionally used in the Mediterranean Sea for environmental quality assessment and several indices have already been widely applied by Mediterranean Contracting Parties, Member States of the EU and compared in the framework of the Mediterranean Geographical Intercalibration Group of the EU Water Framework Directive (MEDGIG) while two indices have also been based on macroalgae and compared in the framework of MED GIG. Already in 2009, the Meeting of MED POL experts on Biological Quality Elements (UNEP/DEPI/MED WG. 342/3) recommended the application of benthic indices developed and tested under the Water Framework Directive for use by all Contracting Parties. To this end the 2015 PERSEUS Project specific training course targeting Southern Mediterranean countries could be utilized.

Indices based on seagrassess utilize selected sensitive species and metrics related to structural, functional and physiological attributes of the system. For Indices based on macroalgae, species or communities sampled are sorted into disturbance- sensitive classes.

Most of the benthic invertebrate indices are indicator taxa (or species) indices (or biotic) which are based on the ecological group theory realizing up to five ecological groups according to their sensitivity to an increasing stress gradient. These indices are based on the model of Pearson & Rosenberg (1978) which predicts a succession of species along an organic matter gradient.

Other indices combine biotic indices with univariate diversity indices such as the Shannon–Wiener diversity index. Within the MEDGIG it has been shown by the majority of the Mediterranean benthos subgroup experts (GIG, 2013), that diversity measures do not show monotonic patterns of response to pressure gradients particularly at the low end of its range, whereas indicator taxa (biotic) indices better reflect the anthropogenic pressure-indicator gradient. Generally, the use of diversity measures for environmental quality status (EQS) assessment has been criticized due to their dependence on many other factors dependent on habitat type, sample size, seasonal variations and natural dominance of characteristic species.

The assessment of habitat condition by biotic indices is a basic and integrative tool in benthos ecology. Monitoring methodologies are well developed and used considerably in national monitoring, but may still have to be adapted to the special requirements of the Ecosystem Approach. They focus on coastal habitats and on indicating eutrophication, micro-pollutants and dredging/dumping as key pressures. Table 1 shows a summary description of the existing (mostly MED GIG) Mediterranean benthic biotic indices.

4.2.2.1 Parameter/metric

Several specific benthic biotic indices have already been developed and have become operational, in particular to fulfill MED GIG requirements (see description in Table 1, and respective References). They are all well methodologically defined, while the way to combine these parameters in sensitivity/tolerance classification or depending on structural, functional and physiological attributes is more heterogeneous, depending on the issue (pressure type), habitat types or sub-region. For unspecific condition indicators, a simple species list and respective sensitivity/tolerance classification of the sampled species per habitat forms an appropriate basis of monitoring parameter for benthic invertebrates and macroalgae. It has to be taken into account that species communities may differ locally even if the habitat is similar. Attention has to be paid to the fact that species lists depend on varying degrees of expertness of taxonomists in the monitoring teams according to the type of biotic index employed. In addition different results could be caused by uneven taxonomic expertise in the teams that could mask the real differences in environmental status, especially for benthic invertebrate indices. The set-up of the relevant metric also has to be habitat specific and might be (further) developed by each Contracting Party with respect to their (sub-) regional reference values.

4.2.2.2 Baseline and Reference level

For baseline setting the reference state, with negligible impacts is recommended and for target setting this would be deviation from the baseline.

4.2.2.3 Setting of GES boundaries

For MED GIG purposes boundaries between classes for status assessment for each index are provided with the original description of methods (see References in Table 1). It has to be highlighted that the natural variability of species composition in space and time has to be considered when further developing the benthic biotic indicators. Further development should include inter-calibration test of the range of values at a (sub-) regional scale, in order to validate a standardized Ecological Quality Ratio (EQR) or equivalent threshold to discriminate the GES/ no GES, including (sub-) regional reference values.

4.2.2.4 Spatial scope

The Benthic Biotic Indices are conceptually applicable in all sub-regions and all type of habitats, and potentially more sensitive to changes due to anthropogenic pressure than the “typical species composition” indicator. Further discussions in expert groups and expert consultation are needed to progress on the selection of ecologically relevant habitats for Benthic Biotic Index assessments. The (often limited) data availability may restrict the number of habitats which can be assessed with sufficient statistical confidence at present.

4.2.2.5 Monitoring requirements

The spatial and temporal planning of the monitoring (assessment area, sampling locations, sampling frequencies) depends on the Biotic Index metrics, habitat types, exposure to pressure and (sub-)regional reference values. This issue should be further discussed by expert groups. Furthermore, monitoring budget constraints often play a role.

The ISO methods, (ISO, 2014 for soft –bottom macrofauna and ISO, 2007 for hard-substrate communities) could be referred to as advisory documents for benthos monitoring.

4.2.2.6 Resources needed

A coarse estimation of the resources needed is the following:

- Research vessels, suited to work from sublittoral to bathyal, depending on subregion
- Scuba diving sampling to infralittoral
- Adequate equipment (box core samplers, grabs, dredges etc) for sampling collection
- Laboratory infrastructure to analyse samples
- Qualified personnel for data processing, analysis and interpretation.
- Taxonomy skills are very determinant

4.2.2.7 Further work

The following steps are essential for methodological development:

1. Identification of existing national monitoring for the relevant parameters and benthic biotic index development projects. Check for consistency and optimization within biogeographical regions.

2. Selection of an essential set of indices for use in the Benthic Biotic Indices for zoobenthos, angiosperms and macroalgae - by an expert group - based on available literature, data and expert judgement.

3. Test the sensitivity of every Benthic Biotic Index to every pressure, with special concern for physical pressures.

4. To obtain classifications of species based on response to every pressure. Many indices need this information. Obviously species sensitivity classifications may be different among indicators, pressures and regions.

5. Clear description of required sampling methodologies and effort

Afterwards, the final operationalization should include:

6. Identification / definition of baselines for the respective habitats and biogeographical regions.

7. inter-calibration test of the range of values at a (sub-)regional scale, and validation of a standardized Ecological Quality Ratio (EQR) or equivalent threshold to discriminate the GES/ no GES, including (sub-)regional specificities.

Table 1: Summary Description of the existing Med (mostly WFD) benthic biotic indices

BENTHIC INVERTEBRATE FAUNA				
INDEX	REFERENCE	SOFTWARE	DESCRIPTION	Countries adopting the index for WFD
M-AMBI	Muxica et al., 2007, Borja et al., 2004	http://www.azti.es	Multivariate index combining AMBI, Shannon Diversity and Species richness in a factorial analysis. Classification scheme with 5 quality classes	Italy Slovenia
AMBI	Borja et al., 2000)	http://www.azti.es	Biotic index combining the percentages of 5 ecological groups of species in a formula. Classification scheme with 5 quality classes	France
BENTIX	Simboura & Zenetos (2002)	http://www.hcmr.gr/	Biotic index combining the percentages of 2 ecological groups of species in a formula. Classification scheme with 5 quality classes	Greece, Cyprus
BOPA	Dauvin and Ruellet, 2007)		Biotic Index combining the frequency or ratio of opportunistic polychaetes to frequency (ratio) of the amphipods group	Spain (Andalusia, Murcia, Valencia)
MEDOCC	Pinedo et al., 2014		Biotic index combining the percentages of 5 ecological groups of species in a formula. Classification scheme with 5 quality classes	Spain (Catalonia and Balearic Islands)

ANGIOSPERMS				
INDEX	REFERENCE	SOFTWARE	DESCRIPTION	Countries adopting the index for WFD
POMI *(Posidonia oceanica* Multivariate Index)	Romero et al., 2007.		1 selected sensitive species, *Posidonia oceanica*, combining a set of metrics related to structural, functional and physiological attributes of the system, using Principal Component Analysis (PCA). Classification scheme with 5 quality classes	Croatia, Spain (Catalonia, Balearic Islands, Murcia, Andalucia)
PREI (*Posidonia* Rapid Easy Index)	Gobert et al., 2009		1 selected sensitive species, *Posidonia oceanica*, using the ratio of epiphytic biomass and leaf biomass (E/L ratio). Classification scheme with 5 quality classes.	France, Italy, Cyprus
BIPO (Biotic Index *Posidonia oceanica)*	Lopez y Royo et al., 2010		1 selected sensitive species, *Posidonia oceanica*, integrating a set of metrics related to structural, functional and physiological attributes of the system for the evaluation of ecological status. Classification scheme with 5 quality classes	
CYMOSKEW	Orfanidis et al., 2010		1 selected sensitive species, *Cymodocea nodosa*, using skewness (asymmetry) of log-transformed relative frequencies of leaf length (SkLnRfLL). Classification scheme with 5 quality classes	Greece
CYMOX	Oliva et al, 2012		1 selected sensitive species, *Cymodocea nodosa,* integrating a set of metrics related to structural, functional and physiological attributes of the system. Classification scheme with 5 quality classes.	
MACROALGAE				
INDEX	REFERENCE	SOFTWARE	DESCRIPTION	Countries adopting the index for WFD
EEI (Ecological Evaluation Index)	Orfanidis et al., 2001, 2003		Species sampled sorted into 2 disturbance- sensitive classes.	
EEI-c (Ecological Evaluation Index continuous)	Orfanidis et al., 2011		Species sampled sorted into 5 disturbance- sensitive classes.	Cyprus, Greece, Slovenia, Bulgaria
CARLIT	Ballesteros et al., 2007		Communities sorted into 9 disturbance-sensitive classes	Croatia, France, Italy, Spain

4.2.3 Elaborating the changes in plankton functional types

Life-form pairs can provide an indication of changes in: the transfer of energy from primary to secondary producers (changes in phytoplankton and zooplankton); the pathway of energy flow and top predators (changes in gelatinous zooplankton and fish larvae); benthic/pelagic coupling (changes in holoplankton (fully planktonic) and meroplankton (only part of the lifecycle is planktonic, the remainder is benthic) Gowen et al. 2011, Tett et al., 2008). Data on pairs can be expressed in abundance or biomass, whichever is most relevant to the group in question and available from monitoring programmes. It is proposed that this approach be adopted on an optional basis for the Mediterranean Contracting Parties, with a view to investigating the applicability of the methodology for Parties with existing time series. A regional workshop to investigate the applicability of the methodology in the Mediterranean would be appropriate.

Table 2 shows proposed plankton life-forms. Pairs chosen will depend on the habitat types, so regional adaptation will be needed. As the knowledge base increases, new pairs can be developed as indicators, including for other pressures.

Table 2: Proposed plankton life-forms

	Lifeforms		**Lifeforms**		**Lifeforms**	
	Diatoms	Dinoflagellates	Large copepods	Small copepods	Holoplankton	Meroplankton
Reasoning:	Shift in algal community composition towards less trophically useful, potentially harmful groups		Shift in size of secondary producers/primary grazers could have food web impacts		Benthic-pelagic coupling	
Pressure(s):	Nutrient run off (point or non-point), hydrological changes, aquaculture, warm water outflows		Fishing		Fishing (including pressure on benthos from trawling), nutrients	

4.2.3.1 Setting baseline and reference level

A possible baseline approach is “baseline set in the past (but not as a reference pristine condition, just as a starting point for change)” and the target may be evaluated as “change away from the baseline”. This is one approach which can be considered at the regional level. This choice is related to the fact that data may not always exist in all regions, time-series length may vary, and the first available data may be from a time period which is not necessarily in GES. The absence of a significant trend in an indicator or lack of a significant correlation between the indicator trend and the trend in a human pressure could be used as evidence that the target for GES (for that criterion and the plankton community as a whole) has been met. However, this pre-supposes that the starting point of the time-series represented baseline (or reference) conditions and hence GES. This may not be the case. Where data exist, it will be necessary to use this to determine the current status of the plankton at those locations but 2 – 3 years of data will have to be collected from new monitoring sites to characterise the status of the plankton. If, however, existing data sets can be used to characterise GES for plankton communities (using ecological theory, modelling, the absence of obvious human pressure and expert opinion), it may be possible to use such data as baseline conditions for new monitoring sites and existing sites at which the status of the plankton does not meet GES.

4.2.3.2. Setting of GES boundaries / targets

A recommended target may be: "Plankton community not significantly influenced by anthropogenic drivers." This target allows unmanageable climate change but triggers management action if linked to an anthropogenic pressure and could be used with all datasets across all Contracting Parties.

4.2.3.3 Spatial scope

This indicator is of significance at the regional level. It is to be assessed at the habitat level. Sampling depth required will vary between monitoring programmes and is also dependent on habitat.

4.2.3.4 Monitoring requirements

	Coastal	Shelf	Offshore
Suggested frequency of data collection*	Bi-weekly recommended, or at least monthly	Monthly	Monthly
Monitoring method	In situ	In situ	In situ
Freq of indicator update and assessment	Annual update	Annual update	Annual update
Minimal amount of monitoring locations	Depends on amount of habitats. The CPR might be considered for a future regional scale plankton monitoring programme.	Depends on amount of habitats. The CPR might be considered for a future regional scale plankton monitoring programme.	Depends on amount of habitats. The CPR might be considered for a future regional scale plankton monitoring programme.

*A complementary need exists for both long-term time-series as well as high frequency monitoring, particularly in habitats considerably influenced by anthropogenic pressures.

4.2.3.5 Further work

1. A regional workshop to investigate the applicability of the methodology in the Mediterranean would be appropriate.
2. New pairs can be developed as indicators for other pressures, habitats and pelagic compartment (bacteria, virus), as the knowledge base increases.
3. Baseline and reference states (not as pristine conditions, but as a starting point for change) need to be developed at the regional scale but this is dependent on length of time-series.
4. Taxonomic resolution should be inter-compared and inter-calibrated.
5. Ideally to truly asses this indicator at the regional scale, it would have to be monitored and assessed using the same methodology throughout the region. However, until funding is available for this, the indicator can still inform an assessment of Good Environmental Status for regions with adequate data collection.

6. Some groups are under-sampled with lots of data missing: microphyto, pico, nano and bacteria and micro zooplankton including ciliates.

4.3. Elaborating species distributional range

4.3.1. Introduction

In biological sciences, the range of a species is the geographical area within which that species can be found (maximum extent). A species range is often represented with a species range map (within that range, dispersion is the variation in local density). Species distribution is the manner in which a biological taxon is spatially arranged within a geographical area.

Therefore, it is an objective of this indicator to know the range of species of seabirds, cetaceans, seals and sea turtles present in Mediterranean waters, especially the species selected by the Parties.

4.3.2. Monitoring strategy and framework

The distributional range of the species is undoubtedly the indicator that can be more easily obtained, simply through geo-referencing of species observations.

However, the degree of knowledge on the occurrence, distribution, abundance and conservation status of Mediterranean marine species, is uneven: in general, the Mediterranean states have lists of species, but their location is not always complete, and there is a serious gap in other related information. Even some of the most important programmes in this direction have significant gaps (e.g. Global databases addressing the Mediterranean region do not reflect real current knowledge (Fig 1).

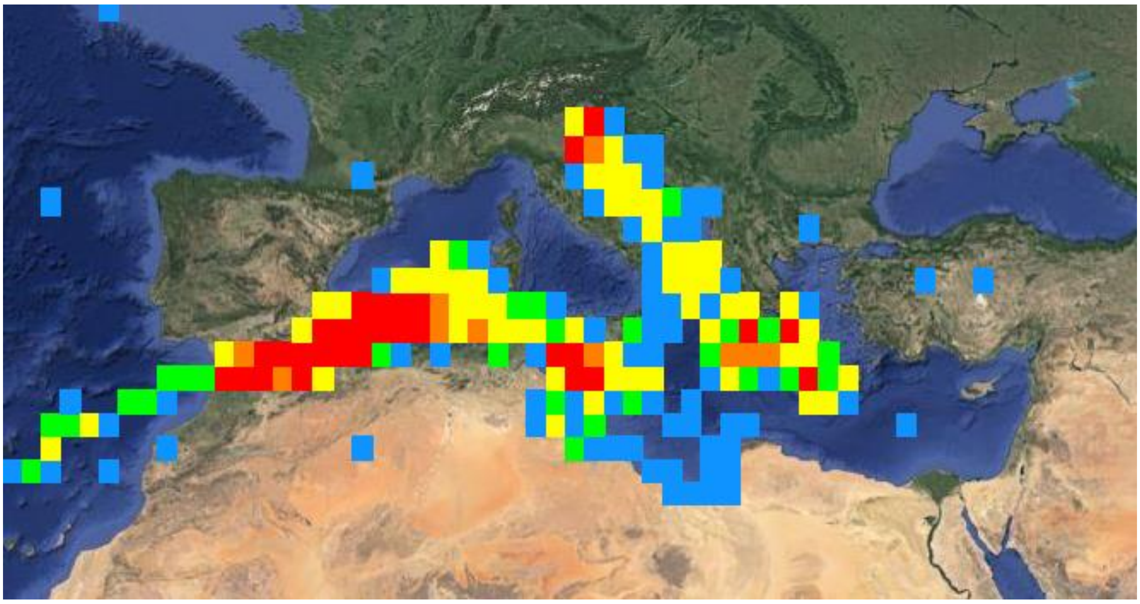

Fig 1: Image from OBIS-SEAMAP: State of the World's Sea Turtle (SWOT). Big gaps appear, while such information is currently available in the Mediterranean

It is therefore necessary to establish minimum information standards to reflect the know distribution of species.

Two types of distribution range involving a different methodological approach can be distinguished:

General range of species distribution:

For a range of distribution is necessary to know the location of the species by sampling information and refer to standardized 10x10 km grid (as FAO[11] grid).

Given the breadth of the Mediterranean, it is not feasible to obtain adequate information of the entire surface so it is necessary to choose sampling methods to allow adequate knowledge of the distribution range of each species. It involves much effort for not fully surveyed areas.

The monitoring effort should be long term and covering all seasons to ensure that information obtained is more complete:

Dedicated ships or aerial surveys:

Linear transects conducted by qualified observers with rigorous protocol on dedicated ships and aircraft.

Two types of samples are proposed: in coastal waters and in remote pelagic waters. Coastal transects always will cover the same area of coastline in “zigzag” while pelagic will be variable, although they will be generally straight and perpendicular to coast.

When cetaceans, seals, seabirds or sea turtles are located, the census is interrupted to confirm the species and collect data position, number of individuals and social structure as possible.

Flights take place at 1000 ft. (approx. 330 m) altitude and 100 knots, navigation is done at 10-12 knots covering the whole arc of the horizon at a distance of about 4 nautical miles (SEC12 protocol13). Aerial surveys pose difficulties in locating and identifying smaller seabirds (Storm Petrel, Lesser crested tern, Gull-billed Tern, Sandwich tern) and sighting shearwater.

PROS:	Medium life-span (from day to decade) Medium range (from kilometre to thousands of kilometres)
CONS:	Very expensive Need high qualification

Opportunistic data, i.e.:

From whale-watching, fisheries sightings (logbooks), surveys in not-dedicated platforms (ferries or merchant marine ships), by-catches (mainly sea turtles and shearwaters in long-lines, and small cetaceans in fishing nets).

[11] www.fao.org
[12] Spanish Cetaceans Society
13 SEC (1999). Recopilación, Análisis, Valoración y Elaboración de Protocolos sobre las Labores de Observación, Asistencia a Varamientos y Recuperación de Mamíferos y Tortugas Marinas de las Aguas Españolas. Ministerio de Medio Ambiente.

PROS:	Medium life-span (from day to decade) Medium range (from kilometre to thousands of kilometres) Less expensive
CONS:	Quality and reliability of the observations Restrictions in space and time

Tagging:

Satellite tracking, radio tracking and photo identification.

The method of capturing and tagging depends on the objectives and species. For distributional range satellite tracking provides the best results.

PROS:	Long life-span (from hour to decade) Wide range (from meters to few thousands of kilometres) Provide other data
CONS:	Very expensive Need high qualification and technology Requires a great effort Small sample sizes

Acoustic data collection:

Active devices (e.g. echo-sounders), towed hydrophone arrays, and autonomous seafloor instruments. Linear transects trailing a hydrophone behind the ship at the end of a long cable. Hydrophones are used in remote locations and acoustic recording devices (e.g. POD "porpoise detector") in coastal areas.

This is a recommended method for cetaceans. Underwater sound travels large distances with whale calls often detected at ranges of tens, or even hundreds, of kilometres. Acoustic surveys of cetacean habitats are therefore a powerful method for identifying the species present, and for locating and tracking individuals.

PROS:	Very long life-span (from hour to century) Very wide range (from meters to ten thousand kilometres)
CONS:	Expensive Need high qualification and technology

	Data analysis required

Specific use areas:

Specific use areas are defined as areas of great importance for some period of the life cycle and are easily identifiable. So we can distinguish:

a) Breeding areas:

Colonies and areas where the target species reproduce (caves, beaches, coastal marshes and cliffs, etc.):

- Location and counting from vantage points.
- Location from ship or plane or drone.

The visual census of the full population for shearwaters does not work, because they nest in burrows or crevices. The census of males in the breeding season can be a fairly precise method (because it avoids the confusion of burrows occupied by other species) and much faster.

Full moon/new moon aerial surveys on beaches to locate traces are recommended to locate breeding beaches of sea turtles. Flights would start at sunrise after high tides (which happen with these moon phases).

b) Wintering areas: areas where the target species overwinter.

c) Feeding areas: areas where the target species feed.

There is no homogeneous method described for the location of those different types of areas. Therefore, location of colonies of birds, nesting beaches of sea turtles and breeding seal caves, wintering and feeding areas can be done by checking the existing bibliographic information, surveys of different groups (fishermen, NGOs, guides, articles), probability of occurrence models (that indicate areas where a species is likely to occur based on statistical models that relate habitat variables to the presence/absence of a species) and regional expert knowledge.

Long-term monitoring of these areas provides information on the temporal evolution.

Distributional range data needs a Geographic Information System (GIS) analysis. Using standardized 10x10 km grid to compare all information will be necessary to obtain total distributional range.

4.4. Elaborating population abundance

4.4.1. Introduction

Measurements of biological diversity often appear as indicators of ecosystem functioning, and in the definition of the former there are several components that define the latter: richness and variety, distribution and abundance. Abundance is one of the groups of parameters that define the demographics of the populations, one of the most important in conditioning the growth or decline of a population, highlights include:

Population Size**:**

The most fundamental demographic parameter is the number of individuals within a population. Population size is defined as the number of individuals present in a subjectively designated geographic range.

Population density**:**

Is the size of a population in relation to the amount of space that it occupies, and represents a complementary description of a population's size. Density is usually expressed as the number of individuals per unit area.

4.4.2. Monitoring strategy and framework

Studies of population abundance and dynamics are based on the knowledge of population size and variation in time. If the population is small, all individuals are counted directly, but most studies require an estimate of population size by sampling.

The objective of this indicator is to determine the population status of selected species by medium-long term monitoring to get trends in populations of species. This requires a census for every biological aspect:

Breeding areas census (rookeries or whelping events):

Once areas have been localized it will be possible to proceed to count (individuals, pairs, nests, whelping sites, etc.) in the most appropriate period. The method used will depend on the species and their characteristics. Counting the number of tracks or crawls is recommended for sea turtles. Camera traps in caves are recommended for seals.

Wintering areas census:

In order to know the state during the winter it is necessary to use a standardized method of sampling (such as the Wetland International method performed since 1967 for aquatic birds) adapting it to the different groups of fauna, although it is typically applied to birds and whales.

Foraging census:

Once localized, individuals in feeding areas are counted at different periods throughout the year.

Feeding area locating can be done for most species by analysis of satellite tracking data and the study of the distribution of prey species (FAO[14]).

Coordinated census from land:

Volunteer observers, ornithologists for birds, working on the same day and in the same time slot), at different observation points with standardized protocols. Information is collected on species, phenology, distribution, relative abundance and migratory behaviour. This method is applicable to cetaceans and seabirds.

Since the 70s this methodology takes place in several countries following the same protocols, through a network of birdwatchers and observers of marine mammals (RAM[15] in Spain and Portugal).

[14] www.fao.org

Migration monitoring:

In addition to the census from land, and in order to account for the migration step it is important to select the best points of Mediterranean migration passages and apply a standardized methodology as carried out in the Strait of Gibraltar by the MIGRES programme[16]. This is useful for cetaceans and seabirds. Additionally there is the possibility to use radar and remote cameras for automated monitoring.

Ship and aerial surveys (from ships, planes, helicopters or drones):

Visual census (sightings) by a stratified transect method. Transects should be conducted at different times of the year, to cover all aspects of phenology.

Dedicated ships or aerial surveys:

Lineal transects conducted by qualified observers with a rigorous protocol on dedicated ships and aircraft.

Two types of samples are proposed: in coastal waters and in remote pelagic waters. Coastal transects always will cover the same area of coastline in zigzag (but transect linking caves with shorter coastlining will be chosen for monk seal boat surveys), while pelagic will be variable, although they will be generally straight and perpendicular to the coast.

When cetaceans, seabirds or sea turtles are located, the census is interrupted to confirm the species and collect data position, number of individuals and social structure as possible.

For seals, known haul out caves are checked in areas easily reachable by synchronous teams or a single speedboat approaching as many active caves as possible in a short time, which precludes counting the same seal twice in separate caves. Such counting is mostly useful during breeding season peaks (September-October), when most females and attending males pass a sizeable time at the caves.

Flights take place at 1000 ft. (approx. 330 m) altitude and 100 knots, navigation is done at 10-12 knots covering the whole arc of the horizon at a distance of about 4 nautical miles (SEC[17] protocol[18]). Aerial surveys present difficulties in locating and identifying smaller seabirds (Storm Petrel, Lesser crested tern, Gull-billed Tern, Sandwich tern) and sighting shearwater.

Monitoring from boat and plane or drone may be the most effective methodology to obtain a size and population density value of cetaceans and seabirds.

Aerial surveys just after full moon/new moon nights to locate traces are recommended to locate breeding beaches of sea turtles.

Platforms-of-opportunity (POP) surveys:

Trained observers are placed on host ships and aircraft. Used for remote pelagic waters.

Acoustic data collection:

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[15] http://redavesmarinas.blogspot.com.es/p/blog-page.html
[16] www.fundacionmigres.org
[17] Spanish Cetaceans Society
18 SEC (1999). Recopilación, Análisis, Valoración y Elaboración de Protocolos sobre las Labores de Observación, Asistencia a Varamientos y Recuperación de Mamíferos y Tortugas Marinas de las Aguas Españolas. Ministerio de Medio Ambiente.

Linear transects trailing a hydrophone behind the ship at the end of a long cable. Hydrophones would be used in remote locations and acoustic recording devices (e.g. POD "porpoise detector") in coastal areas.

The method is recommended for cetaceans. Underwater sound travels large distances with whale calls often detected at ranges of tens, or even hundreds, of kilometres. Acoustic surveys of cetacean habitats are therefore a powerful means of identifying the species present, locating and tracking individuals

<u>Opportunistic data (sightings):</u>

Whale watching and fisheries sightings (logbooks), surveys in not-dedicated platforms (ferries or merchant marine ships), bycatch, mainly sea turtles and shearwaters in longlines, and small cetaceans in fishing nets (catch per unit efford, CPUE[19]).

<u>Beached and stranded specimens monitoring:</u>

Creating a network of notice strandings and beached individual census to get important information (notably mortality and tissue contamination) usually with the help of volunteers. This is a good indicator for seabirds after storms. It is unreliable for cetaceans, seals and sea turtles.

<u>Tagging (capture-recapture):</u>

Sometimes is the only way to obtain the information necessary to know the status of the species. In this sense we can raise campaign marking some populations. Method depends on the objectives and species. Recapture may be synonym of resighting of marked animal.

<u>Seal</u>: satellite tracking, scars, body patches, photo-identification, tags

<u>Seabirds</u>: satellite tracking, rings, bands

<u>Cetaceans</u>: satellite tracking, notches, scars, photo-identification

<u>Sea turtles</u>: satellite tracking, notches, scars, epibionts, tags

4.4.3. Summary and Evaluation

All proposed methods are complementary, so that adequate information for management and conservation of species in the Mediterranean is obtained. However, it is necessary to develop each objective for each species or group of species.

Name	**Pro / Importance**	**Cons**
Census of rookeries or whelping events	Good information Very important information	Sometimes access is very difficult (i.e. for seals)
Census of wintering areas	Good information	Need good coordination
Foraging census	Important information for fisheries impact control	Not easy
Coordinated census from land	Participation of volunteers Useful information Easy to apply Seabirds and cetaceans	Partial information Volunteers and data coordination

[19] www.fao.org

Name	**Pro / Importance**	**Cons**
Migration monitoring	Important information Seabirds and cetaceans	Partial information Training of technicians
Ship and aerial surveys	Good data Useful information Medium life-span Medium range Not-survey dedicated platform	Need of boats and planes Very expensive Need high qualification and training
Beached and stranded specimens monitoring	Participation of volunteers Useful information	Partial information Volunteers and data coordination
Surveys from land	Participation of volunteers Useful information Easy to apply	Partial information Volunteers and data coordination
Tagging: capture-recapture	Very precise information Medium-high life-span Wide range	Requirement for specialist Need technology Expensive Partial information

Monitoring programmes should be able to provide the data needed to assess whether the environmental targets have been achieved.

The strategy used to select sites is partly a statistical/technical issue but foremost it is related to the purpose of monitoring, a decision to be taken when a monitoring strategy is defined. The site selection strategy has fundamental consequences for the monitoring analysis, as it has the selection of the survey method. Monitoring programmes are not compatible or comparable if they use the same survey methods, but different site selection strategies (e.g. deterministic or random selection of transects).

The strategy principles for site selection are described in many handbooks on statistics and monitoring. On a fundamental level, one can either chose sites individually, because they have certain characteristics of interest, or through a representative strategy using random site selection meeting certain criteria.

The ability of a monitoring programme to show a statistically significant trend or difference is called statistical power. Statistical power is influenced by the magnitude of the trend, the variation among replicates, and the number of replicates.

4.5. Elaborating population demographic characteristics

4.5.1. Introduction

Demography is the study of the characteristics of populations. It provides a mathematical description of how those characteristics change over time. Demographics can include any statistical factors that influence population growth or decline, but several parameters are particularly important: population size, density, age structure, fecundity (birth rates), mortality (death rates), and sex ratio.

Demography is used in ecology (particularly population and evolutionary ecology) as the basis for population studies:

- helps to identify the stage(s) in the life cycle that affect(s) population growth.
- application to conservation/exploitation (e.g. fisheries management).

- assess potential competitive abilities, colonization.
- basis for understanding evolution of life history traits.
- Indication of fitness with respect to the surrounding environment

4.5.2. Monitoring strategy and framework

The demographic characteristics describe the population. In this sense, the methodology used should be the same that is used to count the population, while only specific data are taken for each of the selected parameters (categories of age, sex, number of calves, chicks or eggs).

The life history study and demographic analysis, on the other hand, need extensive and often long-term data accumulation from either carcass collection or photo- ID histories. In general these studies may be implemented by different research teams that use different sampling and analyzing processes, which brings another difficulty in constructing quantitative baselines: insufficient connection of demographic parameters among different researches.

It is useful to clarify some points on terms related to the above and how to get those data:

Body size**:**

Body size in cetaceans, seals and turtles can be indicative of the health status of the population.

Seals and cetaceans:

Estimating the size by pictures analysis.

Measurement of stranded specimens.

Measurement in case of capture-recapture.

Seabirds and sea turtles:

Measurement of stranded specimens.

Measurement in case of capture-recapture.

Age structure:

Individuals could be sorted into age-specific categories called cohorts (such as "juveniles" or "sub-adults"). Then, a profile of the size and age structures of the cohorts could be created to determine the reproductive potential of that population, in order to estimate current and future growth.

- Age classes identification in census and transects.
- Stranded specimens aging (cetaceans, seal and sea turtles): teeth analysis in seals and cetaceans, size correlation.
- Beached specimens aging (seabirds): moult and plumage.

Tagging (capture and recapture) specimens aging: teeth analysis in seals and cetaceans, size correlation.

Sex ratio:

It is the ratio between number of males and females within a population, and can help researchers predict population growth or decline. Much like population size, sex ratio is a simple concept with major implications for population dynamics.

- Sex identification in census and transects.
- Stranded specimens sexing (cetaceans, seal and sea turtles): size, dimorphism, genetic analysis.
- Beached specimens sexing (seabirds): dimorphism, genetic analysis.
- Tagging (capture and recapture) specimens sexing: size, dimorphism, genetic analysis.

In cases of collecting and analysing biological samples to know sex and health status, works should be coordinated with the proposed sampling for EO10.

Fecundity (birth rates):

It describes the number of offspring an individual or a population is able to produce during a given period of time. Fecundity is calculated in age-specific birth rates, which may be expressed as the number of births per unit of time, the number of births per female per unit of time, or the number of births per individuals per unit of time.

Mortality (death rates):

It is the measure of individual deaths in a population and serves as the counterbalance to fecundity, usually expressed as the number of individuals that die in a given period (deaths per unit time) or the proportion of the population that dies in a given period (percent deaths per unit time).

4.5.3. Summary and Evaluation

The use of quality control and assurance measures, such as inter-calibrations, use of reference material where appropriate, and training for operators should accompany the implementation of adopted monitoring protocols. These approaches should be developed in the context of dedicated research.

Specific monitoring programmes are required to commence as pilots, to establish minimum sample population size for year and period of sampling, for reliable conclusions.

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Annex I

Guidance on the application of each stage of preparatory tasks for monitoring of biodiversity under the EcAp

Preparatory tasks

The preparatory tasks required in advance of beginning the main monitoring process include, but may not be limited to, the following:

Task 1: Collate human activity and environmental data

Development of an assessment and monitoring programme should be based on a holistic understanding of the region or sub-region to be assessed. Compiling relevant information in a Geographic Information System (GIS) is recommended to enable a spatial (and temporal) understanding of the relationship between human activities (which may be causing adverse pressures on the environment) and the characteristics of the environment, including its biodiversity.

The following information, which will be of direct use for many aspects of EcAp implementation, should be compiled:

a. The main ongoing or past human activities which potentially may affect or have affected biological diversity;

b. The distribution, intensity and frequency of pressures from human activities;

c. Noteworthy administrative and regulatory features;

d. Major physical/oceanographic/geological gradients (spatial and temporal) in the region or sub-region.

e. Biodiversity characteristics, including:

i The distribution of the habitat types on the seabed, and in the water column;

ii Distribution of the species ecotypes;

iii Habitats/communities and species of special interest (i.e. those listed for protection in regional and international agreements, Community legislation);

f. Existing data or ongoing monitoring programmes concerning biological diversity.

Figure A1 illustrates different information layers compiled in a GIS.

Task 2: Identify biodiversity components present in the region or subregion

Identify those biodiversity components that are present in the region/sub-region. Identify sub-species, populations and genetic variants, where relevant (i.e. where likely to need specific assessment). Species which are vagrants to the region/sub-region need not be included.

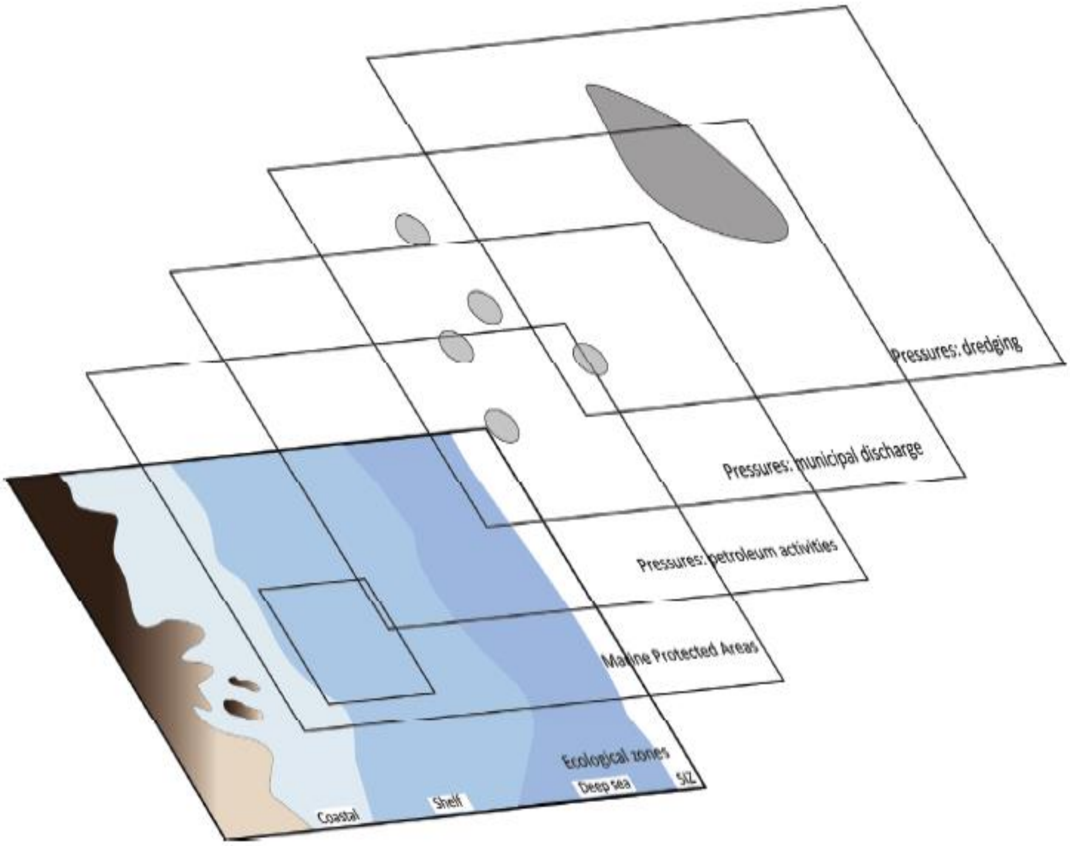

Figure A-1 Illustration of different types of information layers compiled in a Geographical Information System (GIS). See Figure 4.4 for application in decision-making for prioritizing where to monitor.

Task 3: Define ecologically-relevant assessment areas

Define a set of ecologically relevant scales (assessment areas) for assessment of the biodiversity components present in the region or sub-region.

Task 4: Define reference state (condition)

Reference conditions define the un-impacted state of the biodiversity component, and are conditions as would be expected according to ‘prevailing physiographic, geographic and climatic conditions’. This phraseology is understood to allow for the consequences of climate change. Consequently the adverse effects on biodiversity which are a result of changes in water temperature, salinity and hydrography (ocean and tidal currents, wave action) due to climate change (where these are known) are considered to sit outside the determination of GES for this Ecological Objective. There is, however, a need to take account of the effects of climate change in making the GES assessments (e.g. to understand how climate change influences particular criteria for a component, particularly species distribution and composition/abundance in a community). This therefore may need a moving reference condition against which to assess state which accommodates natural/climatic changes in the distribution and composition of species in each assessment area.

Reference conditions are specific to the species, ecotype or habitat/community type and to the ecological assessment area within a region/sub-region. Hence reference conditions need to be set to reflect these main variations in ecological character within each sub-region Reference conditions need only be defined for the biodiversity components and the criteria which are to be assessed and monitored in each assessment area. Reference conditions can be established in a number of ways:

a. Using current data from locations in the assessment area (or equivalent biogeographic areas) which are not considered to be subject to pressures from human activities;

b. Using historical data, taking into account long-term changes in prevailing physiographic, hydrological and/or climatic conditions;

c. Using expert judgment, taking into account the characteristics of the biodiversity component which might be expected under prevailing physiographic, hydrological and/or climatic conditions, and the types of species which are sensitive to ongoing or past pressures from human activities and therefore may not be present now.

d. Some combination of the above options.

Under certain circumstances, it will not be possible to satisfactorily establish reference conditions; instead it may be more appropriate to use baseline conditions, established at a specific time in the past and which are considered to best meet the requirements of reference conditions (i.e. un-impacted by pressures from human activities).

Annex II

Revised indicative list of habitat types and associated biological communities, for ECAP biodiversity monitoring

Pelagic oceanic[20]

Upwelling areas

Fronts

Gyres

Pelagic neritic

Benthic infralittoral (=photophilic, e.g. 0-50m)

Rocky

1. Hard beds associated with communities of photophilic algae, with special attention to:

certain *Cystoseira* belts.

Note: Overgrazed barren areas need to be taken into account

2. Communities of infralittoral algae (organogenic trottoir with *Lithophyllum* spp), with special attention to:

facies with vermetids (“trottoir” with vermetids)

Sedimentary

1. Meadows of sea grass (*Posidonia oceanica, Cymodocea nodosa, Zostera* sp.), with special attention to:

Barrier reefs of *Posidonia* sp.,

Tiger meadows of *Posidonia* sp., *Cymodocea* sp.

2. Communities of infrallitoral sands or muddy sands

Benthic Circalitoral (=Sciaphilic, e.g. 50-200m)

Rocky

1. Hard beds associated with coralligenous communities and semi dark caves,

Sedimentary

[20] Regarding pelagic oceanic habitats, document UNEP(DEPI)/MED WG.382/11 “Towards the Identification and Reference List of Pelagic Habitat Types in the Mediterranean Sea” was prepared on behalf of RAC/SPA, to advance in the compilation of a list of such habitats in support to the implementation of the EcAp roadmap. In the conclusions to this document it has been recommended that an effort be undertaken at compiling a reference list of pelagic habitat types through in-depth multidisciplinary expert consultations.

1. Communities of the coastal detritic bottom

2. Communities of shelf-edge detritic bottoms (facies with *Leptometra phalangium*),

Benthic Bathyal (=dark, e.g. >200 m)

1. Communities of deep-sea corals

2. Seeps and communities associated with bathyal muds (facies with *Isidella elongata)*

3. Communities associated with seamounts

Annex III

Revised indicative list of species for ECAP biodiversity monitoring

A. Indicative list of marine mammals to be considered

- *Balaenoptera physalus* Fin whale
- *Delphinus delphis* Common dolphin
- *Globicephala melas* Long-finned pilot whale
- *Monachus monachus* Monk Seal
- *Physeter macrocephalus* Sperm whale
- *Stenella coeruleoalba* Striped dolphin
- *Tursiops truncatus* Bottlenose dolphin
- *Ziphius cavirostris* Cuvier’s Beaked Whale

B. Revised indicative list of seabirds for ECAP biodiversity monitoring

- *Larus audouinii* (Payraudeau, 1826)
- *Phalacrocorax aristotelis* (Linnaeus, 1761)
- *Puffinus mauretanicus* (Lowe, PR, 1921)
- *Puffinus yelkouan* (Brünnich, 1764)
- *Sterna albifrons*, or *Sterna nilotica* (Gmelin, JF, 1789) or *Sterna sandvicensis* (Latham, 1878)

C. Revised indicative list of marine turtles for ECAP biodiversity monitoring

- *Caretta caretta* (Linnaeus, 1758)
- *Chelonia mydas* (Linnaeus, 1758)

Annex IV

Table A1 Indicative relationship table between environmental pressures and main impacts on the marine environment[21]

[21] Table is the copyright of David Connor-noting that this document represents the views of its author and is not the official position of the European Commission

Pressures		Type	Source of pressure (Examples focus on marine)				Destination of pressure				Impacts on marine environment			
			Air	Land	Water	Marine	Air	Land	Water	Sea	Physical	Hydrological	Chemical	Biological
Physical	Constructions on coast and at sea (concrete, metal, etc)	Inputs			Barrages, dams	Offshore (e.g. renewable energy, tidal power) & coastal (e.g. ports, marinas) industry, coastal defences, barrages, dams					Seabed substrate, topography	Water movement changes (waves, currents, river flows), turbidity	Salinity changes	Loss of habitat for species (mobile) and communities (seabed); barriers to species movements
	Disturbance/damage of sea floor	Change				Fishing, trampling on shores, beach cleaning and replenishment					Seabed habitat structure	Water clarity, turbidity		Community changes
	Mineral extraction (sand, gravel, rock etc)	Extraction				Sand & gravel extraction, navigational dredging					Seabed habitat structure	Water clarity, turbidity		Community changes
	Water extraction	Extraction			Irrigation, domestic use, industrial use	Desalination						Turbidity,water volume	Salinity changes	
Energy	Heat	Inputs				Power station cooling						Sea temperature		Species distributional changes
	Noise	Inputs				Shipping, piling, military								Dispacement of species, behavioural changes
	Light	Inputs				Offshore platforms								Behavioural changes (birds); plant growth
	Electromagnetic waves	Inputs				Cables								Behavioural changes (e.g. fish)
Chemicals and other pollutants	Nutrients (N, P, organics)	Inputs		Agriculture, urban waste water	Aquaculture	Aquaculture						Water clarity	Deoxygenation, nutrient balance	Plankton blooms, macroalgal growth, species mortality
	Contaminants (hazardous substances, radionuclides) - diffuse/point sources	Inputs		Industry, urban, agriculture		Offshore industry (oil & gas), aquaculture							Chemical balance	Sub-lethal effects (incl. seafood)
	Contaminants (acute events, e.g. oil spills)	Inputs				Shipping, oil & gas industry								Death/injury to species, health of species
	CO_2, greenhouse gases	Inputs	Aviation emmissions	Industry, transport, urban	Shipping emmissions	Shipping emmissions						Sea temperature, wave action, currents, sea level	pCO2/ acidification	Species distribution, behaviour and reproductive capacity changes
	Litter	Inputs		Industry, urban		Shipping, offshore operations					Smothering of habitat			Death/injury to species, health of species
Biological	Non-indigenous species	Inputs				Shipping ballast water, hulls, aquaculture								Community changes
	Translocation of (native) species	Change				Aquaculture								Genetic changes
	Introduction of genetically modified species	Inputs				Aquaculture								Genetic changes
	Microbial pathogens	Inputs		Urban waste water, sewage from agriculture		Aquaculture								Shellfish health, human health
	Removal of species (targeted, non-targeted)	Extraction		Hunting	Fishing	Fishing, hunting, harvesting, bioprospecting								Population changes, community changes
	Injury/death to species	Change	Hunting (wildfowl)	Transport		Shipping/wind farm collision; fishing (trawling)								Population changes
	Disturbance of species	Change				Ecotourism, shipping								Behavioural changes

Anthropogenic pressure = an input, alteration or extraction of physical, chemical or biological substances, properties or functions of the natural environment which results directly or indirectly from human activities.

Priority: highest

Priority: medium

Priority: lowest

Annex V

Overview of standards and methods for biodiversity monitoring

A. Overview of relevant international monitoring standards

Relevant standard guidelines developed within ISO and/or CEN are as follows:

EN 14996 Water quality - Guidance on assuring the quality of biological and ecological assessments in the aquatic environment

EN 15204 Water quality - Guidance standard on the enumeration of phytoplankton using inverted microscopy (Utermöhl technique)

EN ISO 16665:2014.Water quality - Guidelines for quantitative sampling and sample processing of marine soft-bottom macrofauna.

EN ISO 19493:2007 Water quality - Guidance on marine biological surveys of hard-substrate communities

EN 15972:2011 Water quality – Guidance on quantitative and qualitative investigations of marine phytoplankton

EN 16260:2012 Water quality - Visual seabed surveys using remotely operated and/or towed observation gear for collection of environmental data

EN 16161:2012 Water quality - Guidance on use of in-vivo absorption techniques for estimation of chlorophyll concentration in marine and fresh-water sample

B. Review of sampling methods for the main components of marine biota

Sampling methods as provided by Katsanevakis et al. (Katsanevakis et al., 2012) together with considerations on imperfect detectability are summarized in Table A.2.

The potential of the use of environmental DNA in marine monitoring has been recently reviewed by Bourlat et al. (Bourlat et al., 2013), while there is an ever increasing information resource available on the internet[22]. Another promising approach is the use of high definition cameras hanging from aircraft for monitoring of cetaceans and seabirds. The method is further developed in several research projects[23].

[22] http://edna.nd.edu/Environmental_DNA_at_ND/Home.html
http://www.environmental-dna.nl
http://pubs.usgs.gov/fs/2012/3146
http://www.asiancarp.us/edna.htm
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[23] http://mhk.pnnl.gov/wiki/images/d/d6/High_Definition_Imagery_for_Surveying_Seabirds_and_Marine_Mammals.pdf

Table A2
Methods applied for monitoring marine populations, for components of marine biota. Underlined: the most common methods for each component, ROV: remotely operated vehicle, CPUE: catch-per-unit-effort, PIT: passive integrated transponder, na: not applicable or not relevant, potential: potentially applicable methods. (from Katsanevakis et al., 2012)

Pilot sampling	Distance sampling	Mark-recapture	Repetitive surveys for occupancy estimations	Removal methods	Other
Invertebrates Endobenthos: Grabs, corers; dredges;burrow counting	na	Tagging of megafauna (mollusk, crustaceans)	Based on repetitive endobenthic samples (potential)	Simple removal or CPUE (for megafauna)	
Epibenthos: Trawls, dredges, sledges;strip transects (divers, ROVs, drop cameras); quadrats, photo quadrats	Line transects by divers or submersibles	Tagging (mollusks crustaceans, echinoderms)	By divers	Simple removal or CPUE	Line intercepts transect or point intercept transect surveys
Hyperbenthos: Sledge-mounted gear	na	na	Based on repetitive sledge samples (potential)	CPUE	
Zooplankton Towed nets; Strip transects for mega-plankton (shipboard, aerial,ROVs,video profilers, divers)	Shipboard line transects (for megaplankton)	na	For megaplankton (potential)	Na	Continuous plankton recorder acoustics
Marine Mammals Cetaceans: Shipboard or aerial strip transects	Shipboard or aerial line transects	Photo identification from natural markings on flukes or dorsal fins	Shipboard or aerial (potential)	CPUE (bycatches), simple removal	Migration counts
Pinnipeds: Quadrat sampling of colonies	na	Photo identification from natural markings in pelage	In marine caves, beaches, etc. (potential)	CPUE (bycatches), simple removal	Colony counts
Seabirds Shipboard or aerial strip transects	Shipboard line transects	Ringing	Shipboard or aerial (potential)	CPUE (bycatches), simple removal	Seawatching
Marine turtles Shipboard or aerial strip transects	Aerial or boat surveys (line transects)	PIT tagging, satellite tagging	Shipboard, aerial, or diver-based (potential)	CPUE (bycatches), simple removal	Nest counts

C. Benthic habitat survey methods

Table A3 Benthic habitat survey methods useful to locate, determine extent and assess biodiversity (as adapted from EC, 2007).

Type of data	Data useful to locate, determine extent and assess biodiversity of habitat according to habitat type			
	"Biocenosis of fine sands in very shallow waters", "Biocenosis of well sorted fine sands"	"Hard beds associated with photophilic algae", "Biocoenosis of infralittoral algae"	"Hard beds associated with Coralligenous biocenosis"	Meadows of sea grass (*Posidonia oceanica*, *Cymodocea nodosa*, *Zostera* spp)
Remote methods :				
Side scan sonar[1]	Locate, extent	Locate, extent	Locate, extent	Applicable
Multibeam bathymetry[1]	Locate, extent	Locate, extent	Locate, extent	Applicable under conditions
AGDS[1] (acoustic ground discrimination systems)	Locate, extent	Locate, extent	Locate, extent	Locate, extent
Satellite images[1,2]	Locate, extent	Locate extent (won't distinguish between sub-types of reef)		Locate, extent
Aerial photography[1,2]	Locate, extent			Locate, extent
Direct sampling or observation methods:				
Grab/core sampling[3]	Extent / Biodiversity	Biodiversity (limited application)	Biodiversity (not recommended)	Biodiversity (not recommended)
Diver sampling	Biodiversity	Biodiversity	Biodiversity	Biodiversity
Towed video[3]	Extent	Extent / Biodiversity (not recommended)	Extent	Extent
Drop-down video/ photography/ROV	Extent / Biodiversity	Extent / Biodiversity	Extent / Biodiversity	Extent / Biodiversity
Epibenthic trawls/dredges[3]	Biodiversity (limited application)	Not recommended[3]	Not recommended[3]	Not recommended

Notes:

1 For all remote sensing, distinguishing habitats from each other and from the surrounding seabed depends on the resolution of the sampling method – higher resolution will provide better data to distinguish habitats, but covers smaller areas and is more expensive to collect and process than lower resolution data.

2 Aerial photography and satellite images are restricted in use to shallower waters (6-7m depth in NW Mediterranean, 10-15m depth in SE Mediterranean), depending on water clarity and other factors.

3 Grab/core sampling and benthic trawling/dredging are relatively destructive sampling methods. These methods can provide useful data, but extensive use of these methods is not recommended for assessment of habitats sensitive to physical damage (e.g. biogenic reef, seagrass and maerl beds), and should not be used to identify their extent. Towed video can also be destructive of fragile habitats, if it impacts with the seabed, and is not recommended in these cases.

Annex VI
Indicators Monitoring Fact Sheets on Ecological Objective 01: Biological Diversity

ECOLOGICAL OBJECTIVE 01: 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

Indicator Name	Indicator No	Operational Objective	State, pressure or impact	DESCRIPTION Parameters and/or Elements, metrics, matrix	Assessment Method	Guidelines	Reference Methods for sampling and treatment	QA/QC	Recommendations /Additional Data needed
Habitat distributional range	1.4.1	1.4 Key coastal and marine habitats are not being lost	State	Actual area occupied by habitat	Size of the range in relation to the size of favourable reference range Range trend	For seabed habitat mapping see Recommended Operating Guidelines under MESH Project[24] This information could be complemented by the upcoming implementation of the RAC/SPA Project "Med Key Habitats" on habitat	For a review of standards and protocols for seabed habitat mapping: Cogan et al., 2007	Requires development	

[24] http://www.searchmesh.net/default.aspx?page=1915

						cartography.			
Condition of the habitat-defining species and communities **Proposed sub-indicator:** **Typical Species Composition (benthic habitats)**	1.4.3	1.4 Key coastal and marine habitats are not being lost	State	Typical-key benthic species composition comprising of both macro-zoobenthos and macrophytes per habitat type, in the specific biogeographic region. Recommended sampling frequency once per year at assessed sites and once every 5 years at reference-baseline condition sites	Simple comparison of typical species in list with respect to baseline conditions	Methods and effort depend on habitat type (and selected species) to be addressed. (see Annex V for recommended methods)	Suggested: ISO 16665:2014 . Water quality - Guidelines for quantitative sampling and sample processing of marine soft-bottom macrofauna . ISO 19493:2007 Water quality - Guidance on marine biological surveys of hard-substr	Requires development	The list of typical species would need to be defined per habitat type with respect to a particular biogeographic region and re-evaluated every 6 years. Checking for consistency of species lists within biogeographic regions. Identification/definition of baselines for habitats and biogeographic regions

				2 replicates at each monitoring station			ate communities See also annex V for recommended guidelines for sampling and treatment		Recommended to identify also indicator groups relevant to specific broad habitat types where manageable pressures exist For macro-zoobenthos taxonomy skills are very determinant
Condition of the habitat-defining species and communities **Proposed sub-indicator:** **Benthic Biotic**	1.4.3	1.4 Key coastal and marine habitats are not being lost	State	Depending on the biotic index: For macrozoobenthos and macroalgae indices: composition	Depending on the biotic index: For macrozoobenthos and macroalgae indices: generally a	See respective references listed in Table 1 of the main monitoring guidance document	Suggested: ISO 16665:2014. Water quality - Guidelines for quantitative sampling	Requires development	Recommended to select an essential set of indices for use in the Benthic Biotic Indices for zoobenthos, angiosperms and macroalgae, based on available literature, data

Indices				of species per habitat type in the specific biogeographic region. Also, for one macroinvertebrate index opportunistic polychaetes and amphipods are to be selected For seagrass indices selected sensitive species (*Posidonia oceanic or Cymodocea nodosa*) and metrics related to	sensitivity/tolerance classification, combining the percentages of ecological groups of species in a formula. Also, for one macroinvertebrate index: combining the frequency or ratio of opportunistic polychaetes to frequency (ratio) of the amphipods group		and sample processing of marine soft-bottom macrofauna. ISO 19493:2007 Water quality - Guidance on marine biological surveys of hard-substrate communities See also annex V for recommended guidelines for sampling and		and expert judgement. The specific training course to be held by the PERSEUS Project in 2015, targeting Southern Mediterranean countries could be utilized For macrozoobenthos taxonomy skills are very determinant Identification / definition will be required of baselines for the respective habitats and

				structural, functional and physiological attributes of the system For details see respective references listed in Table 1 of the main monitoring guidance document and GIG (2013) Recommended sampling frequency once per year at assessed sites and once every 5	For seagrasses: - Combining a set of metrics related to structural, functional and physiological attributes of the system, using Principal Component Analysis (PCA) - Ratio of epiphytic biomass and leaf biomass		treatment		biogeographical regions. Inter-calibration test will be required of the range of values at a sub-regional scale, and validation of a standardized Ecological Quality Ratio (EQR) or equivalent threshold to discriminate the GES/ no GES, including sub-regional specificities.

				years at reference-baseline condition sites 2 replicates at each monitoring station	(E/L ratio) - Leaf length distribution asymmetry of *Cymodocea nodosa* For details see references listed in Table 1 of the main monitoring guidance document and GIG (2013)				
Condition of the habitat-defining species and communities **Proposed**	1.4.3	1.4 Key coastal and marine habitats are not being lost	State	Plankton abundance or biomass per taxa For plankton	Comparison of ratios of plankton abundance in life form pairs with respect to baseline	Gowen et al., 2011; Tett et al., 2008	See annex V for recommend ed guidelines for sampling and	Requires development	A regional workshop to investigate the applicability of the methodology in the Mediterranean would be

optional sub-indicator: **Changes in plankton functional types**				lifeform pairs diatoms and dinoflagellates; large copepods and small copepods; holoplankton and meroplankton. Recommended bi-weekly sampling for coastal or at least monthly, monthly for offshore	conditions		treatment		appropriate. New pairs can be developed as indicators for other pressures, habitats and pelagic compartment (bacteria, viruses), as the knowledge base increases. Baseline and reference states (not as pristine conditions, but as a starting point for change) need to be developed at the sub regional scale but this is dependent on length of time-series. Taxonomic resolution should be inter-

									compared and inter-calibrated. Ideally to truly asses this indicator at the regional scale, it would have to be monitored and assessed using the same methodology throughout the region. The Continuous Plankton Recorder (CPR) might be considered for a future regional scale plankton monitoring programme. However, until funding is available for this, the indicator can still inform an assessment of GES for sub regions with

									adequate data collection.
Species distributional range **Proposed sub indicator** **Range of breeding areas**	1.1.1	1.1. Species distribution is maintained	State	Location, geo-referencing and characterization of colonies in caves, coastal marshes, beaches and cliffs,	Annual comparison. Emphasis in new or disappearing colonies Range trend in the grid	For birds: Seabird monitoring handbook for Britain and Ireland (JNCC[25],RSPB[26],ITE[27],SBG[28]. For seals: cave surveys reports being done by RAC/SPA within the Monk seal management plan	For birds: Marine e-Atlas[29] (BirdLife International) For cetaceans: Protocols Spanish Cetacean Society (SEC)		The review of published information, collectives interview and collaboration of experts is very important in facilitating the location of breeding areas Create a 10x10 Km grid mesh for the Mediterranean. sightings by citizens may be reliable notably for seals distribution

[25] JNCC: Joint Nature Conservation Committee
[26] RSPB: Royal Society for the Protection of Birds
[27] ITE: Institute of Terrestrial Ecology
[28] SBG: Seabird Group
[29] http://www.fameproject.eu/en/

Species distributional range **Proposed sub indicator** **Range of wintering areas**	1.1.1	1.1. Species distribution is maintained	State	Location, geo-referencing and characterization of wintering areas	Annual comparison Range trend in the grid	For birds: Seabird monitoring handbook for Britain and Ireland (JNCC[30],RSPB[31],ITE[32],SBG[33])	For birds: Marine e-Atlas (BirdLife International) For cetaceans: Protocols Spanish Cetacean Society (SEC)		The review of published information, collectives interview and collaboration of experts is very important in facilitating the location of wintering areas; for all species, satellite tracking Create a 10x10 Km grid mesh for the Mediterranean. sightings by citizens may be reliable notably for seals distribution
Species distributional	1.1.1	1.1 Species	State	Location, geo-referencing	Annual comparison	For birds: Seabird monitoring	For birds: Marine e-		The review of published information,

[30] JNCC: Joint Nature Conservation Committee
[31] RSPB: Royal Society for the Protection of Birds
[32] ITE: Institute of Terrestrial Ecology
[33] SBG: Seabird Group

range **Proposed Sub indicator** **Range of feeding areas**		distribution is maintained		and characterization of feeding areas	Range trend in the grid	handbook for Britain and Ireland (JNCC,RSPB, ITE,SBG)	Atlas (BirdLife International) For cetaceans: Protocols Spanish Cetacean Society (SEC)		collectives interview and collaboration of experts is very important in facilitating the location of feeding areas); for all species, satellite tracking combined with prey assessment through telemetry and/or fisheries data Create a 10x10 Km grid mesh for the Mediterranean.
Population abundance **Proposed sub indicator** **Census of rookeries and**	1.2.1	1.2 Population size of selected species is maintained	State	Number of pairs Number of females. For seals, number of	Trend monitoring	For birds: Seabird monitoring handbook for Britain and Ireland (JNCC[34],RSPB[35],ITE[36],SBG[37]	FAME project[38]		

34 JNCC: Joint Nature Conservation Committee
35 RSPB: Royal Society for the Protection of Birds

whelping events				cubs in cave					
Population abundance **Proposed sub indicator** **Population Census in wintering areas**	1.2.1	1.2 Population size of selected species is maintained	State	Number of individuals	Trend monitoring	For birds: Seabird monitoring handbook for Britain and Ireland (JNCC,RSPB,ITE,SBG)	International Waterbird Census (IWC)[39] FAME project		
Population abundance **Proposed sub indicator** **Population Census in Foraging areas**	1.2.1	1.2 Population size of selected species is maintained	State	Number of individuals	Trend monitoring	For birds: Seabird monitoring handbook for Britain and Ireland (JNCC,RSPB,ITE,SBG)	FAME project		

[36] ITE: Institute of Terrestrial Ecology
[37] SBG: Seabird Group
[38] http://www.fameproject.eu/en/
[39] Wetland International (http://www.wetlands.org/)

Population abundance **Proposed sub indicator** **Migration counts**	1.2.1	1.2 Population size of selected species is maintained	State	Number of individuals	Trend monitoring	For birds: Seabird monitoring handbook for Britain and Ireland (JNCC,RSPB,ITE,SBG)	Migres Program[40] FAME project		
Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival, mortality rates) **Proposed sub indicators** **Fecundity rate of monk seal** **Breeding success/failure of seabird species** **Breeding**	1.3.1	1.3 Population condition of selected species is maintained	State	Monk seal pup production (number of counts per colony with respect to the size of the colony Annual seabird colony failure rate (percentage of colonies failing per year, per species) Number of	Trend	For birds: Seabird monitoring handbook for Britain and Ireland (JNCC,RSPB,ITE,SBG)			

[40] www.fundacionmigres.org

success/failure of marine turtles				egg failures to hatch out in marine turtle nesting sites per year					
Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival, mortality rates) **Proposed sub-indicator** **Mortality rate from by-catch, stranding, or beached individuals**	1.3.1	1.3 Population condition of selected species is maintained	State, Impact	Number of individuals in relation to population estimates per population range or management unit, per year Seals and cetaceans Seabirds Marine turtles	Trends	For sea turtles and cetaceans: RAC/SPA[41] guideline For seabirds: Audubon Coastal Bird Survey[42] RSPB Beached Bird Survey[43], or ICAO. SEO/BirdLife[44]	Spanish Cetacean Society (SEC) and European Cetacean Society (ECS) protocols RSPB&SEO/ BirdLife protocols		

[41] RAC/SPA: Regional Activity Center for Specially Protected Areas, UNEP/MAP (http://rac-spa.org/)
[42] www.audubon.org
[43] RSPB: Royal Society for Protection of Birds (www.rspb.org.uk)
[44] ICAO: Beached Birds Inspection. SEO/BirdLife: Spanish Ornithological Society (www.seo.org)