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Integrated Monitoring and Assessment Guidance

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I. INTRODUCING THE MONITORING AND ASSESSMENT GUIDANCE FOR THE MONITORING AND ASSESSMENT OF THE MEDITERRANEAN SEA AND COAST

1. Setting the context

The15th Meeting of the Contracting Parties to the Barcelona Convention (**COP 15**) to the UNEP/MAP Barcelona Convention (Almeria, Spain, 2008) decided (through Decision IG.17/5) to progressively apply the ecosystem approach (**EcAp**) to the management of human activities that may affect the Mediterranean marine and coastal environment for the promotion of sustainable development (UNEP/MAP, 2007).

The 17th Meeting of the Contracting Parties to the Barcelona Convention (**COP 17**, Paris, France, 2012) confirmed the importance given to the EcAp in the Mediterranean, by recognizing it as a guiding principle for the overall work under the Barcelona Convention. In addition, the Contracting Parties agreed (through Decision IG.20/4) on an overall vision and goals for EcAp, on 11 ecological objectives, operational objectives and indicators for the Mediterranean, adopted the timeline for implementing the ecosystem approach until 2019 and established a six-year cyclic review process of its implementation, with the next EcAp cycle to cover 2016-2021 (UNEP/MAP, 2012).

As the most recent milestone, at the 18th Meeting of the Contracting Parties to the Barcelona Convention (**COP 18**), targets for achieving Good Environmental Status of the Mediterranean Sea and its coastal zone by 2020 were adopted. In addition, through Decision IG. 21/3 (the so called **"COP 18 EcAp Decision")**, the Contracting Parties also agreed to design an Integrated Monitoring and Assessment Programme by the next Meeting of the Contracting Parties (**COP 19**), and mandated the Secretariat to carry out an assessment of the state of the Mediterranean environment in 2017 (UNEP/MAP, 2013).

A specific timeline was adopted in the COP 18 EcAp Decision, on how to develop an Integrated Mediterranean Monitoring and Assessment Programme by the 19th Meeting of the Contracting Parties and how to implement it, following the 6 year EcAp cycles structure (with second EcAp cycle in the Mediterranean of 2016-2021) and with giving additional flexibility and time for capacity building during the initial phase of implementation of the Integrated Monitoring and Assessment Programme (IMAP) (2016-2019).

In order to meet the timeline set out in the COP 18 EcAp Decision, an Integrated Correspondence Group (**Integrated EcAp CorGest**) Meeting was held in February 2014, that gave specific recommendations for the future Integrated Monitoring and Assessment Programme, agreed on a list of common indicators, which would form the basis of the Integrated Monitoring and Assessment Programme (UNEP(DEPI)/MED WG.390/4). The Correspondence Groups on Monitoring (**CORMON**s) started their work, with the aim to further specify the common indicators, discuss methodologies and parameters related to them and as such form the core of the Integrated Monitoring and Assessment Programme.

Three CORMON Meetings took place in between May-July 2014, on Pollution and Litter; on Coastal Ecosystems and Landscapes and Hydrographical conditions; and, on Biodiversity and Fisheries. These meetings provided important guidance on and input to the IMAP of the Secretariat.

The 4th EcAp Coordination Group took place in October 2014 and it provided further comments, suggestions, political guidance on the Monitoring and Assessment Methodological Guidance (UNEP(DEPI)/MED WG.401/3) and mandated informal online expert groups, with the leadership of volunteering Contracting Parties, to address the outstanding monitoring and assessment questions, with the overall aim to be able to meet the timelime of the COP 18 EcAp Decision and agree on an Integrated Monitoring and Assessment Programme by COP 19.

An Integrated CORMON Meeting took place in March 30-1 April 2015, to further address outstanding issues of monitoring and assessment of the agreed common indicators, which gave recommendation on the main elements of the Integrated Monoitoring and Assessment Programme.

In addition, informal online working groups were established with the lead of volunteer Contracting Parties, in order to address some specific, technical outstanding issues of the monitoring and assessment specifics of the Mediterranean sea and coast.

The current Integrated Monitoring and Assessment Programme (IMAP) was developed based on the above strong input of the CPs, in a coordinated maner by all UNEP/MAP components.

Furthermore, the draft IMAP strongly builds on relevant existing monitoring and assessment practices in the Mediterranean and in other regions, such as the existing monitoring practice in UNEP/MAP, with the greatest experience of UNEP/MAP MED POL in relation to pollution, the monitoring and assessment experience of the Mediterranean EU countries under the EU Marine Strategy Framework Directive[1], the monitoring and assessment experience of other Regional Sea Conventions, such as OSPAR and HELCOM and ongoing monitoring and assessment activities under the H2020 programme and under various scientific projects in the Mediterranean region.

2. The common indicators

In line with the recommendations of the Integrated EcAp Correspondence Group on Good Environmental Status (**GES**) and Targets Meeting (UNEP(DEPI)/MED WG.390/4), in the context of the Barcelona Convention a **common indicator** is an indicator that summarizes data into a simple, standardized and communicable figure and is ideally applicable in the whole Mediterranean basin, but at least on the level of sub-regions and is monitored by all Contracting Parties. A common indicator is able to give an indication of the degree of threat or change in the marine and coastal ecosystem and can deliver valuable information to decision makers.

<u>The Common indicators agreed, which are at the core of the Integrated Monitoring and Assessment Programme:</u>

1. Habitat distributional range (EO1) to also consider habitats extent as a relevant attribute;
2. Condition of the habitat's typical species and communities (EO1);
3. Species distributional range (EO1 related to marine mammals, seabirds, marine reptiles);
4. Population abundance of selected species (EO1, related to marine mammals, seabirds, marine reptiles);
5. Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to marine mammals, seabirds, marine reptiles);
6. Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas (EO2, in relation to the main vectors and pathways of spreading of such species);
7. Spawning stock Biomass (EO3);
8. Total landings (EO3);
9. Fishing Mortality (EO3);
10. Fishing effort (EO3);

[1] Including of ongoing work in review of the GES Decision 2010/477EU and MSFD Annex III- cross-cutting issues

11. Catch per unit of effort (CPUE) or Landing per unit of effort (LPUE) as a proxy (EO3);
12. Bycatch of vulnerable and non-target species (EO1 and EO3);
13. Concentration of key nutrients in water column (EO5);
14. Chlorophyll-a concentration in water column (EO5);
15. Location and extent of the habitats impacted directly by hydrographic alterations (EO7); to also feed the assessment of EO1 on habitat extent
16. Length of coastline subject to physical disturbance due to the influence of man-made structures (EO8) to also feed the assessment of EO1 on habitat extent;
17. Concentration of key harmful contaminants measured in the relevant matrix (EO9, related to biota, sediment, seawater);
18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9);
19. Occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9);
20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9);
21. Percentage of intestinal enterococci concentration measurements within established standards (EO9);
22. Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source.) (EO10);
23. Trends in the amount of litter in the water column including microplastics and on the seafloor (EO10);
24. Candidate Indicator: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds and marine turtles (EO10);
25. Candidate Indicator: Land use change (EO8)
26. Candidate indicator: Proportion of days and geographical distribution where loud, low, and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animals (EO11)
27. Candidate Indicator: Levels of continuous low frequency sounds with the use of models as appropriate (EO11)

Regarding the common indicator on habitat distributional range (common indicator 1), the CORMON Biodiversity and Fisheries Meeting (Ankara 26-27 July, 2014) recommended that loss of habitat extent is typically more important/at higher risk, with loss of distributional range only secondarily at risk.

The common indicator related to ingested litter (candidate indicator 24) was analysed by the CORMON groups as a common indicator on a trial basis and as there are still many outstanding issues regarding the Integrated Monitoring and Assessment Programme does not include its monitoring at this stage. However related capacity building capacities and possible pilots are strongly recommended to be undertakenduring the initial phase of IMAP.

Furthermore, the CORMON Coast and Hydrography (May 2013) agreed on one more candidate common indicator for the Mediterranean region, noting that the usage of the candidate common indicator, which is related to land use change (candidate common indicator 25), which would need further testing, pilot implementation during the initial phase of IMAP, before the Contracting Parties could agree to its regional usage as a common indicator.

In order to follow-up on this CORMON Coast and Hydrography recommendation, an EcAp pilot project already took place in the Adriatic to test the feasibility of this candidate common indicator on the sub-regional level, in the framework of an EU funded project on the "Implementation of the Ecosystem Approach in the Mediterranean by the Contracting Parties in the context of the Barcelona Convention for the Protection of the Marine Environment and the Coastal region of the Mediterranean and its Protocols (**EcAp-MED project 2012-2015)**. On its basis the PAP/RAC NFPs at their meeting (May 14, 2015) supported the inclusion of this candidate indicator in the initial phase on a testing basis and suggested that the interpretation as well as the definition og GES and management measures is left to the countries so to respect geomorphological, socio-economic, historic and cultural specificities.The results of this pilot are presented in document UNEP(DEPI)/MED WG.420/Inf.18.

In addition, our partner organisation, the Secretariat of the Agreement on the Conservation of Cetageans in the Black Sea, Mediterranean Sea and Contigous Atlantic Area (**ACCOBAMS**) proposed the following candidate indicators:

Candidate Indicator 26: "*Proportion of days and geographical distribution where loud, low and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animals*"

Candidate Indicator 27: "*Levels of continuous low frequency sounds with the use of models as appropriate*"

These two candidate indicator in relation to marine noise are proposed to be implemented during the initial phase of IMAP on a pilot basis.

Furthermore, the Contracting Parties and partner organizations, such as the General Fisheries Commission for the Mediterranean (**GFCM**) and **ACCOBAMS** are still encouraged to propose, update and lead on further development of the (candidate) common indicators, as well as to propose new candidate common indicators, based on scientific and policy developments, taking note of ongoing process on this in the GFCM and ACCOBAMS, during the initial phase of IMAP.

3. IMAP Cross- cutting issues

The underlying aim of IMAP, is to assess based on common region-wide agreed indicators and respective data, the status of the marine and coastal environment towards the achievement of Good Environmental Status of the Mediterranean Sea and Coast.

3.1. The integrated approach of IMAP

An ecosystem based, integrated approach to determine and assess GES follows the main elements of the ecosystem (state- based descriptors, centre) and is closely linked to the effects of pressures from human activities.

An ecosystem-based approach to determination and assessment of GES follows the main elements of the ecosystem (state-based ecolodgical objectives and is closely linked to the effects of pressures from human activities (pressure-based ecological objectives).

This approach has the benefit of bringing structure and function aspects of ecosystem health together at an appropriate resolution (i.e. within each main ecosystem element rather than only at the whole ecosystem level), relating more readily to practical monitoring and assessment processes (e.g. monitoring of birds, mammals and fish is typically undertaken separately using different techniques) and linking more effectively to management needs (as pressures can affect both structure and function). The focus on these main ecosystem elements also facilitates assessment of cumulative effects from multiple pressures on the ecosystem.

This focus on the main elements (including *functional groups* and *predominant habitat types*) provides a way of dividing the complex ecosystems into more manageable units for monitoring, assessment, target setting and measures. Whilst it has these practical advantages, this compartmentalisation may mask some elements of an ecosystem-based approach; these should be addressed by more holistic assessments of ecosystem structure and function.

It is proposed that during the initial phase of IMAP, the CORMON groups will further address how to measure the achievement of the overall goal of EcAp, I ethe achievement of GES for each of the ecosystem component (where these are relevant to the marine (sub)region and/or Contracting Parties areas), based on the following core elements:

a. Assessment of each (main) pressure and its impacts;
b. Assessment of each functional group (for birds, mammals, reptiles, fish and cephalopods) and predominant habitat type (for water column and seabed habitats);
c. Assessment at an appropriate ecosystem level.

This would lead to a clear need to ensure the state and pressure-based assessments are compatible, in terms of scales of assessment and resolution of the ecosystem elements which are assessed under state and as impacts. The pressure- based assessments need to provide outcomes from their impact assessments which are directly useful for the state- based assessments. This in turn implies that the determination of GES also needs to be expressed with this in mind.

It is thus key that Contracting Parties further adrdress these issues during the initial phase of IMAP, in a coordinated manner, under the auspices of UNEP/MAP Barcelona Convention.

Before addressing possible options, some principle requirements need to be outlined and further developed, in particular:

a. Defining scales and areas for assessment of environmental status – regions, subregions, subdivisions and finer scales if needed (required for the different assessment elements – species, habitats, pressures); need to reflect ecosystem-based scales and practical assessment and management needs; need to relate these scales/areas to monitoring data with rules for aggregation of samples);
b. Developing suitable mapping/dissemination tools to show the environmental status of the different descriptors across EU waters (use of nested scale systems, such as HELCOM's, for the different descriptors, accommodating state and pressure aspects to provide a reference layer for information management at EU level; display of assessment outcomes via a grid-based approach to accommodate different scales for different descriptors);
c. Linking the scales of assessment to management issues (the management of pressures via measures, the assessment of cumulative impacts on ecosystem components and its links to decision-making processes for licencing new developments).

Integrated Monitoring for the purpose of the ecosystem approach (**Integrated Monitoring**)

Integrated monitoring for the purpose of the ecosystem approach should provide the data to allow assessment methods to classify a marine and coastal area as reaching or failing to reach GES, more specifically, providing data**:**

a) For the calculation of the different applicable indicators and the assessment of the different ecological objectives covering the range of ecosystem components, pressures and their impacts;

b) Fulfilling the monitoring requirements of different pieces of legislation applying in the region;

c) Covering the monitoring needs of more than one Contracting Party;

d) Collected in a comparable way between Contracting Parties so as to allow integration of the data.

<u>Integrated Assessment to determine the achievement of GES on the basis of common indicators</u>

An indicator is a scientific assessment tool. It consists of one or several parameters chosen to represent (indicate) a certain situation or aspect and to simplify a complex reality. In the context of the implementation of the EcAp, indicators are specific attributes of each GES criterion that can be measured to make such criteria operational and which allow subsequent change in the attribute to be followed over time.

Given the complexity of the GES Ecological Objectives, both in their range of characteristics and number of aspects that contribute to an assessment of state, it is common practice to use a set of indicators to assist in monitoring and to simplify assessment. Generally, there is a variety of indicators falling under three types: state, pressure and impact.

In the context of the Barcelona Convention a common indicator is a measure that summarizes data into a simple, standardized and communicable figure and is ideally applicable in the whole Mediterranean basin, but at least on the level of sub-regions and can be monitored by all Contracting Parties, aiming at delivering valuable information to decision-makers. In particular, indicators should contribute to assess effects of measures taken to achieve or maintain GES.

Based on the above, for the purpose of the UNEP/MAP Barcelona Convention IMAP, Integrated (Ecosystem) Assessment means both a process and a product.

As a process, an assessment is a procedure by which information is collected and evaluated following agreed methods, rules and guidance. It is carried out from time to time to determine the level of available knowledge and to evaluate the environmental state.

As a product, an assessment is a report which synthesises and documents this information, presenting the findings of the assessment process, typically according to a defined methodology, and leading to a classification of environmental status in relation to GES.

Assessments under the IMAP will need to assess the characteristics, pressures and impacts and evaluate the current environmental state in relation to GES and thereby assess the distance between the current state and GES. This is the basis for identifying appropriate environmental targets in relation to state, impact or pressure in order to bridge the gap between current status and GES in order to improve status or to ensure that good status is maintained.

In light of the above, an integrated assessment, as such, is:

(a) An analysis of the essential features and characteristics, and current environmental status of those waters, based on the indicative lists of elements and covering the physical and chemical features, the habitat types, the biological features and the hydro-morphology in an integrated manner;

(b) an analysis of the predominant pressures and impacts, including human activity, on the environmental status of those waters which:

(i) is based on an indicative lists of elements and covers the qualitative and quantitative mix of the various pressures, as well as discernible trends;

(ii) covers the main cumulative and synergetic effects; and

(iii) takes account of the relevant assessments which have been made pursuant to the Protocols and Decisions of the Barcelona Convention;

(c) an economic and social analysis of the use of those waters and of the cost of degradation of the marine environment.

In preparing assessments pursuant to the above, efforts should be taken to ensure that:

(d) assessment methodologies are consistent across the Mediterranean marine region and or subregion an where appropriate with other seas;
(e) transboundary impacts and transboundary features are taken into account.

Initial phase of the Integrated Monitoring and Assessment Programme (2016-2019)

The first years (2016-2019) of the IMAP implementation are initial in the sense that they will focus only on a set of common indicators and in many cases the monitoring will be focused on investigation, data-gathering, while some assessment specifics will need to to be further defined by the end of the initial phase in line with the current Guidance and with specific capacity building activities taking place to ensure that all Contracting Parties are able to adjust to the new elements of the programme.

After the initial phase of the implementation of the IMAP, based on the experience and capacity built in the Contracting Parties and on the further expert level work, scientific developments, the full implementation of the IMAP is foreseen, with possible adjustements and the inclusion of additional (candidate) common indicators.

Furthermore, it is also important to note that while EO3, EO4 and EO6 Ecological Objectives and common indicators are not included in the initial phase of IMAP implementation they are parlty being addressed by the EO1 related common indicators. EO3 related candidate/common indicators are currently being developed by GFCM, in close cooperation with UNEP/MAP Secretariat with the aim of their introduction to IMAP by its next update, possibly by COP 20.

3.2. Good Environmental Status as the underlying aim of IMAP

Good environmental status (GES) is the core concept of what has to be achieved under the EcAp process. All operational provisions are in one way or another linked to GES, which is the central feature allowing the measurement of progress and success in implementation of IMAP:

a. It is needed as the benchmark against which to assess current environmental status
b. It determines whether and what environmental targets are needed to achieve or maintain GES;
c. These targets, in turn, determine what measures are needed to achieve or maintain GES;
d. It guides the monitoring which provides the data and information needed to assess whether GES has been achieved or is being maintained, and to assess progress in delivery of the environmental targets and for assessing the effectiveness of measures.
e. It provides the benchmark for assessing if there is significant risk to the marine

Definition of GES

The definition of environmental status gives a holistic perspective on what needs to be considered in determining GES; it includes aspects related to:

a. The structure, functions and processes of marine and coastal ecosystems;
b. Natural physiographic, geographic, biological, geological and climatic factors;
c. Physical, acoustic and chemical conditions, including those arising from human activities.

The definition of good environmental status is setting the high-level goal of EcAp, i.e. what is 'good', by requiring the need to achieve:

a. Ecologically diverse and dynamic seas which are clean, healthy and productive;
b. Use of the marine environment which is at a level that is sustainable;
c. Ecosystems which function fully and maintain their resilience to human-induced environmental change;
d. Protection of marine species and habitats;
e. Prevention of human-induced decline in biodiversity;
f. Diverse biological components which function in balance;
g. Hydro-morphological, physical and chemical properties of the ecosystems, including those properties which result from human activities, which support the ecosystems;
h. Anthropogenic inputs of substances and energy, including underwater noise, do not cause pollution effects.

The definition of environmental status can be considered as neutral, in that it requires no judgement on whether the status is acceptable or not. This is in contrast to the definition of GES, where a judgement is necessary.

These definitions are following the principles of an ecosystem-based approach to management of human activities, ensuring the collective pressure of such activities is at levels compatible with the achievement of GES, and that the marine and coastal ecosystems have the capacity to respond to human-induced changes and enable sustainable use of marine goods and services.

No.	Short name	GES Description
EO1	Biodiversity	Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.
EO2	Non-indigenous species (NIS)	Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.
EO5	Eutrophication	Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.
EO7	Hydrography	Permanent alteration of hydrographical conditions does not adversely affect marine and coastal ecosystems.
EO8	Coast Coastal ecosystems and landscapes	*The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved*
EO9	Contaminants	Concentrations of contaminants are at levels not giving rise to pollution effects.
EO10	Litter	Properties and quantities of marine litter do not cause harm to the coastal and marine environment.
EO11	Energy, including underwater noise	Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

The Ecological objectives can be broadly characterised as:

a. State-based ecological objectives (Eos), which provide objectives for particular aspects of the marine environment: EO1 (biodiversity)
b. Pressure-based EOs, which provide objectives for aspects of the marine and coastal environment in relation to specific pressures from human activities: EO2 (non-indigenous species), EO5 (eutrophication), EO7 (hydrographic conditions); EO8 (coastal ecosystems and landscapes), EO9 (contaminants), EO10 (litter) and EO11 (energy), including underwater noise).

It should be noted that this state and pressure categorisation at EO level is not maintained at the common indicator level, where a more mixed pressure/impact/state approach per Ecological Objective was introduced.

The determination of GES for state- based EOs concerns the desired state of the marine environment, including the structure, functions and processes of its constituent marine and coastal ecosystems. Whilst determining GES for pressure based EOs is about defining the desired state of the environment, the maximum acceptable levels of pressures in the marine environment can be used to provide a proxy GES determination. The use of 'acceptable pressure levels' in the marine environment as a GES proxy is particularly feasible where there is a known causal relationship between the level of the pressure and its effects (impacts) on marine and coastal ecosystem elements. For example, the levels of nutrient enrichment and hazardous substances in the sea (EO5) which are considered to 'equate' to GES, can be determined based on established effects on particular ecosystem elements. Where the pressure-impact relationship is not yet fully understood, the setting of such pressure levels in the marine environment needs to be on a more precautionary basis. Precautionary levels should be used until the knowledge gaps for determining the pressure-impact relationship are closed, allowing for refinement of the 'acceptable pressure level' over time, based on improved understanding. The establishment of a direct causal relationship between a pressure and impacts is not well developed for all pressures, and thus needs further work in some areas.

The Classification of environmental status can be considered to have three possibilities:

a. In GES – for which monitoring is needed to check status does not deteriorate;

b. Not in GES – for which targets and measures are needed which should lead to GES being achieved and maintained, coupled with monitoring to assess progress in status and against the targets and measures;

c. Unknown status (potentially not in GES) - it will not be possible in all cases to identify a status which is clearly within or clearly outside GES. Where, based on the current best available knowledge, interim boundaries or proxies can be determined, the environmental state within this zone should be classed as 'not in GES'. Where interim boundaries or proxies cannot be determined, classification needs to rely on qualitative (normative) description and expert judgement. According to the precautionary principle , uncertainty of classification must not be used for postponing action. Resulting actions will depend on the shortcomings in the individual case. Actions include at least those to address the shortcomings, e.g. through development of improved assessment methods, more monitoring, complementary research, as well as proportionate measures (e.g. "no regret" measures where improving status is considered necessary even though what constitutes 'good status' remains to be fully defined).

Where GES has not been achieved, the follow-up action should focus primarily on managing and reducing the anthropogenic pressures which are considered to be causing this failure.

Climate change is influencing the characteristics of the marine environment and can be expected to affect hydrological conditions (e.g. sea level, wave action from increased storminess, water temperature, water circulation patterns), water chemistry (increased acidification) and biodiversity (e.g. species range changes due to sea temperature changes).

It is relevant to determine GES in a way which takes account of changes in species composition and range due to the dynamics of the marine and coastal ecosystems, some of which may be affected by climate-induced effects.

Monitoring the effects of climate change-induced pressures is important. It is important to be able to distinguish wider climate-change effects (e.g. temperature, acidification, biodiversity) from more local effects caused by other anthropogenic pressures, as these latter cases are the most practical to address within the context of the IMAP.

The current degree of scientific knowledge and understanding, as well as available data varies across the descriptors, affecting considerably the ability to define clear quantitative GES boundaries for all elements. In cases where there is insufficient knowledge to define a GES boundary, a precautionary approach is needed, including the assumption that GES has not been achieved until sufficient evidence indicates otherwise. With a clear indication that the GES determination needs to be reviewed as further knowledge becomes available. Increased scientific knowledge and understanding should lead to progressively more quantifiable determinations of the GES boundary for all EOs.

Lastly, but importantly, the setting of a GES boundary needs to respect the dynamic nature of ecosystems and their components, which can change in space and time through climatic variation, predator-prey interactions and other factors, and should thus be set in a way which accommodates these dynamics. For example, determining good status for a benthic or pelagic community could focus on the functional components (e.g. filter feeders, deposit feeders) which are typical of the community in (near) unimpacted state, rather than specifying the precise species composition which is more prone to fluctuation. The presence of sensitive/fragile/long-lived species can be good indicators of unimpacted state, but if lost from a community due to anthropogenic pressures, the community may not recover to the same species composition but could still be judged to have recovered to GES if the community has all the functional components and similar diversity of a (near) unimpacted state.

The six-year updating cycle for the determination of GES, as well as the Initial phase of IMAP provide an opportunity to adjust these GES boundaries to accommodate increased scientific understanding and reflect any long-term ecosystem changes, if appropriate.

During the initial phase of IMAP, regarding methodologies and assessment criteria, the following cross-cutting elements are proposed for review/ further expert work:

a. Elements for assessment (of whether GES has been achieved)
b. Criteria for assessment of the elements
c. Reference levels for assessing quality (baseline, GES boundary between GES and not in GES)
d. Aggregation rules across criteria for an element and for multiple elements (e.g. for a functional group)
e. Assessment scale
f. Time period for assessment
g. Data needs (parameters) for ‘indicators’ used in assessment
h. Aggregation methods for data (spatial, temporal)

3.3. Assessment Criteria

As a general approach, the pressure criteria should enable the level of the pressure in the marine environment to be determined: this should normally encompass its intensity and how this varies in space and time. This should be measured in a way which is relevant to the (main) elements of the ecosystem affected by the pressure.

The state/impact criteria should reflect aspects of ecosystem structure, function and processes; wherever possible (and particularly impact criteria associated to particular pressures) they should be focused on aspects of state which are known to be affected by the pressures.

Qualification of GES

Baselines are typically defined according to one of the following approaches:

a. Reference condition or state (sometimes referred to as background levels): a state of the environment considered largely free from the adverse effects of anthropogenic activities (*i.e.* negligible impacts from pressures). This can be defined in relation to aspects of environment state (physical, chemical and/or biological characteristics), or to levels of pressure or impact (*e.g.* an absence of contaminants or certain impacts). This type of baseline is typically used to allow an acceptable deviation in state to be defined which acts as the target threshold value to be achieved (i.e. the GES boundary). Reference state can be defined using a variety of methods, including:
    i. Historic conditions, based on various evidence about conditions before there was significant anthropogenic activity;
    ii. Past date/period, based on time-series datasets in which a time that is considered to best equate to ‘reference state’, is selected;
    iii. Current conditions, in areas considered substantively free from anthropogenic pressures;
    iv. Modelling, to try to predict current state in the absence of pressures.
b. A specified/known state (of the environment, or the pressures and impacts acting upon it) usually implying, due to the methods used to derive it, that it is not a reference state. This specified state can be defined using a variety of methods, including:
    i. Past state, at a specified time (e.g. when a policy or programme was adopted);
    ii. Past state, based on time-series data, but where the data are known to reflect certain levels of impact;
    iii. Current state.

This latter type of baseline is primarily for use in connection with the EcAp Targets (i.e. to improve status in relation to a current/past poor status) as in principal GES should be defined as an acceptable/agreed degree of deviation from reference state (which accommodates sustainable uses at specified scales of assessment).

This type of baseline is only appropriate for use under certain circumstances, such as when a GES boundary cannot yet be defined. In such cases, there should be no further deterioration in environmental quality (caused by increases in the levels of pressures and their impacts) and environmental targets should be set to improve the environmental quality towards GES.

In all these approaches, there is often a need to use expert judgement, but this should be used in a well documented and transparent manner.

Aggregation rules

The process of using data (from monitoring programmes) in an assessment and concluding on the current environmental status involves a number of assessment steps. Given that the starting point is often fine-scale data (individual samples) and the end point may be status assessments for broad ecosystem elements for an entire (sub)region, it is necessary to define the way in which the data are processed (spatial and temporal aggregation) and how they are interpreted for an indicator and criterion; there may be multiple elements to be aggregated to give a broader perspective and multiple assessment areas.

Decisions on a 'boundary' between 'in GES' and 'not in GES' are needed at various steps (levels) in this process:

a. Determine appropriate threshold values for each common indicator used to assess the elements, enabling a clear distinction between when GES for that criterion has been achieved and when it has not been achieved. This can usefully be referred to as a 'GES boundary', a term introduced here in the context of determining GES in a quantified way. For a given parameter/metric which is used for a particular common indicator (e.g. desired concentrations of a nutrient in the water), the threshold boundary could be a value that must not be exceeded (such as for contaminant levels), as a value that must be reached or exceeded for GES to be achieved (such as for habitat extent), or as a range with upper and lower values that must not be exceeded (such as population size). For each of these there can be a margin of variance, depending on the parameter concerned, natural variability and other factors. These GES boundaries should, wherever possible, be set in relation to a baseline which represents unimpacted natural conditions (referred to as 'reference condition', or sometimes as 'background levels' for contaminants). The GES boundary can thus be set as an 'acceptable deviation' from such natural conditions which can consequently accommodate sustainable uses of the marine environment.
b. Where several criteria are used per element, a specified method of aggregation across the criteria[2] is needed in order to arrive at an assessment of whether the element has achieved GES or not, i. e. agreed rules for how the three criteria to assess a commercial fish species, or the pressure and impact criteria of a pressure-based ecological objective, will be aggregated to assess if GES has been achieved. These rules could include the one-out-all-out principle or other specified approaches. In this sense GES can be defined as having been achieved for specified elements of the marine environment (e.g. related to specific EOs or biodiversity elements) rather than as a whole; this allows for a more step-wise approach to assessments and for a means to communicate that GES has been achieved for certain elements but not yet for others.
c. For multiple elements (e.g. multiple species or contaminants) in a broader functional group (e.g. demersal fish, heavy metals), a way to express overall status of the broader group is needed. In this situation, a minimum list of elements which 'represent' the broader group should be specified and then used for assessment of that group. In these cases, all the listed elements within the group should achieve the specified quality levels in order to say the broader group has achieved GES. Progress towards GES for the group could be expressed as the proportion (%) of the minimum list of elements which have achieved GES.

Aggregation rules, following the above principles, structures will be further refined during the initial phase of IMAP.

<u>Scales of Assessment</u>

It has long been clear that the assessment of GES will require choices as regards scales for assessments. Some progress on these issues has been made by Member States and in the regions for the 2012 reporting round, but the Commission's Article 12 assessment found that the approaches, if they were clearly

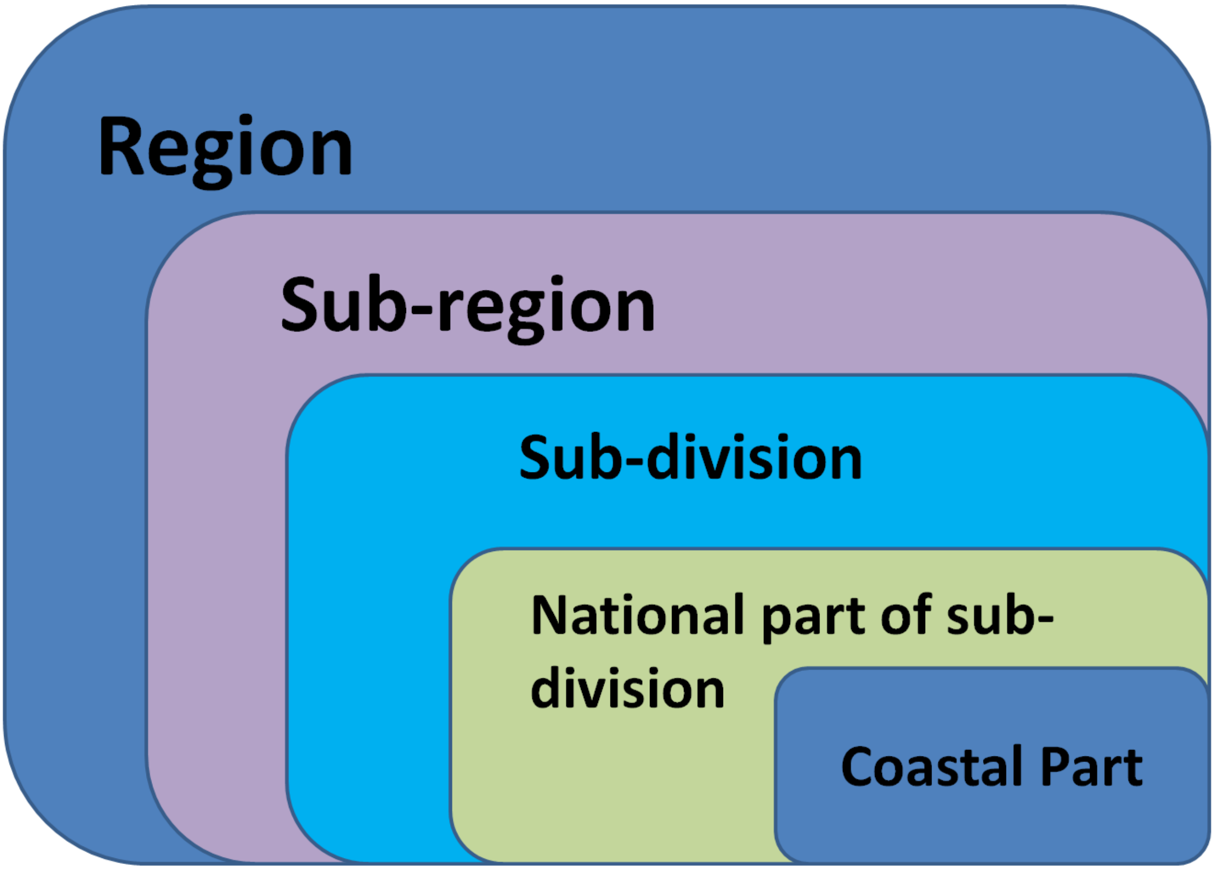
[2] In some cases several indicators could be used per criterion, necessitating aggregation rules up to criterion level also.

mentioned, are very different between countries and therefore lead to a marked lack of coherence in the implementation.

Before addressing possible options, some principle requirements need to be outlined and further developed, in particular:

a. Defining scales and areas for assessment of environmental status – regions, subregions, subdivisions and finer scales if needed (required for the different assessment elements – species, habitats, pressures); need to reflect ecosystem-based scales and practical assessment and management needs; need to relate these scales/areas to monitoring data with rules for aggregation of samples);
b. Developing suitable mapping/dissemination tools to show the environmental status of the different Eos across the whole region (use of nested scale systems, based on the HELCOM's best practice, for the different EOs, accommodating state and pressure aspects to provide a reference layer for information management at regional level; display of assessment outcomes via a grid-based approach to accommodate different scales for different EOs);
c. Linking the scales of assessment to management issues (the management of pressures via measures, the assessment of cumulative impacts on ecosystem components and its links to decision-making processes for licencing new developments).

As a starting point, a "nested approach" to defining assessment areas is being introduced, following the HELCOM best practice, as described under in graph 3.3.1.



A nested system provides a flexible approach to defining scales for assessment (for the different GES descriptors) in a way which also provides consistency and clarity on the scales/areas to be used for assessment. It enables a linkage between state-based and pressure-based assessments, which facilitates linkages to measures. Whilst an outline approach to defining and using such a nested system is presented here, it would be necessary for Contracting Parties, working together on regional level, to develop this into an operational mechanism, by:

a. assigning the elements to be assessed to the most appropriate scale, taking account of the most appropriate ecological scales for state-based elements and relating these to appropriate scales for pressure-based assessments; an initial generic proposal for this is given in Table 8, noting that this needs further discussion and adaptation to suit each region;
b. defining suitable boundaries for the areas to be used for each scale within the region; a set of boundaries for marine regions and subregions[3] should be developed. Additionally in line with the ICZM Protocol and relevant regional legislation, such as the WFD for the EU, the national boundaries are fixed and the boundaries of coastal waters are established. This leaves the main consideration as to whether there is need to subdivide each (sub)region into a suitable (low) number of sub-divisions.
c. adjusting the proposal to accommodate practical implementation issues (e.g. the occurrence of national boundaries, the foreseen assessment process, balancing the number of areas for assessment with implementation needs such as links to measures and management).

[3] The proposal is at an advanced stage, with few issues remaining to be finalised.

Note: it is important to recall that monitoring scales are not the same as assessment scales – the latter define for each specified element the scale at which the determination of whether GES has been achieved or not takes place ans this needs to draw from and aggregate the monitoring data which will often be collected at finer scales.

Table 8: Initial proposal for assignment to appropriate scales of elements to be assessed (as a basis for discussion and further development during the initial phase of IMAP).

Elements for assessment	Region	Subregion	Subdivision	National part of subdivision	Coastal waters
State elements					
Species groups (EO1)	Large cetaceans, deep-sea fish	Offshore birds, small cetaceans, turtles, pelagic & demersal fish	Coastal birds, seals, coastal fish		
Water column and seabed habitats (EO1)			Water column habitats, seabed habitats beyond 1nm		Seabed habitats
Ecosystems (EO1 and 7)		Ecosystems			
Pressure elements					
Physical loss and damage, hydrographical changes (EO6, 7)			Linked to seabed habitats		EO7
UW noise (EO11)	Linked to large cetaceans	Linked to small cetaceans			
Nutrients (EO5)				X	MED POL practice
Contaminants (EO 9)				X	MED POL practice
Litter (EO10)				X	
Removal of species (EO3)	As fish groups/GFCM practice	As fish groups/GFCM practice	As fish groups/GFCM practice		
Non-indigenous species (EO2)				NIS	

A key benefit of such an agreed approach is in being able to visualise the outcomes of assessments in mapping form at national and regional scales.

In addition, it would still need an agreement on the smallest entity for each assessment. This may well vary between and within EOs but pragmatic approaches are needed which allow assessment and management at all relevant levels. It is probably best to start developing these questions on the basis of concrete examples. For eutrophication, the results of the GES assessment can be represented as X% of the assessment area which is affected by eutrophication (i.e. not meeting GES for EO5). However, the assessment is typically based on discreet monitoring data (from specific monitoring stations) which are taken at different levels of density across countries. Modelling could play a role in order to extrapolate the data. Also expert assumptions could be derived when extrapolating the monitoring data. In any case, a clear specification for the aggregation rules of the monitoring data for a particular criterion are needed (see Prins et al. 2014). Furthermore, it is clear that if, for example, a waste-water discharge introduces nutrients to the marine environment, assessment rules should be laid down that allow the effects of nutrient and organic matter enrichment on the environmental status to be evaluated at specified scales.

<u>Time period for assessment</u>

ECAP has six-year cycles, with reporting within each six-year period (current cycle 2016-2021). The determination and assessment of GES cycle. It is necessary to update the assessments of environmental status at least once every six years, in order to assess current status in relation to the determination of GES and to show progress achieved since the last report (against targets set and measures established).

This does not preclude the updating of assessments at more frequent intervals, where this is feasible and desirable. This situation could arise, for example, based on the outcomes of the initial phase of the monitoring programme, on additional new scientific knowledge and data in between the Meetings of the Contracting Parties and in areas where monitoring is undertaken on an annual basis and processing of the data has become routine.

When undertaking assessments there is a need to:

a. Consider data over as long a period as possible, so as to help understand changes in the data, including natural variability as well as anthropogenic influences. This can be particularly relevant for setting baseline values;
b. Use the latest available data from monitoring programmes in the assessment to ensure the assessments reflect the most recent situation;
c. Update all data used in the assessment at least once in the six-year period;
d. Use, as far as possible, data from the same time period when considering combinations of data (e.g. pressure and state/impact data, background oceanographic data);
e. Compare the most recent six-year assessment period with the previous six-year assessment period in order to report progress in achieving GES and targets.

<u>Integrated approach for assessments</u>

In order to have a more integrated approach to the determination of GES and consequently to assessments of whether GES has been achieved, there is a need to focus on during the initial phase of IMAP:

a) More explicitly relating the outcomes of the pressure-based assessments to the state-based assessments, recognising that the overall status of a state element should reflect the multiple pressures and impacts upon it;
b) combining the state-based descriptors to assess the ecosystem elements in a more integrated manner; this would overcome some of the current problems of overlap between descriptors, whilst noting that it may not be possible to eliminate all overlaps.

In order to make best use of this integrated approach, the following logical sequence of assessments is recommended:

a. Map the distribution and intensity of human uses and activities (identifies main areas of activity, potential for use as proxy pressure assessment, supports later identification of measures[4];
b. Assess the pressures – spatial distribution and intensity (and temporal aspects, where necessary) of each pressure;
c. Assess the impacts – extent of impacts in relation to the elements to be used for the state-based assessments.
d. Assess the state – bringing together the relevant impact assessments from (b) and leading to an overall assessment of status using a specified assessment methodological standard.

The sequence above will be undertaken during the initial phase of IMAP, based on the Common Indicator Pressures and Impacts Analysis.

4. Key Principles of the Integrated Monitoring and Assessment Programme

Adequacy (overarching principle 1)

The IMAP aims to provide all the data needed to assess whether GES has been achieved or maintained, the distance from and progress towards GES, and progress towards achieving environmental targets.

Consequently, monitoring covers relevant biotic and abiotic elements in order to quantify pressures associated with activities and assess effectiveness of measures in relation to the targets set. Some of the indicators require biotic (e.g. Abundance of perennial seaweeds and seagrasses) and some abiotic (e.g. Physical, hydrological and chemical conditions of the habitat) data while others require pressures' data (e.g. Trends in the amount of litter washed ashore and/or deposited on coastlines).

Coordination and coherence (overarching principle 2)
Based on the IMAP, the Contracting Parties should, as much as possible follow agreed monitoring strategies, particularly within the same sub-region. Ideally, they should monitor a common regional set of elements, following agreed frequencies, comparable spatial resolution and agreed sampling methods. Joint specifications and use of other observation data in the region, such as satellite imagery, also contribute to coordination.

Such coordinated approaches result in coherence i.e. the same biotic and abiotic components to be monitored in similar habitats and points in time and facilitate the generation of comparable assessment results and associated classification of the state of similarly impacted areas belonging to different Contracting Parties.

Ultimately, coherent monitoring programmes will ensure that the assessment of environmental state is consistent across Contracting Parties, providing a level playing field for the need for measures to reduce the excessive pressures from human activities (i.e. the need to improve status to the same quality standards) and that measures taken by one Contracting Party would facilitate and not prevent the achievement of GES in other Contracting Parties.

Ideally, differences in monitoring strategies would only be justified by demonstrating important differences in the biological and physicochemical characteristic (e.g. species, habitats and pressures) between two or more marine and coastal areas.

Data architecture and interoperability (overarching principle 3)

[4] A precursor, or proxy, to mapping pressures is the mapping of activities, which can also be a contribution to the assessments under Art. 8.1c and support the ecosystem-based approach to management of activities in order to achieve GES.

A coherent IMAP aims to result in the collection of data for a regional set of common parameters. In order to achieve common datasets and interoperability of data, data sources need to ensure that they are capable to deliver data using the same interface format. To achieve common data sets and to avoid duplication of work, existing databases and data flows at international and regional level should be taken into account, which already provide a pool of regionally interoperable data.

The concept of an adaptive monitoring programme (overarching principle 4)

New or previously unknown pressures may emerge in a marine and coastal area and/or existing pressures may decrease or be eliminated. Climate change, as a consequence of increased greenhouse gas emissions is affecting the intensity and impact of other pressures and may drastically change the structure and functions of marine and coastal ecosystems and should be addressed in a horizontal manner in relation to all common indicators.

Environmental state may degrade in an area, requiring investigative monitoring to identify causes. The frequency, intensity and the whole rationale of monitoring programmes may need adjustment to better respond to a changing situation, e.g. an acute pollution event (oil spill) will require more intense monitoring in the years following the event and introduction of a non-indigenous species may require additional and targeted monitoring. Also technical progress may require adjustment of monitoring programmes (e.g. new sampling devices).

The IMAP implementation has a 6 years cycle (with upcoming cycle of 2016-2021) but more frequent adjustment of monitoring programmes may be needed.

The first years of the IMAP (2016-2019) will focus only on the set of common indicators monitoring, where data and practice is the most mature.

A risk-based approach to monitoring and assessment and where appropriate applying the precautionary principle (overarching principle 5).

Areas that are under higher pressures and the biota that are known to be more sensitive should be identified, and monitoring efforts should be prioritised in the areas and topics that most risk not to achieve or maintain GES. These areas should be monitored more frequently in relation to those quality components at risk to achieve/maintain GES and associated relevant pressures than other areas that have maintained GES for a long period of time and are under less pressure. Furthermore, increased monitoring effort may be needed in areas that are close to the boundary of GES in order to increase confidence in assessments and, consequently, in the decision to take measures.

Risk-based approach to monitoring

In the risk-based approach (Cardoso *et al.* 2010), pragmatic prioritization is made, which enables general statements about environmental status at large scales while keeping monitoring requirements manageable.

This risk-based approach is particularly effective for Ecological Objectives that are spatially patchy and where pressures are applied at specific locations. It is recommended to map the pressures that most likely have the largest impacts, and the vulnerability of various properties of the ecosystem. Cardoso *et al.* (Cardoso et al., 2010) recommend prioritization by prior assessment of:

i. the distribution of the intensity or severity of the pressures across the region at large;
ii. the spatial extent of the pressures relative to the ecosystem properties possibly being impacted;
iii. the sensitivity/vulnerability or resilience of the ecosystem properties to the pressures;

iv. the ability of the ecosystem properties to recover from impacts, and the rate of such recovery;
v. the extent to which ecosystem functions may be altered by the impacts; and
vi. where relevant, the timing and duration of the impact relative to the spatial and temporal extent of particular ecosystem functions (e.g. shelter, feeding, etc.).

Variation in the scale of both environmental conditions and impacts of pressures means that assessments of GES could begin with sub-areas of both greatest sensitivity and highest pressures. If the environmental status in these areas is “good”, then it can be assumed that the status over the larger area is good. In contrast, if the environmental status in the sub-areas is not “good”, then monitoring and assessments would be conducted stepwise at additional sites along the gradients of pressure or sensitivity. The size of the appropriate steps along the gradient will depend on the nature of the gradient and the way the environmental conditions are degraded. It may vary significantly with different cases (Cardoso *et al.,* 2010).

Precautionary principle (overarching principle 6)

In a number of cases, it will not be possible to identify a state clearly within or clearly outside GES. In those cases, the precautionary principle has to apply. Where, based on the current best available knowledge, interim boundaries or proxies for a status between GES achieved and GES not achieved can be defined, the environmental state within the range is to be classed as not GES.

Where proxies and interim boundaries cannot be defined, it is considered that classification would need to rely on qualitative description and expert judgement. According to the precautionary principle, uncertainty of classification must not be used for postponing action. Resulting actions will depend on the shortcomings in the individual case. Actions include at least those to address the shortcomings with a view to shifting to a quantitative approach, e.g. through improved methods, more monitoring, complementary research, in a cost-effective manner.

5. Aiming to cost efficiency in relation to socio-economic benefits of monitoring

While the overall Socio-Economic Assessment under the IMAP has been carried out with a focus on the most important sectors and costs induced by the degradationof the Mediterranean marine and coastal environment (UNEP(DEPI)/MED WG.401/6 and UNEP(DEPI)/MED WG.401/7), the importance of ensuring that the IMAP is cost-effective is widely recognized.

In order to achieve the highest level of cost-efficiency, the following recommendations have been taken into account while drawing up the IMAP:

(a) prioritization (both at theme and indicator level) of the monitoring programmes to address the most significant risks and to respond to assessment/management needs, taking into consideration the commun indicators listed above;
(b) key criteria for prioritization taken into account, are scientific credibility, practical monitoring and data requirements and policy/social relevance of criteria and indicators for measures / pressures as they directly link back to the management element;
(c) finding innovative and efficient ways of doing the monitoring;
(d) encouraging country cooperation (bilateral or sub-regional level) as a potential cost-efficient execution of the monitoring programmes (for example opportunity for the EU to contribute to cost-efficiency through the Copernicus marine core services by offering data products in relevant resolutions for national and regional uses in support of the Ecosystem Approach Process in the Mediterranean);
(e) build on exisiting monitoring activities (existing monitoring stations, actions carried out) and on the use of existing resources (e.g. ship time), by improving the efficiency of existing programmes (i.e. use of spare capacity) as much as possible;

(f) Encourage monitoring by industry of the environmental effects of their activities (following initial impact assessments) , as if such monitoring is done to specified standards an its quality is assured and it provides data[5] that are compatible with other monitoring programmes, it can reduce the costs to Contracting Parties significantly.

The costs of environmental monitoring should be viewed in the light of the certainty it brings to understanding the health of the marine environment and in relation to the socio-economic benefits of achieving GES. Monitoring can be considered as the 'insurance policy' that provides Contracting Parties with the knowledge that the marine environment, upon which they depend is to deliver the essential goods and services, in a good state or is moving towards a good state.

Next to ensuring the usage of cost-efficient methods and further identifying possibilities for maximizing the cost-efficiency of the monitoring programme, it is also key to ensure that the implementation of the IMAP will be possible all over the Mediterranean basin. For this, it will be key to further assess the country capacities, noting the starting point of relevant monitoring programmes already in practice and afterward address specifically, on the country level the monitoring and assessment needs, in case of interest, with the assistance of the Secretariat.

6. Data and information sharing

In line with the COP 18 EcAp Decision, during the implementation of the IMAP, the following principles about the handling of data aim to ensure that data are handled in a consistent and transparent manner, as follows**:**

6.1. The Shared Environmental Information System (SEIS):

- Information should be managed as close as possible to its source;
- Information should be collected once, and shared with others for many purposes;
- Information should be readily available to public authorities and enable them to easily fulfill their legal reporting obligations;
- Information should be readily accessible to end-users, primarily public authorities at all levels from local to regional, to enable them to assess in a timely fashion the state of the environment and the effectiveness of their policies, and to design new policy;
- Information should also be accessible to enable end-users, both public authorities and citizens, to make comparisons at the appropriate geographical scale (e.g. countries, cities, catchments areas) and to participate meaningfully in the development and implementation of environmental policy;
- Information should be fully available to the general public, after due consideration of the appropriate level of aggregation and subject to appropriate confidentiality constraints, and at national level in the relevant national language(s); and;
- Information sharing and processing should be supported through common, free open source software tools.

6.2. The Group on Earth Observations (GEO), which has defined the following Data Sharing Principles:

[5] Issue related to data ownership and data accessibility should be tackeled in genreal by CORMON

- there will be full and open exchange of data, metadata and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation;
- all shared data, metadata and products will be made available with minimum time delay and at minimum cost;
- all shared data, metadata and products being free of charge or no more than cost of reproduction will be encouraged for research and education.

6.3. The Global Monitoring for Environment and Security (GMES), which establishes a full, open and free data policy

Of note, that the objectives of these data principles are to support, promote and enable the EcAp implementation process:

a) full, and open access to all kinds of data, metadata and services;
b) where possible, recognizing and respecting the national policies and legislation and the variety of licensing and intellectual property;
c) to share data, metadata and services available with minimum time delay and free of charge or no more than cost of reproduction;
d) the use, re-use and re-combination of data from different sources in different frameworks and media than those for which they were originally commissioned;
e) the protection of the integrity, transparency, and traceability in environmental data, analysis and forecasts;
f) the implementation of SEIS, GMES and GEOSS data sharing principles.

7. Quality Assurance and Quality Control

The accuracy and comparability of the data collected is a key requirement for status assessment and description and for the assessment of anthropogenic influences and required measures. Quality assurance (QA) and quality control (QC) measures ensure that monitoring results of stated quality are obtained across the Mediterranean Region and at any time.

QA/QC should provide confidence in the whole analytical process, from sampling to reporting, for all monitoring parameters, from monitoring at national, sub-regional as well as at Regional scale. Monitoring should provide data, which are representative of the location and time of sampling. For temporal trend monitoring in particular, it is extremely important to perform reliable and reproducible high-quality analyses over decades. Therefore, such analyses require well-documented procedures and experienced analysts.

QA/QC seems to be limited to methods and technical specifications. However, it is important for the whole monitoring chain: from defining targets to achieve GES, related indicators and parameters in order to determine the monitoring requirements to designing and performing the monitoring programme in order to collect and assess the monitoring data. The monitoring data should enable meaningful assessment of status in time and space. Beginning with an assessment of the existing monitoring programme, an iterative process will enable a further modification and revision of the monitoring programme. Monitoring programmes should be adapted to new insights by ensuring that time series remain as much intact as possible. Exchange of best practices, intercalibration and harmonisation activities will forward this process and highlight any deficiencies and inadequacies. This will result in comparable monitoring approaches based on commonly agreed monitoring principles.

QA and QC also apply to data storage and exchange. This includes common data management standards and technical and semantic interoperability between data management systems.

Furthermore, to ensure highest quality of data the Contracting Parties shall, already during the Initial phase of IMAP:

a) Cooperate in carrying out monitoring programmes and submit the resulting data to the Secretariat.
b) Comply with quality assurance prescriptions and participate in intercalibration exercises.
c) Use and develop, individually or preferably jointly, other duly validated scientific assessment tools, such as modeling, remote sensing and progressive risk assessment strategies.
d) Carry out, individually or preferably jointly, research which is considered necessary to assess the quality of the marine environment, and to increase knowledge and scientific understanding of the marine environment and, in particular, of the relationship between inputs, concentration and effects.
e) Take into account scientific progress which is considered to be useful for such assessment purposes and which has been made elsewhere either on the initiative of individual researchers and research institutions, or through other national and international research programmes or under the auspices of the EU or other regional organizations.

In addition, the Secretariat will, during the Initial phase of IMAP, further

a) Define and implement programmes of collaborative monitoring and assessment-related research, draw up codes of practice for the guidance of participants in carrying out these monitoring programmes and tp approve the presentation and interpretation of their results.
b) Carry out assessments taking into account the results of relevant monitoring and research and the data relating to inputs of substances or energy into the maritime area which are provided by IMAP.
c) Seek, where appropriate, the advice or services of competent regional organizations and other competent international organizations and competent bodies with a view to incorporating the latest results of scientific research.
d) Cooperate with competent regional organizations and other competent international organizations in carrying out quality status assessments.

II. MONITORING AND ASSESSMENT OF EO1: BIODIVERSITY

1. The application of the risk based approach to biodiversity monitoring

It is not practical, possible or even necessary to monitor all attributes and components of biological diversity, throughout the region or sub-region. The relationship between environmental pressures and main impacts on the marine environment should be taken into careful consideration when selecting where and what to monitor based on a risk-based prioritisation (An i and based on the best use of ongoing biodiversity monitoring programmes.

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.

Furthermore, in relation to biodiversity monitoring, it is recommended to focus on so called "representative sites" with the criteria for the selection as the following:

- Where pressures to and risks to/effects on biodiversity are most strongly associated, following a risk based approach(vulnerable habitats and species locations);
- 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);
- Expert opinion.

<u>Locations to be monitored should be prioritised to cover at least the following</u>:

- Areas of influence from anthropogenic activities which are expected to cause impacts upon biological diversity, with priority on the areas at highest risk[6] (i.highintensity activities; ii. Multiple activities; iii. Areas where impacts may be particularly severe or long term).
  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 visualization 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.

<u>Monitoring in Marine and Coastal Specially Protected areas</u>

[6] Where possible, use a transect from high to low pressure, so as to cross the 'GES boundary' – can help define the boundary between areas in GES and those not in GES.

Monitoring in marine and coastal protected areas or Specially Protected Areas under the SPA/BD Protocol should be a core activity undertaken during the initial phase (2016-2018 of the IMAP), in order to serve the following 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, even if real pristine conditions are much rare in the Mediterranean, 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.

Reference list of habitats and species

The COP 18 EcAp Decision includes refrence list of habitats and species to be considered for monitoring and assessment, with the note that these lists should be further elaborated as part on work on integrated monitoring. These reference lists were further refined at the CORMON Biodiversity and Fisheries Meeting (Ankara, 26-27 July, 2014) and by the online working group on biodiversity and non-indigenous species.

In relation to the refrence list of habitats, it was agreed that special consideration should be given inter alia to habitats that are considered as essential for important species functions such as spawning and feeding grounds.

In relation to the reference list of species, it was agreed that in order to identify the most suitable biodiversity components to monitor it is recommended to follow a logical set of questions, such as:

- What are considered to be the main pressures on biodiversity in the region/subregions?
- Which main biodiversity components does each pressure most affect (start at level of birds, mammal, reptiles, fish, coastal, shelf and deep sea habitats, but subdivide if necessary, e.g. coastal birds/offshore birds)?
- Which individual species (or groups of species) or habitats types could be monitored to best represent the impacts of the pressure on each broader group? In the case of cetaceans, the few species of cetaceans regularly present in the Mediterranean Sea should all be considered when developing the national monitoring programmes. A minimum of two species has to be identified for monitoring, based on the specificity of their marine environment and biodiversity, and taking account that these species should belong to at least two different functional groups, where possible (Baleen whales / Deep-diving toothed whales / Shallow-diving toothed whales). As far as possible the choice of monitored species should be coordinated at sub regional scale to ensure coherence with cetacean population distribution in the Mediterranean Sea

Assessment of biodiversity common indicators in an integrated manner on EO level

For the purpose of the assessment of the biodiversity EO, it is important to analyze the description of the GES set for this EO.

Tthe definition of the Convention on Biological Diversity (CBD) for ‘biological diversity’ is: “the variability among living organisms from all sources including, interalia, 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 term 'maintained' is key to the quantification of GES for EO 1 and thus for the elaboration of recommendations on criteria and methodological standards. The condition ('maintained') has three determining factors:

a) no further loss of the diversity within species, between species and of habitats/communities and ecosystems at ecologically relevant scales;

b) any deteriorated attributes of biological diversity are restored to and maintained at or above target levels, where intrinsic conditions allow (cf. Art. 1.2 a) and

c) where the use of the marine environment is sustainable.

The term 'habitat' in relation to EO1 addresses both the abiotic characteristics and the associated biological community, treating both elements together in the sense of the term biotope, whereas 'quality', 'occurrence', 'distribution', 'extent' and 'abundance' form the basis of the criteria standards used to assess GES.

For assessment purposes it is important to note that EO1 has a broad scope, requiring assessment at several ecological levels: species, habitats (addressing both the abiotic characteristics and the associated biological community, treating both elements together) and ecosystems.

At the species level, GES shall be defined for the full range of functional and taxonomic groups occurring in the marine environment.

Generally, it seems to be difficult to quantitatively define GES for biological diversity, considering the variety of the elements to be assessed which cannot be homogenously captured by a single quantitative description.

A potential conceptual approach for a quantitative GES can be framed in such a way that the resilience of the ecosystem is suited to accommodate the quantified biodiversity, or in other words, it will be accounted in the determination of the GES boundaries as "acceptable deviation from a reference state which reflects conditions largely free from anthropogenic pressures. Where GES cannot be quantified, it could, as a first step, be qualitatively defined, notably according to the level of knowledge available for many species or habitats.

For example, benthic habitat conditions can be defined qualitatively (based on species composition and proportions) and the presence of lack of GES could be expressed as a deviation (qualitative or semi-quantitative-range) around this qualitatively defined reference point.

Considering the dynamic nature of ecosystems and the naturally varying environmental conditions, GES can only be directly quantified for certain scales, species and habitats. To that end, lists of elements and common classification systems of elements can facilitate a coherent and comparable quantitative determination of GES, regionally.

The CORMONs will thus continute to further explore and quantify as much as possible the GES on EO level, based on the above principles, during the initial phase of IMAP.

2. Monitoring and assessment of biodiversity related common indicators

The common indicators agreed in relation to biodiversity monitoring are as follows:

1. Habitat distributional range to also consider habitat extent as a relevant attribute;
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.

While laying out monitoring specifics for the above common indicators the following two questions were kept in mind:

- 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)?;
- 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?

2.1. Specific considerations on assessing biodiversity common indicators

Temporal scales

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 some pressure elements acting upon biodiversity may be monitored more frequently than the actual state of biodiversity (i.e. more frequent monitoring of fishing activity acting upon the seabed than benthic habitat state). It is also 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 Ecological Objective 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.

3. 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**) . 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[7] 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 III.

4. 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 described and carried out openly, such that all laboratory 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:

- training and training records;
- traceability of work and samples;
- standardised practices throughout;
- calibration of sampling and sample processing equipment or procedures;
- in house and external audit, also referred to as Analytical Quality Control schemes;
- literature updates;
- reference or voucher collections (where specimens are collected; photographs or other documentation for non-destructive sampling).

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[7] www.marbef.org

5. Monitoring for the biodiversity common indicators

5.1. Elaborating habitat distributional range (Common Indicator 1: Habitat distributional range)

The ECAP Operational Objective of the indicator for habitat distributional range is that key coastal and marine habitats are not being lost. Therefore, it is considered that the loss of habitat extent i.e. from infrastructure developments and by damage from physical activities such as trawling and possibly damage from pollution is the important factor to monitor and assess. Furthermore, as mentioned above, the CORMON Biodiversity and Fisheries Meeting (Ankara 26-27 July, 2014) recommended that loss of habitat extent is typically more important/at higher risk, with loss of distributional range only secondarily at risk.

5.1.1 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:

- 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.
- 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 III and a review in Cogan et al (Cogan et al., 2007).
- The MESH Project has developed a series of Recommended Operating Guidelines[8] 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.

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-

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

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[9] 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[10] 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**[11]) undertaking seabed habitat type and pressure mapping in order to assess potential scale of impacts per (broad) habitat type, that is expected to be completed in 2016.

A method that integrates spatial habitat and pressure data to provide a measure of cumulative anthropogenic impacts was established a few years ago (Halpern et al., 2008) and since then has been applied to several sea areas (Halpern et al, 2009; Selkoe et al., 2009; Ban et al., 2010; Kapel and Halpern, 2012; Korpinen et al., 2012, 2013; Andersen et al., 2013), including for the Mediterranean Sea (Coll et al, 2012; Micheli et al., 2013).

5.1.2. Evaluating the status of habitat areal extent through the indicator on area of habitat loss (in line with the operational objective that key coastal and marine habitats are not being lost)

The proposed indicator assesses the proportion of the area of habitats that are permanently or for a long-lasting period lost or subject to change in habitat-type due to anthropogenic pressures. In principle, any habitat type may be assessed on the basis of this indicator through the processing of spatial construction and other pressure data and the compilation of modeled habitat, interpolated habitat or directly measured habitat extent.

The indicator is in principle applicable to all habitat types across the Mediterranean region and it is considered to be highly sensitive to physical pressures. In most cases the indicator will be largely built on mapping and modelling of habitats and available construction footprint and spatial pressure data; this is cost efficient because it minimises monitoring activities in the field.

In habitats which are defined by long-lived habitat-bio-engineering species, changes in the extent of the habitat are likely to be due to anthropogenic physical influences such as bottom-trawl fisheries. Loss of extent of habitat is of most concern for these biogenically-defined habitats (which include sea-grass beds) and typically less of an issue for physically-defined habitats, because the latter are typically less spatially sensitive and have a greater natural extent. A regional risk-based approach should seek to prioritise those habitats that need active, regular monitoring programmes to collect the necessary additional data to that derived from desk-based studies.

This indicator is an area related indicator, closely linked to condition elements i.e. if a habitat condition is sufficiently poor and irrecoverable, it is lost. There are three options for this assessment identified:

- The use of condition indices and a representative sampling and assessment in a restricted number of areas with subsequent extrapolation into the larger area

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

- Modelling habitats and mapping against impacts using sensitivity maps in combination with construction footprint data and spatial pressure intensity data. It may also be possible to combine options 1 and 2.
- Direct monitoring of habitats

Monitoring requirements

The data for this indicator should mainly be derived from activity data sources such as Environmental Impact Assessments and VMS or fisheries log book data. A risk-based approach will identify additional monitoring effort required for certain habitat types and keep the monitoring effort cost effective.

The effort and/or expense of a full monitoring programme for habitat types under protective regulations can be assessed as moderate to high depending on the number and area of the listed habitats. The use of non-invasive methods or models may reduce the effort and/or expense on a long-term basis but these cannot comprehensively address extent and condition parameters.

The required methods and effort strongly depend on the specific habitat. Hard substrates are preferably monitored using optical, non-destructive methods such as underwater-video. Infaunal communities are sampled using standardized grabs or corers commonly used in marine monitoring-programmes. Sampling design and treatment should be in accordance with international or national guidelines (See Annex III for an overview of standards and methods for biodiversity monitoring).

Spatial scope

The spatial basis for assessment should be according to the Mediterranean biogeographic sub-areas in order to reflect changes in the biological character of each habitat type across the Mediterranean and its sub-regions.

Each Contracting Party should assess each habitat across their national maritime waters. However, it is recommended to assess on a smaller scale if they belong to different biogeographical sub-regions or differences in pressure intensity are obvious between sub-basins.

5.1.3. Assessment – specific considerations

Assessment parameter/metric

The parameter/metric for the assessment of this indicator is the surface area of lost habitat for each habitat type. It is suggested to largely use cumulative impact data derived from knowledge of construction and other anthropogenic pressures. As most human activities causing habitat loss are projects requiring licensing procedures and Environmental Impact Assessments (e.g. wind farm constructions, sediment extraction) the data should be available to Contracting Parties. Also for habitat damage caused by other activities, including fishing, a range of activity data is available, including VMS or log book data for larger fishing vessels that undertake bottom trawling. On the basis of these data it should then be decided on a case by case basis, applying a risk based approach, where to focus monitoring/sampling efforts to validate (2 above), extrapolate (1 above) or measure (3 above) habitat area.

Mapping of habitats is the basis of this indicator. Consistent scales and methods will be necessary for mapping a given habitat in a sub-region. The time of sampling should be synchronised for a sub-region so as to standardize the influence of seasonal, interannual or climate-related changes on results.

In general terms, the following steps should be part of the indicator's assessment:

- Generate maps of the marine habitats in each Contracting Party's marine areas;

- Attribute a specific sensitivity to physical pressures to each habitat type;
- Collate construction footprint data for sealed habitats and apply spatial and temporal pressure intensity data (e.g. VMS or log book data for fisheries, activity data from approved plans and projects);
- If vulnerabilities are addressed in first three points, deduce impacts from either (i) known pressure/impact relationships, using reference sites and risk based monitoring of selected stations (link to condition indices), or (ii) mapping construction footprints and impact models (with ground- truthing);
- If vulnerabilities are not addressed in first three points, derive measures of habitat extent;
- Determine whether the target is reached (i.e. proportion of lost or damaged area, related to total area the habitat type, above which GES is not achieved).

Non-invasive surveys (e.g. side scan sonar, video) or models (to be validated by optimized sampling) may be necessary to select the most appropriate sampling strategy. Intervals of 3-6 years are probably appropriate.

Baseline and Reference level

Reference condition/reference state is recommended as the preferred approach to setting baselines for benthic habitats. Where possible, the reference conditions should be determined e.g. using historical maps/data, modelling results. If the determination of reference conditions is not possible, then expert judgement should be used giving particular consideration to the current state.

Some considerations for setting GES boundaries/targets:

As a target, the damaged or lost area per habitat type, especially for physically defined and not biogenic habitats could be set as to not exceed an acceptable percentage of the baseline value. As an example, this target was derived from OSPAR to not exceed 15% of the baseline value and was similarly proposed by HELCOM.

For habitats under protective regulations (such as those listed under the SPA/Biodiversity Protocol, EU Nature directives) the target could be set as habitat loss stable or decreasing and not greater than the baseline value. As an example, as regards the EU guidance for the assessment of conservation status under the Habitats Directive, Member States have generally adopted a 5% tolerance above the baseline to represent 'stable'. However, in some cases a more stringent <1% tolerance has been attached to the maintenance of habitat extent.

Coastal water habitats are likely to be most altered/ sealed already whereas offshore habitats have currently only very small areas built on. It should therefore be considered whether to set targets for different habitat groups.

The definition of baselines interacts with targets for this indicator - e.g. in cases where i.e. 15 % loss has already occurred due to land claims in the past, the baseline could be set at a current state or historic and this, coupled with the ambition of the target would determine whether GES is achieved.

For some habitats under protective status that have historically been reduced, the target should be that the area increases towards the size of the baseline (i.e. towards reference conditions), within a certain time interval, recognising that recolonization of formerly occupied areas may not occur due to changes in environmental or climatic conditions.

Consideration of specific habitats of importance, such as spawning or feeding grounds for mobile species is recommended when applying/further developing or revising this indicator.5.1.4 Cost-effectiveness

A large part of this indicator is dependent on pressure data that is – in principle – already available, rather than on practical sampling and direct state assessments, the costs for monitoring low risk habitats is foreseen to be relatively low. It is envisaged that further data collection on habitat extent and mapping will be needed.

5.1.5 Further work

The following further steps are necessary for operationalization of the indicator during the initial phase of IMAP:

- Define vulnerability/resilience for the habitat types, taking into account their different communities, in relation to physical pressures;
- Agree on a simple and pragmatic model for analyzing generalized pressure/impact relations for habitat types and define qualitative GES on the basis of these results;
- Identify extent (area) baselines for each habitat type;
- Further develop criteria for the risk based approach to monitoring and develop harmonized sampling instructions where appropriate;
- Develop common computing methodologies, sampling concepts and mapping instructions, specifying the accuracy (spatial resolution or grid) of the determination of extent (area) a priori;
- Determine the appropriate assessment scales in detail;
- Develop standardized data flows for spatial pressure data;
- Research GES baselines for habitats types that cannot be inferred from contemporary records of pressure or construction;
- Agree harmonised sampling, cartographic, data collation and GIS protocols.

To further develop this indicator a workshop focusing on the definition and the assessment of vulnerability/resilience of habitats and to identify appropriate spatial pressure/impact models should be initiated.

5.2. Elaborating the condition of habitat defining species and communities (Common indicator 2: Condition of the habitat's typical species and communities)

5.2.1 Elaborating typical benthic species composition

The concept of "typical species" emerges from 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 composition should be near/close to natural conditions for their habitat to be considered in natural condition.

In order to assess the state/condition of a habitat's typical species, the Contracting Parties need to define lists of typical species and to set targets to determine their presence. It is important to compile typical species lists consistently per sub-region/biogeographical region, to allow for the consistent assessment of state/condition.

Typical species composition includes both macrozoobenthos and macrophytes, depending on the type of habitat (i.e. macrophytes do not occur in deep aphotic waters).

This indicator should be implemented as a state condition indicator by using a list of typical species in the communities of different habitats.

Parameter/metric

The selection of the relevant parameters and the development of metrics strongly depend on the selected habitat. It should be highlighted that natural variability in species composition in space and time must be considered when further developing the indicator.

For this state/condition indicator, a simple species list per habitat serves as an appropriate parameter. Species inventories differ locally, even if the habitat is similar. Therefore, the list of typical (and possibly characteristic) species must be defined per habitat type in particular geographic areas (bioregion). This list should be updated every six years.

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

Monitoring requirements

Typical species have already been identified by several Contracting Parties for listed habitat types to fulfill the assessment requirements under the Habitats Directive. Additionally, the coastal area out to 1 nautical mile offshore has already been 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 efforts and has been assessed using appropriate metrics. Consequently, in 2009, the Meeting of UNEP/MAP 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 of certain regions, development work may be 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.

Spatial scope

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

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. The use of past state may be more appropriate, as the definition of a reference state of Mediterranean Sea habitats may be problematic.

Setting of GES boundaries / targets

The general target is to reach a ratio of typical and/or characteristic species similar to baseline conditions as defined above, for all considered communities. Within this process, an “acceptable deviation” from baseline conditions would need to be defined. This deviation 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 adjusted to take into account the sampling effort and methodology used (e.g. video, grab). Therefore, it is important that exact descriptions of the used methodologies are provided to ensure comparability and reproducibility. In addition, to verify comparability, biogeographic regions with common species compositions in same habitats must be identified in advance.

5.2.2 Cost efficiency

The list of required resources includes:

- Research vessels, suited to work from sublittoral to bathyal zones, depending on subregion;
- Adequate equipment (box core samplers, grabs, dredges, underwater camera systems, etc.) for sample collection from intertidal to bathyal zones;
- Laboratory infrastructure to analyse samples (e.g. microscopes, weighing scales).

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

5.2.3. Further work

The following steps are essential for operationalization:

- Identify the species lists of existing Contracting Parties and check for consistency within biogeographical regions and follow-up on the recommendations of UNEP/DEPI/MED WG.342/3 on the application of metrics developed and tested under the Water Framework Directive for use by all Contracting Parties;
- Identify typical and characteristic species for remaining habitats/biogeographical regions, and re-evaluate species lists in six-year periods;
- Identify/define baselines for habitats and biogeographical regions;
- Clear description of required sampling methodologies and effort

5.2.4. Special considerations for 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 change. Seagrasses are key components of coastal marine and coastal ecosystems and many monitoring programmes worldwide assess seagrass health an 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 (**MED GIG**), while two indices have also been based on macroalgae and compared in the framework of MED GIG. Already in 2009, the Meeting of UNEP/MAP 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, sampled species or communities are sorted into disturbance- sensitive classes.

Most 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 MED GIG 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 EcAp Integrated Monitoring nad Assessment. They focus on coastal habitats and on indicating eutrophication, micro-pollutants and dredging/dumping as key pressures The latter in combination with the assessment of species abundance provides a quantitative and targeted assessment of habitat condition linked to pressures in relation to a qualitative assessment through the typical species composition, while the establishment of such a typical species list, is required, as mentioned, to establish the basis for the assessment of benthic biotic indices for macroalgae and macro-zoobenthos. Table 1 shows a summary description of the existing (mostly MED GIG) Mediterranean benthic biotic indices.

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 2, not an exhaustive list, under point 5.2.2, 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. 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.

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.

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.

Setting of Baseline and GES boundaries

For baseline setting the reference state, with negligible impacts is recommended.

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

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.
- Good taxonomy skills are essential for the adequate assessment of this indicator

Specific further work needed for elaborating Benthic Biotic Indices

Table 1 of point 5.2.4. as the basis for further work

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	*B*orja 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, Malta
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. Classification scheme with 5 quality classes	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)

The following steps are essential for further 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 judgment.
3. Clear description of required sampling methodologies and effort afterwards, the final operationalization should include identification/definition of baselines for the respective habitats and biogeographical regions;

Table 2 of 5.2.4. Summary Description of the existing Med (mostly WFD) benthic biotic indices

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, Malta
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, Malta

5.2.5. Special considerations in relation to 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 under 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 1 of 5.2.5: Proposed plankton life-forms

<table>
<tr><th></th><th colspan="2">Lifeforms</th><th colspan="2">Lifeforms</th><th colspan="2">Lifeforms</th></tr>
<tr><td></td><td>Diatoms</td><td>Dinoflagellates</td><td>Large copepods</td><td>Small copepods</td><td>Holoplankton</td><td>Meroplankton</td></tr>
<tr><td>Reasoning:</td><td colspan="2">Shift in algal community composition towards less trophically useful, potentially harmful groups</td><td colspan="2">Shift in size of secondary producers/primary grazers could have food web impacts</td><td colspan="2">Benthic-pelagic coupling</td></tr>
<tr><td>Pressure(s):</td><td colspan="2">Nutrient run off (point or non-point), hydrological changes, aquaculture, warm water outflows</td><td colspan="2">Fishing</td><td colspan="2">Fishing (including pressure on benthos from trawling), nutrients</td></tr>
</table>

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
Frequency 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.

5.2.6. Special considerations in relation to assessing the changes in plankton functional types

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.

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.

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.

5.2.7 Further work needs in relation to assessing the changes in plankton functional types

- A regional workshop to investigate the applicability of the methodology in the Mediterranean would be appropriate;
- 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;
- 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. However, until funding is available for this, the indicator can still inform an assessment of GES for regions with adequate data collection;
- Some groups are under-sampled with lots of data missing: microphyto, pico, nano and bacteria and micro zooplankton including ciliates. A link to pressures effects should justify the need for their inclusion;
- New pairs can be developed as indicators for other pressures, habitats and pelagic compartment (bacteria, virus), as the knowledge base increases.

5.3. Elaborating species distributional range (Common indicator 3: Species distributional range)

5.3.1. Introduction

In biology, the range of a given species is the geographical area in which that occurs (i.e. the maximum extent). A commonly used representation of the total areal extent (i.e. the range) of a species is a range map (with dispersion being shown by variation in local population densities within that range). Species distribution is represented the spatial arrangement of individuals of a given species within a geographical area.

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

5.3.2. Monitoring strategy and framework

The distributional range of a species is an important indicator that may be obtained through the geo-referencing species observations, assuming objective techniques are used.

However, the extent 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 knowledge about the locations used by these species is not always complete, with major gaps existing for other associated information. Even some of the most important programmes on this topic have significant gaps (e.g. Global databases do not reflect actual current knowledge in the Mediterranean region (Fig 1 of 4.3.2).

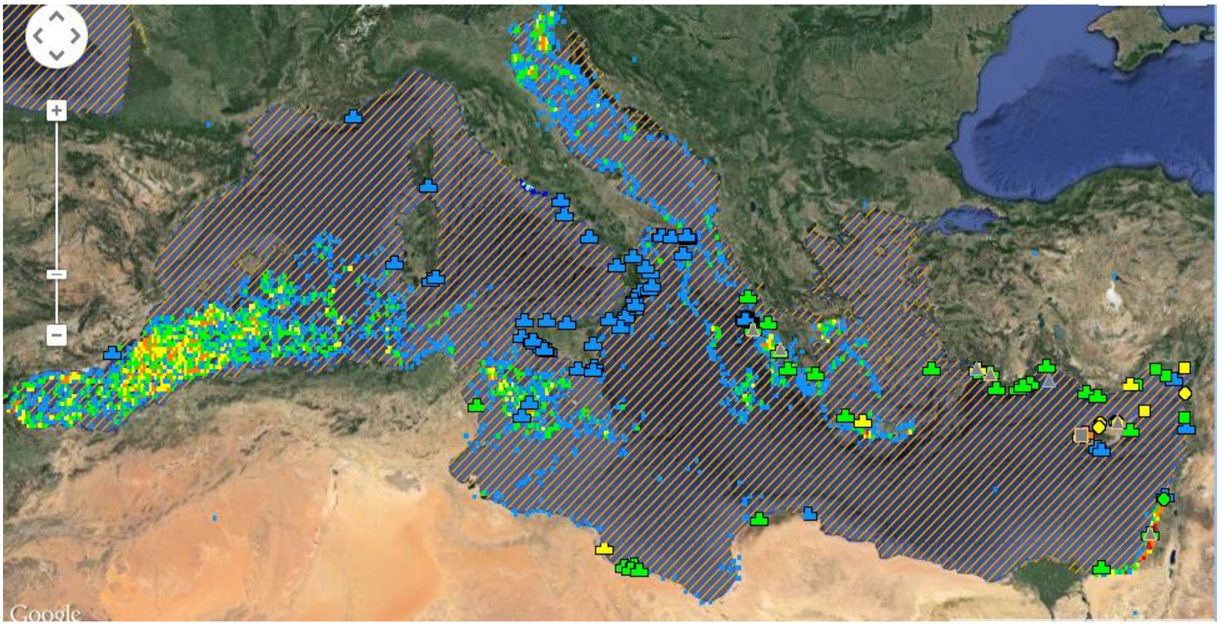

Fig 1 of 5.3.2.: Image from OBIS-SEAMAP: State of the World's Sea Turtle (SWOT). The image presents an example for sea turtles, showing satellite tracking data (dots), nesting sites and genetic sampling sites (shapes) that have been voluntarily submitted to the platform by data holders. Many datasets are missing, including several known nesting sites and a considerable amount of satellite tracking from the eastern, central and western Mediterranean (over 195 routes have been published, and many remain unpublished; Luschi & Casale 2014, Italian Journal of Zoology 81(4): 478-495). The distribution range (lines) of the three sea turtles species present in the Mediterranean encompasses the entire basin. Big gaps exist; yet, this is the only information currently available in the form of an online database and mapping application.

It is therefore necessary to establish minimum information standards to reflect the known distribution of all selected species.
Species distribution ranges can be gauged at local (i.e. within a small area like a national park) or regional (i.e. across the entire Mediterranean basin) scales using a variety of approachest

General species distribution range:

Given the breadth of the Mediterranean, it is not feasible to obtain adequate information about the entire surface (plus, the marine environment is 3 dimensional, with many vertebrate species only being present at the surface briefly to breathe, e.g. sea turtles), so it is necessary to choose sampling methods that allow adequate knowledge of the distribution range of each species. Such sampling involves high effort for areas that have not been fully surveyed to date. Monitoring effort should be long term and should cover all seasons to ensure that the information obtained is as complete as possible.

Dedicated ships or aerial surveys:

Dedicated ship or aerial surveys (including the use of drones) are conducted by performing linear transects with qualified observers following a rigorous protocol. Two types of sampling strategies are proposed: in coastal (neritic) waters and in oceanic (pelagic) waters. Coastal transects consistently cover the same area of coastline uniformly, while pelagic transects are more variable, but will be generally straight and perpendicular to coast. However, both types of transects must be corrected for the likelihood of observing surfacing animals, according to species. For instance, sea turtles are much smaller (particularly juveniles) and spend less time at the surface than sea birds or mammals. Furthermore, animals are more likely to be sighted in shallow waters (<10 m depth) versus deeper waters. All of these issues need to be incorporated into the survey techniques and subsequent extrapolation/analyses. Drones have the additional benefit in that they can fly low over the water surface and can operate in areas that cannot be accessed by planes. In addition they are cheaper and safer, with less effort being required for data collection. The use of drones to monitor sea turtles populations is currently being developed, with specific protocols being required, along with the need to statistically model population size based on the numbers of individuals at the surface during surveys.

When cetaceans, seals, seabirds or sea turtles are located, the species, position, number of individuals and social structure are documented in as much detail as possible/conditions allow. For certain species, it may be necessary to interrupt surveys to confirm these parameters.

Aerial surveys should be conducted at specified altitudes (ranging from 600 to 1000 ft., approx. 200 to 330 m, depending on target species) and 100 knots or less, 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 are not effective at locating and identifying smaller seabirds (Lesser tern, Gull-billed tern or Sandwich tern) or shearwaters and are only effective for sea turtles at shallow sites where they may be observed under the water surface as well as when surfacing (drones may also prove highly effective here). For sea turtles, aerial surveys should be conducted at the peak of the nesting season (around mid-July in the Mediterranean) to locate tracks on previously unidentified nesting beaches.

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

<u>By-catch data:</u>

Many research projects focus on collecting by-catch data for sea turtles , cetaceans and sea birds, with researchers being present on-board vessels to document this information throughout the Mediterranean. Such studies provide information on mortality caused by bycatch, as well as the numbers of live animals that are captured and released. Such work provides an opportunity to collect information about animal morphometrics (e.g. size class, sex etc), population dynamics (including abundance and sex ratios), as well as movement (through capture-mark-recapture of individuals). Such studies are considered low cost and highly effective at obtaining information about animals in deep ocean waters. Monitoring of EO1 sea turtle indicators/GES/targets (i.e. distributional range - feeding, wintering, breeding, migratory, developmental sites) could be facilitated by monitoring to be implemented by GFCM under EO3 (Harvest of commercially exploited fish and shellfish), by documenting live/dead captures by incidental catch, as well as collecting morphometric and demographic data on sea turtles.

PROS:	Medium life-span (from day to decade) Medium range (from kilometre to thousands of kilometres) Low cost

[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.

CONS:	Quality and reliability of the observations Restrictions in space and time, but obtains comprehensive information in open seas

Beached and stranded specimens monitoring:

Creating a network of strandings and beached individual census' to obtain important information, usually with the help of volunteers and officials. This is a good indicator of seabirds after storms. It is also a good indicator for the presence/absence of cetaceans, seals and dolphins in different geographical regions. Dedicated stranding networks already exist for sea turtles/marine mamals in several Mediterranean countries, with stranding information being confirmed to reflect distribution patterns based on satellite telemetry studies. Sea turtle strandings represent a useful index of population abundance and can be used if data are approrpiately collected and standardized. Specific tracts of coast can be selected as index zones for this purpose, or coastlines may be opportunisitcally surveyed with the assistance of the general public.

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

Opportunistic data:

Opportunistic data may be obtained from whale-watching observations, fisheries sightings (logbooks), surveys on non-dedicated platforms (ferries, merchant marine ships or amateurs/yachts, use of citizen science), by-catch data (where dedicated research programs do not exist, for sea turtles and shearwaters in long-lines and other types of fishing gear, and small cetaceans in fishing various types of fishing gear). However, location (i.e. compass or GPS) information may not always be provided in sufficient detail.

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 (capture-mark-recapture – artificial tags & photo-identification):

In many populations animals are given individual markers (i.e. metal/plastic tag) or are subject to ongoing photo identification programs. This information allows the dispersal of animals in a population to be determined, especially if injured tagged animals are found at distant locations (for sea turtles, satellite telemetry has confirmed the distribution range inferred from retrieved tags for one sea turtle population). Sometimes, this is the only way to obtain the information necessary to determine the distribution, abundance and population demographic of a species. Thus, marking key populations is useful, but the effectiveness of marking programs must be regularly re-evaluated (so as not to tag animals/populations endlessly without producing valuable information). The method used depends on the objectives and species. Recapture may be synonym of resighting marked animals.

Photo-identification is being increasingly used for the non invasive natural identification of cetaceans and sea turtles; thus, a photographic database for whales, dolphins and sea turtles could be established, or existing ones strengthened, allowing anyone in the Mediterranean to upload photos and the position that the animal was sighted. This could involve citizen science, such as tourists at coastal sites, people travelling on yachts, ships, fishing boats, etc. Such a system could help fill in the gaps where information about species presence/absence remains limited in the Mediterranean.

PROS:	Long life-span (from hour to decade) Wide range (from meters to few thousands of kilometres) Provide other data Cheap (articifical plastic/metal tags or photo id) Large sample sizes, and across sexes/age classes for photo-id
CONS:	Basic training required (tag application, photo identification) data analysis costs associated with identification of individuals for phot identification Low effort recording resightings of tags; slightly higher effort required for photo id databases, although automated systems have made this much easier Tagging primarily limited to females on nesting beaches for sea turtles but can be extended to males via by-catch/in-water surveys; includes a better cross section of the population for birds.

Telemetry:

Satellite tracking, GPS/GSM tracking, radio tracking and the use of loggers.

The method of capturing and attaching transmitters/loggers to animals depends on the objectives and species. Radio tracking is effective to obtain movement information at a known site used by individuals, but not movement over long distances. Satellite tracking provides detailed information about the movements of individuals within a population, including breeding area use before and during mating/nesting, clutch frequency of individuals (i.e. number of nests laid by specific individuals), internesting period (duration between each nesting event), date of departure from breeding grounds, migration distance and time, idenitification of foraging and wintering sites, wintering/foraging site fidelity and/or the use of multiple sites, remigration intervals to breed (1-2 years in males and 1-3+ years for females, depending on foraging site and animal condition), residency at breeding sites, prospecting of alternative (possibly future under climate change) nesting sites. However, many individuals (>50) need to be tracked to obtain population level inferences about distributional area use (home range), with this technique being very expensive. Also, it is not possible to place transmitters on many smaller animals, due to weight issues.

PROS:	Long life-span (from hour to decade) Wide range (from meters to few thousands of kilometres)

	Provide other data
CONS:	Very expensive (radio and satellite telemetry) – Human effort, tracking effort, transmitter running costs etc. Need experience attaching units and an understanding of the technology involved Requires great effort (data analysis requires statistical competence and need high qualification) Small sample sizes

<u>Acoustic data collection:</u>

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

- Mating and breeding areas: Colonies and areas where the target species reproduce (caves, beaches, coastal marshes and cliffs, etc.);
- Wintering areas: areas where the target species overwinter and
- Feeding areas: areas where the target species feed.
- Developmental areas (where juveniles may forage/overwinter in different locations to adults, as occurs in sea turtles).

When such locations are found, animals may be counted from vantage points or through the use of ships, planes or drones..

However, for many species visual detection is not possible; for instance, shearwaters nest in burrows or crevices and so cannot be directly observed. The census of shearwater males in the breeding season is fairly precise (because it avoids the confusion of burrows occupied by other species) and is much faster.

In comparison, the size of breeding sea turtle populations is inferred from the tracks and nests made by female sea turtles on nesting beaches. Aerial surveys, drones and foot surveys can be used to locate previously unidentified sea turtle breeding beaches, with the best time of year being at peak breeding season (i.e. mid-July in the Mediterranean). However, surveys of tracks only account for the female component of sea turtle populations, not the adult male or juvenile stages, which should also receive dedicated monitoring attention, as the numbers of males and/or numbers of offspring have huge impacts on sea turtle population demography.

To date, all breeding, foraging, wintering and developmental areas of marine species have not been identified in the Mediterranean. The location of many bird colonies[14], sea turtle nesting beaches and breeding seal caves, as well as their wintering, feeding and developmental areas, may be achieved by checking existing bibliographic information, surveys by 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 in species distributions.

Distributional range data requires geographical information system (GIS) analysis. Standardized 10 x10 km grids should be used to compare all information and obtain overall distributional ranges.

5.3.3. Assessing species distributional range

Based on the operational objective of this common indicator, the assessment should focus on whether species distribution is maintained or not, with the following possible assessment methods being implemented:

- For breeding area ranges, annual comparisons should be made with an emphasis on new or disappearing colonies (range trends in grids), noting existing reference methods, such as the Marine e-Atlas developed by the Fame Project and the Protocols of the Spanish Cetacean Society;
- For wintering areas, annual comparisons should be made on range trends in grids, noting existing reference methods, such as Atlas developed byBirdLife International and the Protocols of the Spanish Cetacean Society;
- For feeding areas, annual comparisons should be made on range trends in grids, noting available reference methods, such as those of BirdLife International and the Protocols of the Spanish Cetacean Society.

5.4. Determining population abundance (Common indicator 4: Population abundance of selected species)

5.4.1. Introduction

Measurements of biological diversity are often used as indicators of ecosystem functioning, as several components of biological diversity define ecosystem functioning, including richness and variety, distribution and abundance. Abundance is a parameter of population demographics, and is critical for determining the growth or decline of a population. Key terms include:

<u>Population Size</u>**:**

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[14] Breeding colonies are generally well known in western Mediterranean, but with different time-scale depending on the species, countries, etc

The most fundamental demographic parameter is the number of individuals within a population. Population size is defined as the number of individuals present in an animal aggregation (permanent or transient) in a subjectively designated geographical range.

Population size is defined as the number of individuals belonging to a population designed on the basis of biological parameters. While for some species/populations the geographical range can be easily defined, for other high vagile species it may be not be possible. For species/populations with highly dispersed distributions across broad populations, it may be appropriate to estimate population size for different stage classes independently, e.g. for sea turtles: adults at breeding, foraging and wintering grounds; juveniles at developmental/foraging grounds; and numbers of clutches (from which offspring are produced) on nesting beaches.

Population density:

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

5.4.2. Monitoring strategy and framework

Studies of population abundance and dynamics are based on knowledge about population size and how it varies over time. If a population is small, all individuals may be counted directly; however, most studies must estimate population size by sampling.

The objective of this indicator is to determine the population status of selected species by medium-long term monitoring to obtain population trends for these species. This objective requires a census to be conducted in breeding, migratory, wintering, developmental and feeding areas.

Breeding areas census (rookeries or whelping events):

Once breeding areas have been identified, it is possible to obtain counts (individuals, pairs, nests, whelping sites, etc.) during the most appropriate period. The method used depends on the species and their characteristics. Counting the number of nests or crawls during the early morning is used to infer the number of females in a seasonal sea turtle breeding population, but does not provide information on the number of males present. Camera traps in caves are recommended for seals. Species that breed on cliffs should be monitored from boats.

Wintering areas census: To determine the state of populations during the winter, it is necessary to use a standardized sampling method (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. For sea turtles, wintering areas of adults (but not juveniles) could be identified from existing and new satellite tracking studies, allowing focused effort at these sites. However, as wintering turtles surface less frequently than during breeding or foraging, underwater survey techniques may need to be developed. In addition, for sea turtles, juvenile wintering grounds are not necessarily in the same location as those of adults; therefore, dedicated surveys of areas used by juvenile life stages are also required.

Foraging census: Once identified, individuals in feeding areas are counted at different periods throughout the year. For most species, feeding areas may be located by aerial surveys, bycatch data, telemetry data and the study of the distribution of prey species (FAO[15]). For sea turtles, direct counts at foraging areas may require the development of underwater techniques, due to their low surfacing frequency. This would be particularly important in major feeding areas that are not coastal, such as in

[15] www.fao.org

the central Adriatic, Gulf of Gabes, etc. In addition, for sea turtles, juvenile foraging grounds are not necessarily in the same location as those of adults; therefore, dedicated surveys of areas used by juvenile life stages are also required.

Coordinated census from land: For birds and cetaceans, volunteer observers and ornithologists could be organised to document resident/migratory wildlife at different observation points with standardized protocols, with established programs existing since the 1970s in several countries. These observers collect information about species, phenology, distribution, relative abundance and migratory behaviour. However, it is only applicable to monitoring sea turtles in marine nearshore areas backed with cliffs and where they are known to aggregate; thus, only certain information could be gathered. Since the 1970s, this bird watching methodology has become established in several countries that follow the same protocols, through a network of birdwatchers and observers of marine mammals

Migration monitoring: In addition to land census', and to account for the migration step, it is important to select the best points for Mediterranean bird migration passage and to apply a standardized methodology, as carried out in the Strait of Gibraltar by the MIGRES programme[16]. This technique could be extended to cetaceans and seabirds. It would probably be more difficult to apply to sea turtles; however, opportunistic sightings may be made of resident/passing turtles, which could be followed up in areas where turtles have not previously been documented from stranding/tracking studies. In addition, radar and remote cameras could be used for the automated monitoring of migratory birds.

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 marine animal phenology. These techniques may be used for sea turtles; however, due to their small size (particularly for juvenile stages) and brief surfacing time, the appropriate statistical analyses would be required to assess the collected data objectively. These techniques are best applied in shallow areas where sea turtles are known to aggregate and where they could be detected underwater too.

Dedicated ships or aerial (including drones) surveys: Linear transects conducted by qualified observers with a rigorous protocol on dedicated ships and aircraft. Two types of sampling techniques are proposed: in coastal (neritic) waters and in remote oceanic (pelagic) waters. Coastal transects consistently cover the same area of coastline uniformly (but transects linking caves along the coastline would be selected for monk seal boat surveys), while pelagic surveys would be variable, but generally straight and perpendicular to the coast.

When cetaceans, seabirds or sea turtles are located, as much information is recorded as possible about the species, position, number of individuals and social structure. See section 5.3.2 (Distribution) for descriptions of techniques, examples and possible limitations for the various species. 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 the peak breeding season (September-October), when most females and attending males pass a sizeable time at the caves and nearby surroundings.

Platforms-of-opportunity (POP) surveys: Trained observers would be placed on host ships and aircraft to survey remote pelagic waters. In such cases, data must be extrapolated to infer trends in abundance, as sightings become opportunistic.

Acoustic data collection: See section 4.3.2 (Distribution) for information on this technique.

Opportunistic data (sightings): See section 4.3.2 (Distribution) for information on this technique.

[16] www.fundacionmigres.org

Beached and stranded specimens monitoring: See section 4.3.2 (Distribution) for information on this technique.

Tagging (capture-mark-recapture – artificial tags & photo-identification) and telemetry: See section

5.4.3 (Distribution) for information on this technique.

Species specific techniques:

Seals: satellite tracking, photo-identification of whisker patterns, scars and body patches, artificial tags

Seabirds: satellite tracking, artificial rings and bands

Cetaceans: satellite tracking, photo-identification of notches and scars

Sea turtles: telemetry (satellite, GPS/GSM, radio), artificial flipper tags, PIT tags, photo-identification (facial scute patterns, notches and scars). Epibionts should not be used, as they can fall off after very short periods.

5.4.4. Summary and Evaluation

All proposed abundance monitoring methods are complementary, so that adequate information for the 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 animal rookeries or whelping events	Good and very important information Most accessible index for certain species (e.g. sea turtles) providing key information.	Sometimes access is very difficult (i.e. for seals) or all sites are not known (i.e. sea turtles) or all parts of the population are not included (e.g. sea turtle males and juveniles at breeding sites)
Census of wintering areas	Good information Essential index to provide complete population information for certain species with segregation of age classes (e.g. sea turtles)	Need good coordination Difficult Not all sites are known for many species; for instance, for sea turtles, most sites have been identified by tracking, with many sites existing along the continental shelf, making focal studies difficult
Foraging census	Important information for fisheries impact control	Difficult For sea turtles, the same applies as for wintering areas
Developmental habitat census	Important information for fisheries impact control	Difficult For sea turtles, the same applies as for wintering areas
Coordinated coastal census from land	Participation of volunteers Useful information Easy to apply for certain animal groups:Seabirds and cetaceans	Partial information Volunteers and data coordination This is only viable for certain types of surveys for sea turtles at limited coastal locations backed by cliffs where animals aggregate

Name	Pro / Importance	Cons
Migration monitoring	Important information for: Seabirds and cetaceans Possible for sea turtles but only using satellite telemetry, which produces precise information	Partial information Training of technicians Expensive telemetry technology
Ship and aerial surveys, including drones	Good data Useful information Medium life-span Medium range Not-survey dedicated platform Drones may represent a low cost and highly repeatable technique, replacing plane/helicopter based aerial surveys for data collection	Need of boats and planes Very expensive Need high qualification and training Sea conditions make sighting difficult for certain species that do not surface regularly, like sea turtles
Beached and stranded specimens monitoring	Participation of volunteers Useful information Targeting seabirds after storms Networks for sea turtles already exist in several countries	Partial information Volunteers and data coordination Requires monitoring networks and centralized databases
Tagging & photo identification: capture-mark-recapture	Very precise information Medium-high life-span Wide range Large sample Photo-ID of cetaceans & sea turtles is cheap and with citizen-science involvement	Training Requirements Requires some basic technology Low cost Partial information – tags sometimes fall off quite quickly, preventing long term 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, which must be decided when a monitoring strategy is defined. The sites that are selected and the methods use may influence the monitoring outputs. Monitoring programmes are not compatible or comparable if they use different site selection strategies (e.g. deterministic or random selection of transects), even when the same survey methods are used.

The principles for the site selection strategy are described in many handbooks on statistics and monitoring. At 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 a trend, the variation among replicates, and the number of replicates.

5.4.5. Assessing the population abundance of selected species

Based on the operational objective of this common indicator, the overall aim is to assess whether the population size of selected species is maintained or not, the proposed assessment method is based on trend monitoring, assissing change in the following data:

- Census' of rookeries and whelping events involve identifying the number of females (for seals, number of cubs in a cave; for turtles, number of nests or females or adult breeders) (this method fails to take into account the number of males in a population)
- Population census' in wintering areas involve identifying the number of individuals present;
- Population census' in foraging areas involve identifying the number of individuals present;
- Migration counts of the number of migrating individuals.

The second and third items are difficult to achieve for sea turtles due to their short surfacing times and long submergence times, unless in-water monitoring or by-catch monitoring or new techniques are developed and applied. The final item is also difficult to apply for sea turtles, unless individuals receive satellite transmitters.

5.5. Elaborating population demographic characteristics (Common Indicator 5 on 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)

5.5.1. Introduction

Demography is the study of various population parameters. Demography provides a mathematical description of how such parameters change over time. Demographics may 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. Demography information:

- helps to identify the stage(s) in the life cycle that affect(s) most population growth.
- may be applied to conservation/exploitation (e.g. fisheries management).
- may be used to assess potential competitive abilities, colonization.
- may be used as a basis for understanding the evolution of life history traits.
- may be used to indicate fitness with respect to the surrounding environment

5.5.2. Monitoring strategy and framework

Demographic parameters are used to describe the status of wildlife populations. Thus, the same methods should be used to count populations; however, certain additional information is required, such as age at sexual maturity, growth rate and age structure, fecundity (birth rates), mortality (death rates) for each stage/age class, sex ratios (in turtles: hatchling, juveniles, and adults), number of offspring (e.g. calves, chicks or eggs).

Life history studies and demographic analyses need extensive and, often, long-term data accumulation from either carcass collection or capture-mark-regapture (tagging or photo-id) histories, or a combination of several different techniques. In general, these studies may be implemented by different research teams that use different sampling and analyzing processes. However, demographic parameters must be collected in a standard way among different research groups.

Stranding and beached individual census' (see section 4.4.2.) provide important information about demography through biometrics, tissue sampling and analysis (necropsies or biopsies). Such studies may determine the cause of mortality, contamination, age, sex, , health and size measurement. Live and (fresh) dead animals that are captured/located should be subjected to a standardised program to confirm sex (laporoscopy where necessary, e.g. non-adult stages of sea turtles), collect blood, skin and tissue samples for genetic analyses and determine the health and presence of any contaminants in animals, along with other micro-biological techniques. Such information would help determine the genetic diversity of different animal groups and their general health. In fact, the animals could be used as indicators of ocean health due to the effects of toxins building in the bodies of animals from higher trophic classes. For sea turtles it can be a useful source of information depending on sample size and the extent of coastline covered, although specific tracts of coast can be selected as index/sampling zones.

Biometrics**:**

Body size in cetaceans, seals and sea turtles can be indicative of the health status or age structure of populations. For sea turtles, tail length may be used as an indicator of sex.

Measurement of seals, cetaceans, seabirds and sea turtle body size is achieved by a combination of :

Estimates made from photos.

Measurement of stranded specimens.

Measurement in case of capture-recapture.

For turtles, also, measurements of females during nesting on beaches, or of all size classes during capture at inwater or by-catch surveys at breeding/foraging/wintering/developmental grounds, which also allows indivduals to be sexed.

Age structure:

Individuals could be sorted into age-specific categories called cohorts or age/stage classes (such as "juveniles" or "sub-adults"). Then, a profile of the abundance and different age classes canbe created. The demographic structure may provide an estimate of the annual survival probability and/or reproductive potential of that population, which is critical information along with other paramenters, from which current and future growth may be estimated.

- Age class identification in census' and transects.
- Aging of stranded specimens (cetaceans, seal and sea turtles): teeth analysis in seals and cetaceans, skeletochronology in sea turtles, age-size correlation for certain species.
- Aging of beached specimens (seabirds): moult and plumage.

Aging of tagged (capture and recapture) specimens: teeth analysis in seals and cetaceans, size correlation for sea turtles.

Sex ratio:

The sex ratio is the ratio between the number of males and females within a population and across all age (size) classes, and may 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.
- Sexing of stranded specimens (cetaceans, seals and adult sea turtles): size, dimorphism, genetic analysis.
- Sexing of beached specimens sexing (seabirds): dimorphism, genetic analysis.
- Sexing of tagged (capture and recapture) specimens: size, dimorphism, genetic analysis.
- Sexing of offspring before leaving the nest, and at different growth stages until maturity

Fecundity (birth rates):

This parameter 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.

For sea turtles, the ability of females to create nests also serves as an indicator of female fitness; thus, the number of emergences versus successful nests also represents an important indicator.

Mortality (death rates):

This parameter is the measure of individual deaths in a population and serves as the counterbalance to fecundity, and is usually expressed as the number of individuals that die in a given period (deaths per unit time) or the proportion of the population or an age-class group that dies in a given period (percent deaths per unit time). The parameter should also give an indication on the type of mortamity if it is natural, due to fishing or bycatch etc…

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

5.5.3 Summary of further work for Common Indicators 5.3-5.5 in relation to sea turtles, marine mammals and marine birds:

- Generate or update databases and maps of known nesting, feeding, wintering habitats in each Contracting Party
- Identify possible baselines and index sites.
- Identify monitoring capacities and gaps in each Contracting Party
- Develop a guidance manual to support the monitoring programme, which will provide more detailed information, tools, and advice on survey design, monitoring methodology and techniques that are most cost-effective and applicable to each of the selected sea turtle species, in order to ultimately ensure standardised monitoring, comparable data sets, reliable estimates and trend information.
- Identify techniques to monitor and assess the impacts of climate change.
- Develop monitoring synergies in collaboration with GFCM for- EO3 (Harvest of commercially exploited fish and shellfish), to collect data via sea turtle by-catch
- Investigate monitoring synergies with other relevant EOs that will include coast-based fieldwork, in relation to monitoring of new/unknown sea turtle nesting beaches, and of beached/stranded animals, to obtain more widespread information.

III. MONITORING AND ASSESSMENT METHODLOGICAL GUIDANCE ON EO2: NON-INDIGENOUS SPECIES

1. Introduction

1.1. Definition of key terms

Non-indigenous species (NIS; synonyms: alien, exotic, non-native, allochthonous) are species, subspecies or lower taxa introduced outside of their natural range (past or present) and outside of their natural dispersal potential. This includes any part, gamete or propagule of such species that might survive and subsequently reproduce. Their presence in the given region is due to intentional or unintentional introduction resulting from human activities. Natural shifts in distribution ranges (e.g. due to climate change or dispersal by ocean currents) do not qualify a species as a NIS. However, secondary introductions of NIS from the area(s) of their first arrival could occur without human involvement due to spread by natural means.

Invasive alien species (IAS) are a subset of established NIS which have spread, are spreading or have demonstrated their potential to spread elsewhere, and have an effect on biological diversity and ecosystem functioning (by competing with and on some occasions replacing native species), socio-economic values and/or human health in invaded regions. Species of unknown origin which cannot be ascribed as being native or alien are termed cryptogenic species. They also may demonstrate invasive characteristics and should be included in IAS assessments.

1.2. Invasive species in the Mediterranean

Marine invasive species are regarded as one of the main causes of biodiversity loss in the Mediterranean (Galil, 2007; Coll et al., 2010), potentially modifying all aspects of marine and other aquatic ecosystems. They represent a growing problem due to the unprecedented rate of their introduction (Zenetos et al., 2010) and the unexpected and harmful impacts that they have on the environment, economy and human health (Galil, 2008). This is a general phenomenon that extends to all regions of the Mediterranean (Galil, 2007, Galil et al., 2009; Zenetos et al., 2010). That is why invasive species are considered ‘focal species’ and should be monitored in all regions (Pomeroy et al., 2004). According to the latest regional reviews, more than 6% of the marine species in the Mediterranean are now considered non-native species as around 1000 alien marine species having been identified (Zenetos et al., 2012), while their number is increasing at a rate of one new record every 2 weeks (Zenetos et al., 2012). Of these species, 13.5% are classified as being invasive in nature, with macrophytes (macroalgae and seagrasses) the dominant group in the western Mediterranean and Adriatic Sea, and polychaetes, crustaceans, molluscs and fishes in the eastern and central Mediterranean (Galil, et al., 2009; Zenetos et al., 2010; Zenetos et al., 2012). The vast majority of NIS in the Mediterranean occurs in the eastern Mediterranean; some are located exclusively in the south-eastern basin, others are restricted to the western basin, while others have colonized the entire Mediterranean.

Although invasive alien species may be responsible for high ecological impact in particular for reducing the population of some native species, some NIS, particularly crustaceans and fish have become an important fishery resource. The migration of Lessepsian (meaning through the Suez Canal) NIS appears to play an important role for fisheries, particularly in the Levantine basin.

1.2.1 Pathways of introduction of non-indigenous species in the Mediterranean Sea

According to the latest regional review (Zenetos et al., 2012) more than half (54%) of the marine NIS in the Mediterranean Sea were probably introduced via corridors (mainly the Suez Canal). Shipping is the second most common pathway of introduction, followed by aquaculture and aquarium trade.

The Suez Canal, as a pathway of NIS, is believed to be responsible for the introduction of 493 alien species into the Mediterranean, approximately 11% being invasive (55 species). However, only 270 of these species are definitely classified as Lessepsian immigrants. Of these 270 Lessepsian immigrants, 71 consist of casual records (based on one or two findings) while 175 are successfully established. 126 out of them (including 17 invasive ones) are limited to the Eastern Mediterranean sub-region, whereas the others are progressively spreading into the neighbouring Mediterranean sub-regions.

Shipping is identified directly for the introduction of 12 species only, whereas it is assumed to be the only pathway of introduction (via ballast or fouling) of a further 300 species. For approximately 100 species, shipping counts as a parallel possible pathway along with the Suez Canal or aquaculture.

About 20 NIS have been introduced with certainty via aquaculture, either as escapees of imported species, mostly molluscs, or associated as contaminants: parasites; epibionts; endobionts; or in the packing materials (sessile animals, macrophytes).

Aquarium trade, although currently limited to 2% of introductions, is gaining importance as a pathway of introduction. A total of 18 species are assumed to have been introduced by aquarium trade, the only certain case is that of *Caulerpa taxifolia*. With the exception of four species, for which aquarium trade is suspected to be a parallel mode of introduction, the remaining 13 species are all tropical fish species kept in marine aquaria. The most plausible explanation for their presence appears to be accidental release, though unaided introduction via the Suez Canal cannot be ruled out for those also occurring in the Red Sea.

The growth of marinas in many Mediterranean coastal areas in recent years could be providing a platform (hulls, chains, anchors, propellers, immersed sides of floating pontoon units, poles, immersed portions of floating structures supporting boardwalks) for the spread of NIS as these sites are closely associated with the movements of vessels (fishing or recreational boats) carrying alien species as hull fouling. Although antifouling paints help to control fouling, hulls are still an important means of transport for non-indigenous species.

NIS introduced via corridors (essentially the Suez Canal) are the majority in the Eastern Mediterranean sub-region, and their proportion declines towards the western basin. The reverse pattern is evidenced for ship-mediated species and for those introduced with aquaculture. Regarding those species linked to both the Suez Canal and to shipping some of these Indo-Pacific species might have actually been introduced by shipping and not by natural means via the Suez Canal but there is insufficient information. They constitute a considerable portion ranging from approximately 9% in the Eastern Mediterranean sub-region to approximately 6% in the Western Mediterranean sub-region.

1.2.2 Climate change effects on the spread of NIS in the Mediterranean Climate change is likely to affect the structure of marine communities and provide further opportunities for alien species to spread and out-compete native species. In general, many native and alien species are shifting their areas of distribution towards higher latitudes (CIESM, 2008). As the majority of NIS in the Mediterranean are thermophilic that originated in tropical seas of the Indo-Pacific, warming sea temperatures favour the introduction of more Red Sea species into the south-eastern Mediterranean and their spread northwards and westwards. Similarly, it will also assist the spread of species of (sub) tropical Atlantic origin into the western basin, although by definition such introductions via the Strait of Gibraltar do not count as non-indigenous species introductions.

2. Monitoring Strategy

2.1. Selection of monitoring locations

The monitoring of IAS generally should start on a localised scale, such as “hot-spots” and “stepping stone areas” for alien species introductions. Such areas include ports and their surrounding areas, docks, marinas, aquaculture installations, heated power plant effluents sites, offshore structures. Areas of special interest such as marine protected areas, lagoons etc. may be selected on a case by case basis, depending on the proximity to alien species introduction “hot spots”. The selection of the monitoring sites should therefore be based on a previous analysis of the most likely “entry” points of introductions and “hot spots” expected to contain elevated numbers of alien species. Pristine areas far from most likely NIS entry points could however be selected i.e. for those suspected to be at risk from recreational boating during the tourist season. New sampling sites may need to be considered according to future human and resource user activities in the sea. Table 1 shows an example of how data relating to different pathways could be used to quantify pathway intensity.

Monitoring at “hot-spots” for alien species would typically involve more intense monitoring effort, sampling at least once a year at ports and their wider area (ports and surrounding areas, docks, marinas, aquaculture installations, heated power plant effuents sites, offshore structures). The number of monitoring stations would also be expected to vary depending on the type of area of introductions (i.e. whether large ports and their immediate surroundings or aquaculture sites, offshore structures). Monitoring should preferably take place in the period of the year where most species would be expected to be present.

Regarding the spatial scope of monitoring, marine species, and especially invasive marine species, tend to have relatively large distributional ranges in comparison to terrestrial and fresh water species as there are less physical barriers in the marine environment that may limit their spread. Most species for example have a pelagic stage during which they can drift along with the sea currents over large distances. Monitoring the presence of marine non-indigenous species in for example a part of a sea port, will therefore provide a reasonably good indication of the species that are present in the whole port and adjacent waters. One can therefore obtain an overview of the non-indigenous species present at a large spatial scope, while only monitoring a relatively small number of locations.

Table 2.1. Indicative example of estimating the relative pathway intensity into locations (OSPAR 2014).

Pathway	**Data used to determine intensity of the different pathways.**		**Pathway intensity score formula.**	**Scale.**
Commercial Shipping	The total number of unique connections into ports within a grid square.	The total number of voyages into ports within a grid square.	Number of unique connections multiplied by number of voyages. E.g. if grid receives traffic from 10 different ports and receives in total 300 voyages, the likelihood of introduction score for that grid = 3000. It is however also necessary to have an understanding of the differences in volume of ballast water discharges	0-100.
Recreational Boating	The total number of potential recreational cruising routes into each grid square (present information)	The estimated intensity with which the cruising routes are used (present information).	The sum of the number of recreational cruising routes multiplied by the Intensity (where heavy intensity =3, medium intensity =2, low intensity =1). E.g. if there is 1 heavy intensity route, 4 medium intensity routes, and 5 light intensity routes into a grid square, the likelihood of introduction score for that square = (3*1)+(2*4)+(1*5)=16).	0-100
Aquaculture	The number of live imports into that grid (present information). The number of individual animals imported is not incorporated into the score.		Total number of imports.	0-100
Natural dispersal – ocean current (for secondary introductions of NIS from the area(s) of their first arrival)	For grid squares identified as being at increased risk of introduction of non- indigenous species by ocean current: proximity by sea from landmass where ocean current is flowing from.		Proximity to landmass *proximity to offshore platforms and buoy associated with oil and gas platforms * proximity to operating wind farms	0-100
Natural dispersal – offshore structures (for secondary introductions of NIS from the	Offshore structures (oil, gas and wind) in close proximity.		The total number of offshore structures in the coastal grid and the adjoining coastal grid	0 - 100

area(s) of their first arrival)			
Combined	Scaled risk scores for each individual pathway	Mean of scores for each pathway.	0-100

2.2. Deciding what to monitor

2.2.1 Creation and regular updating of a national database of invasive species

Each Contracting Party, if not having already embarked on the endeavor, would need to conduct survey(s) in order to create an initial list of NIS and particularly of invasive species existing in their marine waters, while preferably also monitor all cryptogenic species known in an area. The area of origin and a pathway account should as far as possible also be linked to the species identified as a measure of anthropogenic pressure. Ongoing surveys should list newly arrived NIS, IAS and cryptogenic species, along with newly colonised localities.

An important tool for deciding what species to target for monitoring, are already existing national, regional and international information networks and databases, notably for the Mediterranean the Marine Mediterranean Invasive Alien Species (MAMIAS[17]) database developed for RAC/SPA with information up to 2012. The “Andromeda” invasive species database for the Mediterranean and Black Sea is currently being developed under the PERSEUS[18] Project, to be operational by end of 2014. The European Alien Species Information Network (EASIN[19]) developed by the Joint Research Centre of the European Commission facilitates the exploration of non-indigenous species information in Europe (and the entire Mediterranean), from distributed resources through a network of interoperable web services, following internationally recognized standards and protocols. .

Risk assessing species to determine potential impact and risk of introduction is an important tool in developing policy and control programmes for invasive species. Within this mechanism risk assessments are conducted by independent experts and peer reviewed. From this process species can be assigned into one of four categories: high, moderate, low and unknown impact. It could be useful to prepare a risk matrix detailing the relative importance of invasive species traits for introduction mechanisms associated with key pathways. Risk assessment forms the basis of criteria for exemptions to ballast water treatment and therefore a cost efficient tool upon which to base monitoring requirements for NIS potential introductions through commercial shipping.

2.2.2. Collection of socioeconomic information

Important complementary information to the monitoring of invasive species will be the collection of data on socioeconomic factors linked to the pathways of invasive species introduction such as shipping traffic at major ports, recreational craft traffic at marinas, aquaculture production, aquarium trade statistics, etc.

2.3. NIS, IAS data collection method

It is recommended to use standard monitoring methods traditionally being used for marine biological surveys, including, but not limited to plankton, benthic and fouling studies described in relevant guidelines and manuals. However, specific approaches may be required to ensure that alien species are likely to be found, e.g. rocky shores, port areas and marinas, offshore areas and aquaculture areas. Further, it is important to consider sampling of different depths for e.g. plankton and use of appropriate methods for the sampling and storage of delicate organisms, such as jellyfish.

To be most cost efficient, existing monitoring and surveying programmes should be adapted, as appropriate:

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[17] http://www.mamias.org
[18] http://www.perseus-net.eu
[19] http://easin.jrc.ec.europa.eu/

- Make researchers aware of the problems caused by alien species and that aliens should be documented in monitoring efforts no matter for what reasons those were undertaken (e.g. monitoring studies required prior and after off shore installations, such as for wind farms and larger bridge constructions and previously completed port sampling programmes (e.g. CIESM PORTAL[20]).
- Using different methodologies at high priority sampling sites (hot spots, stepping stones)
- Consider more frequent sampling events to catch all life stages of NIS which may only occur during certain seasons.
- Not all taxonomic groups are addressed in ongoing monitoring efforts. For example the bathing water quality monitoring is focused on certain human pathogens. Possibly, these studies can broaden their scope also including non-indigenous disease agents, bacteria and viruses.
- Monitoring of marine protected areas could be adapted for bio-invasion assessments. (Otero et al., 2013).
- Consider the monitoring efforts of all other Ecological Objectives as appropriate.
- Consider scientific publications

Future monitoring programmes should always provide for documentation (i.e. voucher specimens, including samples for molecular investigations) of NIS/IAS and a standardization of sampling strategies and frequencies.

It is recommended that Contracting Parties make an inventory of existing marine biological monitoring programmes, surveys, and datasets which may be used (adapted) to report findings of IAS. Examples include:

- National and sub-regional databases, that should be eventually linked so that the spread of IAS can more easily be monitored;
- Fisheries data collection systems applicable in the region, in particular young fish and trawl survey data should be considered;
- Continuous Plankton Recorder surveys;
- Environmental Impact Assessment surveys (off shore oil terminals, ports, etc.);
- Areas of special interest, such as nature conservation sites e.g. MPAs monitoring;
- Consideration of dedicated working group reports, such as ICES and CIESM reports.
- Collected under the auspices/implementation of the IMO Ballast Water Management Convention.

Points of importance when setting up a monitoring protocol focusing on finding non-indigenous species (as adapted from OSPAR, 2013a):

- Involve taxonomists, typically working for or in close cooperation with natural history museums. These are scientists specialized in identifying and describing species. Identifying

[20] http://www.ciesm.org/marine/programs/portal.htm

non-indigenous species can be very difficult as these species may originate from anywhere worldwide. The involvement of "true" taxonomists is therefore very important;

- The number of samples that has to be taken in an area should be estimated based on the homogeneity of the species communities in that area. This can for example be done by the obligation that one needs to take/search through new samples until at least 90% of the species in that area are found. To check this, various statistical analytic methods exist with which the total species diversity in an area can be estimated on the basis of the species found in past samples taken;
- An assessment should preferably be made of the micro-habitats based on variations in salinity, substrate, wave-action, etc. that are present at a location, and to ascertain that an assessment of non-indigenous species is carried out in each of these habitats with the best available monitoring method (from a cost-benefit perspective). Hereby one should focus on scoring species of various trophic groups and life strategies including endofauna and epifauna, but also the species with a mainly pelagic occurrence;

2.3.1 Rapid Assessment Surveys (RAS)

As a complimentary measure and in the absence of an overall IAS targeted monitoring programme, rapid assessment studies may be undertaken, usually but not exclusively at marinas, jetties, fish farms (e.g. Minchin, 2007, Pedersen, 2005, Ashton et al., 2006).

An RAS is conducted by a team of marine species experts to identify both native and introduced species found at selected sites. The goal of an RAS is to make a quick assessment of introduced species present and use this information to document their distribution and collect environmental data.

A team of scientists, each with a different specialty in marine taxonomy, spend approximately one hour at the survey site and identify species. A site master records the scientists, findings and abundance of species at each site. Samples of specimens are usually taken back to the lab, where scientists spend several more hours, to confirm species identities. Water quality data such as salinity, dissolved oxygen content, and water temperature is also taken at every site. For online mapping purposes the longitude and latitude of the location is also taken.

RAS provide a baseline of species in fouling communities and, for those monitored over time, show the changes in introduced and cryptogenic populations versus the native populations. This allows scientists to analyze the spread of the species and predict future changes in the marine population. Such surveys assist management in controlling alien species. It may be possible to eliminate them when found at an early stage, reduce their rate of spread or develop techniques to mitigate effects to commercial interests.

Port studies, such as those undertaken in Australia, (Hewitt et al., 1999, Hewitt and Martin, 2001) involve a wide range of sampling techniques, including diving, and these surveys provide extensive accounts of both native and alien biota. However there is considerable effort involved in such surveys. The relative ease that species can be collected make the RAS approach time efficient. Although many of the species collected in such surveys have little recognizable impact, some invasive forms are readily identifiable (Minchin, 2007).

Rapid assessment can be further refined through developing a supplementary target list of invasive species not present in the country, or (sub) region, that could be sought in future surveys based on four criteria that include known invasiveness elsewhere, their presence with known vectors and whether these vectors are active. In a desk assessment, these species can be arranged according to relative risk of invasion (Hayes et al, 2002).

2.3.2. Citizen Science support to monitoring NIS

Detection gap generates biases in the observed spatial and temporal distribution of alien species and contributes to underestimating the dimension of marine bio-invasions, with obvious consequences for management. Due to the large work force needed to monitor expansive areas, citizen science is a vital component for the success of properly monitoring the spread of invasive species. Indeed members of local communities, because of their broad geographic distribution and familiarity with their natural environment, can be of great help to track invasive species in both terrestrial and aquatic systems (Delaney et al., 2008). Moreover the increasing use of inexpensive photo and video equipment is giving citizens unprecedented chances to provide real data and verifiable observations about the natural world. Volunteers are increasingly involved in environmental research and their role in monitoring biological invasions is rapidly expanding in the internet era. The creation and proliferation of ‘‘bio-blitzes’’, with volunteers gathering samples to be identified by scientists may trigger important synergies, generating public awareness and enhancing the exchange of information within the broad public, something that is another primary goal, in the field of invasion biology (Delaney et al., 2008). The compilation of citizen scientist input, validated by taxonomic experts, demonstrated the geographic expansion of more than twenty invasive species in Greece, while it provided information on four previously considered “casual” species known only from single records (Zenetos at al., 2013).

3. Monitoring to address Common Indicator 6:“Trends in abundance, temporal occurrence and spatial distribution of non- indigenous species, particularly invasive non indigenous species, notably in risk areas in relation to the main vectors and pathways of spreading of such species”

The February 2014 Integrated Correspondence Group on GES and Targets (Integrated CorGest) of the EcAp process of the Barcelona Convention selected the common indicator “Trends in the abundance, temporal occurrence and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas in relation to the main vectors and pathways of spreading of such species” from the integrated list of indicators adopted in the 18th Conference of the Parties (COP 18), as a basis of a common monitoring programme for the Mediterranean in relation to non-indigenous species.

3.1. Status of development

The trend indicator for non-indigenous species is considered to become operational when at least two years of relevant data on the parameters are made available. In the absence of relevant data, it is advised to use two years data collected after the development of the indicator.

3.2. Selection of parameter/metric

3.2.1 Abundance of non-indigenous species

Abundance of non-indigenous species may be considered to play a limited role in the calculation of the trend indicator for non-indigenous species. Abundance monitoring is relatively expensive. Effort, also from a cost benefit perspective, may be focused more on recording all local non-indigenous species, as this may be more targeted to NIS-goals for the trend indicator:

- ideally no new non-indigenous species are introduced, and
- ideally the number and composition of non-indigenous species remains at a level where only non-indigenous species that have already settled at a location are present, i.e. a reference level indicating that the number of non-indigenous species has remained the same in the period of three successive years i.e. the non-indigenous encountered species in the system appear to have settled for the “long-term”.

Assessment of abundance may be merited in cases of species that have crossed a pre-defined spread threshold criterion. For example, for a species that was observed in 3 different locations over > 50 km of coastline for 2 years or more. The threshold criterion will depend inter alia on the life history of the taxonomic group.

3.2.2 Temporal occurrence and spatial distribution of non-indigenous species

The management measures for marine non-indigenous species should be focused on preventing new introductions through various ways. This approach is the most cost-efficient and in most cases it is the only way to manage non-indigenous species. To evaluate this management measure, one should monitor the trends in the temporal occurrence and spatial distribution of recently introduced species. To monitor the trend indicator of non-indigenous species two parameters [A] and [B] should be calculated on a yearly basis. Parameter [A] provides an indication of the introductions of "new" species (in comparison with the prior year), and parameter [B] gives an indication of the increase or decrease of the total number of non-indigenous species:

[A]: The number of non-indigenous species at T_n (for example T_{2013}) that was not present at T_{n-1} (for example $T_{2013-1=}T_{2012}$). To calculate this parameter the non-indigenous species lists of both years are compared to check which species were recorded in 2013, but were not recorded in 2012 regardless of whether or not this species was present in 2010 and earlier years. To calculate this parameter the total number of non-indigenous species is used in the comparison (although species names should also be listed Annex IV).

[B]: The number of non-indigenous species at T_n minus the number of non-indigenous species at T_{n-1}. Hereby T_n stands for the year of reporting.

Trends in both [A] and [B] should be monitored to develop the best management plan for non-indigenous species in an area. A positive or negative trend in [B] illustrates respectively an increase and a decrease in the total number of non-indigenous species in an area, which is a good trend indicator of non-indigenous species. One also needs to calculate [A] however as it is possible to have both a negative trend in [B], indicating a decrease in the total number of non-indigenous species, and a positive trend in [A] at the same time, indicating that management in the area is not sufficient yet. A positive trend in [A] ([A]>0) indicates that "new" species are introduced into the area and one should therefore investigate how and with which pathway they are introduced. If this concerns a pathway introduced by anthropogenic activities, one may focus management on that pathway. If the new non-indigenous species arrive by their natural distribution capacities, one may focus on back tracking the location of origin and focus management on that location.

These parameters should be calculated for at least 2 "hot spot" locations per "potential import pathway", e.g. "commercial shipping", "marinas", and "aquaculture transport". The criteria on the basis of which these locations are chosen can be the following:

- Past research has shown them to be hotspots for non-indigenous species that can be transported with the transport vector concerned;
- The species communities at the two locations do not directly influence each other;
- Vulnerable areas with prospects for invasion by new introductions.

The number of non-indigenous species at each of the selected locations has to be monitored following a specific protocol for that location, ensuring that the number of non-indigenous species within a location can be compared over the years to produce trends. The monitoring protocol developed for each location should aim at reflecting the occurrence of many non-indigenous species at that location. Monitoring protocols may be different between locations. The use of different monitoring protocols at different locations must not be a problem as long as all protocols aim at scoring non-indigenous species present in the location.

3.3. Assessing common indicator 6

Baseline and Reference level

The target for the trend indicator for non-indigenous species is trend-based: An acceptable target situation for the indicator is set by considering the following statements:

- Ideally no new non-indigenous species are introduced; and,
- Ideally the number of non-indigenous species reduces to a level where only non-indigenous species that have already settled at a location are present, i.e. the number of non-indigenous species is decreased to a level where only settled non-indigenous species are present. It is hereby assumed that the eradication of settled non-indigenous species in the marine environment is virtually impossible.

Consequently, [A] at T_n = [A] at T_{n-1} = [A] at T_{n-2} = 0 and [B] at T_n = [B] at T_{n-1} = [B] at T_{n-2}, should indicate that no new non-indigenous species were introduced in the last three years, and that the number of non-indigenous species is decreased to a level where only settled (for at least three years) non-indigenous species are present. Of course, this target accounts for all locations that are monitored.

To be able to achieve GES under EO2, it is important to understand which NIS are present within the marine region and sub-regions. A baseline assessment of the extant NIS would provide a reference point against which the success of future actions could be measured. Once this baseline data has been gathered it will be possible to set reference levels.

3.4. Concluding remarks

Contracting Parties should have at least three years of data per location in order to calculate the trend indicator and to define the reference level for the non-indigenous species. This is assumed to be so when no new non-indigenous species were introduced in the last three years, and the number of non-indigenous species is decreased to a level where only characteristic resident non-indigenous species (settled for at least three years) are present. For developing new monitoring protocols specifically aiming at finding non-indigenous species, one should at least plan two years during which each country monitors non-indigenous species according to the monitoring programme they have developed. During those two years, the results of the monitoring programmes can be compared in time (between the two years) and space between the various Contracting Parties. These results are compared with one question in mind: how can each of the monitoring programmes be improved (from a cost/benefit point of view) aiming at finding as many non-indigenous species as possible. After those two years an evaluation should take place during which what percentage is estimated of the non-indigenous species present at the various locations, which is indeed found in the monitoring protocol that was chosen. If less than ~90% of the non-indigenous species present in an area are scored, the monitoring protocol is probably not fit for producing the data necessary to calculate the non-indigenous species trend indicator. If the majority of the Contracting Parties are not able to develop and maintain a monitoring programme that is able to score at least ~90% of the non-indigenous species present in an area, the use of any "trend indicator for marine non-indigenous species" would not be feasible.

IV. MONITORING AND ASSESSMENT METHODLOGICAL GUIDANCE ON EO5: EUTROPHICATION

1. Introduction

Eutrophication is a process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of nutrients causing changes to the balance of organisms; and water quality degradation. The consequences of eutrophication are undesirable if they appreciably degrade ecosystem health and/or the sustainable provision of goods and services. These changes may occur due to natural processes. Management concern begins when they are attributed to anthropogenic sources. Additionally, although these shifts may not be harmful in themselves, the main worry concerns 'undesirable disturbance': the potential effects of increased production, and changes of the balance of organisms on ecosystem structure and function and on ecosystem goods and services.

In the Mediterranean, the UNEP/MAP MED POL Monitoring programme included from its inception the study of eutrophication as part of its seven pilot projects approved by the Contracting Parties at the Barcelona meeting in 1975 (UNEP MAP, 1990a,b). The issue of a monitoring strategy and assessment of eutrophication was first raised at the UNEP/MAP MED POL National Coordinators Meeting in 2001 (Venice, Italy) which recommended to the Secretariat to elaborate a draft programme for monitoring of eutrophication in the Mediterranean coastal waters. In spite of a series of assessments reviewing the concept and state of eutrophication, there are important gaps in the capacity to assess the intensity of this phenomenon, even more to compare or grade the various sites. Efforts have been devoted to define the concepts to assess the intensity and to extend experience beyond the initial sites in the Adriatic Sea admittedly the most eutrophic area in the entire Mediterranean Sea.

GES with regard to eutrophication is achieved when the biological community remains well-balanced and retains all necessary functions in the absence of undesirable disturbance associated with eutrophication (e.g. excessive algal blooms, low dissolved oxygen, declines in sea-grasses, kills of benthic organisms and/or fish) and/or where there are no nutrient-related impacts on sustainable use of ecosystem goods and services. The conceptual model of eutrophication is presented in Figure 1 for information purposes.

2. The choice of indicators for monitoring and assessing eutrophication

Despite the great variability born by the water layers subject to active hydrodynamic processes, monitoring the characteristics of the seawater is still the most direct way of assessing eutrophication. A number of parameters have been identified as providing most information relative to eutrophication e.g. chlorophyll, dissolved oxygen, inorganic nutrients, organic matter, suspended solids, light penetration, aquatic macro-phytes, zoo benthos, etc. They all may be determined either at the surface or at various depths. However even though these variables are routinely determined by most marine laboratories they may pose some problems to some less specialized institutions. Remote sensing may also be employed and with great success when eutrophication extends over large areas such as in the case of the northern Adriatic Sea.

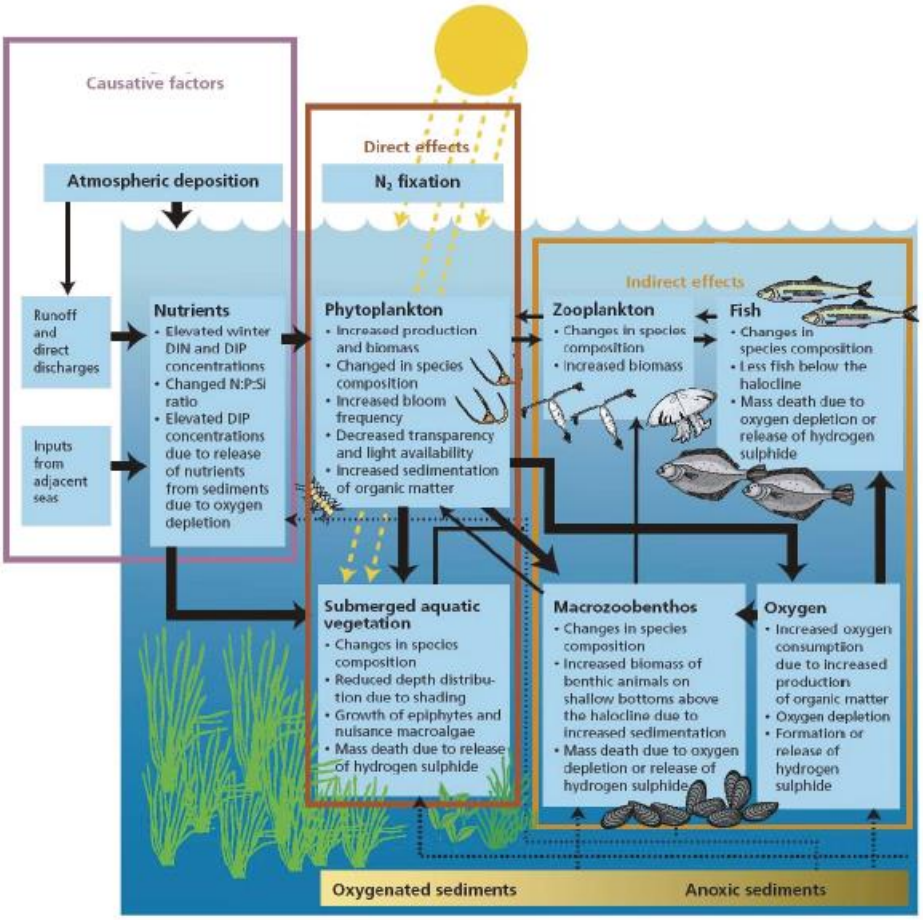


Figure 1. Conceptual model of eutrophication. The arrows indicate the interactions between different ecological compartments. A balanced marine and coastal ecosystem is characterised by: (1) a pelagic food chain (phytoplankton ►zooplankton/zoobenthos ►fish), which effectively couples production to consumption and minimises the potential for excess decomposition (2) natural species composition of plankton and benthic organisms, and (3) if appropriate, a natural distribution of submerged aquatic vegetation. Nutrient enrichment results in changes in the structure and function of marine and coastal ecosystems, as indicated with bold lines. Dashed lines indicate the release of hydrogen sulphide (H2S) and phosphorus, under anoxic conditions at the sediment-water interface, which is positively related to oxygen depletion. In addition, nitrogen is eliminated by denitrification in anoxic sediment.

If only limited means are available, determination of those parameters that synthesize the most information should be retained. Chlorophyll determinations for example, although not very precise representations of the system, are data which provide a great deal of information. Reliable data on nutrients are extremely useful indicators of potential eutrophication. Turbidity and seawater colour (Forell scale, Wernard and van der Woerd, 2010) may also be a good measure of eutrophication, except near the mouths of rivers where inert suspended solids may be extremely abundant. Dissolved oxygen is one parameter that integrates much information on the processes involved in eutrophication, provided it is measured near the bottom or, at least, below the euphotic zone where an oxycline usually appears.

2.1. The choice of eutrophication indicators to be monitored under the LBS Protocol and the Integrated Monitoring and Assessment Programme (Common indicators 13 and 14, Concentration of key nutrients in the water column and Chlorophyll-a concentration in the water column)

Decision 21/3 of COP 18 of the Contracting parties to the Barcelona Convention (Istanbul, December 2013) provides for assessing eutrophication for the Ecosystem Approach by combining the information on nutrient levels, direct effects (specifically chlorophyll – a concentration and water transparency for the 2016 ECAP monitoring activities) and indirect effects (oxygen concentration for the 2016 ECAP monitoring activities). These elements to be monitored reflect the short term eutrophication monitoring strategy of UNEP/MAP MED POL Phase III and IV (UNEP (DEC) WG.231/14) according to which pilot monitoring programmes were implemented in different Mediterranean locations to build capacity in setting up and implementing integrated eutrophication monitoring programmes, (in which phytoplankton total abundance, abundance of major groups and bloom dominance would also be monitored on a discretionary basis). It is considered that the aim would now be focused within the ecosystem approach framework towards developing complete coherent datasets at the entire regional sea level.

In addition it is fundamental to link up to budgets of nutrient sources and loads (e.g. terrestrial, airborne) so the load can be associated with impairment and successful management measures can be developed from that relationship. Such an inventory of pollution sources and loads from land based activities (**NBB**) is prepared periodically by UNEP/MAP MED POL in the framework of the implementation of the LBS Protocol and the Strategic Action Programme (**SAP-MED**) to Address Pollution from Land Based Activities (adopted in 1997 and launched in 2000). The third cycle of the NBB reporting is currently ongoing and expected to be finalized in early 2015.

No single analytical tool is adequate to measure the degree of eutrophication of a given body of water. Instead, most experts believe the best approach is to measure many different parameters and to synthesize the results into a general model providing an overall, somewhat integrated degree of eutrophication for the water. Unless proper selection of the parameters to be measured is made, the amount of work required to assess the extent and intensity of eutrophication may be rather costly.

Measurement strategy and sampling design are therefore keys to the success in monitoring eutrophic areas. It will certainly have to adapt to the morphological characteristics of the area to be monitored, its hydrodynamics and the sources of nutrients. It should be realized that simple measuring and sampling schemes will not provide much insight into an extremely complex phenomenon. Depending on the importance of the impact of eutrophication (plankton blooms, HABs, anoxic events) the amount of effort needed to be put into a monitoring plan can be assessed.

3. Monitoring strategy

3.1. Considerations regarding eutrophication monitoring methods

Traditional methods for eutrophication monitoring in coastal waters involve in situ sampling/measurements of commonly measured parameters such as nutrients concentration, chlorophyll 'a' concentration, phytoplankton abundance and composition, transparency and dissolved oxygen concentration. Concerning available methods for in situ measurements, ships provide flexible platforms for eutrophication monitoring, while remote sensing provides opportunities for a synoptic view over regions or sub-regions. Besides traditional ship measurements, ferry-boxes and other autonomous measuring devices have been developed that allow high frequency and continuous measurements.

<u>In situ measurements are more suitable:</u>

- In (sub) regions/areas/sites with an increasing eutrophication problem,
- When a sub-region/area/site is close to or under GES for eutrophication
- When the status with respect to eutrophication is still unclear
- In sub-regions/areas/sites where for other reasons accurate and reliable data are needed (generally these are coastal sub-regions, in particular close to rivers)

Modelling and remote sensing should also be considered as alternatives or in addition to in situ measurements, depending on the requirements with respect to data. In general, in situ measurements always remain necessary to validate and calibrate the models and data calculated from satellite measurements.

Model generated data are more suitable:

- In (sub) sub-regions with a stable, predictable eutrophication status
- In sub-regions in GES or where the eutrophication problem is decreasing
- In offshore areas where taking in situ measurements is costly and where nutrient levels are correlated with levels in the coastal zone (extrapolation)
- In case satellite data are inaccurate or not available
- Where there is a need for an average picture of the local eutrophication status; models are very good at calculating this average picture combining hydraulic models and in situ measurements of standard sampling sites (interpolation)

As with models, remote sensing generally allows the production of data with a higher spatial and temporal resolution than in situ measurements. Thanks to the use of satellites it is possible to have synoptic measurements over large areas. This makes the satellite data particularly useful for large-scale studies and observations and/or for studies of temporal trends.

Satellite data are more suitable:

- In (sub) sub-regions/areas/sites with a stable, predictable eutrophication status
- In sub-regions/areas/sites in GES or where the eutrophication problem is decreasing
- In offshore sub-regions/areas/sites where taking in situ measurements is costly and where nutrient levels are correlated with levels in the coastal zone
- In case models are inaccurate or not available
- For comparisons of the eutrophication status over large sub-regions
- For validation and calibration of the information on spatial distribution
- In sub-regions/areas where funds are limiting
- In sub-regions/areas where for other reasons the accuracy can be lower than provided by in situ measurements (generally these are offshore areas)
- In addition to in situ measurements

However, satellite data need to be supported by ground truth data.

A good strategy appears to be a combination of remote sensing and scanning of the area known or suspected to be affected with automatic measuring instruments such as thermo-salinometer, dissolved oxygen sensors and in vivo fluorometer and/or nephelometer. Sampling for the determination of “in vitro” fluorescence and nutrient analysis may be carried out with relatively little effort if a proper pump and hose are mounted on the ship. The measurements may be done at the surface or just below it with a water intake on the hull of the vessel or at fixed or varying depths with a towed “fish” and pumping system.

Processing and evaluating the data should be carried out having a predefined model of the system under study. Models of the aquatic ecosystem may be good tools for monitoring eutrophication efficiently. Since none of the eutrophication indicators alone can provide an absolute account of the extent and /or intensity of eutrophication, numerical models in which quantitative relationships among the various characteristics are given, allow an overall assessment of the phenomenon to be made with a small number of field and/or laboratory measurements.

3.2. The frequency of eutrophication monitoring and location of sampling sites

The extent of eutrophication shows spatial variation, for instance coastal regions versus the open sea. The frequency and spatial resolution of the monitoring programme should reflect this spatial variation in eutrophication status and pressures following a risk based approach and the precautionary principle.

The first factor promoting eutrophication is nutrient enrichment. This explains why the main eutrophic areas are to be found primarily not far from the coast, mainly in areas receiving heavy nutrient loads. However, some natural symptoms of eutrophication can also be found in upwelling areas. Additionally, the risk of eutrophication is linked to the capacity of the marine environment to confine growing algae in the well-lighted surface layer. The geographical extent of potentially eutrophic waters may vary widely, depending on:

(i) the extent of shallow areas, i.e. with depth ≤ 20 m;
(ii) the extent of stratified river plumes, which can create a shallow surface layer separated by a halocline from the bottom layer, whatever its depth
(iii) extended water residence times in enclosed seas leading to blooms triggered to a large degree by internal and external nutrient pools; and
(iv) upwelling phenomena leading to autochthonous nutrient supply and high nutrient concentrations from deep water nutrient pools, which can be of natural or human origin.

Sub-regions/areas that are in sub-GES status in terms of eutrophication, or that could be considered at risk of not achieving GES generally require more intense monitoring than regions shown to be achieving GES.

Flexibility should be incorporated into the design of the monitoring programme to take account of differences in each marine sub-region/area. Furthermore in cooler regions winter is an optimal period for measuring nutrients since the data are not disturbed by (variable) uptake by algae/macrophytes. In those regions, spring/summer is an optimal period of the algal growing season and therefore for measuring effects of high nutrient availability. In warmer regions productivity continues during (a large part of) the winter period. In these regions, year round measurements of nutrients may be more appropriate.

In brief the geographical scale of monitoring for the assessment of GES for eutrophication will depend on the hydrological and morphological conditions of an area, particularly the freshwater inputs from rivers, the salinity, the general circulation, upwelling and stratification. The spatial distribution of the monitoring stations should, prior to the establishment of the eutrophication status of the marine sub-region/area, be risk-based and proportionate to the anticipated extent of eutrophication in the sub-region under consideration as well as its hydrographic characteristics aiming for the determination of spatially homogeneous areas. Consequently, each Contracting Party would be required to determine the optimum frequency per year and optimum locations for their monitoring stations. Each Contracting Party is responsible for the choice of the most representative sampling stations in order to detect a change over a selected period.

Salinity gradients can be a proxy for river discharge and salinity and nutrient concentrations are often strongly correlated. Salinity can thus be used to determine an optimal spatial distribution of sampling sites, in particular if a model is available to couple salinity and hydrodynamics to nutrient levels. Salinity and temperature are also important parameters supporting the interpretation of eutrophication indicators. Therefore, annual and seasonal temperature regime and, where relevant, spatial and temporal distribution of salinity should be measured in both GES and non-GES regions.

The current national eutrophication monitoring programme implemented so far by the Contracting Parties in the framework of the UNEP/MAP MED POL programme should be used as a sound basis for monitoring under the EcAp complemented with the additional elements based on the above mentioned considerations and each country/sub region/area specificity.

3.3. Characterization of Ecological Quality Status of coastal marine waters with regard to eutrophication

The TRIX index (Vollenweider et al., 1998) may be used for a preliminary assessment of the trophic status of coastal waters in relation to eutrophication providing that its advantages and shortcomings are taken into account (Primpas and Karydis, 2011). The adopted UNEP/MAP MED POL short term eutrophication monitoring strategy monitored parameters to support the TRIX index. This Index is widely used to synthesize key eutrophication variables into a simple numeric expression to make information comparable over a wide range of trophic situations:

TRIX Index = (Log10 [ChA·aD%O·DIN·TP]+ k)·m

where:

ChA = Chlorophyll a concentration as μg/L;

aD %O = Oxygen as absolute % deviation from saturation;

DIN = Dissolved Inorganic Nitrogen, N-(NO3+NO2+NH4) as μg/L;

TP = Total Phosphorus as μg/L.

k=1.5

m = 10/12 = 0.833

The parameters k and m are scale coefficients necessary to fix the lower limit value of the Index and the extension of the related Trophic Scale, i.e. from 0 to 10 TRIX units. Referring to the ChA and DO%components, these factors are direct indicators of productivity, in terms of both the amount of phytoplankton biomass produced and the dynamic of that production, respectively. In other words, the TRIX Index summarises what the coastal system does (by including the contribution of the direct indicators of productivity, as “actual productivity”) and what the coastal system could do (contribution of the nutritional factors components, as “potential productivity”). As a result of the Log transformation of the four original variables, the annual distributions of TRIX over homogeneous coastal zones are usually of normal kind, and show a fairly stable variance, with STD around 0.9. As for the interpretation of TRIX values, those exceeding 6 TRIX units are generally associated to highly productive coastal waters, where the effects of eutrophication are represented by frequent episodes of anoxia in bottom waters. Values lower than 4 TRIX units are typical of scarcely productive waters, while values lower than 2 are generally associated to the open sea.

The TRIX index used for the assessment of trophic status of coastal waters has been applied in many European seas (Adriatic, Tyrrhenian, Baltic, Black Sea, and North Sea). However, all these waters are characterized by high nutrient levels and phytoplankton biomass; an index calibration based on systems that are principally eutrophic may introduce bias to the index scaling. In the work of Primpas and Karydis, 2011, the TRIX trophic index is evaluated using three standard sets of data characterizing oligotrophy, mesotrophy, and eutrophication in the Aegean (Eastern Mediterranean) marine environment. A natural eutrophication scale based on the TRIX index that is suitable to characterize trophic conditions in oligotrophic Mediterranean water bodies is proposed. This scale was developed into a five-grade water quality classification scheme describing different levels of eutrophication.

It is recommended also that the contracting parties rely on the classification scheme on chl-a concentration (μg/l) developed by MEDGIG as an assessment method easily applicable by all Mediterranean countries based on the indicative thresholds and reference values adopted therein (see Table 2).

4. Development of assessment thresholds and identifying reference conditions for eutrophication in order to be able to monitor the achievement of GES

Three approaches may be used for GES determination:

a. In order to assess quantitatively the achievement of GES in relation to eutrophication, a measurable assessment threshold may be set, including the definition of reference conditions. GES assessment thresholds and reference conditions (background concentrations) may not be identical for all areas, especially where the marine environment is already disturbed by human presence for many years. In these cases a decision has to be made whether to set the threshold value for GES achievement independently to the setting of the reference conditions. The approach is based on the recognition that area-specific environmental conditions must define threshold values. A threshold value could include provisions to allow for statistical fluctuations (example: No nutrients and chl-a values exceeding the 90th percentile are present in a frequency more than statistically expected for the entire time series). GES could be defined on a sub-regional level, or on a sub-division of the sub-region (such as the Northern Adriatic), due to local specificities in relation to the trophic level and the morphology of the area.
b. A second approach to determine GES for eutrophication is to use trends for nutrients contents, and direct and indirect effects of eutrophication. When using the trend approach, a reference value representing the actual situation is needed, for comparison. In the case of nutrients and chl-a, such reference values exist due to data availability in most areas. Therefore, GES could be defined as no increasing trends in nutrient and/or chlorophyll-a concentrations over a defined period of time in the past (ex. 6 years), which are not explained by hydrological variability. For indirect effects, GES could ask for no decreasing trend in oxygen saturation beyond what would be statistically expected.
c. GES thresholds and trends are recommended to be used in a combined way, according to data availability and agreement on GES threshold levels. In the framework of UNEP/MAP MED POL there is experience with regard to using quantitative thresholds. It is proposed that for the Mediterranean region, quantitative thresholds between "good" (GES) and "moderate" (non GES) conditions for coastal waters could be based as appropriate on the work that is being carried out in the framework of the MED GIG intercalibration process of the EU Water Framework Directive (WFD), a project closely followed by the UNEP/MAP MED POL programme.

In this context regarding the definition of subregional thresholds for chlorophyll a water typology is very important for further development of classification schemes of a certain area. Within the MEDGIG exercise the recommended water types for applying eutrophication assessment is based on hydrological parameters characterizing a certain area dynamics and circulation. The typological approach is based on the introduction of a static stability parameter (derived from temperature and salinity values in the water column): such a parameter, on a robust numerical basis, can describe the dynamic behaviour of a coastal system.

Typology is very important for further development of classification schemes of a certain area.The recommended water types for applying eutrophication assessment are based on hydrological parameters characterizing a certain area dynamics and circulation. The typological approach is based on the introduction of a static stability parameter (derived from temperature and salinity values in the water column). Such a parameter, on a robust numerical basis, can describe the dynamic behaviour of a coastal system. It is accepted that surface density is adopted as a proxy indicator for static stability as both temperature and salinity are relevant in the dynamic behavior of a coastal marine system. More information on typology criteria and setting is presented in document UNEP(DEPI)/MED WG 417/Inf.15.

In the Mediterranean a considerable number of eutrophication experts have built a typology scheme for the Mediterranean coastal waters during the first inter-calibration phase for the EU Water Framework Directive implementation, which is still in use after their update according to Commission Decision 2013/480/UE and represents a very simple typology approach that could be easily applied Mediterranean wide for coastal waters (sensu WFD, i.e. 1nm), since these coastal waters have been intercalibrated.. In this context the e major water types have been defined on the basis of surface density and salinity values as presented in Table 1:

Table 1 Definition of major coastal water typees in the Mediterranean that have been intercalibrated (applicable for phytoplankton only) according to EU Comission Decision 2013/480/EU

	Type I	Type IIA, IIA Adriatic	Type IIIW	Type IIIE	Type Island-W
σ t (density)	<25	25<d<27	>27	>27	All range
salinity	<34.5	34.5<S<37.5	>37.5	>37.5	All range

The different coastal water types, in an ecological perspective, can be described as follows:

- Type I — coastal sites highly influenced by freshwater inputs
- Type IIA — coastal sites moderately influenced not directly affected by freshwater inputs (Continent influence)
- Type IIIW — continental coast, coastal sites not influenced/affected by freshwater inputs (Western Basin)
- Type IIIE — not influenced by freshwater input (Eastern Basin)
- Type Island: — coast (Western Basin)

In addition, the coastal water type III was split in two different sub basins, the Western and the Eastern Mediterranean ones, according to the different trophic conditions and is well documented in literature.

Some examples of Water Types presence finally defined for the European countries, Party to the Barcelona Convention and LBS Protocol are shown in the Table 2.

Table 2 Examples of coastal water types in some Mediterranean countries

New types		**Croatia**	**Cyprus**	**France**	**Greece**	**Italy**	**Slovenia**	**Spain**
	Description							
Type I	Highly influenced by freshwater input			**X**		**X**		
Type II	Moderately influenced by freshwater input	**X**		**X**		**X**	**X**	**X**
Type III WM	Not influenced by freshwater input	**X**		**X**		**X**		**X**
Type III EM	Not influenced by freshwater input		**X**		**X**			

Proposed recommendations

1. Contracting parties are invited to agree on the proposed criteria for typology of coastal waters as presented in Table 1.
2. Contracting parties are invited to apply the above criteria and define their coastal water types with the support from MED POL if needed, in the course of 2015.

As sugested by the on line expert group on eutrophication established by the Contracting parties it is recommended that with regard to nutrient concentrations, until commonly agreed thresholds have been determined, negotiated and agreed upon at a sub regional or regional level, GES may be determined on a trend monitoring basis.

With regards to chlorophyll a, the on line Mediterranean eutrophication group recommend the reference and threshold values of the MEDGIG approach to be used for assessing ewutrophication status as presented in Table 2. (results of the 2nd phase of MEDGIG exercise)

Reference and threshold (Good/Moderate status) derived values (G-mean annual values based on long time series (>5 years) of monthly sampling at least) differ from type to type on a sub-regional scale and were build with different strategies. Summaries values are given in Table 3.

Table 3: Reference and threshold values of Chla in Mediterranean coastal water types (according to Commission Decision of 20 September 2013 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Decision 2008/915/EC) .

Coastal Water Typology	Reference conditions of Chla (µg L^{-1})		Boundaries of Chla (µg L^{-1}) for G/M status	
	G_mean	90 % percentile	G_mean	90 % percentile
Type I	1,4	**3,33[21] - 3,93[22]**	6,3	**10[20] - 17,7[21]**
Type II-FR-SP		1,9		3,58
Type II-A Adriatic	0,33	0,8	1,5	4,0
Type II-B Tyrrhenian	0,32	0,77	1,2	2,9
Type III-W Adriatic			0,64	1,7
Type III-W Tyrrhenian			0,48	1,17
Type III-W FR-SP		0,9		1,80
Type III-E		0,1		0,4
Type Island-W		0,6		1,2 – 1,22

<u>Proposed recommendations on further development of the assessment of eutrophication related common indicators during the initial phase of IMAP:</u>

1. The Contracting Parties are recommended to rely on the classification scheme on chl-a concentration (µg/l) in coastal waters as a parameter easily applicable by all Mediterranean countries based on the indicative thresholds and reference values presented in Table 3.

2. However, for a complete assessment of eutrophication and GES achievement, GES thresholds and reference conditions (background concentrations) are needed not only for chlorophyll-a, but such values must be set,in the near future, through dedicated workshops and exercises also for nutrients, transparency and oxygen as minimum requirements.Nutrient, transparency and oxygen thresholds and reference values may not be identical for all areas, since is recognized that area-specific environmental conditions must define threshold values. GES could be defined on a sub-regional level, or on a sub-division of the sub-region (such as the Northern Adriatic), due to local specificities in relation to the trophic level and the morphology of the area.

3. Following the evaluation of information provided by a number of countries and other available information, it has to be noted that the Mediterranean countries are using different eutrophication non mandatory assessment methods such as TRIX, Eutrophication scale, EI, HEAT, OSPAR ,etc. These tools are very important to continue to be used at sub-regional or national levels because there is a long term experience within countries which can reveal / be used for assessing eutrophication trends.

4. However, in order to increase coherency and comparability regarding eutrophication assessment methodologies is recommended that further efforts should be made to harmonize existing tools

[21] Applicable to Golf of Lion Type I coastal waters

[22] Applicable to Adriatic type I coastal waters

through workshops, dialogue and comparative exercises at regional/subregional/subdivision levels in Mediterranean with a view to further develop common assessment methods.. .

In conclusion it is recommended to rely on the classification scheme on chl-a concentration (µg/l) in coastal waters as a parameter easily applicable by all Mediterranean countries based on the indicative thresholds and reference values presented in table 2.

However following the evaluation of information provided by a number of countries and other available information it has to be noted that the Mediterranean countries are using different eutrophication assessment methods such as TRIX, Eutrophication scale, EI, HEAT, OSPAR etc. These tools are very important to continue to be used as appropriate at sub-regional or national levels because there is a long term experience within countries which can reveal / be used for assessing eutrophication trends.

V. MONITORING AND ASSESSMENT METHODLOGICAL GUIDANCE ON EO9: CONTAMINANTS

1. Introduction

In most Mediterranean countries, the monitoring of concentrations of a range of chemical contaminants in water, sediments and biota is undertaken in response to the UNEP/MAP Barcelona Convention, its Land-Based Protocol, UNEP/MAP MED POL monitoring programmes, international (e.g. WFD) or national drivers. The scope and scale of this monitoring varies, but should be considered as a base from which to introduce a greater degree of harmonisation between Contracting Parties and to ensure that contaminants and matrices of importance within assessment sub regions are covered by appropriate monitoring programmes. Biological effects monitoring is generally less widely established in both national or international programmes, and the number of countries undertaking such studies (and the intensity of the coverage) is much smaller. Therefore, it will be essential in coming years to expand and develop further the use of biological effects methods to cover properly the EO9.

GES under Ecological Objective 09 is achieved when contaminants cause no significant impact on coastal and marine and coastal ecosystems and human health. As the type and quantities of emissions have changed and environmental legislation has led to reductions in pollution for certain substances and areas, the monitoring of contaminants needs to be adapted and focused to address present and upcoming risks that might affect the achievement of GES (GES). However coverage from current national programmes is limited. Therefore, for pragmatic reasons, initial assessments of GES under EO 9 will probably be based upon data of a relatively small number of contaminants and biological effects, reflecting the scope of current programmes and the availability of suitable agreed assessment criteria. Important development areas over the next few years will include harmonisation of monitoring targets (determinands and matrices) within assessment sub-regions, development of suites of assessment criteria integrated chemical and biological assesment methods,, and review of the scope of the monitoring programmes to ensure that those contaminants which are considered to be important within each assessment area are included in monitoring programmes. Through these, and other, actions, it will be possible to develop targeted and effective monitoring programmes tailored to meet the needs and conditions within each assessment sub-region.

A considerable amount of monitoring data from the past decades is available through the pollution monitoring and assessmenr component of UNEP/MAP MED POL Programme under UNEP/MAP-Barcelona Convention. These data have been used e.g. for the identification of significant marine contaminants and the development of monitoring strategies and guidance. With respect to implementing the requirements of the Ecosystem Approach Process, there are considerable benefits to be gained from taking advantage of monitoring data and information developed through the UNEP/MAP MED POL Monitoring programme. Such actions include (1) the use of existing experience in the design of monitoring programmes, (2) the use of existing guidance on analytical etc. methods to inform technical aspects of ecosystem approach monitoring, (3) the use of existing sampling station networks as a framework for ecosystem approach sampling networks, (4) the use of existing statistical assessment tools and work on assessment criteria as the basis for assessments of ecosystem approach data, (5) the use of existing data to describe the distributions of contaminants and effects in the sea, and (6) the use of existing time series as the basis of monitoring against a “no deterioration” objective. The availability of quality assured data with confirmed quality is of importance for the assessment of trends in pollutant concentrations.

Monitoring the pressure deriving from chemical contaminants over time and space is a basic requirement for a quantitative assessment of the environmental status of the seas. Baseline assessments are necessary in order to monitor trends and prevent deterioration. Monitoring plans need to be proactive, not reactive and combined with risk assessments. Monitoring instruments and assessment criteria need to be sensitive and comparable.

While all Land Based Sources and Activities (**LBS**) Protocol substances should ideally be considered, their monitoring in the marine environment might not be performed for all, due to the absence of sources or the physicochemical characteristics of the substances. The availability of source information is crucial to the selection of substances for monitoring.

In view of the adoption in COP 19 of the UNEP/MAP Barcelona Convention Offshore Protocol[23] Action Plan, the development and adoption of Mediterranean monitoring procedures and programmes for offshore activities, is envisaged to take place in 2016 - 2017. building, inter alia, on the IMAP of the EcAp.

Sampling a particular environmental compartment should be based on the anticipated pathway, fate and effect of each pollutant. Each compartment of the marine environment (water, sediments, biota) provides specific information about the pollution status, trends and sources of toxic substances.

The identification of pollution sources and how their associated inputs change over time is also fundamental to assess the effectiveness of the pollution mitigation strategies and to direct the further efforts needed to achieve GES. UNEP/MAP MED POL implements a periodic inventory of pollution sources and loads from land based activities, in the framework of the LBS Protocol and the Strategic Action Programme (SAP) to Address Pollution from Land-based Activities (adopted in 1997 and launched in 2000). The pollution sources database of UNEP/MAP MED POL holds 12,500 records of pollutants loads from industrial and municipal sources reported by the countries on a 5-year period (Data reported on 2003 and 2008). Each record indicates the emission of a substance for a given activity sector and sub-sector, in an administrative region and country. The database covers about 100 different substances or groups of substances and parameters according to national legislation and country development specificities. However a restricted number of substances are common to almost all national pollutant releases.

2. Monitoring Strategy for contaminants and effects (Applicable to all contaminants related indicators, ie Common Indicators 17-21

2.1. The risk approach and precautionary principle

According to the risk approach monitoring needs to be carried out in coastal and marine areas where chemical contaminants have been found to represent significant risks to the marine and coastal ecosystems, and the data provided by the monitoring should serve the needs posed by the Ecosystem Approach process. Monitoring should allow the necessary statistical data treatments and long-term time-trend data analysis. Early warning of upcoming issues, such as emerging contaminants, should eventually become an integral part of the future monitoring systems.

The precautionary principle requires that, in doubt, protective measures should be implemented. In particular the marine environment is vulnerable due to possible accumulation of contaminants in the specific food chains and the irreversibility of impact on its ecosystems.

2.2. Selecting locations for environmental monitoring of contaminants and biological effects

The grid of monitoring stations will depend on the purpose of the specific campaigns. Most monitoring stations will be part of the UNEP/MAP MED POL monitoring schemes. It has been recognized that the open and deep sea is much less covered by monitoring efforts than coastal areas. There is a need to

[23] The Protocol for the Protection of the Mediterranean Sea against Pollution from the Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil (Offshore Protocol). The Protocol entered into force on 24 March, 2011 and according to the Offshore Action Plan Contracting Parties that have not already done so should endeavor to ratify the Protocol by 2017.

include within monitoring programmes also areas beyond the coastal areas in a representative and efficient way, where risks warrant coverage.

A joint strategy for monitoring should include master stations, distributed spatial spread and other approaches, such as transect sampling, if applicable.

The selection of sites for the monitoring of contaminants and biological effects in the marine environment is a direct function of the assessment of risks and the monitoring scope:

- Areas of concern identified on the basis of the review of the existing information and linked to UNEP/MAP MED POL and WFD assessments.
- Areas of known past and/or present release of chemical contaminants.
- Offshore areas where risk warrants coverage (aquaculture, offshore oil and gas activity, dredging, mining, dumping at sea...).
- Sites representative in monitoring of other sea-based (shipping) and atmospheric sources.
- Reference sites: For reference values and background concentrations.
- Representative sensitive pollution sites/areas at sub regional scale.
- Deep-sea sites/areas of potential particular concern

The selected sites should allow the collection of a realistic number of samples (e.g. be suitable for sediment sampling, allow sampling a sufficient number of biota for the selected species during the duration of the programme). Modelling tools can provide information for the best placement of monitoring stations with respect to ocean currents and input pathways.

Contracting Parties should provide their proposed sampling locations and the reasons for monitoring. It is essential that the monitoring strategies are being coordinated at regional and/or sub regional level. Coordination with monitoring for other Ecological Objectives is crucial for cost-effective approaches. The organization of cruises as a joint effort from different Contracting Parties might be an effective option.

2.3. Geographic scale of monitoring and assessment

The geographic scale of monitoring for the assessment of GES for contaminants and their effects depends on the specific conditions of an area that may influence the background concentration of contaminants, including local mineralogy, inputs from rivers, hydrodynamic conditions, sediment texture, etc. A risk based approach should be used in order to follow a screening procedure to decide the areas to be assessed and monitored more frequently.

The areas where greater pollution pressure occurs could be divided into smaller areas for assessment purposes and could be monitored more frequently than remote and non-affected marine waters.

Monitoring for the assessment of GES for totally anthropogenic contaminants such as organochlorine compounds, could be carried out on a regional scale, since the background concentration for these contaminants is zero. However, local specificities in the production and use of these compounds (pesticides and industrial compounds) have created a difference between the sub-regions that has to be considered.

Furthermore, although coastal levels of pollutants are mainly influenced by local processes (river runoff, coastal hot spots), open-sea biota and sediments are mainly influenced by regional or even super-regional pathways (atmospheric transport and deposition of pollutants emitted from remote areas). The latter is also true for PAHs.

Based on the above, it could be appropriate to consider monitoring for assessing a regional GES threshold for open sea and a different one for coastal zones.

For naturally occurring contaminants such as heavy metals in addition to the previous remarks, as local mineralogy plays an important role in the definition of the GES threshold, since metal deposits are present in different Mediterranean locations, monitoring for the assessment of GES for heavy metals may need to be carried out on a subdivision of the sub-region according to local characteristics.

For contaminants biological effects and occurrence of oil spills, monitoring for the assessment of GES could be carried out on sub-regional or even regional level, provided appropriate information is available.

Also, for pathogenic microorganisms in bathing water, monitoring for the assessment of GES could be carried out on a sub-regional or even local level due to the nature of microbiological contamination (the impact is restricted to a relatively short distance from the pollution source due to the short survival time of microorganisms in seawater).

2.4. Monitoring frequency

Monitoring frequencies will be determined by the purpose of the sampling effort. They can range from shorter time scales for seasonally variable input, to large time scales for sediment core monitoring. For trend determination the timescales will depend on the ability to detect trends considering the variability in the whole analytical process and the number of replicates. It can be possible to decrease the monitoring frequency in cases where established time series show concentrations well below levels of concern, and without any upward trend over a number of years. For multiannual parameters, opportunities for joint organization between Contracting Parties and between or within Regional Seas Conventions should be considered.

3. Development of assessment criteria for the definition of threshold limit values for chemical environmental status monitoring of contaminants in order to be able to determine the achievement of GES.

Report UNEP(DEPI)MED WG.394/Inf.3 on the development of assessment criteria for hazardous substances in the Mediterranean presents a methodology to develop assessment criteria for the definition of threshold limit values for contaminants, in order to assess the achievement of GES in the Mediterranean marine environment in relation to the Ecological Objective EO9, in the framework of the gradual application of the ecosystem approach for the management of human activities in the Mediterranean, by MAP.

The report follows a relevant methodology developed by OSPAR, which proposes two threshold limits to be defined in sediments and biota: T0 to define the threshold at “pristine” sites and T1 to define the threshold between acceptable (GES) and unacceptable environmental conditions.

Using Mediterranean data from the UNEP/MAP MED POL database and applying the OSPAR methodology, the report presents an evaluation of the background concentrations (**BCs**) and the background assessment concentrations (**BACs**)[24] of trace metals (mercury, cadmium and lead) and organic contaminants (chlorinated hydrocarbons and PAHs) in sediments and biota in the Mediterranean basin.

Regarding the definition of BACs in Mediterranean sediments, the report states that it should be noted that limited data was available and therefore more dated sediment cores from different areas are needed in order to increase the confidence of the proposed values. Additionally, in order to further test if normalization is for sediment particle variability, aluminum (Al) and organic carbon (OC) should be

[24] Background assessment concentrations” (BACs) are statistical tools defined in relation to the background concentrations (BCs), which enable statistical testing of whether observed concentrations can be considered to be near background concentrations. Observed concentrations are said to be ‘near background’ if the mean concentration is statistically significantly below the corresponding BAC

considered as mandatory parameters in the new IMAP. There are already evidences from certain regions of the NW Mediterranean where it is well demonstrated that normalization is not convenient as these environmental factors are not well correlated with contaminant concentrations (León et al. et al, 2014). It will be also necessary to further investigate subregional differences on sedimentation rate and geocomposition of the sediments.

In order to define the relationship between BC and BAC, the report states that a statistical test is required, taking into consideration the data variability of reported data on Certified Reference Materials (sediment and biota) used by Mediterranean laboratories in proficiency tests and in inter-calibration exercises. At this stage a statistical test, as described in the text of the report, on the UNEP/MAP MED POL monitoring programme is not yet available. Alternatively the report states that OSPAR defined relationships between BC and BAC for metals in sediments, fish and shellfish to assess the BACs levels could be adopted. Thus, for sediments and shellfish BAC = 1.5 x BC, for fish BAC = 2 x BC. However, that report states that it is recommended to perform a statistical test to evaluate the precision of UNEP/MAP MED POL monitoring programmes (on a country basis).

Furthermore, the report states that considering the statistical evaluation of the UNEP/MAP MED POL database performed in the report, and the large variability in the concentration levels, it is essential to perform a quality control examination of the datasets in order to better assess BAC values.

As regards the definition of Mediterranean Assessment Criteria for biota using the UNEP/MAP MED POL database, the report underlines that it is biologically inappropriate to evaluate absolute BC, BAC and Environmental Assessment Criteria (**EAC**) metal levels in one species from the parallel levels of even a close relative species. Therefore, BCs and BACs levels were calculated / assessed in the report generally according to OSPAR procedures.

The report states that in OSPAR assessments, some EACs have not been used mainly because they are less than the OSPAR BACs. The EACs for Cd and Pb in sediment, Hg in mussels and Hg and Cd in fish are below the corresponding BACs. In addition, the BCs and BACs for trace metals in sediments are normalized to 5% aluminum whilst proposed EACs are normalised to 1% organic carbon. It has been concluded by OSPAR that EACs for PAHs or trace metals in sediment and for metals or CBs in biota cannot be used to describe the threshold (T1) between acceptable (GES) and unacceptable environmental conditions. Therefore, in cases where the EACs have not been recommended, alternative approaches to appropriate criteria for the assessment of data on contaminant concentrations in sediment and biota were applied (as shown in Table 9.1.):

- For the Transition (T0) which represents an assessment that concentrations should be at, or close to, background concentrations, BACs are used by OSPAR.
- For the Transitions (T1), the assessment criteria were the ERLs (Effects Range Low[25]) for PAHs and trace metals in sediment.
- It is a demanding task to determine real EAC levels, generally and also according to OSPAR documents. Therefore, until an appropriate approach becomes available for the assessment criteria for metals in biota, the EC maximum acceptable dietary levels (Commission Regulation (EC) No 1881/2006) were used by OSPAR (QSR 2010 assessment).

[25] Effects range low (ERL) and effects range median (ERM) are specific chemical concentrations that are derived from compiled biological toxicity assays and synoptic sampling of marine sediment. These numerical values are sediment quality guidelines that were developed by Long and Morgan for the National Oceanic and Atmospheric Administration's (NOAA) National Status & Trends programme as informal tools in screening sediment. ERL and ERM are considered guidelines to help categorize the range of concentrations in sediment at which effects are scarcely observed or predicted (below the ERL) and the range above which effects are generally or always observed (above the ERM). These guidelines are used for screening sediments for trace metals and organic contaminants

In addition, it has to be noted that there are experiences in the Mediterranean according to which ERL has been adopted as threshold for T1 as it was not possible to normalize for TOC in sediment due to low TOC content

Table 3. Transition points for assessing contaminants in sediments and biota applied by OSPAR (OSPAR 2009).

Contaminant	Transition Point	Sediment	Biota
Hg, Cd, Pb	T0	BAC	BAC
Hg, Cd, Pb	T1	ERL	EC
PAHs	T0	BAC	BAC
PAHs	T1	ERL	EAC
PCBs (individual congeners)	T0	BAC	BAC
PCBs (individual congeners)	T1	EAC	EAC
Σ7CBs ICES	To	BAC	-
Σ7CBs ICES	T1	ERL	-
Lindane	To	BAC	BAC
Lindane	T1	ERL	EAC
HCB	To	BAC	BAC
HCB	T1	ERL	-
pp-DDE	T0	BAC	BAC
pp-DDE	T1	ERL	
α-HCH	T0	-	BAC
α-HCH	T1	ERL	-
Dieldrin	T0	BAC	-
Dieldrin	T1	ERL	

3.1. Forward procedure for monitoring the achievement of GES for contaminants in the Mediterranean marine environment.

The recommendations and information presented in the report are proposed to be followed up/utilized to establish a forward procedure for monitoring the achievement of GES for contaminants. This inter alia would imply further work in separate Contracting Party allocated expert groups, particularly for updating the current BACs and setting EACs for contaminants in biota on a sub-regional level.

Until EACs are defined for the major substances of concern, a two-fold approach could be adopted to support monitoring for the assessment of GES: i) a threshold value for GES(BAC) could be set using concentrations from relatively unpolluted areas on a sub-regional level and ii) a decreasing trend should be observed from values representing the actual level of contaminants concentrations that are above the background assess concentrations (BACs). Thus, GES could be defined for toxic metals (Hg, Cd, Pb), chlorinated organic compounds and PAHs, for which monitoring data exist as a result of running monitoring programmes.

<u>Temporal trend monitoring</u>

Marine monitoring implies the repetitive observing for defined purposes, of one or more elements of the marine environment, according to prearranged spatial and temporal schedules using comparable methodologies. The temporal trend monitoring starts with the objective to detect trends in concentrations with the aim of monitoring the effectiveness of control measures taken at polluted sites. Trends in pollutant or contaminant levels, in general, are also considered as “state” indicators of pollution and are included in most of the regional monitoring programmes to provide inputs to the assessments of the state of the marine environment.

Surface sediments and biota can be used for recognizing possible temporal trends of trace metals organochlorine compounds, PAHS, and those that are accumulated in these matrices in the marine environment and, thus, can be an important tool for the assessment of the effectiveness of control measures taken at the polluted sites and also for state assessment. However, data variability can be influenced by several factors other than contaminant inputs, namely those associated with sampling and the representativeness of the collected samples. In any case, the first requirement is the availability of data series long enough, so that long-term monitoring programmes are maintained in time.

In the 2005 review and analysis of UNEP/MAP MED POL Phase III Monitoring Activities (UNEP (DEC)/MED WG 282/3) consisting of an evaluation of the UNEP/MAP MED POL database for the trend monitoring of contaminants it was concluded that the UNEP/MAP MED POL Phase III programme objectives preliminarily set, were not sufficient to achieve the temporal trend of any selected contaminant for a selected site. The major reason for this was the various difficulties in data analysis, especially when normalization was intended for reducing the variance of the data set by taking into account the differences in morphology (e.g. sediment grain size) or composition (e.g. tissue fat content) of the samples. Both the selected trace metals and the organic contaminants will co-vary strongly with such factors[26].

A second aspect to be considered is the time span necessary for trends assessment.

In general, the first temporal trend evaluation using sessile marine organisms can be performed with data sets of more than five years ongoing programmes. The use of sediments still require a longer time span (>10yr) for evidencing and assessing significant variations. However, after ten years of the monitoring programme, certain countries still did not have valid and continuous data covering at least five years.

The 2011 analysis of the trend monitoring activities and data for UNEP/MAP MED POL Phase III and IV (UNEP (DEPI) MED365/Inf.5) concluded that though substantially improved after the last trend data evaluation in 2009, some problems were identified mainly dealing with the lack of maintaining the declared sampling strategy. The weakest part of the programme remains the data transfer and manipulation. To overcome these problems, the report states that involved countries are encouraged to write a detailed programme manual where all issues regarding a successful programme achievement would be addressed. Such a manual would include the programme objectives and a detailed methodological approach to successfully maintain the programme over time (positioning, sampling, methods, and data elaboration, exchange and presentation).

From the trend monitoring point of view the report states that the best sampling strategy always leads with attaining the best information on the sampling variance and with that a valuable determination of the underlying trend. While it is advisable to avoid pooling whenever possible, the suggested strategy for smaller organisms, mainly molluscs that are not always sufficient for all analyses, is to use 3-5 samples with 15 pooled specimens or in any case a number of pooled specimens that guarantees the necessary amount of sample to conduct all the chemical analyses. If one sampled organism, mainly fish, provides enough sample for all analyses the use of from 15 to 25 (preferred) samples is suggested if the

[26] A revised manual for sediment sampling and analysis was adopted in 2006 (UNEP(DEC)MED WG.282/Inf.5/Rev.1.)

underlying variances are not known. The sample should be collected in a length stratified manner: divide the size distribution in three or five classes (log scale and depending on size: MG -1 cm; MB - 2 cm.) and sample the central one; the same size class should always be sampled.

4. Monitoring Biological Effects

Biological effects monitoring is considered as an important element in programmes which aim to assess the quality of the marine environment, since such monitoring aims to demonstrate links between contaminants and ecological responses. Biological effects monitoring can thus be used with the intention to indicate the presence of substances, or combinations of substances, not previously identified as being of concern and to identify regions of decreased environmental quality.

Biomarkers include a variety of measures of specific molecular, cellular and physiological responses of key species to contaminant exposure. A response is generally indicative of either contaminant exposure or compromised physiological fitness. The challenge is to integrate individual biomarker responses into a set of tools and indices capable of detecting and monitoring the degradation in health of a particular type of sentinel organism.

The use of biomarkers is relatively new when compared to traditional chemical monitoring. Even today those biomarkers which are considered well understood often still lack historic track records and simple data management adequate for routine risk assessment and monitoring. Some results were produced in the last twenty years through individual research projects national or international programmes in marine waters (BIOMAR, BEEP, IOC-IMO UNEP funded programme of Global Investigation of Pollution of the Marine Environment). Despite the important principle underlying the biomarker concept, that is, response should lead to ecological effects, there are still few examples where biomarker measurements have been directly linked to community level responses. However, many examples revealing environmental problems, that is, acting as warning signals of potential future problems, have been demonstrated in the past decades (Demetrio et al., 2003; Martínez-Gómez et al., 2010; Fernández et al., 2011)..

Biological effects monitoring should be coordinated with the monitoring of chemical contaminants in a cost-effective manner, conducting field sampling, whenever possible, within the same time-frame.

The integrated assessment (biological effect and chemical measurements) should comprise only a limited number of stations including at least:

- Reference sites: For reference values and background concentrations
- Areas of concern identified on the basis of the review of the existing information linked to MED POL, WFD and MSFD assessments
- Representative sensitive pollution sites/areas at subregional scale

Strategy for sampling and analysis should include, whenever possible:

- Sampling and analyses of the same tissues and individual/populations than chemical monitoring
- Sampling of individuals for biological effects from the same site/area as that used for chemical analyses at a common time
- Sampling sediments at the same time and location as collecting biota (i.e. fish)

For all stations, biometrics (size/length, age), biological supporting parameters such as condition index (mussels), condition factor, gonadosomatic index, hepatosomatic index (fish) and data on temperature, salinity and oxygen dissolved of the ambient water should be also registered.

For an integrated biomarker data management, an Expert System has been developed at the University of Piemonte Orientale, Italy (**DiSAV**) in the framework of the **BEEP** (Biological Effects of Environmental Pollutants) EU programme. The function of the Expert System is to rank the level of the pollutant-induced stress syndrome by integrating the data obtained from:

- Early warning biomarkers: i.e. sensitive biomarkers of stress, or of exposure, revealing the effects of pollutants at the molecular and/or cellular level.
- Biomarkers of stress, suitable to reveal the development of the stress syndrome at the tissue/organ level: i.e. histological biomarkers, but also biochemical biomarkers such as the GST (Glutathione Transferase) test recently developed (i.e. evaluation of the GST released from the cells and present in molluscan haemolymph).
- Biomarkers of stress at the organism level: i.e. biomarkers able to show that the stress syndrome has decreased the mussel's capacity of survival and/or growth and reproduction (such as stress on stress response, scope for growth, gonad and gamete alterations, survival index).

A good interpretation of the development of the stress syndrome by the expert system depends on the possibility to utilize control samples for each assessment and biomarkers of stress able to integrate the toxic effects of pollutants over a sufficient caging period. Among these, are those biomarkers that show a trend characterized by a continuous increase or decrease in the value of the selected parameter (such as lysosomal membrane stability, lysosomal lipofuscin accumulation, lysosomal neutral lipid accumulation, micronuclei frequency) in relation to an increase in toxicity. Moreover, the expert system takes into account possible interferences among the different biomarkers. . However, the representation of the assessment does not maintain all of the supporting information, and it is not easy to identify the causative determinands that may be responsible for the final result on the level of stress syndrome. In addition, different stages of the assessment cannot be readily unpacked to a previous stage to identify either contaminant or effects measurements of potential concern or sites contributing to poor regional assessments.

Besides of expert system, different indexes have being developed to assess contaminant-related biological responses by combining results from different biomarkers such as Integrated Biomarker Response (IBR) (Belaieff and Burgeot, 2002), the Health Assessment Index (HAI) (Adams et al., 1993), the Bioeffect Assessment index (Broeg at al., 2005), and the Integrative Biomarker Index (Marigómez et al., 2013). Furthermore, different models are becoming available in the Mediterranean region to elaborate various typologies of data with the 5 classes approach, and to aggregate them in a final evaluation, still based on the 5 classes discrimination (Benedetti et al., 2012).

Molluscs (mainly mussels, *Mytilus* sp.) and fish (*Mullus* sp., *Platichthys flesus* L., *Zoarces viviparus, Perca* sp.) from natural populations have both been widely employed as sentinel organisms in routine biomonitoring programmes, both at a national and an international level (UNEP/MAP UNEP/MAP MED POL Biomonitoring Programme; OSPAR Convention, RAMOGE, etc.). .), although some subregional and national research projects have also been conducted in the past years using caged mussels (RINBIO; MYTILOS, MYTIMED Project, etc). Exposure periods lasting several months are generally required to assess bioaccumulation of most persistent organic contaminants and to reveal more subtle chronic effects on organisms. Although caged musseld can be used to assess certain early biological effect responses, they cannot substitute the pollution biomonitoring programmes based on the sampling of mussels from natural populations. As the experience have demonstrated, the use of caged mussels for large-scale biomonitoring programmes involves a higher-cost monitoring strategy than the use of mussels from natural populations because at least, two field sampling campaings have to be organised, and recovery of the cages is not guaranteed. The use of caged mussels for effect monitoring can however be useful in short-term exploratory environmental studies, e.g. around hot spots

While the use of fish in biological effects monitoring programmes, building on the key position of these organisms in the trophic chain and their high commercial value is well established, their usage already in the initial stage of the monitoring programme on a regional level would present some problems, including the difficulties encountered in caging experiments with fish as well as more importantly the cost of sampling, caging, transportation. However, field sampling to assess contaminants levels in fish tissues could be integrated and coordinated with sampling of other fish tissues (liver, blood, gonads, brain, etc) to implement in future the use of biological effects in fish from natural populations instead of caging fish. Their inclusion in the integrated monitoring programme thus is not foreseen in the initial phase, but could be envisioned afterwards..

Molluscs have been taken as the bioindicators of choice on the basis of their wide geographic distribution, their straightforward availability in the field and through aquaculture, and their suitability for caging experiments along coastlines.

In the framework of UNEP/MAP MED POL Phase IV, it was decided to apply a 2-tier approach, using caged molluscs:

- the first tier would include a single biomarker, namely, lysosomal membrane stability, and mortality;
- the second tier would include a whole set of biomarkers including acetyl cholinesterase activity, micronuclei frequencies, lipofuscin accumulation, neutral lipid accumulation, , oxidative stress, metallothionein content, , peroxisome proliferation, lysosome to cytoplasm ratio, and stress on stress.

An intercalibration exercise financed by UNEP/MAP MED POL was organised in 2010 by DiSAV with the participation of 11 Mediterranean laboratories from 8 countries (Croatia, Egypt, Greece, Italy, Slovenia, Spain, Syria and Tunisia) and 3 non-Mediterranean laboratories (Norway and UK, from the OSPAR region). The results of the intercalibration exercise showed excellent performance of all laboratories for the measurement of lysosome membrane stability and very good performance for the measurement of metallothionein content. Also a Training course on the measurement of two biomarkers (lysosome membrane stability and micronuclei frequency) was organised in Alessandria, Italy by DiSAV in 2010, with the participation of 15 scientists from 10 countries (Algeria, Croatia, Egypt, Greece, Italy, Morocco, Slovenia, Spain, Tunisia, Turkey) and with the contribution of scientists from ICES-OSPAR (UK).

Based on the work already carried out, the results of the intercalibration exercises and the publication of relevant papers by Mediterranean scientists involved in the UNEP/MAP MED POL programme on biological effects monitoring, there is a network of laboratories in the Mediterranean region with the capacity to carry out biomonitoring activities, in line with the new monitoring requirements to be defined in the framework of the Ecosystem Approach for the management of human activities in the Mediterranean.

Of the second tier biomarkers proposed, only the micronuclei frequency biomarker is able to indicate the presence of genotoxic chemicals in the environment, especially in sites heavily polluted by polycyclic aromatic hydrocarbons, and in organisms that may also be considered as seafood. With growing concern over the presence of genotoxins in the sea, the application of cytogenetic assays to ecologically relevant species offers the chance to perform early tests on health in relation to exposure to contaminants. Acetylcholinesterase activity is a cost effective biomarker of neurotoxic effects of pollutants, especially pesticides, applicable with instrumentation available in the Contracting Party laboratories. Its responsiveness has been demonstrated also to various other groups of chemicals present in the marine environment, including heavy metals, and hydrocarbons. Laboratory and field studies have demonstrated the applicability of anoxic/aerial survival as an early warning indicator of contaminant-induced stress. The reduction of survival in air, or stress on stress (SoS), is a simple, low–cost, whole-organism response and can show pollutant-induced alterations in an organism's physiology that render the animal more sensitive to further environmental changes. Bivalve molluscs can survive for a long time in air, but individuals stressed by pre-exposure to pollutants show greater mortality than controls or individuals collected from a reference location. The method for determining SoS in mussels has been applied routinely to both toxicant-exposed mussels in laboratory studies and mussels collected in national monitoring programmes from polluted environments and along pollution gradients. Taking into account the number of samples to be analyzed and available facilities in the Contracting Party laboratories, the best number of further to these biomarkers to be gradually introduced into the biological effects monitoring programme could be determined.

While recognizing that contaminant-specific techniques that cannot guarantee that measuring responses within marine organisms from natural populations are cuased to the single exposure of specific contaminants, the most widely used specific technique is the measurement of TBT effects (imposex) on gastropods, where a cause and effect relationship has been established. There is a possibility to use available information for TBT thresholds for GES from other regions (Davies and Vethaak, 2012) in order to propose similar effects thresholds for the Mediterranean.

In general the monitoring of contaminant-related biological effects should be coordinated with the monitoring of chemical contaminants in a cost-effective manner, conducting field sampling, whenever possible, within the same time-frame.

4.1. Assessing Biological Effects

In a similar manner to contaminant concentrations, ICES/OSPAR has proposed two/three categories to assess the biological effects observed, by using two assessment criteria: BAC and EAC (Davies et al., 2012). Assessing biomarker responses against BAC and EAC allows establishing if the responses measured are at levels that are not causing deleterious biological effects, at levels where deleterious biological effects are possible or at levels where deleterious biological effects are likely in the long-term. In the case of biomarkers of exposure, only BAC can be estimated, whereas for biomarkers of effects both BAC and EAC can be established. However, unlike contaminant concentrations in environmental matrices, biological responses cannot be assessed against guideline values without consideration of factors such as species, gender, maturation status, season and temperature.

It is expected that in the forthcoming years, the scope of experts groups would be to prepare an adapted manual establishing the BAC and when possible, the formulation of EAC for selected biomarkers in Mediterranean species.

One of the challenges in assessing the health status of organisms using assessment criteria is precisely the strategy by which to integrate the multivariate results obtained. The approach recently developed by ICES was based on an assessment of single responses by assessment criteria, then scoring them in a multi-step process to arrive at a final risk assessment (Davies and Vethaak, 2012).

5. Monitoring acute pollution events for the quantification of acute chemical spills, specifically of oil and its products, but not excluding others (Common Indicator 19Occurrence, origin and where possible extent of acute pollution events)

The UNEP/MAP-Barcelona Convention and its Prevention and Emergency Protocol aimat the protection of the environment against oil and chemical spills with a coherent coverage and equal level of protection for the entire Mediterranean Sea.. The Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (**REMPEC**) is responsible for the prevention of, preparedness for and response to marine pollution. In this regard, the Centre's database on alerts and accidents in the Mediterranean Sea contains data on accidents causing or likely to cause pollution of the sea by oil (since 1977) and by other harmful substances (since 1989). [27]

While there should be no overlap or double work with existing provisions, the guidance on integrated monitoring should here ensure that all aspects are being covered under the various frameworks, that monitoring information is exchanged between the networks and that potential for a cost effective integrated monitoring is used.

The operational objective contains two different criteria:

- Occurrence, origin, extent.
- Impact on biota physically affected.
- Monitoring efforts can therefore use the following methods for quantification:
- Quantification of oil and other chemical spills and their size by observation and reporting.
- Satellite radar images, plane observation and imaging approaches.
- Backtracking of oil spills to their source by hind cast modelling.
- Fingerprinting using chemical analysis (GC-MS) and comparison with possible sources.

The organizational framework under which the monitoring of oil and other chemical spills is being dealt with under the UNEP/MAP Barcelona Convention is REMPEC. Mediterranean coastal States, contracting Parties to the 2002 Prevention and Emergency Protocol to the UNEP/MAP Barcelona Convention, committed themselves (Article 9 of the Prevention and Emergency Protocol) to inform each other, either directly or through the Regional Centre (i.e. REMPEC) on:

- all accidents causing or likely to cause pollution of the sea by oil and other harmful substances
- the presence, characteristics and extent of spillages of oil or other harmful substances observed at sea which are likely to present a serious and imminent threat to the marine environment or to the coast or related interests of one or more of the Parties;
- their assessments and any pollution combating actions taken or envisaged to be taken the evolution of the situation.

In relation to their obligations under the abovementioned Article 9 of the Prevention and Emergency Protocol, at their Fifth Ordinary Meeting, the Contracting Parties to the UNEP/MAP Barcelona Convention adopted the Guidelines For Co-operation In Combating Marine Oil Pollution In The Mediterranean (UNEP/IG.74/5, UNEP/MAP, 1987) which recommend Parties to report to REMPEC at least all spillages or discharges of oil in excess of 100 cubic metres.[28]

Article 18 of the UNEP/MAP Barcelona Convention Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil, states that in cases of emergency the Contracting Parties shall implement mutatis mutandis the provisions of the Emergency Protocol.

While Contracting Parties are under the obligation for the above monitoring, data submitted to REMPEC is stil scarce. Thus the main aim during the Initial Phase of the IMAP is to strengthen monitoring efforts towards this already existing obligation.

At the same time, for the further development of the Integrated Monitoring and Assessment Programme, it is recommended to analyse closer the links in between acute pollution events and their effects on biota and develop specific assessment criteria for this latter. (see Martínez-Gómez et al., 2010)

6. Monitoring of contaminants in fish and other seafood used for human consumption (Common Indicator 20 Actual levels of contaminants that have been detected and number

[28] . http://www.rempec.org/admin/store/wyswigImg/file/News/Forthcoming%20Meetings/MEDEXPOL2013/E-%20Reference%20Documents/E-%20REMPEC%20-%20Guidelines%20for%20co-operation%20in%20combating%20marine%20poll%20in%20the%20med.pdf

of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood)

Substances to be monitored

Monitoring of contaminants in biota used for human consumption only measures contaminants in fish and other seafood for which regulatory limits have been set in national and international regulations for public health reasons[29]..The significance of an increase for specific contaminants in the marine environment through trend analysis should be regarded as an important element for inclusion in seafood monitoring. Similarly, when results from monitoring of contaminants in the marine environment indicate a very low likelihood for elevated levels in fish and seafood for human consumption, additional monitoring on these commodities is not justified.

Monitoring should at least consider the following contaminants for which regulatory levels have been laid down: Heavy metals (lead, cadmium, and mercury), polycyclic aromatic hydrocarbons, dioxins (including dioxin-like PCBs). Additionally, further contaminants of relevance should be identified.

Species

The selection of the species to be used for monitoring should consider the following criteria:

- Species more prone to biomagnify/bio-accumulate specific classes of contaminants
- Species representative of the different trophic levels or habitats
- Species representative for entire (sub) region
- Species representing consumer habits

Moreover, in order to make monitoring results more comparable between (sub) regions, it would be advisable to select a limited \number of target species from the most consumed species of fish and other seafood.

Sample collection

Only unprocessed products should be sampled for this purpose. A key element will be to analyse seafood in the sea from known locations. The monitoring of contaminants in seafood is executed by the responsible authorities in charge, which often are different from the authorities implementing the EcAp and its associated monitoring. Here, cooperation with authorities and environmental institutions in charge of health monitoring is strongly encouraged. Topics for coordination are:

- Providing information on the origin of the samples: Sampling of fish and seafood at retail stage shall only be done when all necessary conditions (e.g. avoid cross contamination, traceability to (sub) region) can be guaranteed
- Exploring synergies in the monitoring of marine top predators
- Exchanging information on data, approaches and methodologies between environmental monitoring institutions and human health risk related monitoring institutions

7. Monitoring microbiological pollution (Common Indicator 21: Percentage of intestinal enterococci concentration measurements within established standards)

Taking into consideration that the Mediterranean Sea continues to attract every year an ever increasing number of international and local tourists that among their activities use the sea for recreational

[29] A list of maximum levels for contaminants in foods set by the FAO/WHO Codex Alimentarius Commission can be found at ftp://ftp.fao.org/codex/Meetings/cccf/cccf7/cf07_INFe.pdf

purposes, the issue of monitoring for potential microbiological pollution is of particular importance. Although the general situation has improved considerably in several parts of the region through the establishment of sewage treatment plants and the construction of submarine outfall structures, the matter is still of major concern in a number of areas and the quality of recreational waters needs regular monitoring.

Revised Mediterranean guidelines for bathing waters were formulated in 2007 based on the WHO guidelines for “Safe Recreational Water Environments” and on the EC Directive for “Bathing Waters”. The proposal was made in an effort to provide updated criteria and standards that can be used in the Mediterranean countries and to harmonize their legislation in order to provide homogenous data.

The values agreed for the Mediterranean region in COP 17 (Decision IG.20/9 Criteria and Standards for bathing waters quality in the framework of the implementation of Article 7 of the LBS Protocol, (UNEP/MAP, 2012) are presented in Table 9.2 and could be used to define GES for the indicator on pathogens in bathing waters.

By definition monitoring for the assessment of GES for bathing waters is expected to be close to the shore, but the threshold is valid on a regional level. Therefore, the category A or B values could be defined as a GES threshold for intestinal enterococci in bathing waters in the Mediterranean.

Table 7. Water quality criteria for intestinal enterococci in bathing water

Category	**A**	**B**	**C**	***D***
Limit values	<100*	101-200*	Up to 185**	>185**(1)
Water quality	Excellent quality	Good quality	Sufficient	Poor quality/ Immediate Action

* 95th percentile intestinal enterococci/100 mL (applying the formula 95th Percentile = antilog (μ + 1,65 σ)

** 90th percentile intestinal enterococci/100 mL (90th Percentile=antilog (μ + 1,282 σ), μ=calculated arithmetic mean of the log10 values; σ= calculated standard deviation of the log10 values.

8. Quality Assurance and Quality Control of contaminants monitoring

The accuracy and comparability of the data collected is a key requirement for the assessment and description of environmental status and for the assessment of anthropogenic influences and required measures. Quality assurance (**QA**) and quality control (**QC**) measures ensure that monitoring results of stated quality are obtained across the Mediterranean Region and at any time.

Much effort has been made by the MAP Secretariat so that the Contracting Parties would be in a position to generate accurate data on marine contaminants. UNEP/MAP MED POL will continue to collaborate with the International Atomic Energy Agency and the specific Marine Environmental Studies Laboratory (**MESL**), based in Monaco.

The MESL produces Certified Reference Materials (for trace elements and organic compounds in sediment and marine biota) and develops fit-for purpose Recommended Analytical Methods for the analysis of contaminants in marine samples. Also, in collaboration with Regional Organisations and national authorities, MESL organises Proficiency Tests and Training Courses on the analysis of contaminants of concern.

9. Reference methods and guidelines for marine pollution monitoring under UNEP/MAP-UNEP/MAP MED POL

In the framework of the LBS Protocol, UNEP/MAP is assisting Mediterranean Contracting Parties in the assessment of the state of the marine environment and of its resources, of the sources and trends of pollution and the impact of pollution on human health, marine and coastal ecosystems and amenities. In order to assist the countries and to ensure that the data obtained through this assessment can be compared on a world-wide basis and thus contributing to the Global Environmental Monitoring System (**GEMS**) of UNEP, a set of reference methods and guidelines for marine pollution studies, covering technical aspects of monitoring, sample selection, preservation and analysis, have been developed and recommended to be adopted by Governments participating in the Regional Seas Programme. The methods and guidelines have been prepared in cooperation with the relevant specialised bodies of the United Nations system (WHO, FAO, IAEA, IOC) as well as other organisations and are tested by competent experts. The Methods and Guidelines are periodically revised taking into account the development of our understanding of the problem, of analytical instrumentation and the actual need of the users. The Marine Environment Laboratory of the International Atomic Energy Agency (**IAEA**) in Monaco is responsible for the technical co-ordination of the development, testing and intercalibration of Reference Methods.

The Reference Methods for the analysis of pollutants in water, sediment and biota, in the framework of the UNEP/MAP-UNEP/MAP MED POL, can be found at www.unepmap.org (Document and publications; Library Resources; Reference Methods). A list of UNEP reference methods for selected chemical contaminants is provided in Annex VII. UNEP/MAP has recently updated selected recommentedrecommended methods to be used as appropriate for monitoring of contaminants in trhethe marine environment.

<u>Proposed recommendations on further development of the assessment of contaminants related common indicators during the initial phase of IMAP:</u>

1. Indicate sampling methodology to follow and assess biological responses in the Main elements of the Integrated Monitoring and Assessment Programme for Ecological Objectives 5, 9 and 10 (UNEP(DEPI)/MED WG 417/6) based where appropriate on the relevant methodologies used in OSPAR or other fora
2. Amend the UNEP/MAP Technical Report Series No. 120 with particular reference to the sampling period (case of fish) and sampling frequency (case of sediments) based where appropriate on the relevant methodologies used in OSPAR or other fora
3. Assess and test in the coming years the convenience of normalisingmetal concentrations in samples from certain regions of the Mediterranean Sea when Aluminium and Organic content data from sediments would be available in MED POL database from possibly all Contracting parties);
4. Recommend mussel and fish LMS as mandatory biomarker;
5. Follow the OSPAR approach of a “traffic light” system for both contaminant concentrations and biological responses, where there are two “thresholds” $_{T0}$ and $_{T1}$ to be defined (OSPAR, 2008; Davies et al., 2012);
6. Adopt BCs and BACs of contaminants (for naturally occurring substances) in sediments obtained from the analysis of pre-industrial layers of dated sediment cores established for the

Mediterranean region (UNEP(DEPI)/MED WG.365/Inf.8) where appropriate based on data availability;

7. Use for indicative purposes the existing EACs of contaminants in sediments and biota and of biological responses established by ICES/OSPAR until new ecotoxicological information is available including for Mediterranean species; (OSPAR, 2008; Davies et al., 2012);
8. Request the Contracting Parties and MED POL to further work and develop as appropriate new BCs and BACs of contaminants in sediments obtained by using data from sediments sampled at sites/areas which Mediterranean contracting parties consider being reference stations/areas to be defined based on commonly agreed criteria;
9. Request the Contracting Parties and ME POL to further work and develop new BCs and BACs of contaminants in biota (mussels and fish) obtained by using only data from organisms sampled at sites/areas which Mediterranean contracting parties consider being reference stations/areas to be defined based on commonly agreed criteria
10. Use the existing BACs and EACs of LMS, SoS, MN frequency and AChE activity biomarkers established (Davies et al., 2012); and further work to develop and discuss new BAC by using data from organisms sampled at sites/areas which the Mediterranean contracting parties consider a reference stations/areas, to be defined based on commonly agreed criteria;
11. Extend and amend the existing reporting formats used for contaminants and biological responses in MED POL database to avoid gaps of the information required and to facilitate the proper assessment of environmental criteria;
12. Request the Secretariat (MED POL) to continue supporting the Online Contaminants Working Group for long term developments of activities dedicated to chemical pollution and development of assessment.

VI. MONITORING AND ASSESSMENT METHODLOGICAL GUIDANCE ON EO10: MARINE LITTER

1. Introduction

In the UNEP/MAP Barcelona Convention/LBS Protocol system, the monitoring of marine litter is regulated both through the Regional Plan on Marine Litter management (herein after referred to as **MLRP**), adopted by COP 18, 2013 and the COP 18 EcAp Decision. The latter specified the key relevant marine litter ecological and operational objectives as well as a set of three ML state indicators.

Article 12 of the MLRP provides for a Mediterranean Marine Litter Monitoring Programme, which will be in synergy with the relevant international and regional guidelines including the relevant work carried out under the EU MSFD.

The EcAp CorGest meeting held in February 2014 adopted EcAp marine litter common indicators (common indicators 16-17) and one candidate indicator (candidate common indicator 18).

Special attention was paid to two key relevant documents on marine litter monitoring namely the UNEP Operational Guidelines for Comprehensive Beach Litter Assessment (Cheshire *et al.* 2009) and the "Guidance on Monitoring of Marine Litter in European Seas" produced between 2012 and 2013 by the European Union Task Group on Marine Litter (**TSG ML**). Both aforementioned documents were presented as information documents UNEP(DEPI)/MED WG.394/Inf.4 and UNEP(DEPI)/MED WG.394/Inf.5 for the EcAp Coordination Group in September 2015

The recent overviews by UNEP (Cheshire *et al*, 2009), and by NOAA, (Opfer *et al.* (2012), are the most comprehensive and useful overviews for monitoring methods on the coast. The UNEP overview includes a comprehensive comparison of existing marine litter survey and monitoring methods and protocols in which beach surveys were assessed. Much of the information included in the TSG ML report for the monitoring of beach litter is taken from the UNEP Operational Guidelines for Comprehensive Beach Litter Assessment (Cheshire *et al.,* 2009) and the NOAA Marine Debris Shoreline Survey Field Guide (Opfer *et al.,* 2012).

The objective of the "Guidance on Monitoring of Marine Litter in European Seas" is to provide EU Member States with recommendations and information needed to implement harmonized monitoring programmes for marine litter. The report describes specific protocols and considerations to collect, report and asses data on marine litter, in particular beach litter, floating litter, seafloor litter, litter in biota and micro-litter.

The TSG ML monitoring guidance document was developed through a collaborative programme involving the European Commission, all EU Member States, the Accession Countries and Norway, international organisations, including all the Regional Sea Conventions and other stakeholders and Non-Governmental Organisations. The document should be regarded as presenting an informal consensus position on best practice agreed by all partners. Dealing with a topic under development through research efforts and by fast growing experience this guidance is regarded as a living document to be regularly reviewed.

All the protocols suggested by TSG-ML are aimed mainly at assessing environmental status and environmental targets. All protocols can supply quantitative data, and allow the assessment of trends. The beach litter protocol is also designed to identify sources by using a detailed list of identifiable items, while other protocols can do this to some extent through their lists of items, but also by modifying the sampling strategy (where and when to sample) to match the likely effects of specific measures.

In their analysis of the protocols, the issue of compatibility and coherence has been important. Most of the protocols proposed can be applied across the Regional Seas scale. However, some of the protocols for litter in biota cannot be identical, for the simple reason that the proposed species do not all occur across the Regional Seas.

A complete analysis of risk should ideally include quantitative knowledge of harm. An analysis of harm will be a focus area for future work. In the event of insufficient quantitative data availability on harm, the risk-based approach is chosen to be addressed by an assessment of where the amounts of litter are likely to be highest or the type of litter which has the largest impact (e.g. microplastics). Already in the selections of protocols a degree of risk-based approach is used. For example, it is proposed to measure litter on the sea surface rather than in the whole water column, because pilot studies indicate that litter quantities are higher on the sea surface. Similarly, the protocols for monitoring on the sea floor propose to assess where litter tends to accumulate (e.g. through pilot studies or oceanographic modelling), and then to direct monitoring towards such areas. While there may be problems to generalize the results from this kind of monitoring to other areas, such strategies are in line with a risk-based approach.

As mentioned above in the document, due to lack of experience on marine litter monitoring within the UNEP/MAP MED POL programme, the Secretariat has developed the present working document drawing largely on the above mentioned UNEP Operational Guidelines for Comprehensive Beach Litter Assessment and on the Guidance on Monitoring of Marine Litter in European Seas.

2. Establishing a monitoring framework for marine litter in the Mediterranean

The COP 18 EcAp Decision includes definitions of GES and targets for marine litter indicators. These indicators refer to litter washed ashore or deposited on coastlines, litter in the water column, including microplastics, and on the seafloor and litter ingested by or entangling marine organisms, especially marine mammals, seabirds and marine turtles.

Fulfilling the monitoring requirements under the Regional Plan on Marine Litter and under EcAp is a major undertaking, and resources for monitoring can be limited. Contracting Parties are, therefore, faced with the decision of what to monitor, and whether it is essential to assess litter amounts, in all of the environmental compartments mentioned above. It is then important to remember that these different compartments can indicate different pathways and sinks for marine litter, and do not necessarily substitute each other.

Our present understanding of litter in the marine environment, which is based on information for only a subset of these compartments, is not sufficient to draw conclusions about the trends and amounts of litter, in the various size categories, in the total marine environment. Biota indicators have a different, but not less important, function: they give an indication of possible harm. Furthermore, the compartments selected for monitoring should also provide information for the identification of sources, not only in terms of the nature and purpose of the items, but also their original source (which can be related to unsuitable or accidental disposal), and the pathway through which the item entered the marine environment. Again, this may vary among the different environmental compartments. At the same time, it is acknowledged that the protocols/methods such as those listed in the TSG-ML report have different degrees of maturity, i.e. to what extent they are tested in the field, and are in common use.

It is strongly recommended that Contracting Parties, which currently have plans to monitor only in a subset of environmental compartments, to start with small pilot research or development projects in other compartments. This would provide baseline data to make an informed decision about future, full-scale monitoring programmes. Without information on trends and amounts, in all the marine compartments, a risk-based approach to litter monitoring and measures is not possible.

A considerable number of citizens, communities (NGOs, civil society initiatives) and environmental protection associations and institutes across the Mediterranean are already taking part in activities to tackle marine litter. The aim would be to enable them to participate in a Mediterranean regional attempt to address marine litter issues as envisaged through the MLRP and to empower citizen networks to help improve the evidence base needed to reach the EcAp main objectives.

2.1. Some general considerations on spatial distribution of survey sites: site selection strategies

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 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. special site selection on the basis of litter pollution levels, or a randomised selection of sites.)

Sites can be chosen individually because they have certain characteristics. and they represent what is needed for the CPs (maritime pollution, characterization of sources, etc.) This may be because they are considered to have certain environmental or societal values. For example, a beach that has a high number of visitors, because the beach is situated in a certain area, or simply because the site has heavy litter loads. Usually, the site is revisited during subsequent surveys to assess trends. The advantage of this approach is that if several sites are chosen for sharing the same characteristics, the litter load they receive is expected to be more similar than those chosen randomly and, therefore, the variation will be less than those chosen randomly. With this in mind, the ability to detect statistically significant trends will be increased. The main disadvantage of the strategy is that, as individual sites are chosen deliberately for special features, they are therefore different from other sites. Hence they may be less suitable for drawing conclusions about average litter levels etc. for a given region. It may add difficulty in interpreting statistical results for technical and philosophical reasons.

Sites may be chosen randomly from a large number of possible sites, meeting certain criteria based upon the method and the monitoring purpose. Sites may be revisited or chosen for each monitoring occasion; the important issue is how they were selected in the first place, e.g. a random selection from many possible sites. The main advantage of this strategy is that results can be extrapolated to other possible sites, i.e. we can use the results to draw conclusions about larger areas. Nevertheless, the variation among sites can be high, making it difficult and costly to find statistically significant trends.

In practice, these two strategies are rarely used in their pure form. Instead a combination is used which is sometimes referred to as, “stratified randomised sampling strategy”. Sites meeting certain criteria are (more or less) randomly chosen. The criteria may include geographic, environmental, societal and other factors. An example would be to choose sites that are close to harbours, to monitor effects of pollution from harbours, and/or sites that are situated in relatively remote areas, to monitor large-scale pollution levels without strong influence from local sources. This is compatible with a risk-based approach. Priority should be given to monitoring programmes that measure environmental status and trends, in sites where the risk of harm is greatest. The criteria for the site selection should then be based on prediction of potential harm. Prediction of potential harm could be based on practical knowledge of which environmental values are most sensitive to harm. However, the current understanding of how different species or biotopes react to litter is insufficient, and should be further researched. Another approach to harm may be based on aspects that are particularly “valuable” to society for other reasons e.g. economically, socially or environmentally. A third approach is to assume that harm is more likely to occur in areas/environments where there is a lot of litter and select sites based on screening monitoring to identify them. While this option may be practical and make sense in terms of societal needs, it is important to remember that we do not know if statistical trends from such sites are representative of other sites (probably not), but represent a “worst case” scenario.

One way to make best use of limited resources is to take advantage of other studies and programmes where litter monitoring can be integrated (what is called “opportunities to reduce costs”). An example is to combine monitoring for litter on the sea floor with scientific trawling for fish stock biomass estimation (such as under the Mediterranean International Trawl Survey, MEDITS). In such a case, the selection of sites is designed for the original monitoring programme purpose, and representation of other areas are already defined. Where use of such a scheme is made, it is important to analyse the sampling strategy to assess if this is suitable for litter monitoring too.

For marine litter, a stratified, randomised sampling strategy where possible is advocated. Also, that the purposes of the monitoring programmes define the criteria for selecting sites. Simplification is necessary when resources are limited, and concentration of monitoring effort is the logical result.

Monitoring for trend analysis: Statistical power or how many sampling stations are needed to detect a change?

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.

The magnitude of the trend is a characteristic of the combined effect of the environment and our (miss-) handling of litter. In that sense, the magnitude of the trend is dependent on the action we take against litter. When designing a monitoring programme an important decision is related to the magnitude of change we wish to detect. It is of course easier to detect a large trend than a small trend. The smaller the magnitude we want to detect, the more comprehensive the monitoring programme needs to be. If the action plans to tackle marine litter aim at reducing litter amounts significantly, then monitoring programmes can detect real changes.

The number of replicates is something that is easy to change given sufficient resources. Replicates, in the case of litter trends, are a combination of monitoring sites and monitoring occasions. Using the same amount of sites, the ability to detect a significant trend increases with time. In monitoring programmes, which often are complex with multiple temporal and spatial layers, the actual number of replicates is less easy to define.

The variation among replicates is a characteristic of the system studied. All biological systems tend to be very variable. To a certain extent, we can influence this by having well defined monitoring protocols and quality assessments, to minimize the added variation due to handling. More important, however, is the ability to decrease variation among sites, by introducing criteria for the sampling, as described in the section on site selection strategies above. This is not cutting corners or cheating, but it is important to realize that the possibility to extrapolate to un-sampled sites decreases.

Common to all three factors influencing statistical power is that they are case specific. It is not possible to give general advice on how many replicates are adequate, except to say the more the better. Firstly, decisions about the purpose of a specific monitoring programme, and what the sites should represent have to be made. Then some estimate of variation is necessary. The data on variation should, ideally, come from a pilot study using the same sites. Otherwise data from similar programmes can be used. Only then can calculations of statistical significance be made, and thus the required number of sites for the monitoring programme be arrived at.

An important and encouraging fact is that it is of value to start a monitoring programme even if the initial resources are limited. The initial data from monitoring can nevertheless be used for subsequent trend analysis (albeit with reduced statistical power), but more importantly, the data collected can be used to refine the design of the programme, including power calculations.

Power calculations for litter monitoring, using methods suggested in this report, have been made for some protocols, e.g. the Sea-bird litter ingestion protocol applied to Fulmars.

A possible challenge in monitoring of time trends of microparticles

Microparticles in the marine environment may enter directly as such from synthetic textile fragments, plastic particles used in cosmetic, or industrial cleansers, etc., but they can also result from the progressive fragmentation of larger pieces or items already present in the sea. If the former source is the dominant, conclusions may be drawn from fluctuation of trends. If the latter is the main source it is more problematic. Then it is possible to interpret increasing or decreasing trends as a net input of fragments or microparticles into the marine environment, when the increase may be caused by changes in the rate of breakdown of larger particles, i.e. not caused by a change in the overall amount of marine litter.

2.2. Some general considerations regarding Quality Assessment/Quality Control approaches and requirements

Since important decisions will be taken, based on the results obtained by monitoring programmes, it is important that the data generated is of acceptable quality. In order to ensure the quality and integrity of marine litter monitoring data, investment must be made in the capacity-building of national, regional and local survey coordination and management.

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.

The value of the monitoring programmes results can be enhanced where a standard list of litter items is used as a basis for preparing assessment protocols. A master-list of categories of litter items has been prepared by TSG-ML. The use of appropriate field guides with examples of each litter type will assist survey team members (particularly volunteers) to be consistent in litter characterization. Such field guides should be coupled to the master list of litter items, and be made available over the web to increase consistency between survey teams working at remote locations.

The use of standard lists and definitions of items will enable the comparison of results between regions and environmental compartments. Items can be attributed to a given source e.g. fisheries, shipping etc. or a given form of harm e.g. entanglement, ingestion etc. The value of monitoring results can be increased further by identifying the main sources of marine litter pollution, and the potential level of harm that marine litter may inflict. This will enable a more target-orientated implementation of measures. Throughout the period 2013-2014, the TSG-ML will further elaborate on approaches to link detailed categories of items to the most probable source, and to other important strategic parameters which can help design and monitor measures and UNEP/MAP may also benefit from this work.

3. Monitoring of litter washed ashore and/or deposited on coastlines (Common indicator 22, Trends in the amount of litter washed ashore and/or deposited on coastlines, ie Beach Litter)

3.1. Introduction to Beach Litter

The recent overviews by UNEP, in Cheshire et al. (2009), and by NOAA, in Opfer et al. (2012), are the most comprehensive and useful overviews for monitoring methods on the coast. The UNEP overview includes a comprehensive comparison of existing marine litter survey and monitoring methods and protocols in which beach surveys were assessed (Cheshire et al., 2009).

Much of the information included in the Final Report of TSG ML is taken from the UNEP Operational Guidelines for Comprehensive Beach Litter Assessment (Cheshire et al., 2009) and the NOAA Marine Debris Shoreline Survey Field Guide (Opfer et al., 2012).

When designing marine litter surveys it is necessary to differentiate between standing-stock surveys, where the total load of litter is assessed during a one-off count, and the assessment of accumulation and loading rates during regularly repeated surveys of the same stretch of beach with initial and subsequent removal of litter.

Both types of survey provide information on the amount and types of litter, however, only the accumulation surveys provide information on the rate of deposition of litter and trends in litter pollution. As the ECAP requires an assessment of trends in marine litter recorded on coastlines only methods for the assessment of accumulation would be recommended.

The type of survey selected depends on the objectives of the assessment and on the magnitude of the pollution on the coastline. A single survey method has been recommended by TSG-ML with different spatial parameters for light to moderately polluted coastline and for heavily polluted coastlines

3.2. Categories of marine litter on the beaches

Regarding the categories of marine litter on the beaches, the Marine Litter Working Groupsuggests that the CORMON should agree on a reduced list (desirably close to that in use in the others RSC), which would include the items more frequently found on the Mediterranean beaches, avoiding those that are found rarely. Moreover, the lists of litter categories considered in countries having monitoring programs dedicated to two RSC (e.g. Turkey, France or Spain) would need harmonization. For this, the MSFD derived MED POL list is now compatible with other RSC lists of beach litter categories.

With regards to the MSFD form presented in the Marine litter chapter integrated monitoring programme document UNEP(DEPI)/MED WG.417/6, it is proposed to merge some types of beach litter (e.g. different types of plastic drink bottles or different types of caps/lids and rings, etc.), split glass and ceramic items categories, consider the sanitary and medical wastes as a separate category and not to include several specific items that have not appeared in the running Mediterranean countries monitoring programmes (e.g. Spanish Monitoring Program on beach marine litter, implemented from 2013 in the Mediterranean). In addition, the online group proposes to use for surveys a minimum lower limit of particle size at 0.5 cm (upper size of microlitter); UNEP(DEPI)/MED WG.417/6.

3.3. Requirements of a harmonised protocol

The comparison of beach litter data between assessment programmes is the primary aim of a harmonised protocol. Comparison is difficult if different methods, different spatial and temporal scales, different size scales of litter items and different lists or categorisation of litter items recorded on beaches are used within the Regional Seas

The type of survey selected depends on the objectives of the assessment and on the magnitude of the pollution on the coastline. A single survey method is recommended by the TSG-ML, with different spatial parameters for light to moderately polluted coastline and for heavily polluted coastlines.

Amounts of litter on the shore can be relatively easily assessed during surveys carried out by non-scientists using unsophisticated equipment. Coastal surveys are thus a cost effective way of obtaining large amounts of information. The litter deposited on the coastline can vary greatly between sites and seasons, affected by hydrographical and geomorphological characteristics of the area (e.g. prevailing winds and currents, exposure of the beach to the sea) but also depending on the use of the coast (e.g. larger amounts can be deposited during the tourist season or during special events). Therefore, coastal surveys should focus on fixed sites, which fulfil the requirements of the protocol, and the timing of the survey (i.e. season) should take into account the potential sources of litter to the site (e.g. flooding in rainy seasons may increase the amounts). Sites can be placed far from known sources, in order to better reflect reference values for background litter pollution levels, or close to potential sources. By using temporal trends for assessments, both of the survey strategies give important information for managers.

3.3.1 Amounts, composition, distribution and sources of Beach Litter

Amounts of litter on the shore can be relatively easily assessed during surveys carried out by non-scientists using unsophisticated equipment. Coastal surveys are thus a cost effective way of obtaining large amounts of information. The litter deposited on the coastline can vary greatly between sites and seasons, affected by hydrographical and geomorphological characteristics of the area (e.g. prevailing winds and currents, exposure of the beach to the sea) but also depending on the use of the coast (e.g. larger amounts can be deposited during the tourist season or during special events). Therefore, coastal surveys should focus on fixed sites, which fulfil the requirements of the monitoring protocol, and the timing of the survey (i.e. season) should take into account the potential sources of litter to the site (e.g. flooding in rainy seasons may increase the amounts). Sites can be placed far from known sources, in order to better reflect reference values for background litter pollution levels, or close to potential sources. By using temporal trends for assessments, both of the survey strategies give important information for managers.

Trends in amounts of litter

The variation in the amount of litter present on a given beach between surveys and the variation between beaches, even in the same region, can be extremely large. This makes the identification of trends difficult, especially taking into account seasonal variations. Moreover, as litter accumulates on beaches, surveys should be carried out at regular intervals in time so that the accumulation periods are approximately of the same length.

Composition of litter

The assessment of composition of litter is one of the great strengths of coastal assessments. A detailed assessment of litter composition provides information on potential harm to the environment and in some cases on the source of the litter found. The assessment of composition must follow commonly agreed categories in order to provide results which are comparable over larger regions.

Spatial distribution

Amount and composition of marine litter varies over geographical scales and reflects hydrographical (e.g. currents, wave exposure, wind directions) and geomorphological (e.g. steepness of a shore, amounts of inlets islands) characteristics of the coast. Hydrographical characteristics determine the amount of litter accumulating in waters adjacent to the coast, whereas geomorphological characteristics determine how much of this litter becomes washed ashore.

Sources of marine litter

The source of litter found on the coast can be clearly identified for some litter items. These are mostly items which originate from fisheries, or debris flushed down sewerage systems. Even with these items some caution is needed e.g. a fish box may originate from a fishing vessel or from a fishing port.

A comprehensive master list of items and categories has been developed within the TSG-ML. The sources for some items need to be designated at a regional level, because initial assessments of litter on coastlines show that sources for a given item can be different between regions.

The master list will enable at least a rough estimate of the sources of litter found on coastlines, but it should be evaluated in survey sites against known local sources. If detailed information is required it will, be necessary to carry out detailed research into the sources involved e.g. to identify between litter deposited directly on the beach by tourists and litter arriving on the beach from adjacent waters. In addition drift analysis of litter in adjacent waters could provide valuable information on its geographical origin.

3.3.2 Strategy for monitoring beach litter

Selection of survey sites

Ideally the selected sites should represent litter abundance and composition for a given region. Not any given coastal site may be appropriate, as they may be limited in terms of accessibility, suitability to sampling (sand or rocks/boulders) and beach cleaning activities. If possible the criteria below should be used:

- A minimum length of 100m;
- Clear access to the sea (not blocked by breakwaters or jetties) such that marine litter is not screened by anthropogenic structures;
- Accessible to survey teams year round, although some consideration needs to be;
- Ideally the site should not be subject to any other litter collection activities, although it is recognized that in many parts of Europe large scale maintenance cleaning is carried out periodically; in such cases the timing of non-survey related beach cleaning must be known such that litter flux rates (the amount of litter accumulation per unit time) can be determined.
- Survey activities should be conducted so as not to impact on any endangered or protected species such as sea turtles, sea birds or shore birds, marine mammals or sensitive beach vegetation; in many cases this would exclude national parks but this may vary depending on local management arrangements.

Within the above constraints, the location of sampling sites within each zone should be stratified such that samples are obtained from beaches subject to different litter exposures, including:

- Urban coasts may better reflect the contribution of land-based inputs;
- Rural coasts may better reflect background values for litter pollution levels
- Coasts close to major rivers, if downstream from the prevailing drift, may better reflect the contribution of riverine input to coastal litter pollution.

Number of sites

At present there is no agreed statistical method for recommending a minimum number of sites that may be representative for a certain length of coast. This depends greatly on the purpose of the monitoring, on the geomorphology of the coast and how many sites that meet the criteria described above are available. The representativeness of survey sites should be assessed in pilot studies, where initially a large numbers of beaches are surveyed. Subsequently, selection of representative beaches from these sites should be made on the basis of a statistical analysis.

Frequency and timing of surveys

At least two surveys per year in spring and autumn are recommended and ideally 4 surveys in spring, summer, autumn and winter. However, because of the large seasonal variation in amounts of litter washed ashore, initially a higher frequency of surveys may be necessary in order to identify significant seasonal patterns, which can then be considered when treating raw data for long-term trend analyses.

Preferably, the surveys for all participating beaches in a given region should be carried out within the shortest timeframe possible within a survey period. Coordinators within these regions should try and coordinate the survey dates between beaches. Furthermore a given beach should be surveyed on roughly the same day each year if possible.

It should be kept in mind that circumstances may lead to inaccessible and unsafe situations for surveyors: heavy winds, slippery rocks and hazards such as rain, snow or ice, etc. The safety of the surveyors must always come first. Dangerous or suspicious looking items, such as ammunition, chemicals and medicine should not be removed. Inform the police or authorities responsible. If working on remote beaches it is recommended to work with a minimum of two people.

Documentation and characterisation of sites

It is very important to document and characterise the survey sites. As surveys should be repeated on exactly the same site the coordinates of the site should be documented.

Sampling unit

Once a beach is chosen sampling units can be identified. A sampling unit is a fixed section of beach covering the whole area between the water edges (where possible and safe) or from the strandline to the back of the beach.

- At least 1 section of 100m on the same beach, optimum 2 sections, are recommended for monitoring purposes on lightly to moderately littered beaches
- At least 2 sections of 100 m for heavily littered beaches (exceptionally 50m section with a normalisation factor of up to 100m to ensure coherence)

Permanent reference points must be used to ensure that exactly the same site will be monitored for all surveys. The start and end points of each sampling unit can be identified by different methods. For example numbered beach poles could be installed at the site or easily identifiable landmarks could be used. Coordinates obtained by GPS are useful for identifying the reference beaches especially where easily identifiable landmarks are lacking.

Units (quantification) of litter

Counts of items are recommended as the standard unit of litter to be assessed on the **coastline.**

Collection and identification of litter items

All items found on the sampling unit should be entered on survey forms. On the survey forms, each item is given a unique identification number. Data should ideally be entered on the survey form while picking up the litter. Collecting the litter first and identifying it later may alter numbers as collected litter tends to get more entangled or broken.

Unknown litter or items that are not on the survey form should be noted in an appropriate “other item box”. A short description of the item should then be included on the survey form. If possible, digital photos should be taken of unknown items so that they can be identified later and, if necessary, be added to the survey form.

A master list of litter categories and items is included in the TSG-ML Final Report. This master list includes a list of categories and items to be recorded during beach litter surveys. . A reduced list for the Mediterranean, MSFD and OSPAR compatible (see annex), that includes the most frequent items found in Mediterranean beaches may be considered and more useful and practical for the field work. This will also enable a coordinated and harmonized monitoring when operated by NGOs.

It has been strongly recommended to produce regional photo guides including pictures of all litter items on the regional survey protocol. This will assist in the correct identification and allocation of recorded items.

Size limits and classes of items to be surveyed

There are no upper size limits to litter recorded on beaches.

The lower limit of detection, when walking a beach, is probably somewhere around 0.5 cm (plastic pellets), however, it is doubtful that such small items can be monitored effectively using the standard protocol for Marine Litter and in a repeatable fashion during beach surveys.

A lower limit of 0.5 cm in the longest dimension is recommended for litter items monitored during beach surveys. This would ensure the inclusion of caps & lids and cigarette butts in any counts.

Removal and disposal of litter

Removal of litter should be carried out at the same time as monitoring the litter. Coupling removal with monitoring ensures better accuracy of reporting and enables comparison of litter accumulation over time; It also has the added advantage of leaving a clean beach. It is important to note that only the 100m ref section(s) need to be monitored and cleaned. Further areas of a beach can be cleaned without monitoring if surveyors/volunteers wish to do so.

The litter collected should be disposed of properly. Regional or national regulations and arrangements should be followed. If these do not exist local municipalities should be informed.

Larger items that cannot be removed (safely) by the surveyors should be marked, with for example paint spray (for marking trees) so they will not be counted again at the next survey.

Many municipalities will have their own cleaning programme, sometimes regularly, sometimes seasonal or incident related. Arrangements should be made with the local municipalities so that they either exclude the reference beach from their cleaning scheme or they provide their cleaning schedule so surveying can be carried out a few days before the municipality will clean the beach.

Preferably a set time should be established for each beach between the date when the beach was last cleaned and the date when the survey is carried out. It is advisable to contact the municipality before starting a survey to obtain the latest information on beach cleaning activities. Sometimes an incident, for example a storm, will alter their cleaning programme.

3.4. Quality Assessment /Quality Control for beach litter

Based on the UNEP Guidelines (Cheshire et al., 2009), any long-term marine litter assessment programme will require a specific and focussed effort to recruit and train field staff and volunteers. Consistent, high quality training is essential to ensure data quality and needs to explicitly include the development of operational (field based) skills. Staff education programmes should incorporate specific information on the results and outcomes from the work so that staff and volunteers can understand the context of the litter assessment programme.

Quality assurance and quality control should be primarily targeted at education of the field teams to ensure that litter collection and characterization is consistent across surveys. Investment in communication and the training of the country/regional and local survey coordinators and managers is thus critical to survey integrity.

The quality assurance protocol of Ocean Conservancy's National Marine Debris Monitoring Program (USA) required a percentage of all locations to be independently re-surveyed immediately following the scheduled assessment of litter (Sheavly, 2007). The collected litter from the follow-up survey could then be added to that of the main collection and could be used to provide an estimate of the error level associated with the survey.

3.5. Conclusion

In order to enable temporal and spatial comparisons within and across regions, standard litter survey methods should, where possible, be applied at all levels (local to regional) and the assessment of its composition follows agreed categories of items.

4. Monitoring of litter at the sea (Common Indicator 23 Trends in the amount of litter in the water column including microplastics and on the seafloor)

Note: Because of the low occurrence of litter in midwater, it is recommended that the indicator focus on surface and seafloor litter

4.1. Introduction to floating litter

There exists early documentation of the occurrence of man-made objects, mainly plastic, floating at sea (Venrick 1972, Morris, 1980). While significant actions in waste management and disposal have been taken, floating litter is still a concern. It poses a direct threat to fish, marine mammals, reptiles and birds. Harm can occur through ingestion of whole items or pieces or by feeding on larger litter items. Entanglement can occur by floating bags, nets and other fishing gear. It can be assumed that marine macro litter is a precursor of marine micro litter.

4.2. Scope and key questions to be addressed

Monitoring of litter at open sea and on long transects, is not currently addressed as this requires different approaches, in particular regarding the observation conditions provided by the ships used for the surveys and regarding the possibility to monitor smaller items.

The fraction of litter under discussion, includes floating items in the water column close to the surface, as caused e.g. by the temporary mixing of floating particles under the water surface due to wave action. Litter in the deeper water column is currently not recommended for routine monitoring and should be subject of research efforts.

4.3. Existing approaches for visual ship-based observation of floating litter

HELMEPA (Hellenic Mediterranean Protection Association) uses a fleet of ocean going member vessels on a voluntary basis to obtain monitoring data through a reporting sheet. The EcoOcéan Institut is performing monitoring of floating litter in parallel with monitoring of marine mammals in the north-western Mediterranean Sea. UNEP guidance considers both sampling of an area through a dedicated observation pattern and transect sampling for monitoring of surface floating litter (UNEP, 2009).

4.3.1. Discussion of observation protocol elements

The observation of floating marine litter from ships is subject to numerous variables in the observation conditions. They can be divided into operational parameters, related to the ship properties and observation location.

The processing of the collected information, starting from the documentation on board, its compilation, elaboration and further use should be part of a protocol in order to derive comparable final results. The format should allow a compilation across different observing institutes and areas or regions. This would allow a plotting of floating litter distribution over time and thus finally allow the coupling with oceanographic current models.

4.4. Strategy for monitoring of floating litter

4.4.1 Source attribution of floating marine litter

Due to the observation methodology, the source attribution for floating litter is challenging. The type of marine litter objects can only be noted during very short visual observation. Therefore, in difference to beach litter, it is likely that only rough litter categories can be determined.

The spatial distribution of floating marine litter instead gives, in combination about currents, and river information indications about the physical source, i.e. the litter input zone and its pathway, which is very valuable information about source strength and may help to design appropriate measures and check their efficiency.

The monitoring of floating litter is very likely to be an iterative process during which in an initial phase hot spots and pathways are determined, while in an evolving monitoring programme selected transects help with the quantification of trends.

4.4.2. Spatial distribution of monitoring

The monitoring of floating marine litter by human observers is a methodology indicated for short transects in selected areas. In a region with little or no information about floating marine litter abundance it might be advisable to start by surveys in different areas in order to understand the variability of litter distribution. The selected areas should include expected low density areas (*e.g.* open sea) as well as expected high density areas (*e.g.* close to ports). This will help to obtain maximum/minimum conditions and train the observers. Other selected areas (*e.g.* in estuaries), in the vicinity of cities, in local areas of touristic or commercial traffic, incoming currents from neighbouring areas or outgoing currents should be considered.

Based on the experience obtained in this initial phase, a routing programme including areas of interest should then be established.

4.4.3. Timing of floating marine litter monitoring

The observation of floating marine litter is much depending on the observation conditions, in particular on the sea state and wind speed. The organization of monitoring must be flexible enough to take this into account and to re-schedule observations in order to meet appropriate conditions. Ideally the observation should be performed after a minimum duration of calm sea, so that there is no bias by litter objects which have been mixed into the water column by recent storms or heavy sea.

The initial, investigative monitoring should be performed with a higher frequency in order to understand the variability of litter quantities in time. Even burst sampling, *i.e.* high sampling frequency over short period, might be appropriate in order to understand the variability of floating marine litter occurrence.

For trend monitoring the timing will depend on the assumed sources of the litter, this can be *e.g.* monitoring an estuary after a rain period in the river basin, monitoring a touristic area after a holiday period.

The timing of the surveys will also depend on the schedule of the observation platforms. Regular patrols of coast guard ships, ferry tracks or touristic trips may offer frequent opportunities which thus also allow the use during the needed calm weather conditions.

4.5. Visual monitoring of floating litter

The reporting of monitoring results requires the grouping into categories of material, type and size of litter object. The approach for categories of floating litter is linked with the development of a “master list” with the categories for other environmental compartments such as the “master list” prepared by the TSG-ML. This allows cross comparisons.

The categories of items for floating litter should be, as far as practical, consistent with the categories selected for beach litter, seafloor litter and others. There are limitations to this, but in principal the derived data should allow a comparison across different environmental compartments, in particular between beach and surface floating litter. Therefore the list of item categories that should be adopted for floating litter corresponds to the Master List of items. For the practical use during the monitoring the list has to be arranged by object occurrence frequency so that the data acquisition can be done in the required short time. Tablet computer applications for facilitating the data documentation are under development.

As floating litter items will be observed but not collected, the size is the only indicative parameter of the amount of plastic material that it contains. The size of an object is defined here as its largest dimension, width or length, as visible during the observation.

The lower size limit for the observations is determined by the observation conditions. These should be harmonized so that a lower limit of 2.5 cm can be achieved. That size appears to be reasonable for observation from “ships-of-opportunity” and is in line with the size for beach litter surveys. This denotes that observations not achieving this minimum size limit cannot be recommended.

For reporting purposes size range classes must be introduced as visual observation will not permit the correct measuring of object sizes. Only the estimation of size classes is feasible.

The size determination/reporting scheme should enclose the following classes:

- 2.5 – 5 cm
- 5 - 10 cm
- 10 – 20 cm
- 20 – 30 cm
- 30 – 50 cm

While also wider size range classes (*e.g.* 2.5–10cm, 10–30cm, 30–50 cm) could be utilized, it will be important that a common approach is used, as the data will be combined in common data bases. The test phase of implementing a monitoring protocol should allow the determination of overall accepted and final size range classes. The upper size limit will have to be determined by statistical calculations regarding the density of the object occurrence in comparison to transect width, length and frequency. In coherence with the beach litter surveys an upper limit of 50 cm is here provisionally proposed. It has to be evaluated in experiments and from initial data sets if items larger than 50 cm should be reported, as their relevance in the statistical evaluation of data from short and narrow coastal transects might be questionable.

4.6. Visual monitoring of floating litter

A harmonized approach for the quantification of floating marine litter by ship-based observers has been developed by the TSG-ML. It has the scope to harmonize the monitoring of floating marine litter:

- In the size range from 2.5 to 50 cm,
- Observation width needs to be determined according to observation set-up,

- It is planned for use from ships of opportunity,
- It is based on transect sampling,
- It should cover short transects, and
- Also record necessary metadata.

4.6.1. Observation

The observation from ships-of-opportunity should ensure the detection of litter items at 2.5 cm size. The observation transect width will therefore depend on the elevation above the sea, the ship speed and the observation conditions. Typically a transect width of 10 m can be expected, but a verification should be made and the width of the observation corridor chosen in a way that all items in that transect and within the target size range, can be seen. Table 10.1 below provides a preliminary indication of the observation corridor width, with varying observation elevation and speed of vessel (kn = knot = nautical mile/h). The parameters need to be verified prior to data acquisition.

The ideal location for observation will often be in the bow area of the ships. If that area is not accessible, the observation point should be selected so that the target size range can be observed, eventually reducing the observation corridor, as ship induced waves might interfere with the observations. An inclinometer can be used to measure distances at sea (Doyle, 2007).

Table 4.6.1: Width of "observation corridor" based on observation height and ship speed (to be reviewed)

Observation elevation above sea	Ship speed 2 knots = 3.7 km/h	6 knots =11.1 km/h	10 knots = 18.5 km/h
1 m	6m	4m	3m
3m	8m	6m	4m
6m	10m	8m	6m
10m	15m	10m	5m

The protocol will have to go through an experimental implementation phase during which it is applied in different sea regions by different institutions, its practicality is tested and feedback for definition of observation parameters is provided.

The observation, quantification and identification of floating litter items must be made by a dedicated observer who does not have other duties contemporaneously. Observation for small items and surveying intensively the sea surface leads to fatigue and consequently to observation errors. The transect lengths should therefore be selected in a way that observation times are not too long. Times of 1 h for one observer could be reasonable, corresponding to a length of a few kilometres.

4.6.2. Reporting of monitoring results

A harmonized reporting of monitoring results is crucial for the comparison of data. The data output from the application of the protocol, when using a computer interface, is a list of geo-referenced objects according to a list of categories. The use of a portable computer device for documenting marine floating litter has clear advantage over paper documents. A specific application, based on the TSG -ML protocol for the monitoring of floating macro litter will be developed by JRC and field tested within the PERSEUS project.

It is not uncommon that floating litter items appear grouped, either because they have been released together or because they accumulate on oceanographic fronts. The reporting system should acknowledge this and foresee a way to report such groups. The occurrence of such accumulation areas needs to be considered when evaluating the data.

For floating marine litter the unit of reporting will be: items/km². The data will be available for the different categories and size classes. They can then be aggregated at different levels for providing overview data.

Along with the litter occurrence data, a series of metadata should be recorded, including geo-referencing (coordinates) and wind speed (m/s). This accompanying data shall allow the evaluation of the data in the correct context.

4.6.3. Quality assessment/Quality control

The widespread acquisition of monitoring data will need some kind of inter-comparison or calibration in order to ensure comparability of data between different areas and over time, for trend assessments. Approaches for this should be developed and implemented. This can be hands (eyes)–on training courses with comparisons of observations. Such events should be organized at Regional level with further implementation at national scale.

A methodology for calibrating observation quality by artificial targets may be devised through research efforts.

4.6.4. Equipment

The equipment used for the monitoring of floating litter is very limited. Besides the transportation platform some instruments may facilitate the work:

- A system for visually marking the observation area,
- GPS for determination of ship speed and geographical coordinates,
- A tablet PC (with GPS) for documenting the results (including a dedicated application/program),
- A system for training and calibrating size classification.

4.6.5. Implementation of the TSG-ML Protocol

The finalization and wide acceptance of the protocol proposed by TSG –ML will require an experimental testing period during which observation parameters and reporting approaches are being studied on a wide range of ships and conditions, covering different regional seas. This can be achieved through the ECAP implementation process and through dedicated activities in research projects, such as PERSEUS. Resulting data can be used for adjusting the protocol. Once the protocol parameters, such as standardized size ranges, categories and observation conditions are confirmed, a final version can be prepared. The final protocol should be widely disseminated and accompanied by activities for its implementation. Training courses and workshops can contribute to the harmonized acquisition of comparable datasets.

4.7. Other methodologies

<u>Open sea surveys</u>

While the proposed protocol is aiming at coastal surveys, there are also approaches for monitoring of litter from large, seagoing vessels. While covering large areas, these surveys face considerably different observation conditions and therefore different observation protocols.

Aerial surveys

The opportunistic use of aerial surveys (e.g. for marine mammal observation/monitoring) has been considered. The minimum size of observed objects is at ca. 30 cm, therefore this approach might be adequate to the size fraction above 30 cm considered by the TSG-ML.

Net tow surveys for macro litter

Physical sampling of floating macro litter requires large net openings operated at the sea surface. Given the density of larger macro litter items occurrence this would require significant dedicated ship time and specific equipment. This method is applicable for floating micro litter. There should be methodological research on how to cover the size range between 5 mm and 2.5 cm, which is very relevant to ingestion by marine biota.

Riverine litter monitoring

While not envisaged in the current litter monitoring framework, the TSG –ML protocol is equally well applicable for the monitoring of floating litter on rivers as an indication of a potential source of loads of litter to the marine environment, by observation from bridges or similar platforms.

New methodologies

Closely related to the monitoring by human visual observation is the monitoring through image acquisition by digital camera systems and their subsequent analysis by image recognition techniques. Such is the Sealittercamera, which is being developed by the EC JRC, a system being temporarily deployed on Costa Crociere cruise ships in the Western Mediterranean Sea (Hanke, 2011, publication in preparation).

4.8. Conclusions

Key messages to the ECAP implementation process:

- The monitoring of floating marine litter in selected coastal transects is recommended
- Monitoring Marine Litter suspended in the middle water column is not recommended
- Monitored size categories should include a range covering relevant small items
- Monitoring of floating litter should follow a specific protocol agreed on a Regional scale within the ECAP/UNEP/MAP MED POL monitoring implementation process

5. Seafloor Litter (Common Indicator 23, Trends in the amount of litter in the water column including microplastics and on the seafloor)

5.1. Introduction to seafloor litter

The most common approaches to evaluate sea-floor litter distributions use opportunistic sampling. This type of sampling is usually coupled with regular fisheries surveys (marine reserve, offshore platforms, etc.) and programmes on biodiversity, since methods for determining seafloor litter distributions (e.g. trawling, diving, video) are similar to those used for benthic and biodiversity assessments. The use of submersibles or Remotely Operated Vehicles (ROVs) is a possible approach for deep sea areas although this requires expensive equipment. Monitoring programmes for demersal fish stocks, undertaken as part of the Mediterranean International Bottom Trawl Surveys (MEDITS), operate at large regional scale and provide data using a harmonized protocol, which may provide a consistent support for monitoring litter at Regional scale on a regular basis and within the ECAP requirements.

5.2. Scope and key questions to be addressed

For shallow waters, the monitoring of litter on the seafloor may not be considered for all coastal areas because of limited resources. In these areas the strategy is to be determined by each contracting Party at national level, depending on the priority areas to be monitored. Opportunistic approaches may be used to minimize costs. Valuable information can be obtained from on-going monitoring of benthic species in protected areas, during pipeline camera surveys, cleaning of harbours and through diving activities. Additional monitoring might have to be put in place to cover all areas creating a consistent monitoring network. The sampling strategy should enable the generation of good detail of data, in order to assess most likely sources, the evaluation of trends and the possibility of evaluating the effectiveness of measures. The TSG-ML proposes simple protocols based on existing trawling surveys and two alternative protocols based on diving and video imagery which fit with the ECAP requirements and support harmonisation at Regional level, if applied trans-nationally.

Trawling (otter or beam trawl) is an efficient method for large scale evaluation and monitoring of sea-floor litter. The monitoring strategy for sea-floor can efficiently be based on on-going monitoring already developed at Regional level. It must be noted, however, that the geomorphology may impact the accumulation of litter in the seafloor and some sampling restrictions in rocky areas (incompatible with trawling) may lead to underestimation of the quantities present. Designing and developing an adequate monitoring programme will have to take account of these limits. Existing fisheries stock assessment programmes are covering most Regional Seas.

Only some countries will have to consider deep sea areas in terms of monitoring of sea-floor litter. The strategy is to be determined by each Contracting Party at national level, depending on affected areas but previous results indicate that priority should be given to coastal canyons. Protocols based on video imagery are the only approaches to monitor deep sea areas. These protocols are based on the use of (ROVs)/submersibles. As litter accumulates and degrades slowly in deep sea waters, a multiyear evaluation will be sufficient.

5.3. Monitoring the shallow sea-floor (<20m)

The most commonly used method to estimate marine litter density in shallow coastal areas is to conduct underwater visual surveys with SCUBA/snorkelling. These surveys are best based on line transect surveys of litter on the sea-floor, which is derived from UNEP (Cheshire, 2009). The protocol is actually in use for evaluation of benthic fauna. It requires SCUBA equipment and trained observers. Only litter items above 2.5 cm are considered, between 0 and 20 m (to 40 meters with skilled divers).

5.3.1. Technical requirements

<u>Frequency</u>

The minimum sampling frequency for any site should be annually. Ideally it is recommended that locations are surveyed every three months (allowing an interpretation in terms of seasonal changes).

<u>Transects</u>

Surveys are conducted through 2 line transects for each site. Unbiased design-based inference requires allocating the transects randomly in the study area or on a grid of systematically spaced lines randomly superimposed. However, with a model-based approach like density surface modelling (DSM), it is not required that the line transects are located according to a formal and restrictive survey sampling scheme, although good spatial coverage of the study area is desirable. Line transect are defined with a nylon line, marked every 5 meters with resistant paints, that is deployed using a diving reel while SCUBA diving.

Individual litter within 4 m of the line (half of the width –Wt - of the line transects) are recorded. For each observed litter item, when possible, the corresponding line segment of occurrence and its perpendicular distance from the line (yi - for the estimation of detection probability, measured with the use of a 2 m plastic rod), and litter size category (wi) are recorded. The nature of the bottom/habitat is also recorded. The length of the line transects vary between 20 and 200 m, depending on the depth, the depth gradient, the turbidity, the habitat complexity and the litter density (Katsavenakis, 2009). Results are expressed in litter density (items/m^2 or items/ 100 m^2).

Detectability

In distance sampling surveys, detectability is used to correct abundance estimations (Katsavenakis, 2009). The standard software for modelling detectability and estimating density/abundance, based on distance sampling surveys, is DISTANCE (Thomas et al., 2006).

5.3.2. Use of volunteers in shallow waters surveys

Recreational and professional scuba divers can provide valuable information on litter they see underwater and they are uniquely positioned to support benthic litter monitoring efforts. They can access, have the skills and the equipment needed to collect, record, and share information about litter they encounter underwater. Many dive clubs and dive shops organize underwater clean-ups, often in partnerships with NGOs or local governments. Many of these events, when managed, can be a valuable source of information and possibly be a part of a regular survey, monitoring or even assessment efforts while using volunteers.

For some Contracting Parties use of volunteer divers might be a good opportunity for shallow-water litter monitoring but standardization and conformity with common methodologies and tools such as those propose by TSG-ML should be achieved. Fixed sites, common frequency and sampling methodology can be easily established by each Contracting Party and training, material distribution etc. can be achieved relatively easily when partner NGOs or research institutions are involved.

5.4. Monitoring the Sea-floor (20-800m)

From all the methods assessed, trawling (otter trawl) has been shown to be the most suitable for large scale evaluation and monitoring (Goldberg, 1995, Galgani et al., 1995, 1996, 2000). Nevertheless there are some restrictions in rocky areas and in soft sediments, as the method may be restricted and/or underestimate the quantities present. This approach is however reliable, reproducible, allowing statistical processing and comparison of sites. As recommended by UNEP (Cheshire, 2009), sites should be selected to ensure that they (i) Comprise areas with uniform substrate (ideally sand/silt bottom); (ii) consider areas generating/accumulating litter, (iii) avoid areas of risk (presence of munitions), sensitive or protected areas; (iv) do not impact on any endangered or protected species.

Sampling units should be stratified relative to sources (urban, rural, close to riverine inputs) and impacted offshore areas (major currents, shipping lanes, fisheries areas, etc.).

General strategies to investigate seabed litter are similar to methodology for benthic ecology and place more emphasis on the abundance and nature of items (e.g. bags, bottles, pieces of plastics) rather than their mass. The occurrence of international bottom trawls surveys such as MEDITS

(Mediterranean/Black Sea) provide useful and valuable means for monitoring marine litter. These are using common gears depending on region (MEDITS net in the Mediterranean) and provide some harmonized and common conditions of sampling (20 mm mesh, 30-60 min tows, large sampling surface covered) and hydrographical and environmental information (surface & bottom temperature, surface & bottom salinity, surface & bottom current direction & speed, wind direction & speed, swell direction and height). More than 20 sampling units are sampled within each region as recommended by UNEP (Cheshire, 2009).

Therefore, the TSG-ML strongly recommends using these on-going and continuous programmes to collect data on marine litter in the sea-floor. This will enable to compare data from one country to another and to evaluate transnational transportation.

Technical Requirements

The protocol of the TSG-ML for sampling and trawling margins (20-800m) has been standardized for each region:

Mediterranean and Black Seas

For the Mediterranean Region, the protocol is derived from the MEDITS protocol (see the protocol manual, Bertran et al., 2007). The hauls are positioned following a depth stratified sampling scheme with random drawing of the positions within each stratum. The number of positions in each stratum is proportional to the surface of these strata and the hauls are made in the same position from year to year. The following depths (10 – 50; 50 – 100; 100 – 200; 200 – 500; 500 - 800 m) are fixed in all areas as strata limits. The total number of hauls for the Mediterranean Sea is 1385; covering the shelves and slopes from 11 countries in the Mediterranean.

The haul duration is fixed at 30 minutes on depths less than 200m and at 60 minutes at depths over 200m (defined as the moment when the vertical net opening and door spread are stable), using the same GOC 73 trawl with 20 mm mesh nets (Bertran et al, 2007) and sampling between May and July, at 3 knots between 20 and 800 m depth.

Detecting trends

Consistency of results is based on sampling strategy and monitoring efforts. Long term monitoring of litter on the sea floor has been performed in Spain and France. In some cases such as the margins of gulf of Lion (France), trends studies (70 Stations, depth 40-800m,) indicated a statistically significant decrease [Abundance (10-4) = 0.038 x (Year) + 1.062 (R2 =0.36)] enabling the measurement of 15% decrease in 15 years.

However, Power Analysis of IBTS related sampling by Cefas indicates that detection of a 10% change over 5 or 10 years is unlikely without massive sample sizes. However, 50% changes over 5 or 10 years look to be readily detectable with current designs based on fish stock surveys such as IBTS.

Data recording and Management

Templates for data recording have been integrated in MEDITS Manuals . Data on litter should be collected on these templates using items categories such as those listed for Sea-floor prepared by TSG-ML. Other elements from the haul operations should be also recorded – See MEDITS for the Mediterranean/Black Sea.

Data on litter should be reported as items/ha or items/km2 before further processing and reporting.

5.5. Litter categories for Sea-floor

As marine litter degradation is affected by light, oxygen and wave action, the persistence of marine litter on the sea floor and deep sea floor is increased with notable outcomes on the nature of litter found. Another important factor influencing the composition of benthic litter is related to the type of activity. Typically, the analysis of sources indicated the importance and differences between ship based litter, as in the Southern North Sea, and land based litter such as in the Mediterranean. The definition of categories will have to take this in account when defining a protocol. Although marine litter is strongly affected by transportation, fishing has been shown as a main source of litter in some fishing or aquaculture grounds. Similarly specific types of marine litter were also found in areas affected by tourism, around beaches, as in the Mediterranean Sea. This may affect the strategy for monitoring selected areas, such as shallow waters.

A standardized litter classification system has been defined for monitoring the sea floor by TSG-ML. The categories were defined in accordance with types of litter found at regional level, enabling common main categories for all regions. The main categories have a hierarchical system including sub categories. It considers 4 main categories of material for the Mediterranean (wood, paper/cardboard, other, unspecific). There are various subcategories for a more detailed description of litter items. Other specific categories may be added by Contracting Parties and additional description of the item may provide added-value, as long as the main categories and sub-categories are maintained. Furthermore, the weight, picture and note of potential attached organisms may further complement the classification of items.

Other parameters

Site information and trawling sampling characteristics such as date, position, type of trawl, speed, distance, sampled area, depth, hydrographical and meteorological conditions should be recorded

Data-sheets should be filled out for each trawl and compiled by survey. If multiple counts (transects/observers) are run at any given site then a new sheet should be used for each trawl shot. After each survey data must be aggregated for analysis and reporting.

5.6. Complementary sea-floor monitoring – Video camera

Large-scale evaluations of marine litter in the deep sea-floor are scarce because of available resources to collect data. Special equipment is necessary including ROVs and/or submersibles that may be very expensive to operate, especially in deep sea areas.

Towed video camera for shallow waters (Lundqvist, 2013) or ROVs for deeper areas are simpler and generally cheaper and must be recommended for litter surveys. There are some available protocols where litter is counted on routes and expressed as item/km, especially when using submersibles/ROVs at variable depths above the deep sea floor (Galgani et al., 1996) however technology enables the evaluation of densities trough video-imagery using a standardized approach especially for shallow waters.

5.7. Quality Assessment /Quality Control for sea-floor litter

Several Contracting Parties from UNEP/MAP MED POL have indicated they will use their fish stock surveys for benthic litter monitoring. This is considered to be an adequate approach although quantities of litter might be underestimated, given restrictions in some areas. The adoption of a common protocol will lead to a significant level of standardization among the Contracting Parties countries that apply this type of sampling strategy.

Data on litter in shallow sea-floor are collected through protocols already validated for benthic species.

Until now, no quality assurance programme has been considered for litter monitoring on the sea-floor. For MEDITS, sampling data are collected in the DATRAS database and participate in data quality checking for hydrographical and environmental conditions. This process may also support quality insurance for data on litter. Currently, there are on-going discussions on how to organize and harmonize a specific system to collect, validate and organize data through a common platform, enabling the review and validation of data. MEDITS has included litter data to be analysed within a specific sub-group.

5.8. Conclusions

Considering opportunities to couple monitoring efforts may be the best approach to monitor litter on the sea-floor.

There may be other opportunities to couple marine litter surveys with other regular surveys (monitoring in marine reserves, offshore platforms, etc.) or programmes on biodiversity.

6. Litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles (Litter in Biota, Candidate Common Indicator 24, Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds and marine turtles)

Note: Due to the availability of protocols and the state of knowledge, it is recommended that the indicator focus on the sea turtle *Caretta caretta*

6.1. Scope and key questions to be addressed

In the North Sea, an indicator is available, which expresses the impact of marine litter (OSPAR EcoQO). It measures ingested litter in Northern Fulmar and it is used to assess temporal trends, regional differences and compliance with a set target for acceptable ecological quality in the North Sea area (Van Franeker et al., 2011). A combined protocol is proposed by TSG-ML which can be used for seabirds in general, e.g. to be applied in regular monitoring for shearwaters in parts of the Mediterranean.

However alternative tools are needed for the Mediterranean Sea. On the basis of available information and expertise, a monitoring protocol for marine litter in sea turtles with focus on relevant parameters for application in the Mediterranean is proposed by TSG-ML The approach taken for the development of the protocols for ingestion consists of the application of the same categorization of marine litter for all ingestion studies of vertebrates. The applied standard categories follow the existing fulmar methodology, in which a number of plastic categories is counted, and weighted as a unit.

Additionally further knowledge is being compiled on the occurrence of entanglement events in marine organisms. Based upon these findings a harmonized protocol for the assessment of the use of plastic litter as nesting material and associated entanglement mortality in birds breeding colonies including shearwater is proposed by the TSG-ML for immediate application.

Entanglement in beached animals, entanglement in live animals (others than in relation to seabird nests), ingestion of litter by marine mammals, ingestion of litter by marine invertebrates and research on food chain transfer are reflected in the final report of the TSG-ML. However only ingestion of and entanglement in marine litter by marine mammals are considered by the TSG-ML for further development whereas the other aspects are crucial issues for research but not suitable to be recommended for wide monitoring application at this stage.

6.2. Seabirds

The methodology of the tool proposed by the TSG-ML follows the OSPAR Ecological Quality Objective (EcoQO) methods for monitoring litter particles in stomachs of northern fulmars (Fulmarus glacialis). The stomach contents of birds beached or otherwise found dead are used to measure trends and regional differences in marine litter. Background information and the technical requirements are described in detail in documents related to the fulmar EcoQO methodology. A pilot study evaluating methods and potential sources of bias was conducted by Van Franeker & Meijboom (2002). Bird dissection procedures including characters for age, sex, cause of death etc. have been specified in Van Franeker (2004). Further OSPAR EcoQO details were given in OSPAR (2008, 2010a, b) and in Van Franeker et al., (2011a, 2011b).

Related marine compartments:

Seabirds like fulmars or shearwaters are feeding on the surface of the sea. Therefore the water column and especially the water surface is the marine compartment addressed when quantifying litter in the stomachs of fulmars.

6.2.1. Technical requirements

Bird corpses are stored frozen until analysis. Standardized dissection methods for Fulmar corpses have been published in a dedicated manual (Van Franeker, 2004) and are internationally calibrated during annual workshops. Stomach content analyses and methods for data processing and presentation of results were described in full detail in Van Franeker & Meijboom (2002) and updated in later reports. The methodology has been published in peer reviewed scientific literature (van Franeker et al., 2011a, b). For convenience, some of the methodological information is repeated here in a condensed form.

At dissections, a full series of data is recorded to determine sex, age, breeding status, likely cause of death, origin, and other issues. Age, the only variable found to influence litter quantities in stomach contents, is largely determined on the basis of development of sexual organs (size and shape) and presence of Bursa of Fabricius (a gland-like organ positioned near the end of the gut which is involved in immunity systems of young birds; it is well developed in chicks, but disappears within the first year of life or shortly after). Further details are provided in Van Franeker 2004.

After dissection, stomachs of birds are opened for analysis. Stomachs of Fulmars have two 'units': initially food is stored and starts to digest in a large glandular stomach (the proventriculus) after which it passes into a small muscular stomach (the gizzard) where harder prey remains can be processed through mechanical grinding. For the purpose of most cost-effective monitoring, the contents of proventriculus and gizzard are combined, but optional separate recordings should be considered where possible.

Stomach, contents are carefully rinsed in a sieve with a 1mm mesh and then transferred to a petri dish for sorting under a binocular microscope. The 1 mm mesh is used because smaller meshes become easily clogged with mucus from the stomach wall and with food-remains. Analyses using smaller meshes were found to be extremely time consuming and particles smaller than 1 mm seemed rare in the stomachs, contributing little to plastic mass.

If oil or chemical types of pollutants are present, these may be sub-sampled and weighed before rinsing the remainder of stomach content. If sticky substances hamper further processing of the litter objects, hot water and detergents are used to rinse the material clean as needed for further sorting and counting under a binocular microscope.

<u>Litter Categories – source related information</u>

In the Fulmar EcoCO, stomach contents are sorted into categories, and this categorisation is followed for marine biota monitoring ingestion in seabirds, marine turtles and fish.

The fulmar categorisation of stomach contents is based on the general 'morphs' of plastics (sheet-like, filament, foamed, fragment, other) or other general rubbish or litter characteristics. This is because in most cases, particles cannot be unambiguously linked to particular objects. But where such is possible, under notes in datasheets, the items should be described and assigned a litter category number using as master list, such as the "Master List" developed by the TSG ML group.

For each litter category/subcategory an assessment is made of:

1) incidence (percentage of investigated stomachs containing litter);

2) abundance by number (average number of items per individual), and

3) abundance by mass (weight in grams, accurate to 4th decimal)

Because of potential variations in annual data, it is recommended to describe 'current levels' as the average for all data from the most recent 5-year period, in which the average is the 'population average' which includes individuals that were found to have zero litter in the stomach.

As indicated, EcoQO data presentation for Northern Fulmars is for the combined contents of glandular (proventriculus) and muscular (gizzard) stomachs. Results of age groups are combined except for chicks or fledglings which should be dealt with separately. Potential bias from age structure in samples should be checked regularly.

Size range

In the fulmar monitoring scheme, stomach contents are rinsed over a sieve with mesh 1 mm prior to further categorisation, counting and weighing. The size range of plastics monitored is thus ≥ 1 mm. Unpublished data on particle size details in stomachs of fulmars show that a smaller mesh size would not be of use because smaller items have passed into the gut.

Spatial coverage

Dead birds are collected from beaches or from accidental mortalities such as long-line victims; fledgling road kills etc. (for methodology see Van Franeker, 2004).

Survey frequency

Continuous sampling is required. A sample size of 40 birds or more is recommended for a reliable annual average for a particular area. However, also years of low sample size can be used in the analysis of trends as these are based on individual birds and not on annual averages. For reliable conclusions on change or stability in ingested litter quantities, data over periods of 4 to 8 years (depending on the category of litter) is needed.

Maturity of the tool

The method is mature and in use.

Regional applicability of the tool

The tool is applicable to the regions where fulmars occur; for similar seabird species such as any of the family of the tubenoses, the methodology can follow this approach. This could for example be applied to shearwater species occurring in the Mediterranean Sea.

6.2.2. Quality Assessment /Quality Control

The methodology referred to in this tool is based on an agreed OSPAR methodology which has been developed over a number of years with ICES and OSPAR and which has received full quality assurance by publication in peer reviewed scientific literature (Van Franeker et al., 2011a). The EcoQO methodology has been fully tested an implemented on Northern Fulmars *Fulmarus glacialis*, including those from Canadian Arctic and northern Pacific areas. All methodological details can be applied to other tubenosed seabirds (Procellariiformes) with no or very minor modifications. Trial studies are being conducted using shearwaters from the more southern parts of the north Atlantic and Mediterranean. In other seabird families, methods may have to be adapted as stomach morphology, foraging ecology, and regurgitation of indigestible stomach contents differ and can affect methodological approaches.

<u>Trend assessment</u>

In the Fulmar EcoQO, statistical significance of trends in ingested litter, i.e. plastics, is based on linear regression of ln-transformed data for the mass of litter (of a chosen category) in individual stomachs against their year of collection. ‘Recent’ trends are defined as derived from all data over the most recent 10-year period. The Fulmar EcoQO focuses on trend analyses for industrial plastics, user plastics, and their combined total.

6.3. Sea turtles

The stomach contents of stranded Loggerhead sea turtles Caretta caretta (Linnaeus, 1758) are used to measure trends and regional differences in marine litter. A recent pilot study evaluating methods and potential sources of bias was conducted during 2012 by ISPRA, CNR-IAMC Oristano, Stazione Zoologica Napoli; University of Siena, University of Padova, ArpaToscana.

Related marine compartments

Caretta caretta feeds in the water column and at the seafloor. Therefore these two marine compartments are addressed when quantifying litter in the stomachs of stranded Loggerhead sea turtles.

6.3.1. Technical requirements

The Loggerhead sea turtle *Caretta caretta* is a protected species (CITES Appendix I), therefore only authorized people can handle them.

Upon finding the animal, its discovery should be reported to the main authorities and the operation of coordinated with the local authorities (depending on national law). Based on initial observations and if possible still at the place of discovery, some data should be recorded on an “Identification Data” Sheet. The animal should be transported to an authorized service centre for necropsy. In case the body is too decomposed, the integrity of the digestive tract should be assessed before disposal at the licensed contractor. If the necropsy cannot be carried out immediately after recovery, the carcass should be frozen at -16 ° C, in the rehabilitation facility.

Before the necropsy operation, morphometric measurements should be collected and recorded on an appropriate Data Sheet. External examination of the animal should be conducted, including inspecting the oral cavity for possible presence of foreign material. The methodology suggested in the TSG ML report could be followed to carry out a dissection of the animal to expose the gastrointestinal system (GI).

The following sampling procedure of GI contents can be applied to any section of the GI: the section of the GI should be placed in a graduated beaker of adequate size, pre-weighed on electronic balance (accuracy of ± 1g). The section of GI should be open and the contents emptied into the beaker with the help of a spatula, followed by the record of the net weight and volume of the content. The section of the GI should be observed and any ulcers or any lesions caused by hard plastic items should be recorded.

The contents should be inspected for the presence of any tar, oil, or particularly fragile material that must be removed and treated separately. The liquid portion, mucus and the digested unidentifiable matter should be removed, by washing the contents with freshwater through a filter mesh 1 mm, followed by a rinse of all the material collected by the filter 1mm in 70% alcohol and finally again in freshwater. The retained content should be enclosed in plastic bags or pots, labelled and frozen, not forgetting the sample code and corresponding section of the GI. Finally, the contents can then be sent for analysis.

NOTE: If the contents are stored in liquid fixative, note of the compound and the percentage of dilution should be noted and communicated to the staff in charge of further analysis.

For the analysis of the contents of the GI, the organic component should be separated from any other items or material (marine litter). The fraction of marine litter should be analysed and categorised with the help of a stereo-microscope, following the approach used in the protocol for ingestion in birds (Van Franeker et al., 2005; 2011b; Matiddi et al., 2011) and using a Standard Data-Sheet.

The fraction of marine litter should be dried at room temperature and the organic fraction at 30°C. Both fractions should be weighted, including the different categories of items identified within the marine litter fraction. The volume of the litter found should also me measured, through the variation of water level in a graduated beaker, when the items are immersed without air. If possible, different categories of "food" should also be identified. Otherwise, the dry contents should be kept in labelled bags and sent to an expert taxonomist.

An optional methodology for application for sampling litter excreted by live sea-turtles (faecal pellet analysis) in case of finding a specimen alive is recommended by the TSG-ML.

<u>Extraction of data</u>

Following the protocol for seabirds, abundance by mass (weight in grams, accurate to 3th decimal) is the main information useful for the monitoring programme.

Data entry is carried out using a Standard Form.

<u>Litter Categories - source related information</u>

For turtle analyses, stomach contents are sorted into the same categories as for birds. Following the method for seabirds, abundance by mass (weight in grams, accurate to 3th decimal) is the main information useful for the monitoring programme. Other information such as the colour of items, volume of litter, different type of litter, different incidence of litter in oesophagus, intestine and stomach, incidence and abundance by number per litter category, are useful for research and impact analysis.

<u>Size range</u>

≥1 mm (stomach contents are rinsed over 1 mm mesh sieve)

<u>Spatial coverage</u>

Dead sea turtles are collected from beaches or at sea from accidental mortalities such as victims of long-line fishing (by catch) or of boat collisions.

Survey frequency

Continuous sampling is required. Minimum sample population size for year and period of sampling must be established for reliable conclusions on change or stability in ingested litter quantities.

Maturity of the tool

The tool is not considered mature at this stage. Specific monitoring programmes are required.

Regional applicability of the tool

The tool is applicable to the Mediterranean Sea region.

6.3.2. Quality assurance/quality control

There is a lack of quality assurance/quality control (QA/QC) due to lack of long-term monitoring programmes. More publications in peer reviewed scientific literature are required.

Trend assessment

Specific long-term monitoring programmes are required.

Target definitions

Specific long monitoring programmes are required.

6.4. Considerations on further options for monitoring impacts of marine litter on biota

6.4.1. Entanglement rates among beached animals

Direct harm or death is more easily observed and thus more frequently reported for entanglement than for ingestion of litter. This applies to all sorts of organisms, marine mammals, birds, turtles, fishes, crustaceans etc.

It is, however, difficult from simply looking at the outside appearance of an animal to identify whether a particular individual has died because of entanglement in litter rather than from other causes, mainly entanglement in active fishery gear (by-catch). Nevertheless it is possible to differentiate between animals that have died quickly due to entanglement and sudden death in active fishing gear and those suffering a long drawn out death after entanglement in pieces of nets, string or other litter items, because entangled birds, which have been entangled for a time before death are emaciated.

Proportions of sea birds found dead with actual remains of litter attached as evidence for the cause of mortality are extremely low. The possible use of entangled beached birds as an indication of mortality due to litter will be further investigated by the TSG-ML[30].

In marine mammals, numbers of beached animals and especially cetaceans are often high and many have body marks suggesting entanglement, although remains of ropes or nets on the corpses are mostly rare. Given that in a number of places well working stranding networks are already in place, dead marine

[30] European shags which are using litter as nest materials and can entangle themselves in it (There is an ongoing work on an indicator “litter in shag nets, developed in Britain and then extended to the Normandy and Corsica in the context of the MSFD)

mammals should, whenever possible, become subject to pathologic investigations which need to include an assessment for the cause of disease and death and the relevance of marine litter in this connection.

This issue will be further investigated and the development of a dedicated monitoring protocol for the entanglement of marine mammals in marine litter will be considered in the next report of the TSG ML.

6.4.2. Ingestion of litter by marine mammals and entanglement.

Ingestion of litter by a wide range of whales and dolphins is known. Although known rates of incidences of ingested litter are generally low to justify a standard ECAP monitoring recommendation at this point, it can also be argued that the number of pathologically studied animals is low as well. Dead marine mammals should, whenever possible, become subject to pathologic investigations which need to include an assessment for the cause of disease and death and the relevance of ingested marine macro- and microlitter in this connection.

The development of a monitoring protocol for the ingestion of marine litter in the different size categories by marine mammals will therefore be considered in the next report of the TSG ML. Opportunistic monitoring of marine mammals is envisaged under the population demographic characteristics component of the EcAp biodiversity common indicators.

7. Microlitter (with special reference to microplastics)

7.1. Introduction to microlitter

In effect microparticles consist of similar materials to other types of litter; they are merely pieces of litter at the very small end of the size spectrum. Microparticles of a range of common material types including glass, metal, plastic and paper litter are undoubtedly present in the environment. The focus is on microplastics, implying that they are considered to be the most significant component of the microlitter in the environment. This statement is partly based on the frequency of reports of microplastics (Hidalgo-Ruz et al. 2012, but relative proportions of material types will be influenced by the physical conditions of the habitat sampled, for example metal and glass microlitter is not likely to be found at the sea surface.

When first described the term microplastic was used to refer to truly microscopic particles in the region of 20 µm diameter (Thompson et al. 2004. The definition has since been broadened to include all particles < 5 mm (Arthur et al. 2009. Microplastics are widely dispersed in the environment and are present in the water column, on beaches and on the seabed.

Under EcAp, it is considered that in order to achieve GES that the quantities of microplastics in the environment should not result in harm. When defining methodological criteria it is essential to recognise that our understanding of the potential impacts of microplastic on organisms and the environment (i.e. the ‘harm’ that they might pose from the perspective of EcAp) is still not fully understood.

An upper size bound of 5mm has been widely (but not exclusively) adopted and for the purpose of EcAp it is suggested that the upper bound to be taken to as items <5mm in their largest dimension as recommended by the TSG-ML. Current definitions do not explicitly state a lower size limit and lower size limits have seldom been reported for microplastic concentrations in the environment. The lower size limit is perhaps assumed to be the mesh size of the net or sieve through which the sample passed during the sampling, sample preparation or extraction. The size limits of microplastic particles that can be reported are also dependent on the method of detection, in many cases microscope-aided visual inspection. When identifying microparticles there are also size limits imposed by the analytical techniques employed (e.g. minimum sample intake requirements for detection and analysis). Hence an important part of establishing standard methods and protocols within EcAp will first be to define the appropriate size range, and this aspect is considered in the report of the TSG-ML.

After an initial period of discovery, microplastics research now finds itself at a stage of development where there is a lack of quality assurance/quality control (QA/QC) instruments available: e.g. no organisations yet offer proficiency training or testing, there have been no inter-laboratory studies, no certified reference materials are available, no standardized sampling and analysis protocols have been published, no accreditation certificates have been issued and some procedures in use have not yet been validated. Approaches for QA/QC will therefore be very useful for evaluating sources of variability and error and increasing confidence in the data collected.

Microplastics comprise a very heterogeneous assemblage of pieces that vary in size, shape, colour, specific density, polymer type, and other characteristics. For meaningful comparisons and to answer the specific questions and to test hypotheses through monitoring, it is important to define methodological criteria to quantify such metrics as for e.g. the abundance, distribution and composition of microplastics and to ensure sampling effort is sufficient to detect the effects of interest. Protocols to monitor microplastic in sediments, sea surface, and biota have been prepared by the TSG-ML. At present our understanding of the sources, distribution and fate of microplastics in the environment are very limited, as is our understanding of any associated effects on wildlife. As a consequence it is not possible to present fully validated standard operating procedures. Instead the TSG-ML presents recommendations for monitoring supported by a discussion of considerations and limitations according to the knowledge base at the time of writing. It considers monitoring design, sampling, analysis, reporting. The aim of the TSG-ML text is to maximise consistency and comparability of future data collection by recommending approaches.

7.2. General Sampling Methods

Sampling of microplastics in different main marine environments (sea surface, water column, sediment and biota) has been approached using a variety of methods: samples can be selective, bulk, or pre-treated to reduce their volume (Hidalgo-Ruz et al., 2012).

Most studies use a combination of these steps after which a purification step is required to sort the micro litter from natural particulates. Visual characterisation is the most commonly used method for the identification of microplastics (using type, shape, degradation stage, and colour as criteria). Chemical and physical characteristics (e.g., specific density) can also be used. However, the most reliable method is to identify the chemical composition of microplastics by infrared spectroscopy (Hidalgo-Ruz et al., 2012). This approach requires equipment that may be considered relatively costly compared to sampling of large items of debris.

In all four compartments (sea surface, water column, sediment and biota) the TSG-ML recommends quantifying microplastics in the size range 20µm to 5mm. Since the lower size limit is perhaps assumed to be the mesh size of the net or sieve through which he sample passed during the sampling, sample preparation or extraction, for sampling purposes this could in the majority of cases taken to be 330 µm. Microplastics should be categorised according to their physical characteristics including size, shape and colour. Categories used to describe microplastics appearance are available in the TSG M-L report. To achieve the greatest efficiency regarding sampling frequency it is recommended that microparticles be sampled alongside other routine sampling programmes. Sampling of the sea surface could be incorporated into routine monitoring programmes.

Sampling seawater for microplastics

Seawater samples have mostly taken by nets, the main advantage being that large volumes of water can be sampled quickly, retaining the material of interest. Most studies from surface waters have used Neuston nets and from the water column, zooplankton nets. Another instrument, that is deployed on a global scale and that has also been used for microplastic sampling is the continuous plankton recorder (CPR). The most relevant characteristics of the sampling nets are mesh size and the opening area of the net. Mesh sizes used for microplastic sampling range from 0.053 to 3 mm, with a majority of the studies (rather than individuals samples collected) ranging from 0.30 to 0.39 mm. The net aperture for rectangular openings of neuston nets (sea surface) ranged from 0.03 to 2.0 m^2. For circular-bongo nets (water column) the net aperture ranged from 0.79 to 1.58 m^2. The length of the net for sea surface samples has varied from 1.0 to 8.5 m, with most nets being 3.0 to 4.5 m long. Techniques using apparatus to collect seawater and pass it through a filter on-board ship are being developed where the ship water inlet is used, collecting seawater from the side at specified depths, mostly ranging between 4m and 1m depth. The seawater is passed through sieves or nets in closed containers after which these can be removed and analysed for microplastics.

A key consideration in collecting seawater samples is the cost of ship time. Hence the advantage to sample during existing cruises or from existing monitoring programmes such as the Continuous Plankton Recorder. Manta and bongo nets have been used at the sea surface. With nets it is important to deploy the trawl out of the wake zone as turbulence inside the wake zone does not allow for a representative sample to be collected. A spinnaker boom or ‘A’ frame may be used to deploy the trawl away from the side of the vessel. A close eye on the net while trawling would need to be kept to observe its performance and adjust speed and cable length if necessary. Sampling at the peak of plankton blooms should be avoided as this may clog the net.

Since most plastics are buoyant they are likely to accumulate at the sea surface. Surface sampling techniques can be used close inshore, but are restricted to calmer weather conditions, whereas CPR and other sub surface approaches can be used in rougher weather. High speed Manta trawls can be deployed in a range of sea states, but CPR is the least sensitive to sea state and samples at an average depth of around 6m. Manta trawls can be used to sample large volumes of surface water, but are relatively insensitive to smaller size fractions (< 1mm) which can be difficult to separate or sort form the large surface area of the net. CPR has a very much smaller aperture (around 1.6cm^2) and hence samples smaller quantities of water per km but can be deployed for much longer periods (distances) than the Manta trawl without clogging. With the CPR the entire filter is sealed automatically and then transferred to the laboratory for examination under the microscope. Preliminary data indicate CPR and Manta nets collect similar quantities of debris per unit volume of water sampled; however because of the larger aperture of nets such as Manta the quantity of debris collected per distance towed is substantially greater than CPR. During trawls it is important to maintain a steady linear course at a constant speed. A hi-speed manta trawl can be deployed up to 8 knots, building up the speed slowly towards maximum speed. Higher speeds reduce the ability to sieve seawater, creating a bow wake in front of the trawl. For surface samples, results are most often expressed as items/ meter square, because the vertical movements of neuston and manta nets do not enable estimations of net opening.

At present it is not appropriate to recommend one approach over all others. Each approach has advantages and disadvantages and may be preferable according to local availability / sampling opportunities, the characteristics of the area to be sampled. The recommendation of the TSG-ML is to obtain samples from sea water and to ensure the following details are recorded to accompany each sample: type of net, aperture, mesh size (preferably 333 µm mesh, 6m length for greatest inter-comparability among sampling programmes). It is not possible to specify standard haul duration as at some times of year, for example during a plankton bloom, nets may readily become clogged with natural material rendering them inefficient – a duration of 30 min is suggested and the duration of the trawl and the estimated water volume must be recorded. Samples from nets should be stored in glass jars taking care to rinse material as thoroughly as possible from the sides of the net using filtered sea water. Microparticles are recorded as the total quantity of such captured by the net during the period it is deployed.

The TSG-ML report provides detailed information on Laboratory analyses of microplastics samples collected in the field and detailed protocol for sampling surface waters.

ID	PLASTIC/POLYSTYRENE	Nº units
G1	4/6-pack yokes, six-pack rings	
G3	Shopping bags incl. pieces	
G4	Small plastic bags, e.g. freezer bags incl. pieces	
G5	Plastic bag collective role; what remains from rip-off plastic bags	
G7/G8	Drink bottles	
G9	Cleaner bottles & containers	
G10	Food containers incl. fast food containers	
G11	Beach use related cosmetic bottles and containers, e.g. Sunblocks	
G13	Other bottles & containers	
G14	Engine oil bottles & containers <50 cm	
G15	Engine oil bottles & containers >50 cm	
G16	Jerry cans (square plastic containers with handle)	
G17	Injection gun containers (including nozzles)	
G18	Crates and containers / baskets	
G19	Car parts	
G21/24	Plastic caps and lids (including rings from bottle caps/lids)	
G26	Cigarette lighters	
G28	Pens and pen lids	
G29	Combs/hair brushes/sunglasses	
G30/31	Crisps packets/sweets wrappers/ Lolly sticks	
G32	Toys and party poppers	
G33	Cups and cup lids	
G34/35	Cutlery and trays/Straws and stirrers	
G36	Fertiliser/animal feed bags	
G37	Mesh vegetable bags	
G40	Gloves (washing up)	
G41	Gloves (industrial/professional rubber gloves)	
G42	Crab/lobster pots and tops	
G43	Tags (fishing and industry)	
G44	Octopus pots	
G45	Mussels nets, Oyster nets including plastic stoppers	
G46	Oyster trays (round from oyster cultures)	
G47	Plastic sheeting from mussel culture (Tahitians)	
G49	Rope (diameter more than 1cm)	
G50	String and cord (diameter less than 1 cm)	
G53	Nets and pieces of net < 50 cm	
G54	Nets and pieces of net > 50 cm	

ID	PLASTIC/POLYSTYRENE	Nº units
G56	Tangled nets/cord	
G57/58	Fish boxes - plastic or polystyrene	
G59	Fishing line/monofilament (angling)	
G60	Light sticks (tubes with fluid) incl. Packaging	
G62/63	Floats for fishing nets/ Buoys	
G65	Buckets	
G66	Strapping bands	
G67	Sheets, industrial packaging, plastic sheeting	
G68	Fibre glass/fragments	
G69	Hard hats/Helmets	
G70	Shotgun cartridges	
G71	Shoes/sandals	
G73	Foam sponge	
G75	Plastic/polystyrene pieces 0 - 2.5 cm	
G76	Plastic/polystyrene pieces 2.5 cm - 50 cm	
G77	Plastic/polystyrene pieces > 50 cm	
G91	Biomass holder from sewage treatment plants	
G124	Other plastic/polystyrene items (identifiable) including fragments	
Please specify the items included in G124		
ID	**RUBBER**	Nº units
G125	Balloons and balloon sticks	
G127	Rubber boots	
G128	Tyres and belts	
G134	Other rubber pieces	
Please specify the items included in G134		
ID	**CLOTH**	Nº units
G137	Clothing / rags (clothing, hats, towels)	
G138	Shoes and sandals (e.g. Leather, cloth)	
G141	Carpet & Furnishing	
G140	Sacking (hessian)	
G145	Other textiles (incl. rags)	
Please specify the items included in G145		
ID	**PAPER / CARDBOARD**	Nº units

ID	PLASTIC/POLYSTYRENE	Nº units
G147	Paper bags	
G148	Cardboard (boxes & fragments)	
G150	Cartons/Tetrapack Milk	
G151	Cartons/Tetrapack (others)	
G152	Cigarette packets	
G27	Cigarette butts and filters	
G153	Cups, food trays, food wrappers, drink containers	
G154	Newspapers & magazines	
G158	Other paper items,including fragments	
Please specify the items included in G158		
ID	**PROCESSED / WORKED WOOD**	Nº units
G159	Corks	
G160/161	Pallets / Processed timber	
G162	Crates	
G163	Crab/lobster pots	
G164	Fish boxes	
G165	Ice-cream sticks, chip forks, chopsticks, toothpicks	
G166	Paint brushes	
G171	Other wood < 50 cm	
Please specify the items included in G171		
G172	Other wood > 50 cm	
Please specify the items included in G172		

ID	METAL	Nº units
G174	Aerosol/Spray cans industry	
G175	Cans (beverage)	
G176	Cans (food)	
G177	Foil wrappers, aluminium foil	
G178	Bottle caps, lids & pull tabs	
G179	Disposable BBQ's	
G180	Appliances (refrigerators, washers, etc.)	
G182	Fishing related (weights, sinkers, lures, hooks)	
G184	Lobster/crab pots	
G186	Industrial scrap	
G187	Drums, e.g. oil	
G190	Paint tins	

G191	Wire, wire mesh, barbed wire	
G198	Other metal pieces < 50 cm	
Please specify the items included in G198		
G199	Other metal pieces > 50 cm	
Please specify the items included in G199		

ID	**GLASS**	Nº units
G200	Bottles incl. pieces	
G202	Light bulbs	
G208	Glass fragments >2.5cm	
G210a	Other glass items	
Please specify the items included in G210a		

ID	**CERAMICS**	Nº units
G204	Construction material (brick, cement, pipes)	
G207	Octopus pots	
G208	Ceramic fragments >2.5cm	
G210b	Other ceramics items	
Please specify the items included in G210b		

ID	**SANITARY WASTE**	Nº units
G95	Cotton bud sticks	
G96	Sanitary towels/panty liners/backing strips	
G97	Toilet fresheners	
G98	Diapers/nappies	
G133	Condoms (incl. packaging)	
G144	Tampons and tampon applicators	
	Other sanitary waste	
Please specify the other sanitary items		
ID	**MEDICAL WASTE**	Nº units
G99	Syringes/needles	
G100	Medical/Pharmaceuticals containers/tubes	
G211	Other medical items (swabs, bandaging, adhesive plaster etc.)	
Please specify the items included in G211		

ID	**FAECES**	Nº units
G101	Dog faeces bag	

ID	PARAFFIN/WAX PIECES	Nº units
G213	Paraffin/Wax	

Presence of industrial pellets?	YES ☐ NO ☐

Presence of oil tars?	YES ☐ NO ☐

1. **Proposed baselines values (Rationale for this proposal presented in document UNEP(DEPI)/MED WG 417/Inf.15**

Indicator	minimum value	maximum value	mean value	Proposed baseline
16.**Beache**s (items/100 m)	11	3600	920	**450-1400**
17. **Floating litter** (items/km^2)	0	195	3.9	**3-5**
17**. Sea floor** (items/km^2)	0	7700	179	**130-230**
17. **Microplastics** (items/km^2)	0	4860000	340000	**200000-500000**
18. **Sea Turtle**s Affected turtles (%) Ingested litter(g)	14% 0	92.5% 14	45.9% 1.37	**40-60%** **1-3**

"It must be noted that the amount of existing information is limited to set definitive baselines that may be adjusted once the national monitoring programs could provide additional data. Moreover, Average values over large areas are difficult to harmonize, in particular for beach litter. Then, the setting or derivation of baselines should take the local conditions into account and may follow a more localized approach. Finally, additional specific baselines may be decided by CPs on specific litter categories especially when they may represent an important part of litter found or a specific interest (targeted measures, etc.).".

2. **Proposed Marine litter environmental targets:**

EcAp Indicators	Type of Target	Minimum	Maximum	Recommandation	Remark
Beaches (EI16)	% decrease	significant	30	20% by 2024 or [2030]	Not 100% marine pollution
Floatin Litter (EI 17)	% decrease	-	-	Statistically Significant	sources are difficult to control (trans border movements)
Sea Floor Litter (EI 17)	% decrease	stable	10% in 5 years	Statistically Significant	15% in 15 years is possible
Microplastics (EI 17)	% decrease	-	-	Statistically Significant	sources are difficult to control (trans border movements)
Ingested Litter (EI 18) Number of turtles with ingested litter (%) Amount of ingested litter	% decrease in the rate of affected animals % decrease in quantity of ingested weight(g)	- -	- -	Statistically Significant Statistically Significant	Movements of litter and Animals to be considered

VII. MONITORING AND ASSESSMENT METHODLOGICAL GUIDANCE ON EO7: ALTERATION OF HYDROGRAPHICAL CONDITIONS

1. Introduction

1.1. Identification of issues to address

Monitoring under this Ecological Objective is meant to address any developments large enough to have the potential to alter hydrographical conditions, either at broad scale or through acting cumulatively with other developments. For the purposes of this common indicator linked to an EcAp operational objective dealing with constructions and installations, it is recommended to focus on constructions in coastal waters or open sea (including wind farms, ocean energy device arrays, offshore airports, artificial islands, and aquaculture facilities).

Monitoring under this Ecological Objective is meant to address permanent alterations in hydrographical conditions. Therefore, it is important to differentiate between permanent and temporary changes taking into consideration the potential for recovery, and the timescales involved need to be factored in. As a first approach, constructions lasting for more than 10 years may be considered to be permanent.

As mentioned above, this Ecological Objective is meant to address new developments, as well as the existing permanent constructions that have already changed the hydrographic conditions and related habitats. For this reason it is pertinent to choose a baseline in the (very) near future from which monitoring for good status can be based upon. This does not mean that the current status can or should be maintained in all circumstances; it is important to recognise that there can be good reasons for an activity that changes the hydrographical conditions and some of these changes may only be temporary. Efforts should, however, be made to prevent further deterioration and to minimise any negative effects on the ecosystem.

The approach to this Ecological Objective would be to track and record the licensing applications of any proposed developments that would be considered large enough to have the potential to alter hydrographical conditions. The Contracting Parties would thus need to ensure that any proposed developments that have the potential to affect hydrographical conditions are recorded. This will confirm whether there is need for any additional licensing, monitoring or assessment requirements for Government, marine licensing authorities or developers.

Close coordination with monitoring under the Biodiversity Ecological Objective (and in due course with the Food Webs and Sea Floor Integrity Ecological Objectives) will be necessary due to the links with these as some of the targets and indicators for these Ecological Objectives may also be relevant in relation to Ecological Objective 7.

1.2. Monitoring of physical characteristics

The physical characteristics to be monitored are considered to be: bathymetric data, seafloor topography, current velocity, wave exposure, turbulence, and turbidity, temperature and salinity. The knowledge of parameter related local dominant time-scales of natural variability are a pre-condition for an authoritative assessment of change in the hydrographical background conditions.

Even though climate change is considered to be part of the prevailing environmental conditions and therefore not explicitly addressed through the EcAp, for the interpretation of monitoring data, the effects of climate change need to be taken into account. For this reason the existence of an adequate monitoring programme able to describe these background large-scale changes, together with a long time series dataset is an implicit requirement for this Ecological Objective and for the EcAp as a whole.

1.3. Evaluation of impacts

In order to evaluate the impacts, any monitoring programme tailored to meet the requirements of Ecological Objective 7 should be designed to determine the extent and intensity of any changes in the hydrographical regime resulting from human activities. This could be undertaken within EIA and/or SEA.

Changes in bottom shear stress, due to the consequences on inducing changes on sediment re-suspension and nutrient enrichment, is a good example of modifications of the dynamic environment of the seabed with effect on biota development. Direct measurements are not easy and it is usually deduced by wave motion measurements. Wave motion measurements would therefore be relevant for monitoring in shallower waters to the extent that the seafloor is affected by wave action. The repetitive pressure variation induced by waves at the seabed facilitates the erosion of crumbly sediments so that an increase in wave height in shallower waters may significantly increase the erosion of a specific habitat.

2. Monitoring Strategy

The monitoring of hydrographical conditions could be treated in two ways:

- Monitoring in order to give background information at different spatial and temporal scale on variations of hydrographical conditions which might not be connected (at least not directly) to the human activities;

- Specific monitoring for Ecological Objective 7 purposes to assess the extent of area affected by alterations and impacts with a focus on the list of areas where alterations could be expected due to new developments.

If the hydrographical conditions are unknown they are initially monitored over the entire marine area to characterize the hydrographical regime and to provide background information for physical characteristics and establishment of hydrographical models to be used in the assessment of human activities. Particular attention would be given to monitoring hydrographical conditions in sensitive areas such as marine protected areas, spawning, breeding and feeding areas and migration routes of fish, seabirds and marine mammals. Parameters, monitoring positions and frequencies are defined based on the local natural variability (both in time and space) but also with regard to the requirements specified by the needs of other Ecological Objectives/indicators for background information.

2.1. Selection of monitoring methods

The selection of monitoring methods for some hydrographical parameters could consider the following:

- Satellite products services can provide area wide near-real time data;

- Use of autonomous devices or scientific vessels allowing high-resolution data collection (currents, waves, mixing characteristics, etc.), including data about the development of vertical stratification, circulation, water masses distribution etc.;

- Use of numerical circulation and ecosystem models to characterize the conditions over the large sea areas and to forecast local changes due to direct human impacts;

- Other global or regional operational oceanographic observing systems that provide marine forecasts, can also be part of the ecological Objective 07 monitoring;

- Basin-wide assessment of hydrographical changes and local status reports can provide valuable information on long-term change.

Such an approach (with proper modifications) could also be generalized to other parameters describing hydrographical conditions.

It is recommended that the monitoring of the effects of hydrographical changes should not aim primarily at field based measurements in the affected area, but concentrate on modelling of the changes due to human activities in the area (this may be undertaken within EIA and/ or SEA), using appropriately calibrated models, validated with in situ datasets. This will make it possible to determine the extent of any parameter changes including how large the change will be in a certain area. From this starting point the effect on coastal and marine ecosystems can be determined. Field measurements will be necessary in areas where the changes are large enough to have significant effects on the marine ecosystem at which point ground-truthing will be considered appropriate. In such a situation on-going monitoring of changes in habitats could be used to indicate any effects of permanent hydrographical alterations. Even when there is no clear indication that an activity will cause an important hydrographical alteration, some minimum field measurements will be needed to confirm the prediction of the models.

2.2. Considerations regarding the appropriate scale of monitoring

Ecological Objective 7 states that the alteration of hydrographical conditions should not adversely affect coastal and marine ecosystems. As human interventions on hydrographical conditions with regard to the potential impact on ecosystems are hardly visible on a very large scale, i.e. on the scale of the sub-region, (e.g. of the Western Mediterranean Sea), it will be necessary to consider smaller scales in the first instance in order to build a full picture of GES at the relevant scale. It should be noted that using very small scales to determine GES is not appropriate given that they cannot be connected directly to status of ecosystems, as required under the EcAp.

3. Guidance on how to include impacts assessment due to change in hydrographical regime in Environmental Impact Assessments and other relevant assessments noting local specifics

Noting that assessment under the hydrography theme should be linked to Environmental Impact Assessment procedure, the UNEP/MAP Barcelona Convention “Guidance on how to include impacts assessment due to change in hydrographical regime in Environmental Impact Assessments and other relevant assessments” can be regarded as an important regional basis, to specify local physical, ecological, biological impacts of hydrographical changes.

VIII. MONITORING AND ASSESSMENT METHODLOGICAL GUIDANCE ON EO8: COASTAL ECOSYSTEMS AND LANDSCAPES

1. Introduction

In the Mediterranean, there is a particularly strong and increasing occupancy of the coastlines. Coastal zones play a key role in the economic development of regions and nations as they are a significant source of various goods and services. Coastal ecosystems and landscapes are continually being altered by the addition of the infrastructure needed to sustain residential, commercial, transport and tourist activities. Transformation of coastal landscapes in response to urbanization is not limited to the land. The intertidal zone and nearshore estuarine and marine waters are also increasingly altered by the loss and fragmentation of natural habitats and by the proliferation of a variety of built structures, such as ports, marinas, breakwaters, seawalls, jetties and pilings.

From the morphological perspective the Mediterranean coastline is 54 % rocky and 46% of sedimentary types. The latter is characterized by important yet fragile ecosystems such as beaches, dunes, deltas and lagoons, highly exposed to coastal processes, i.e. erosion and extreme storms, or consequences of climate changes such as sea-level rise (UNEP/MAP/PAP, 2001).

The coastal zone is a dynamic area of natural change. Coastal manmade infrastructures cause irreversible damage to landscapes, losses in habitat and biodiversity, and strong influence on the configuration of the shoreline. Indeed, physical disturbance due to the development of artificial structures in the coastal fringe can influence sediment transport, reduce the ability of the shoreline to respond to natural forcing factors and fragment the coastal space.

Despite the known impacts on ecosystems, utilization of coastal resources shows no signs of levelling off. The use of hard coastal defence structures is predicted to increase in response to forecast sea-level rise and increased intensity and frequency of large storms (Michener et al., 1997). Long-term growth in world trade is likely to lead to more development of shipping-related infrastructure. As ships get larger and bring more containers, some ports will need to get bigger too. This can lead to expanding the port into adjacent land or reclaiming land from the sea (REMPEC, 2008). Moreover, spontaneous coastal urbanization by the tourism industry is an expanding driving force in the Mediterranean region.

Article 8 of the Protocol on Integrated Coastal Zone Management (the ICZM Protocol, UNEP/MAP/PAP, 2008) clearly stipulates the establishment of a 100 meters coastal setback zone as the agreed measure that plays an important role in the preservation of natural habitats, landscapes, natural resources and ecosystems, and also, the prevention and/or reduction of the effects of coastal hazards. Moreover, its definition should be based on an integrated approach taking into account various physical coastal processes, ecosystem services, coastal resistance and exposure with regard to development activities, as well as settlements and infrastructure located along the coast (Rochette, J. et al., 2010).

One particularity of the EcAp (compared to the EU MSFD) is the inclusion of the Ecological Objective focusing on the coast and the merging (*EO8-The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved*). The latest reflects the aim of the Barcelona Convention to also include or cover coastal areas in the assessment, which became a legal obligation upon the recent entry into force of its ICZM Protocol. Thus the spatial coverage of this EO extends to the terrestrial part of the coastal zone. EO8 emphasizes the integrated nature of the coastal zone, particularly through consideration of marine and terrestrial parts as its constituent elements.

Mediterranean coastal areas are particularity threatened by coastal development that modifies the coastline through the construction of buildings and infrastructures. However, there has not been systematic monitoring, in particular not quantitatively based monitoring or any major attempt to systematize characteristics of coastal ecosystems on a wider Mediterranean basis. The status assessment of EO8 aims to fill this gap.

The complexity of coastal ecosystems makes very difficult their assessment at all levels and in all areas. The two operational objectives of this EO (8.1. and 8.2.) refer to several important components of coastal ecosystems. The first operational objective (*8.1 The natural dynamic of coastlines is respected and coastal areas are in good condition*) referring to the "natural dynamics", essentially reduces itself to the issue of coastal erosion. The second operational objective (*8.2 Integrity and diversity of coastal ecosystems, landscapes and their geomorphology are preserved*) refers to the integrity of coastal ecosystems, which is, essentially, expressed through the issue of coastal landscapes (UNEP/MAP, 2013).

The agreed Coastal Common indicator “Length of coastline subject to physical disturbance due to the influence of manmade structures” belongs to Operational Objective 8.1. It incorporates coastal dynamics as an integral part of the EcAp. It is worth recalling that, main impacts on coastal erosion due to human-induced pressures are covered by the set of 8.1 Operational Objective indicators[31]. They include the length of coastal erosion and/or instability (indicator 8.1.1) changes in sediment inflows (indicator 8.1.2), beach nourishment measures (indicator 8.1.3), and finally, the agreed coastal common indicator referring to manmade coastline (indicator 8.1.4).

The monitoring aim of the EO8 common indicator is twofold: (i) quantified the rate and the spatial distribution of the Mediterranean coastline artificialitsation and (ii) to provide a better understanding of the impact of those structures to the shoreline dynamics. It has an operational target on impact, thus it is associated to concrete implementation measures related to specific human activities (i.e. appropriate management measures) to minimize negative impacts and to inform about progress towards GES.

International standards methodologies and guidelines exist for the assessment and monitoring of some indicators relevant for Ecological Objectives of GES, such as in EO9 Contaminants or EO5 Eutrophication (subject to adaptation according to local and regional specifics) (European Commission, 2011a). This is not the case of those indicators related to EO8 Coastal Ecosystems. This EO does not have a precedent in other regional ecosystem approach initiatives, such as Helcom or OSPAR. Indeed, the EcAp Coast related common indicator is matchless to those proposed by the MSFD and related initiatives. However, works on the development of indicators close to EO8 are in progress in some countries (for instance Spain and France).

Additionally, beyond the working document UNEP/MAP, (2013) no legal document of the UNEP/MAP Barcelona Convention provides a baseline reference of the aim and scope of this indicator. Thus, there is a general lack of technical guidelines, agreed methodologies and parameters adequate for the future Integrated Monitoring and Assessment Programme on hydrography, other than the following basis laid under.

1.1. Identification of issues to address: (i) manmade structures causing (ii) physical disturbance

Monitoring under this Ecological Objective is meant to address human activities causing coastal artificialisation by sealing the coast with the implementation of coastal structures. More concretely, the types of structures included by the term ‘manmade structures’ sorted by category are:

(i) Hard coastal defence (excluding soft techniques e.g. beach nourishment),

(ii) Ports and marinas

(iii) Land claim

(iv) Impervious surface in the hinterland (100 meters from the coastline).

[31] Decision 20/4 of the 17th Contracting Parties Meeting in Paris in 2012.

The term 'manmade structures' typically refers, solely, to coastal defences and ports (and indirectly to land claim). However, landward impervious surfaces also exert a physical disturbance leading to direct impacts affecting coast integrity and dynamics (see Tab 2). Accordingly, including the monitoring of the impervious surface into the Coastal common indicator should aims at identifying proximity to reach GES on EO8.

Therefore, coastal segments are said to be "artificialised" when all or part of the 100 meter area on both sides (i.e. land and sea) are subject to transformation by Man, modifying their original physical state.

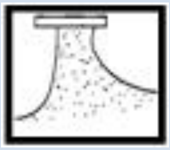
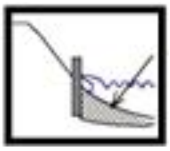
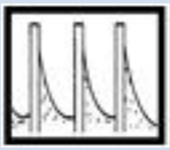
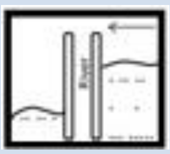
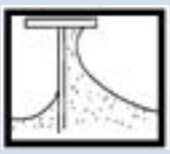
Below, detailed description of the 'manmade' typologies included into the Coastal indicator:

(i) Coastal defence structures, so called coastal protection, means all artificial or man induced structures along the coast, with the basic function of providing shelter to the segment of the shoreline, which they protect. Consequently, the protection is limited to the segment.

Coastal defence are usually classified as hard and soft techniques. Even if soft techniques are also responsible of *physical disturbance*, the coastal common indicator only refers to manmade structures (i.e. structural techniques), thus soft techniques (e.g. beach nourishment) are not covered by this indicator. Main hard coastal defence structures on the basis of their main physical effects on the environment are listed in Table 1 below. They are slightly modified from the EUROSION Shoreline Management Guide (European commission and Directorate General Environment, 2004, Annex 2).

Hard coastal defence modifies coastal sediment transport patterns through 3 major processes: (i) intercept and reduce the along-shore transport of sediments; (ii) interfere with cross-shore sediment transport (iii) wave diffraction, i.e. the alteration of the wave crest direction which results in wave energy to be either diluted in some places or concentrated in some other places. The presence of coastal defence structures can be accompanied with accelerated downcoast erosion transferring the problem to another location (Frihy and Deabes, 2012; Özhan, E., 2002)

Table 1: Hard coastal defence structures (modified from the EUROSION Shoreline Management Guide, EU, 2004).

Positioning/Orientation respect to the shore	Type of structure	Action and purposes
Not connected to shore parallel or fish tail 	Breakwaters	Reduce the intensity of wave forces in inshore waters creating a low-energy zone behind the structure. Used for protecting ports, and as coastal defences.
Onshore parallel on open coasts 	Seawalls Bulkheads	Reduce the impact of waves on shore; used as a tool against coastal erosion and as a constituent of ports, docks and marinas.
	Revetments	A revetment is a facing of erosion resistant material, such as stone, geotextiles or concrete. Sloped structures which break up or absorb the energy of the waves used to reduce the landward migration of the beach due to coastal erosion. It is built to protect a scarp, embankment, or other shoreline feature against erosion.
	Sea dike	Large land-based sloped structures used to prevent overtopping during high tide and storm events. Instead of providing protection against wave action, sea dikes fix the land-sea boundary in place to prevent inland flooding.
Connected to shore perpendicular 	Groins	Reduce along-shore transport of sediments; used in coastal defence schemes, often in association with breakwaters.
	Jetties	Reduce wave- and tide-generated currents; used for developing, ports, harbours, marinas and as constituents of coastal defence schemes.
	Groins (composite)	Reduce along-shore transport of sediments; used in coastal defence schemes. Used to avoid the formation of stationary eddies.

(ii) Harbours, marinas & ports of refuge: refers to construction consisting of an ensemble of seawalls and landfills used in various ways (car park, road, shops, boatyard, etc.). This ensemble delimits a contained body of water designed to offer shelter to boats of various sizes and functions (fishing, pleasure boating, business, etc.). Under this category floating docks and piling are included.

Marinas and port facilities can act as artificial headlands that break up the orientation of the shoreline, change refraction and diffraction patterns, trap sediment, deflect sediment offshore, and starve adjacent downdrift beaches of long-shore sand transport (McLachlan and Brown, 2006; Nordstrom, 2003).

(iii) Land reclamation is defined as the gain of land from the sea or coastal wetlands e.g. for recreation, agricultural purposes, industrial use and harbour/airport expansions. Under this category, only land reclamation projects adjacent to the shoreline or within tidal basins, bays and estuaries are included (those projects undertaken in offshore waters are covered by other EcAp Ecological Objective).

Land reclamation activities, closely related to coastal defence projects, disrupt long-shore sediment transport, and modify the position of the coastline and its near-shore bathymetry, as well as its orientation relatively to the front direction. Consequences of these modifications are particularly severe on the behaviour of waves propagating in the neighbourhood of reclaimed areas and particularly on wave refraction (European commission and Directorate General Environment, 2004b). Moreover, within bays and estuaries, land reclamation projects can result in a reduction of the tidal volume and therefore a change in the ebb and flood currents transporting sediments. As a result, relatively stable coastal stretches may begin to erode (European commission and Directorate General Environment, 2004a).

(iv) Impervious surfaces refer to non-permeable surfaces associated with urban areas: residential, commercial, transport facilities, and tourist resorts. Basically, determines if the landward boundary (buffer of 100m from the coastline) is artificial or natural. Urbanisation projects right behind the coastline modifies and remove the shoreline vegetation, which act as a factor of soil cohesion; the soil stability is undermined and more exposed to landslide events, especially along cliffs. Moreover, clearing of vegetation for building purpose may alter wind transport patterns. Vegetation acts as an Aeolian trap and helps the re-deposition and sand particles transported by the wind. This is particularly the case in coastal dunes areas (European commission and Directorate General Environment, 2004b).

1.2. Evaluation of impacts

Assessments of the state of ecosystem components (or Ecological Objectives) are informed by the impacts upon them which arise from each pressure. Mediterranean coastal areas are threatened by coastal development that modifies the coastline through the construction of manmade structures and linear infrastructures. This development represents a reduction or elimination of the needed space for dynamic environmental processes and a physical barrier between the terrestrial and marine environments. Coastal artificialisation interferes and/or inhibits the natural fluxes and interrelations among habitats, species, as well as the flow of matter and energy.

The main consequences of coastal development in the context of coastal dynamics are changes in the deposition processes and wave regime that lead to increasing erosion. However, sealing the coast, not only represent a physical disturbance to the inter-relationships between the marine and terrestrial parts of the coastal zone, but a physical damage usually irreversible. Therefore, focusing on EO8 direct impacts, while the pressure ‘physical disturbance’ refers to the potential impacts on the natural dynamics of this transitional ecosystem (i.e. Operational Objective 8.1) ‘physical damage’ is directly connected to coastal landscape impacts (i.e. Operational Objective 8.2) (See Fig 1 under). Therefore, the common indicator focuses on the impact exerted by the pressure ‘physical disturbance’.

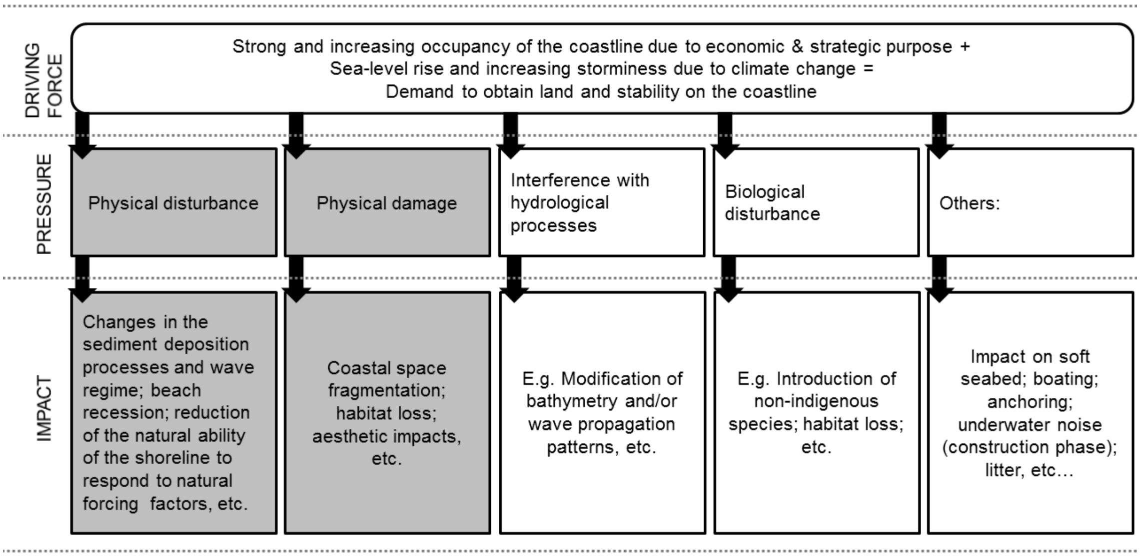


Fig 1 of point 1.2: Pressures and impacts of coastal artificialisation.

Human activities (or driving forces) can cause different pressures to the coastal and marine environment. To this regard, coastal manmade structures have the potentiality to cause direct and indirect pressures and impacts on any part of the ecosystem (or Operational Objective). In grey main impacts affecting EO8.

Physical disturbance under the Operational Objective 8.1 *The natural dynamic of coastlines is respected and coastal areas are in good condition* essentially reduces itself to the issue of coastal erosion. Indeed, coastal erosion is the most obvious example of coastal (natural) dynamics and one of the most important socio-economic problems that challenge the capabilities of states and local authorities. (UNEP/MAP, 2013).

Coastal erosion results from combinations of various factors both natural and human-induced which has different time and space patterns and have different nature (continuous or incidental, reversible or non-reversible) (European commission and Directorate General Environment, 2004a). Natural factors influencing coastal erosion are: waves, winds, tides, near-shore currents, storms or sea level rise. Human influence, particularly urbanisation and economic activities, in the coastal zone has turned coastal erosion from a natural phenomenon into a problem of growing intensity.

Manmade structures included in the common indicator are part of the set of human-induced pressures on coastal erosion; however, they are not the only human activities responsible for this pressure. The EUROSION *Guidelines for incorporating coastal erosion issues into Environmental Assessment (EA) procedures* (European commission and Directorate General Environment, 2004b) grouped those human activities in 6 categories:

- Category 1: Land reclamation projects
- Category 2: River water regulation works
- Category 3: Sediment extraction projects
- Category 4: Construction of tourism and leisure facilities
- Category 5: Coastal defence works
- Category 6: Hydrocarbon and gas mining activities

Table 2 under gather a review of impact associated with the set of categories included as "coastline manmade structures" by the EO8 common indicator (i.e. categories: 1, 4 & 5) as far as coastal erosion is concerned.

Table 1 of point 1.2: Coastal manmade structures having an impact on coastal erosion process. Source: modified from European commission and Directorate General Environment, (2004b)

IMPACTS MANMADE STRUCTURES	Modification of bathymetry	Modification of wave propagation patterns	Disruption of long-shore drift	Reduction of volume of tidal basins	Modification of soil weathering properties	Modification of Aeolian transport patterns
Land reclamation	□	□	□	□		
Imperviousness 100m buffer (Construction of tourism/leisure facilities, etc.)					□	□
Hard coastal defence, seawalls or sea dykes		□	□			
Ports	□	□	□	□		

Impacts of coastal manmade structures on coastal dynamics depend on the techniques applied, the characteristics and the sensitivity of the areas and the combination and cumulative impact of other human activities and developments that take place far away from the coast (e.g. dams, afforestation works, etc.) as well as the effects of natural factors affecting the coastline length. In conclusion, coastal erosion can rarely be attributed to one single cause (be it natural or human-driven) but to a combination of various factors.

The *length of coastline subject to physical disturbance due to the influence of manmade structures* is an impact indicator, which assumes that the coastlines occupied by manmade structures are potentially impacted areas. However, to progress towards GES the monitoring exercise needs to include the shoreline evolution of those sandy coastlines affected by the presence of manmade structures.

2. Analysis of relevant policies and/or regulations of Mediterranean countries

The methodologies required for assessment and monitoring of the Mediterranean coastal environment need to take into account and, where appropriate, be based upon those applicable under existing national legislation and, where relevant, information, knowledge and approaches developed by Mediterranean countries.

The relevance to take into account national and regional legislation regarding coast protection and planning is twofold: (i) To understand the baseline policy context and identify current experiences of surveying and mapping coastal artificialisation of the coastline and (ii) to inform about progress towards

GES. It is worth recalling, that the target on EO8 indicator is an operational target on impact, thus it is associated to concrete implementation measures related to specific human activities (i.e. appropriate management measures) to minimize negative impacts.

Regarding the national legislation, all Mediterranean littoral States have undertaken some measures to try and protect their coastal zones from overdevelopment, or development that is socially and environmentally damaging. In spite of well-reasonable and carefully drafted regulations, the pressure has continued to increase (Markandya et al., 2008). The report UNEP/MAP/PAP, (2000) introduce the state of Mediterranean national legislations. The document gathers and summarizes the outputs of a questionnaire relating to the coastal zones' integrated planning legislation addressed by the PAP/RAC to Mediterranean countries.

At regional level, according to the Article 8 of the ICZM Protocol, the Parties: (*a) Shall establish in coastal zones, as from the highest winter waterline, a zone where construction is not allowed. Taking into account, inter alia, the areas directly and negatively affected by climate change and natural risks, this zone may not be less than 100 meters in width subject to the provisions of subparagraph (b) below. Stricter national measures determining this width shall continue to apply.* The rationale to include this article in the Protocol is twofold: to prevent and/or minimize the extent of the linear development along the coastline and to adapt to expected climate changes in the coastal zone (in particular sea level rise). Indirectly, this provision also aimed to minimize coastal erosion (Sanò et al., 2010, 2011).

Aware of the implementation difficulties and political sensitivities of the setback issue, the Mediterranean countries have adopted several exceptions to the establishment of the setback zone along their coastline, as it is stipulated in Article 8. *(b) May adapt, in a manner consistent with the objectives and principles of this Protocol, the provisions mentioned above: 1) for projects of public interest; 2) in areas having particular geographical or other local constraints, especially related to population density or social needs, where individual housing, urbanisation or development are provided for by national legal instruments.*

Moreover, all conducted activities and established facilities addressed to national defence, (as is stipulated in article 4.4[32]) have full right to be established within the 100 m strip and do not fall under the scope of the Article 8. In addition, it is necessary for the Parties to enact a specific national legal instrument regarding this issue. However, a majority of the Mediterranean countries have well established legislations and specifications for national defence and security activities within the 100 m strip and grant them special exemption (Rochette, J. et al., 2010) (see Tab 3).

[32] Issues of national security, defence activities and facilities within coastal areas are clearly stipulated in the Article 4.4 of the ICZM Protocol: "*nothing in this Protocol shall prejudice national security and defence activities and facilities... such activities and facilities should be operated or established, so far as is reasonable and practicable, in a manner consistent with this Protocol*".

Table 3 Examples of National legislations in relation to 'projects of public interest'. Source: (SHAPE project)

	Legal provision	Year of issue	Description of provision	Permitted facilities
Turkey	Coastal Law 3621/3830	1990	Facilities aimed at the protection of the shoreline or the use of the coast for the public interest may be developed in the "shoreline buffer zone" within 100 metres in accordance with legal permits issued by land-use planning authorities.	Piers, ports, harbours, berthing structures, quays, breakwaters, bridges, seawalls, lighthouses, boat lifts, dry berths and storage facilities, salt production plants, fishery installations, treatment plants and pumping stations, etc.
Algeria	Law 2002-02, Article 16.	2002	Adaptation allowed from min. 100 to max. 300 metres of the coastal setback zone in the interest of activities requiring immediate proximity to the sea. Differences between activities related or not to a public interest are not clarified.	Roads in the coastal zone where they are normally prohibited (within an 800 metre strip from the seashore).

It is not possible to establish how effective the different instruments as the setback policies and other regulations have been in protecting coastal zones. There is no detailed assessment of the extent of violation of the setback rule (Markandya et al., 2008). To this regard, the monitoring strategy proposal for the assessment of the EO8 status represents an opportunity to fill this data gap.

3. Practices and lessons related to monitoring and mapping manmade structures

Article 16 of Part Three of the Protocol, in particular, identifies the functional tools for integrated management as appropriate mechanisms for coastal monitoring and observation, existing or newly established. In detail, it highlights the need to maintain regularly updated national inventories of coastal zones regarding information on resources, activities, institutions, legislation and planning tools. In this context, the monitoring and observation of coastal areas must be developed within a network of cooperation and organization along the Mediterranean, scientifically and institutionally.

To this end, the Protocol refers to the need to identify, between the Contracting Parties, tools and reference procedures for the standardization of the information contained in the national inventory. The observation of coastal zones is interpreted as a structured repertoire of available information regarding the status and trends of coastal areas, so as to be made accessible to local communities and all relevant territorial stakeholders, both public and private (Rochette, J. et al., 2010).

Coastal monitoring became an important and functional activity, essential to coastal planning and management. In spite of that, monitoring often lacks standardised procedures and is frequently based on a time scale that is not compatible with the processes under act, failing to provide information that can effectively support decision-making.

The need for developing and validating new monitoring techniques, and sharing them among countries that border the Mediterranean, where similar environmental characteristics allow an easier standardisation of the methodologies (Pranzini, 2008), has given birth to a significant projects focused on the health of Mediterranean coastal areas such as Maremed[33], Coastance[34], Shape[35], Res-Mar[36], Pegaso[37], Medina[38], among others.

To this regard, it is worth mention project-clustering initiatives like FACECOAST *Face the challenge of climate change in the Mediterranean coastal zones* (http://www.facecoast.eu/), launched within the Capitalisation process started by the European MED Programme, in order to strengthen cooperation among Regions, coastal administration bodies, universities and other stakeholders, thus maximising results and favouring potential synergies. Moreover, the existing PEGASO ICZM Governance Platform has been created to facilitate sharing of data and information among projects as well as with other stakeholders including decision makers, practitioners and donors.

At local scale, several ongoing initiatives (some of them linked to the already mentioned projects) are monitoring artificialisation and morphological evolution of the coast (see Tab 1 under).

Tab 1 of point 3: Some Mediterranean examples of web based dissemination of geospatial data related to coastal monitoring.

Balearic islands (Spain)	SACosta	Based on NOAA 2002 classification	http://gis.socib.es/sacosta/composer
French Mediterranean coasts	MEDAM (French Mediterranean Coasts. Inventory and Impact of Reclamations from the Sea)	Port; Port of refuge; Landfill; Artificial beach (horseshoe shaped beach); Groyne; Pontoon; River mouth dykes.	http://www.medam.info/index.php/en/medam-module-donnees-chiffrees
Costa di Tosca (Italy)	ResMar	Coastal defence; ports	http://www.res-mar.eu/it/

4. Monitoring Strategy

The monitoring of the coastal common Indicator entails an inventory of: (i) the length and location of manmade coastline, (ii) the surface area reclaimed from the 1980's onwar (ha) and (iii) the surface impervious area in the coastal fringe (100m from the coastline). Therefore, monitoring should focus, in particular, on the location, the spatial extent and the types of coastal structures. Additionally, in those sandy coastal segments where manmade structures have been identified, the shoreline evolution of the

[33] MAritime REgions cooperation for the MEDiterranean (http://www.maremed.eu/)
[34] Regional action strategies for coastal zone adaptation to climate change (http://www.coastance.eu/)
[35] Shaping an Holistic Approach to Protect the Adriatic Environment between coast and sea (http://www.shape-ipaproject.eu/)
[36] Rete di Tutela Ambientale nello Spazio Marittimo (http://www.res-mar.eu/it/)
[37] People for Ecosystem-based Governance in Assessing Sustainable (http://www.pegasoproject.eu/)
[38] Marine Ecosystems and Dynamics for North Africa (http://www.medinaproject.eu/puplic/home.php)

coast will be also monitored in order to analyse the beach response to the presence of manmade structures.

Accordingly, the monitoring parameters are spatial metrics. Due to the strong spatial component of the indicator concerned, space and airborne earth observation systems are the most suitable tool to conduct the monitoring strategy of the EO8 common indicator.

The list of parameters to monitor can be group in two categories: monitoring of coastal fringe artificialisation and the length of sandy areas influenced by such artificialitsation. The needs and requirements to monitor the two groups of parameters differ substantially. Therefore, they are treated separately through this section. In regard to shoreline survey of sandy coastal lengths under the presence of manmade structures, some general guidelines are provided. Surveying this parameter does not pretend an exhaustive analysis of shoreline regression (which in fact is covered by the EcAp indicator 8.1.1 *Areal extent of coastal erosion and coastline instability),* but a better understanding of the impacts due to the presence of manmade structures in terms of coastal dynamics.

In addition to the parameters identified above, it is highly recommended to compile auxiliary data to predict those coastal segments more vulnerable to the physical presence of manmade structures (see Annex I). Physical disturbance due to manmade structures induce different degrees of impacts according to the nature and particularities of the coastline concerned. Therefore, incorporating these ancillary data would provide robustness to the indicator offering a linkage between monitoring and status assessment needs (e.g. determination of thresholds).

4.1. Considerations regarding monitoring methods

The application of Earth Observation data for coastal monitoring has been the subject of numerous studies during the past 10 years. Examples include flood risk mapping, pollution monitoring, waves, coastal erosion, nearshore bathymetry and marine water quality monitoring. The clear advantage in using satellite data for monitoring the coastal environment is the facility to provide repeat surveys for large (and often inaccessible) areas.

Coastal manmade structures can be easily detected from remote sensing imagery. The only constrain is the need of high resolution data. Traditionally, airbone-based data has been used to analyse shoreline evolution and manmade structures detection. However, newly available, very high resolution (VHR) satellite images can provide a cost-effective source of such information.

In regard to manmade structures monitoring, one of the primary advantages of VHR imagery over moderate resolution imagery, like Landsat, is the ability to identify specific components of the built environment. The typical size of individual components in the built environment is generally between 10 and 20 meters (Small, C., 2009). Sensors with spatial resolutions of 10 meters begin to resolve individual features like buildings and smaller roads. Sensors with sub-meter resolution generally allow recognition, identification, and in some cases description, of these features (Deichmann, U. et al., 2011).

For short and long term shoreline monitoring, the 10 meters accuracy is not satisfactory since the displacement of the shoreline in general presents much lower rates. However, the accuracy offered by VHR satellite images is compatible with the scale of the phenomena that are being monitored. Therefore, VHR images are suitable both for the detection of manmade coastline as for the shoreline evolution of sandy areas under physical disturbance.

In line with the above, it is recommended to apply optimum resolution criteria according to the type of coastal area (i.e. natural, urbanised, industrialised, etc), for the scale/resolution of imagery dataset to identify man-made coastal infrastructures.

4.1.1 Available methodologies

Available methodologies suitable for the monitoring needs are not detailed here but rather introduced in general terms together with some practical recommendations. Fig 1 illustrates some examples of the capabilities and visualization of remote sensing imagery to detect coastal manmade structures and shoreline dynamics.

- VHR: A major breakthrough for the application of remote sensing for operational applications has been the latest generation of very high resolution (VHR) optical satellites with a pixel size of 1 meter or less (see Figure 1 of point 4.1.1. under).

Tab 1 of point 4.1.1.: Optical satellite imagery useful for monitoring coastal manmade structures source: Modified from Deichmann, U. et al., (2011)

Satellite	Spatial resolution [m] (at nadir)	Spectral resolution	Swath Width [km]	Orbit repeat cycle (max. revisit time) [days]*
GeoEye	0.41	Panchromatic	15.2	3
	1.65	Red, Green, Blue, Near Infrared		
WorldView-1	0.5	Panchromatic	17.6	(1.7)
Quickbird	0.6	Panchromatic	16.5	1-3.5
	2.4	Red, Green, Blue, Near Infrared		
EROS-B	0.7	500-900 (pan)	7	
Ikonos	0.8	Panchromatic	7	3 (?)
	4	Red, Green, Blue, Near Infrared	11	14 (1-3)
OrbView-3	1	Panchromatic	8	16 (3)
	4	Red, Green, Blue, Near Infrared		
KOMPSAT-2	1	Panchromatic	15	(5)
	4	Red, Green, Blue, Near Infrared		
Formosat-2	2	Panchromatic	24	(1)
	8	Red, Green, Blue, Near Infrared		
Cartosat-1	2,5	Panchromatic	60	(2-3)
SPOT-5	2.5	Panchromatic		
	10	Red, Green, Near Infrared, Mid Infrared	60	(2-3)

Monitoring manmade structures

VHR images can resolve individual elements such as buildings, transport infrastructure or pipelines. They also more closely resemble standard air photos. In contrast to more traditional satellite data VHR images can be interpreted visually even with minimal training (Deichmann, U. et al., 2011).

However, an important factor, which must not be forgotten, is the relative high economic cost of data. Both commercial datasets and the acquisition and digitization of data by the end user might be substantial expense factors especially with increasing accuracy of the data.

To this regard, the integration and accessibility of worldwide high resolution satellite data by the development and provision of virtual globes, such as Google Earth™, Microsoft® Virtual Earth™, Nasa World Wind or ArcGIS® Explorer resolves the difficulty of the economic constrain of commercial imagery. The integration and accessibility of worldwide high resolution satellite data, their intuitive user interface, and the ability to integrate own data combined together with a high performance support their success (Deichmann, U. et al., 2011). Even if their options for geospatial analysis are limited, the use of these geographic information platforms (available for non-geospatial experts and available free of charge) represents a satisfactory alternative for the purpose of the monitoring and mapping needs under EO8. However, these spatial platforms integrate a mosaic of imagery at different temporal resolutions. To mitigate the adverse effects of their implicit temporal heterogeneity, the use of auxiliary data and techniques is highly recommended (see section 2.4).

Monitoring shoreline dynamics of sandy coastline under physical disturbance:

For the selection of images to be used, multispectral images should be preferred, even though spatial resolution is lower. The normalised ratio between the infrared and red bands (NDVI) has indeed proved to be particularly suitable for the identification of the water/sand interface. This ratio, furthermore, makes it possible to compare images taken at different times, since it minimises the effects caused by different atmospheric conditions on sand radiance, as ascertained from spectroradiometric measurements in situ and in the laboratory.

Aerial photograph

Due to their high spatial resolution this techniques has been widely used for coastal monitoring and land use planning. They allow easily visual interpretation and digitalisation of coastal manmade structures. Probably, the most remarkable strength in the context of EO8 monitoring needs is the possibility they offer for temporal trends analysis (or determination of reference conditions). To this regard, historical survey prior to any reclamation is of paramount importance to capture and digitalized the original coastline (on the basis of old maps) prior to any reclamation. Therefore, they complement VHR space imagery.

Laser scanners

The use of laser scanners has been increasing lately. This technology may be transported on board of a plane or placed on a boat combined, for example, with a multibeam echosounder. This makes possible to acquire detailed measurements of a structure (both emerged and submerged parts) over large areas and short times (Pranzini, E. and Rossi, L., 2013) see Fig 2. LiDAR (Light Detection And Ranging) is a technology that allows a large scale approach of beach survey, especially interesting for monitoring the topography and the bathymetry of the nearshore area. Two different wavelengths, infrared (1064 µm) and green (532 µm), operate at the same time in each laser pulse the infrared one is returned by the water sea surface, whereas the green one is returned by the sea floor. Water depth is retrieved from the difference in return time of the two beams.

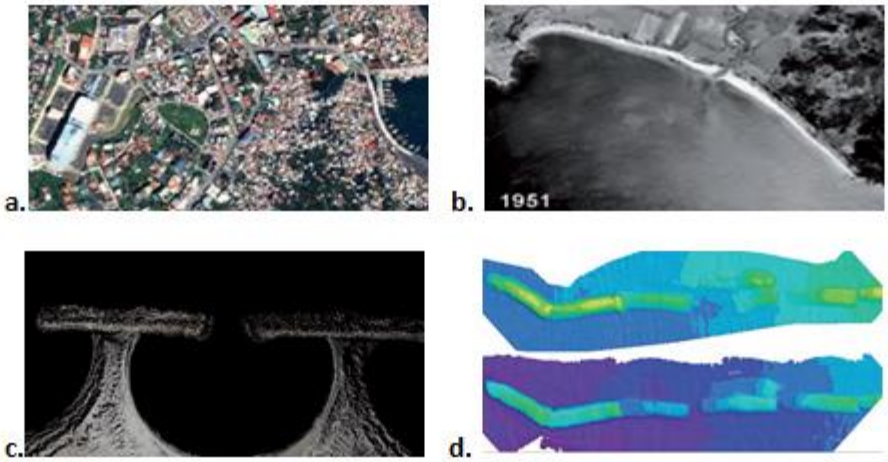


Fig 1 of point 4.1.1. a) Pan-sharpened Quickbird imagery Source (source: Deichmann, U. et al., (2011); b) Historic aerial photograph of Taravo beach illustrating evolution in the past decades (orthophotos© IGN); c) Laser scanner survey of a beach (by Geocoste for Politecnico di Bari). Source: Pranzini, E. and Rossi, L., (2013); d) Submerged groin survey using Multibeam Reson 8125 (top) and Odom ES3 (below). Source: Pranzini, E. and Rossi, L., (2013).

4.1.2 Mapping tools and methods

Geographic information systems (GIS) provide the platform for information integration, analysis and dissemination.

<u>Image processing</u>
Image processing systems are specialized tools to manipulate satellite data. Raw images will need relatively complex procedures to geometrically and radiometrically correct images to improve location accuracy and enhance the ability to identify features on the map.

<u>Detection of manmade structures and mapping</u>
Images can be analysed visually or quantitatively using machine assisted algorithms to extract information from the imagery in an automatic way. Visual or manual techniques (i.e. delineating image features on the computer screen) are still the procedures most used to detect and map coastal manmade structures. Automatic processing of the VHR imagery implies complexity due to sophisticated requirements and typically do not works very well on very high resolution satellite images, thus this is still very much a research area (Deichmann, U. et al., 2011).

Visual interpretation and manual digitalization can also be used to delineate the overall extent of built-up areas. However, one efficient and rapid method to generate a digital map of urban extent from VHR imagery is by means of a built-up area index which can be derived using automated computer techniques. It uses an algorithm that evaluates the textural characteristics of different areas in a satellite image (Pesaresi et al., 2008). The strength of the built up area index is that when applied in relatively sparsely settled urban areas with VHR imagery, the approach can capture single buildings or clusters of buildings similar to information that is typically found on maps at 1:10000 scale. It is thus an improvement over land cover maps that usually provide information at coarser than 1:25,000 scale (Pesaresi et al., 2008). Therefore, the latest can hardly capture sparse and spontaneous coastal urbanization.

A proposal of the cartographic representation of the elements concerned (i.e. coastal defence, ports and marinas; land claim and impervious surfaces) is summarized below. Basically, two different approaches are suggested according to the metrics involved: (i) length of coastline (meters) and (ii) area occupied by those structures.

Linear representation

Linear representation can be used as a simple and satisfactory way is to keep the baseline coastline and symbolize manmade coastal segments differently than the 'natural' coastline; thus, maintaining the original shape of the coastline. However, manmade coastal segments could have associated a table of attributes storing relevant information e.g. kind of structure (groyne, breakwater, etc..), port characteristics (commercial, leisure, etc.), geographical position (centroid coordinates).

Alternatively, different symbols could be used to differentiate coastal defence typologies (see Fig 2.a).

Finally, other possibility is to digitalize the exact location of the coastal defence (by delineation its shape) independently from the coastline. This approach offers more accuracy but it is time consuming (see Fig 3.b).

Additional information concerning the architectural characteristics and the history of the structure, as well as aerial and ground photographic documentation, could be stored in attached files and may be available through hyperlinks on the map.

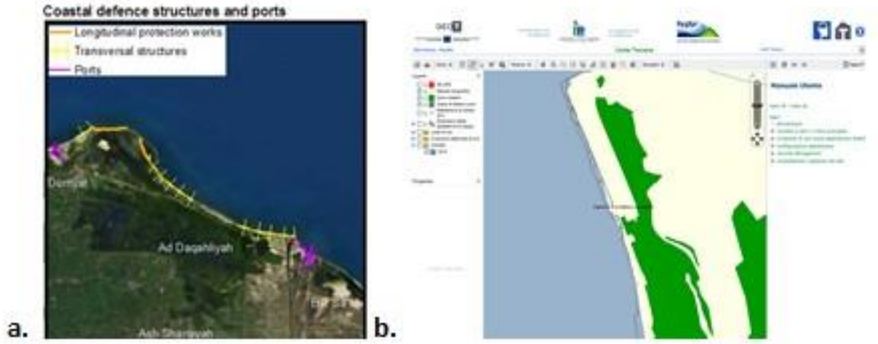


Fig 2 a) Example of cartographic representation of coastal defence and ports in Egypt. (Source: MEDINA Project[39]); b) Coasta Toscana (Source: ResMar Project[40])

Area representation

Land claim and urban-built up should be represented according to their spatial footprint. Therefore, a polygon approach is recommended. It is worth to mention that the 'land claim' class could be interpreted as impervious surfaces class. To avoid this uncertain, historical imagery is needed. Differentiated symbols can be used to discriminate land claim from urban built-up. An example of the land claim spatial representation is offered by MEDAM geoportal (see Fig 3).

39 www.medinageoportal.eu/
40 http://www.res-mar.eu/

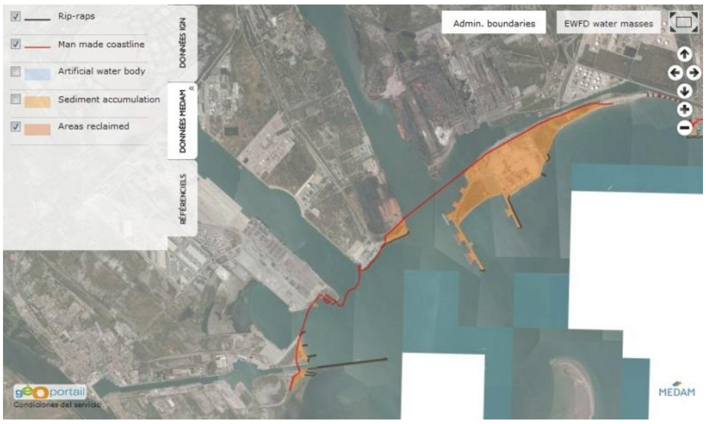


Fig 3 of point 4.1.2.: Inventory of manmade coastline and areas reclaimed (French Mediterranean coast). Source: MEDAM[41]

Shoreline evolution of sandy lengths subject to physical disturbance

One of the main problems lies in locating the shoreline via a method that is not bound to the "subjectiveness" of the interpreter or of the operator. In the Beachmed (2004) report, the authors note that shorelines plotted using digital orthophotographs by different operators may be subject to positioning differences of several metres.

To guarantee the systematic monitoring of the shoreline it is however necessary to use an image processing procedure that is less bound to subjective variables, in order to optimise processing times and to enable measurements to be made autonomously by operators not highly specialised but employed in the sphere of territorial management.

Finally, regardless the data acquisition metadata, with source/processing/accuracy information are crucial in a shared databank allowing reliable wide-scale analysis and intra- and extra-Region comparisons.

4.1.3. Assessment considerations

In comparative terms, the assessment of environmental coastal issues requires a detailer monitoring scale than the offshore waters approach (e.g. subregion level). This is especially true when coping with coastal infrastructures detection. The spatial coverage where manmade structures can be found only involves a coastal fringe of 200 meters in amplitude (offshore structures are covered by other EcAp indicator). Moreover, some of the elements required to monitor are structures of a few meters in length and/or amplitude (e.g. groynes, seawalls, etc.).

For the assessment purpose, ideally the appropriate scale would be at the level of coastal water bodies[42]. Thereafter, if needed, the scanned data (i.e. meters of coastline affected, or hectares reclaimed or occupied by impervious surfaces) can be added to higher levels (e.g. administrative boundaries or Mediterranean subregions). The MEDAM inventory[43] offers a good example of this bottom up approach by recording the length of manmade structures and the area occupied by land claim at different spatial levels: water body, town, departement, region and country.

For assessment of indicator on length of coastline influenced by man-made structures, definition of thresholds as % or meter should be based on expert assisted procedure to take into account the typology

[41] http://www.medam.info/index.php/en/

[42] As required by the Water Framework Directive (European Commission, 2000)

[43] Meinesz A., Blanfuné A., Chancollon O., Javel F., Longepierre S., Markovic L., Vaugelas de J. et Garcia D., 2013. Côtes méditerranéennes françaises: inventaire et impacts des aménagements gagnés sur la mer. Ed. Lab. ECOMERS, Université Nice Sophia Antipolis, 156 pp.et publication éléctronique: www.medam.org.

of the coast including its ecosystem goods and services related to social and economic benefits. The assessment should also include disturbance that comes from such structures.

4.2. Location of sampling sites

Manmade structures:

In regard to the appropriate location of sampling sites, monitoring should not be limited to concrete coastal lengths, but should cover the entire Mediterranean coastline of each Contracting Party. However, taking into account that coastal defence, ports, marinas and land claim are usually found in the vicinity of coastal urban centers and touristic resorts, special attention should be given to those hotspots coastal segments in order to properly detect and monitor coastal structures.

Shoreline evolution of sandy coastline under physical disturbance:

Only those sandy areas where manmade structures have been identified will be monitored. With regard to the positive and eventually negative effects of coastal defence structures, the beach segment to evaluate the impacts should extent to the whole physiographic unit by means of long-term monitoring (Pranzini, E. and Rossi, L., 2013).

Whenever monitoring is carried with the scope of evaluating coastal manmade structure impacts, surveys should have as study area a length of coast of at least one magnitude order higher than that of the structure, since the instant structure impact on coastal processes develops for a beach length between 1 and 3 times the largest dimension of the structure. In fact, the impact of the structure may first affect first the sediment dynamics of the beach segment immediately downdrift (and in cases also updrift). However it may progressively extend to the whole physiographic unit (Pranzini, E. and Rossi, L., 2013).

4.3. Frequency of monitoring

Although each coastal section and each process responsible for shaping it requires specific procedures for surveying and for data analysis, operation time scales must be set. This shall lead to a homogeneous level of knowledge, which will make data comparison and transfer/exchange of project and management experiences more effective. While monitoring manmade structures data should be update at least every six years, shoreline survey of sandy coastline under manmade pressure should be repeated annually (at the same time of the year, as mentioned earlier).

It is well known that the beach is an extremely dynamic morphological entity, whose change is closely tied up with weather and sea conditions and tide variations. In monitoring coastlines using a semiautomatic system based on the use of high resolution satellite images, the role of sea conditions at the time of data acquisition is fundamental. Correct monitoring should therefore be based on the acquisition of satellite images taken, when possible, when the sea is calm in order to prevent the over-estimation or under-estimation of variations. In some localities along the Mediterranean coast, tidal conditions should also be known and taken into consideration.

4.4. Collection of field samples and data from other observation techniques

Besides Earth Observation data, potential source of data useful to validate and to enhance the accuracy of the monitoring effort are: detailed plans of constructions (e.g. ports, marinas, touristic resorts, etc.); local urban plans; census of the public works; ground survey of the shoreline by manual systems (GPS); collection of photographs from the ground (manual, web-camps, etc).

4.5. Land use change

The CORMON Coast and Hydrography (May 2013) agreed on a specific candidate common indicator for the Mediterranean region addressing land use change, noting that this candidate common indicator would need further testing, pilot implementation (including during the initial phase of IMAP), before the Contracting Parties could agree to its regional usage as a common indicator.

In order to follow-up on this CORMON Coast and Hydrography recommendation, an EcAp pilot project already took place in the Adriatic to test the feasibility of this candidate common indicator on the sub-regional level, in the framework of an EU funded project on the "Implementation of the Ecosystem Approach in the Mediterranean by the Contracting Parties in the context of the Barcelona Convention for the Protection of the Marine Environment and the Coastal region of the Mediterranean and its Protocols (EcAp-MED project 2012-2015)".

The results of this pilot are presented in document UNEP(DEPI)/MED WG.420/Inf.18.

In relation to candidate indicator 19 on land use change, Contracting Parties are thus encouraged during the initial phase of IMAP, to develop monitoring programmes and undertake monitoring activities on a pilot basis, in line with the outcomes of the EcAp-MED pilot project.

The main conclusions of the Pilot project suggest that by using the common remote data and a common method for processing and presenting the results are feasible and a very positive step forward as far as monitoring the processes, the state and evolution of the coastal zones.

Consequently, the interpretation of the monitoring results can provide information on the impacts to coastal ecosystems, habitats and landscapes.

However, the Pilot suggests, and the PAP/RAC National Focal Points concluded that the interpretation of the results and the assessment which should lead to the definition of management measures and the achievement of GES should be done on the country level.

The reasons are related to the definition of the coastal zone and in particular of the analytical units in a respective country, and a very strong socio-economic, historic and cultural dimensions in addition to specific geomorphological and geographical conditions in each country that have to be taken into account.

Therefore, the interpretation of the results should be descriptive and should point out the negative trends and status of coastal zones that are not in line with the ICZM Protocol requirements or/and national policies, plans and programmes regulating the development of coastal zones and the definition of GES or similar descriptions of good status of coastal zones including specificities for good environmental status.

The method proposed provides a strong and appropriate tool to make land use changes visible on the maps and provides information if required management measures are needed. Since the management and related measures to achieve GES incorporate all those dimensions of sustainable development and impacts on the coastal ecosystems, biodiversity and landscapes depend on the results of such an analysis, i.e. the indicator itself, it should be left to the countries to build-in the flexibility to reflect countries' local specificities and conditions for the management purposes.

With regard to the definition of the coastal zone the Article 3 of the ICZM Protocol should be the basic unit for this candidate indicator, and as far as the analytical units this should be left to the countries to decide. The Pilot can serve as a source of inspiration.

In sum, the candidate indicator on land use change (candidate indicator 19) is very important for the analysis of processes in coastal areas and as it is a simple tool it should be promoted and developed so to allow countries to propose adequate measures to achieve GES (to be specified by the countries themselves taking local specificities into consideration) and, consequently, to bring more objectivity into reporting on the state and evolution of their coastal zones and implementation of the ecosystem approach in coastal zones.

IX. ECOLOGICAL OBJECTIVE 11: ENERGY INCLUDING UNDERWATER NOISE

A basin-wide strategy for underwater noise monitoring in the Mediterranean

*This part of the Integrated Monitoring and Assessment Programme has been prepared, thanks to the support of **ACCOBAMS** and **UNEP/MAP** by experts from the Joint ACCOBAMS/ASCOBANS/CMS Working Group on Noise (Alessio MAGLIO as coordinator, Manual CASTELLOTE and Gianni PAVAN).*

1. Executive summary

The Ecosystems Approach (EcAp) initiative, as implemented in the framework of the UNEP/MAP Barcelona Convention, is structured in 11 Ecological Objectives, where the eleventh is energy including underwater noise (EO11). In this context, the Agreement on the Conservation of Cetaceans in the Black Sea, the Mediterranean Sea and the contiguous Atlantic area (ACCOBAMS), in accordance with the Secretariat of the Mediterranean Action Plan of the United Nations Environment Program (UNEP/MAP), launched a study to develop a basin-wide strategy for underwater noise monitoring in the Mediterranean. Hence, the present technical guidance was developed by members of the Joint ACCOBAMS/ASCOBANS/CMS Noise Working Group (JNWG). This guidance outlines the indicators related to EO11, and provides the necessary information for stakeholders to secure a correct and straightforward implementation. The basis for developing such strategy was the Descriptor 11 of the Marine Strategy Framework Directive (MSFD) of the European Union and therefore two separate indicators are used for impulsive noise and continuous noise (indicator 11.1.1 and 11.1.2, respectively). Indicator 11.1.1 addresses space-time distribution of impulsive noise sources, while the 11.1.2 addresses levels of continuous noise through the use of measurements and models. The proposed strategy on noise monitoring recommends several adaptations for the Mediterranean case. Particularly, both indicators are more closely related to the acoustic biology of key marine mammal species of the Mediterranean which are known to be sensitive to noise, i.e. the fin whale, the sperm whale and the Cuvier's beaked whale. The proposed monitoring strategy, represents a further important progress towards an effective and widely agreed regulation of underwater noise at a regional scale.

Possible Candidate Indicator 26: Proportion of days and geographical distribution where loud, low and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animals

GES related to indicator 11.1.1 is defined in terms of the space-time distribution of impulsive noise sources. However, in the above definition some terms and expressions need to be explained before defining GES: *proportion of days* is to be interpreted as the number of days over a calendar year; *geographical distribution* is defined as the number of grid cells over a 20 × 20 km grid covering the whole Mediterranean basin; i*mpulsive sounds* are to be interpreted as source levels of anthropogenic noise sources; *impact* is defined as severe and/or sustained and/or long-term avoidance of an area, and/or disruption of acoustic behaviour, i.e. stop calling and/or stop clicking. Further, we need to define what impulsive noise sources are to be taken into account. The JNWG recommends addressing all human activities using low frequency noise sources, regardless of their source level, thus accounting for fin whale sensitivity over very long ranges. Also, it is recommended to address human activities using mid frequency noise provided their source levels exceeds a fixed threshold. Thresholds for mid frequency noise sources were set in order to account for Cuvier's beaked whale sensitivity to mid frequency sounds. So, in order to define GES related to indicator 11.1.1, it is recommended to establish a spatial threshold (i.e. a number of cells over a grid) and a time threshold (i.e. a number of days over a calendar year). Exceeding either of such thresholds in a given year means that GES is not attained for that year. Indicator 11.1.1 is presented in synthesis in table 1 below.

Possible Candidate Indicator 27: Levels of continuous low frequency sound with the use of models as appropriate

GES related to indicator 11.1.2 is defined in terms of levels of continuous noise in specific frequency bands. These are third-octave bands centred at 20, 63, 125, 250, 500 and 2000 Hz. Frequency bands were selected where shipping noise is likely to be dominant compared to other sources according to Mediterranean data (63, 125, 250 and 500 Hz), but also where noise potentially masks fin whale calls and sperm whale clicks (20 Hz and 2000 Hz, respectively). Two metrics are recommended for monitoring: the annual arithmetic mean Sound Pressure Level (SPL), expressed in dB re 1µPa (rms); and the annual 33.3% Exceedance Level (or $L_{33.3}$), meaning the noise level exceeded 33.3 % of a calendar year. $L_{33.3}$ is aimed at accounting for possible increase in ambient noise levels due to recreational craft in summer. In fact, it is assumed that recreational craft can cause significant increase in ambient noise levels during the summer period, i.e. June to September, which represents a third (= 33.3%) of a year. So, in order to define GES related to indicator 11.1.2, it is recommended to establish a conservative noise threshold. If the annual arithmetic mean SPL is above the noise threshold, GES is not met that year for that region while if the mean is below, the $L_{33.3}$ is inspected to figure out if during summer the threshold was exceeded. If so, GES is not met again. Indicator 11.1.2 is presented in synthesis in table 2 below.

Needs for GES assessment concerning Ecological Objective 11

For GES assessment related to EO11, three thresholds need to be established: a spatial and a temporal threshold concerning indicator 11.1.1 and a noise threshold concerning indicator 11.1.2. The JNWG considers that at this stage conservative thresholds can be proposed for both indicators and hence the ACCOBAMS Secretariat is requested to carry out the following tasks with a view to find out the thresholds:

1. Reviewing what spatial and temporal thresholds have been selected by European Member States for implementing impulsive noise indicator of D11
2. Fulfilling action CA 2b1 of the 2014-2016 Work Plan ("Identifying Noise Hotpots for cetaceans in the ACCOBAMS area") in order to provide the necessary baseline information on space-time distribution of impulsive noise sources across the Mediterranean
3. Reviewing ambient noise data available for the Mediterranean Sea as a follow up of the present work in order to identify the threshold for continuous noise indicator 11.1.2.

2. Introduction

Anthropogenic energy introduced by human activities into the marine environment includes sound, light and other electromagnetic fields, heat and radioactive energy. Among these, the most widespread and pervasive is underwater sound (Dekeling *et al.*, 2013a). Sound energy input can occur at varying spatial and temporal scales. Anthropogenic sounds may be of short duration (i.e. impulsive) or be long lasting (i.e. continuous). Sound transmission in the marine environment is very variable. Lower frequency sounds can travel far (tens to thousands of kilometres), whereas higher frequency sounds transmit less well in the marine environment (hundreds of meters to few kilometres (Urick, 1996). Sources of marine noise pollution include ship traffic, geophysical exploration and oil and gas exploitation, military sonar use and underwater detonations, telemetry devices and acoustic modems, scientific research involving the use of active acoustic sources, and finally offshore and inshore industrial construction works. Such activities are growing throughout the Mediterranean Sea (e.g.De Micco; OWEMES, 2012; US Energy Information administration, 2013).

Marine organisms can be adversely affected both on short and long timescales (and include acute or chronic impact and temporary or permanent effects (Richardson et al, 1995). Adverse effects can be subtle (e.g. temporary reduction in hearing sensitivity, stress effects causing reduced immunity, reproduction success or survival), or more obvious (e.g. injury, death). The former may be difficult to observe and evaluate while the latter may in some circumstances be related to acute short-range noise exposures. Management concern is primarily associated to the negative effects of noise on sensitive protected species, such as some species of marine mammals, though there is growing awareness that an ecosystem-wide approach also needs to be considered.

In the framework of the Mediterranean Action Plan of the United Nations Environment Program (UNEP/MAP), the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (UNEP/MAP Barcelona Convention) defines pollution as follows: "*Pollution" means the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results, or is likely to result, in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of seawater and reduction of amenities* (article 2-a). With regard to assessment and monitoring purposes, underwater noise is concretely being considered by the Contracting Parties to the UNEP/MAP Barcelona Convention for the first time under the ongoing implementation of the Ecosystems Approach process (**Decision 17/6**). Eleven Ecological Objectives (EO), and respective operational objectives and indicators have been agreed for the Mediterranean through **Decision 20/4** during the 17th Meeting of Contracting Parties (COP 17). Indeed, following the definition contained in the Decision 20/4, the EO11 is achieved when **noise from human activities causes no significant impact on marine and coastal ecosystems**. However, during the last Meeting of Contracting Parties (COP 18, Istanbul, 2013), **Decision 21/3** provided a specific list of descriptions of good environmental status and targets for the other EOs, contrary to EO11, considered not yet sufficiently understood to allow a proper definition of good environmental status.

In this context, the Agreement on the Conservation of Cetaceans in the Black Sea, the Mediterranean Sea and the contiguous Atlantic area (ACCOBAMS), in accordance with the Secretariat of the UNEP/MAP, launched a study to develop a basin-wide strategy for underwater noise monitoring in the Mediterranean. Hence, the present technical guidance was developed by members of the Joint ACCOBAMS/ASCOBANS/CMS Noise Working Group (JNWG). This document outlines the importance of assessing and monitoring underwater noise in the Mediterranean Sea, and discusses the issues related to the choice of indicators currently proposed for the implementation of Descriptor 11 of the MSFD, with a view to propose adaptations to the Mediterranean case, whenever possible. The monitoring strategy here proposed brings forward the work carried out so far by UNEP/MAP, in coherence with other international legal frameworks operating in the area (such as ACCOBAMS and the European Union Directives).

2.1. Underwater noise in the Mediterranean Sea

The Mediterranean basin is an almost enclosed sea area highly exploited by humans, where all the aforementioned noise-producing human activities take place on a regular basis. Some features belonging specifically to the Mediterranean region need to be taken into account while addressing underwater noise impacts:

- The presence of highly sensitive and/or endangered species
- The heavy human development of the coastal region
- The high concentration of cumulative pressures in many areas

It has been demonstrated that naval exercises involving the use of mid-frequency active sonars caused several mass stranding events of Cuvier's beaked whales along the coasts of the Mediterranean Sea and in other sea areas at least during the last 20 years (e.g. Frantzis, 1998; Fernandez *et al.*, 2004; Martin *et al.*, 2004; Agardy *et al.*, 2007; Filadelfo *et al.*, 2009). Such correlation has not been identified with any other anthropogenic noise source, although this cannot be ruled out for the case of geophysical surveys (e.g. Southall *et al.*, 2013; Castellote and Llorens 2013). There is concern that such anthropogenic noise sources may play a role in increasing stress on marine fauna (Rolland et al., 2012). It should be remembered as well that the Mediterranean harbours one of the most critically endangered mammal populations in the world, i.e. the Mediterranean Monk Seal. Furthermore, based on recent IUCN assessments, several cetacean species are experiencing a decreasing population trend, e.g. the bottlenose dolphin and the sperm whale (Notarbartolo di Sciara et al,. 2012; Bearzi et al,. 2012).

Several international legal frameworks addressing environmental protection and conservation recognise noise as a pressure factor that need to be assessed, monitored and where necessary mitigated. In this context, the ACCOBAMS Agreement is concretely working toward a wide adoption of operational measures aimed at mitigating the impacts of anthropogenic noise on marine mammals. The main tools already developed include:

- ACCOBAMS Resolution 4.17 (*Guidelines to address the impact of anthropogenic noise on cetaceans in the ACCOBAMS area*, adopted by Parties in 2010), in which operational measures and procedures are outlined for each noise-producing human activity;
- *Guidance on underwater noise mitigation measures* (ACCOBAMS, 2013), a practical document aimed at guiding industrial companies in the implementation of procedures to reduce the risk of inducing acoustic impacts.

1. The choice of indicators for monitoring and assessing anthropogenic underwater noise

Underwater noise can be classified as impulsive or continuous in terms of its effects on marine life. It is well known that high powered impulsive noise may cause direct acute effects such as hearing loss, tissue damages and death to individuals of sensitive species such as cetaceans. It may also cause permanent effects, such as when animals are displaced permanently from an important feeding area. Continuous noise entails a chronic exposure mainly associated with stress and behavioural changes potentially leading to negative effects at the population level over time. Hence **relevant indicators should be developed in order to consider, and appropriately manage, these two categories of noise**. Other than the impulsive or continuous nature of noise, its frequency spectrum is relevant for designating indicators, because sound propagation is frequency dependent. Also, marine species sensitivity to sound is frequency dependent. Therefore, on one hand, the **frequency nature of noise should be considered as a determining factor**, on the other hand key species (sensitive, emblematic, etc.) of the Mediterranean Sea should be considered while addressing monitoring guidance. The JNWG proposes considering the potential impact of noise on the fin whale (*Balaenoptera physalus*), the Cuvier's beaked whale (*Ziphius cavirostris*) and the sperm whale (*Physeter macrocephalus*), three sensitive and emblematic species of the Mediterranean region.

In order to be in coherence with the Marine Strategy Framework Directive of the European Union (MSFD) and to harmonise measures, it is proposed that the base for developing an assessment strategy (and thus indicators) for the Mediterranean Sea be the guidance for implementing the Descriptor 11 (D11) of the MSFD (Dekeling *et al.*, 2013). This guidance, developed by the Technical Sub-Group on Underwater Noise (TSG Noise) of the European Commission, will soon be adopted in part of the Mediterranean region (EU countries bordering the area). The MSFD explicitly gives instructions to Member States on how to apply an ecosystem-based approach to the management of anthropogenic noise in order to attain the Good Environmental Status (GES). With the Commission Decision 2010/477/EU, two indicators are retained addressing **low and mid frequency impulsive noise** and **low frequency continuous noise**.

Concerning low and mid frequency impulsive noise, it should be clear that this indicator, according to the basic principle of the MSFD, addresses the ecosystem rather than individual animals or species, and the cumulative impact of activities, rather than that of individual projects or programmes. Such concepts can be applied to the objectives of the UNEP/MAP and in the framework of the EcAp process. Hence, impulsive noise can be monitored by setting up a **register of anthropogenic activities** which use loud noise sources. By knowing the date and location of such activities, **the proportion of days within a**

given period, and over a given geographical scale, in which activities generating impulsive sounds take place can be computed, monitored and managed. Nonetheless, not all noise sources impact the marine environment, thus not all noise-producing activities need to be taken into account. TSG Noise proposes to use a threshold system as a condition to include human activities in the register. In other words, activities are taken up in the register if they use low and mid-frequency impulsive noise sources exceeding a certain source level threshold. With regards to the MSFD, thresholds are mainly based on studies focussing on the onset of behavioural disruption in harbour porpoise (*Phocoena phocoena*), a very common species in the North Sea, but absent in the Mediterranean Sea. In the present document, the JNWG describe adaptations of the impulsive noise indicator to Mediterranean species.

With regards to the indicator for ambient noise, TSG Noise state that the primary objective thereof should be to detect a trend in sound levels over a given temporal scale, considering a consistent range of frequencies. Simple averaging methods of sampling units are recommended for calculating noise levels over a year in the frequency bands where shipping is likely to be dominant compared to other continuous noise sources, i.e. 63 and 125 Hz third-octave frequency bands. However, for the UNEP/MAP needs, further options could be proposed. First, detecting a trend in sound levels could not be the best option if we are aiming at taking into account the potential negative effects of noise to marine wildlife, and particularly to cetaceans. In fact, even a decreasing trend, which satisfies the definition of GES *sensu* TSG Noise, could stay above biologically relevant thresholds, i.e. levels causing negative effects, during a long time (several years). In this regard, **the establishment of a noise threshold for ambient noise should be considered**. Further, baleen whales may be covered by reporting energy up to 1 kHz, and ships are known to produce noise in a wider band than the two octaves indicated for the MSFD. Additionally, if we are concerned about GES for sensitive and vulnerable toothed whales, it could be relevant to include higher frequency bands. Therefore, the main difference between the ambient noise indicator of D11 and **the ambient noise indicator proposed for the EO11** is that the former only focus on the frequency content of noise from shipping regardless of its potential impact on marine wildlife, while the latter **wants to take into account also the potential impact on key cetacean species**. This can be achieved by selecting biologically relevant frequency bands for monitoring. Finally, as a seasonal component exists in levels of some human activities (e.g. recreational craft) throughout the Mediterranean Sea, and given that these aspects have never been deeply studied, a finer temporal scale for averaging could be proposed (e.g. seasonal or monthly). Such issues are discussed in sections 3.2.

3. Monitoring Strategy

The monitoring strategy depends on several factors, including the types of noise sources to be monitored, the choice among in-situ measurements or models and mapping or a combination, the spatial and temporal scales, the frequency and location of sampling sites, the definition of baseline values and thresholds, the sound metrics to compute results and the summary statistics to show such results. Such variability is reflected in different monitoring strategies addressed in the following paragraphs.

3.1. Impulsive noise indicator (11.1.1)

Taking the UNEP/MAP COP 17 definition (2012), the indicator for impulsive noise is defined as follows: *Proportion of days and geographical distribution where loud, low and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animals*.

In order to be in coherence with the definition from TSG Noise, impulsive sounds are to be interpreted as **source levels of anthropogenic sound sources**. As stated previously, implementing this indicator can be achieved through the establishment by Contracting Parties of a register of maritime activities using impulsive noise sources. Recommendations related thereto are discussed in the following sections.

3.1.1 Noise sources

There is general agreement on what human activities use impulsive noise sources which should be included in the register. These are naval exercises involving the use of low and mid-frequency sonars, geophysical surveys, underwater detonation, pile driving and the use of acoustic deterrent devices. For the purpose of the UNEP/MAP, the JNWG proposes that whether or not a given human activity is taken up in the register depend on the significant impact caused to key cetacean species found in the Mediterranean Sea, namely the fin whale, the sperm whale and the Cuvier's beaked whale. Therefore, the meaning of significant impact needs to be defined. The JNWG proposes to adapt the definition used by TSG Noise, that is: **severe and/or sustained and/or long-term avoidance of an area, and/or disruption of acoustic behaviour, i.e. stop calling or stop clicking**.

Thus, based on the available knowledge on the acoustic biology/ecology of fin whales and Cuvier's beaked whales, the JNWG proposes to include two different lists of human activities at sea, one for **low-frequency** impulsive noise sources, and one for **mid-frequency** impulsive noise sources. The former addresses the sensitivity range of the fin whale, and lists activities that need to be included in the register regardless to the source level, i.e. all activities using low frequency impulsive noise sources should be included in the register. The latter addresses the sensitivity range of sperm whales and Cuvier's beaked whales and is based on a threshold system as a condition for inclusion in the register. This proposal is based on the fact that displacement and/or acoustic behavioural disruption may occur for Mediterranean fin whales in response to low frequency impulsive noise at very long ranges, reaching more than 200 km (Borsani *et al.*, 2008; Castellote *et al.*, 2012). Setting a minimum source level threshold for inclusion in the register of low-frequency sources would be useless as all activities would be very likely to be included. On the other hand, sperm whales and beaked whales have been identified to be highly sensitive to mid-frequencies (e.g. Aguilar de Soto *et al*., 2006; Weir, 2008). Power contained in mid-frequency bands is normally related to power contained in low frequency bands, and travels less far than low frequencies. Using a threshold system for inclusion of human activities in the register appears consistent because it simplifies methodology, and reduces cost for monitoring.

In summary, **activities using low frequency impulsive noise sources with no threshold** for inclusion in the register are the following:

- Low frequency military sonar (LFA)
- Geophysical surveys (both commercial or scientific, using any source like airguns, sparkers, subbottom profilers, etc.)
- At sea or shore based detonations
- Pile driving (only for "assisted press-in systems" which include all types of piston-based hammers)

The **activities with a minimum threshold** for inclusion in the register, include the following mid frequency noise sources:

- Mid frequency military sonar: SL > 176 dB re 1 μPa m
- Mid frequency acoustic deterrent: SL > 176 dB re 1 μPa m
- Other non-pulse sound source: SL > 176 dB re 1 μPa m
- Other pulse sound source SLE > 186 dB re 1 $\mu Pa^2 m^2 s$

Such thresholds follow the recommendations given by TSG Noise (Dekeling *et al.*, 2013) and presented hereafter. First, received noise levels eliciting behavioural reactions are identified through a literature review. Then, it is assumed that significant impact occurs when such noise levels reach a range of 1000 m from the noise source, meaning that sources producing levels that cause behavioural reaction at 1000 m from the source are included in the register. Finally, noise levels eliciting behavioural reaction at 1000 m are back calculated to find the **source level (SL) used as threshold for inclusion in the register**, indicated in the list above. Considering non-pulse sound sources (mid-frequency military sonar, acoustic deterrent devices and other non-pulse sources), thresholds are based on beaked whale reaction to mid-frequency military sonar. A study focussing on Blainville's beaked whale (*Mesoplodon densirostris*) suggests 140 dB re 1μPa (rms) as the thresholds for the onset of behavioural reaction due to mid-frequency sonars (Tyack *et al.*, 2011). After back calculation (see Dekeling et al., 2013 Part III for details), the source level threshold is 176 dB re 1µPa. However, it is worth recalling a recent study from DeRuiter *et al.* (2013) focussing on Cuvier's beaked whale behavioural reaction to simulated mid-frequency sonar. This work suggests lower levels, i.e. levels ranging from 89 to 127 dB re 1µPa (rms), for triggering behavioural reactions in Cuvier's beaked whale. Such reactions include ceasing normal fluking and echolocation, changing swim pattern and extending both dive duration and subsequent non-foraging interval (DeRuiter et al., 2013). Of course this latter study is more coherent for the Mediterranean case, but the range of noise levels triggering a response, as suggested, appear too large. Furthermore, the same study shows that distant sonar exercises incidentally exposing a tagged whale to comparable received levels (78 – 106 dB re 1µPa rms) did not elicit such responses. Hence, the JNWG proposes as interim criterion to use the noise level recommended by TSG Noise based on Tyack et al. (2011), i.e. 176 dB, as a threshold for mid-frequency non-pulse noise sources. Updating this threshold will be necessary once deeper knowledge will be available. For *other pulse sound source*s, the JNWG advices to adopt as interim criterion the threshold used in the technical guidance for implementation of D11. Such threshold is based on the onset of behavioral disruption for the harbor porpoise at 1000 m, which is the marine mammal with lowest TTS thresholds known to date (Lucke *et al.*, 2009). Finally, in order to establish the register, for each of the above activities, the basic information required to derive the number of days in which activities using impulsive sources occur in an area, is:

- Position data (geographic position: lat/long)
- Period of operation (start – end)
- Source Level dB re 1µPa rms at 1m
- Number of hours of activity per day
- Duty cycle (ON/OFF ratio) or % of time ON
- Frequency range
- Source level (for mid-frequency sources)

3.1.2. Temporal and Spatial scales

Concerning temporal scales, the JNWG recommend using 1 year for the impulsive noise indicator, in coherence with D11. Hence, the indicator addresses the number of days within 1 year in which activities generating impulsive sounds take place. With regards to spatial scales, the geographical distribution of impulsive sound sources can be easily represented under the form of cartography by means of a spatial grid. Such a grid could be used for the following tasks:

- Collecting and storing data
- Presenting cartographic data
- Assessment purposes
- Other management actions

Thus, grid cell size needs to be defined. Options considered by the TSG Noise are based either on administrative or biological reasoning. For instance, in the UK, data concerning seismic surveys are registered in standard hydrocarbon licensing blocks that are 10 minutes latitude by 12 minutes longitude. A different option could be to base the grid on estimated impact. Based on studies carried out in the North Sea, the reported range of displacement effects for harbour porpoises from pile driving has been of the order of 20 km (Tougaard *et al*, 2012; Dähne *et al.*, 2013). Hence, taking a 20 km radius, this means an area of about 1250 km². This implies that in a grid cell of about the same surface over which a pile driver is active, it can be assumed that porpoises are absent in that cell, and hence the potential habitat loss can be estimated. The problem with this is that harbour porpoises, which presently represent the best reference about displacement effects, are absent in the Mediterranean Sea. Instead, after consultation with the ACCOBAMS Scientific Committee, it seems practicable to use a grid size based on biological reasoning, particularly on the grid size used for studying ecological features of cetacean populations in the Mediterranean Sea. A study from Azzellino *et al.* (2011) assessed the feasibility of using models of beaked whale distribution developed in an area to another area (a model developed in the Ligurian Sea to the Alboran Sea, considering that study), in order to formulate (early) recommendations on conservation measures in non surveyed areas. The main result of this study suggests that applying "uncertainty buffers" of 20 km radius around the centroid of predicted presence cells may guarantee that the prediction process is appropriately conservative and robust. Following Azzellino *et al.* (2011), a grid size of 20 x 20 km is proposed. This grid size would enable to assess the potential habitat loss for beaked whales. This also would help meeting the need of adapting TSG Noise recommendations to the Mediterranean case.

3.2. Ambient noise indicator (11.1.2)

UNEP/MAP COP 17 (2012) define the indicator for ambient noise as follows: Trends in continuous low frequency sounds with the use of models as appropriate. As stated in section 2, a threshold could be a better option for the objectives of the UNEP/MAP with respect to monitoring trends. Therefore, the JNWG propose to simplify the definition of the ambient noise indicator as follows: *Levels of continuous low frequency sound with the use of models as appropriate*. Issues related to the implementation of a monitoring of ambient noise are discussed in the following sections.

3.2.1 In-situ measurements, models and noise mapping

The use of in-situ acoustic measurements is essential for:

- Gathering fundamental field data to establish information on the ambient noise in a given location
- Reducing uncertainty on source levels to be used as the input for modelling
- Increasing evidence base to improve management decisions

The use of models is essential for:

- Reducing the time required to establish a trend (the expected trend in shipping noise, based on observations in deep water, is of the order of 0.1 dB/year; and therefore it takes many years, possibly decades, to reveal such small trends without the help of spatial averaging)
- Reducing the number of stations required to establish a trend over a fixed amount of time (similar reasoning to above), therefore reducing the cost of monitoring
- Helping with the choice of monitoring positions and equipment (selecting locations where the shipping noise is dominant as opposed to explosions or seismic surveys being dominant).
- Producing noise maps, which are a valuable tool to quickly understand the ensonification levels over large areas, and a fundamental tool to calculate the extent of potentially impacted (non-GES) areas
- Predicting future scenarios and therefore testing different noise reduction strategies, e.g. by answering simple questions such as what happens if we reduce by XX dB the noise of 1% (or 20% etc.) of the circulating ships? Will this be a significant reduction?
-

  - **Location of sampling sites**

Recommendations for the placement of measurement devices are listed as follows:

- Monitoring in both high traffic and low traffic areas, also searching and including spots where the noise is supposed to be the lowest
- Monitoring may be more cost effective if existing oceanographic stations (e.g. EMSO/INFN networks, (Favali *et al.*, 2013)) included noise monitoring along with the other oceanographic variables already being monitored;

- Consider local topography and bathymetry effects e.g. where there are pronounced coastal landscapes or islands/archipelagos it may be appropriate to place hydrophones on both sides of the feature;
- As far as possible avoid locations close to other sound producing sources that might interfere with measurements e.g. oil and gas exploration or offshore construction activities. Areas of particularly high tidal currents may also affect the quality of the measurement.
- Monitoring station should be primarily located in important cetacean habitat, as identified by ACCOBAMS (see Fig. 1).
- Whenever possible use deep monitoring stations, either autonomous or cabled, to limit the influence of surface and sub-surface noise.

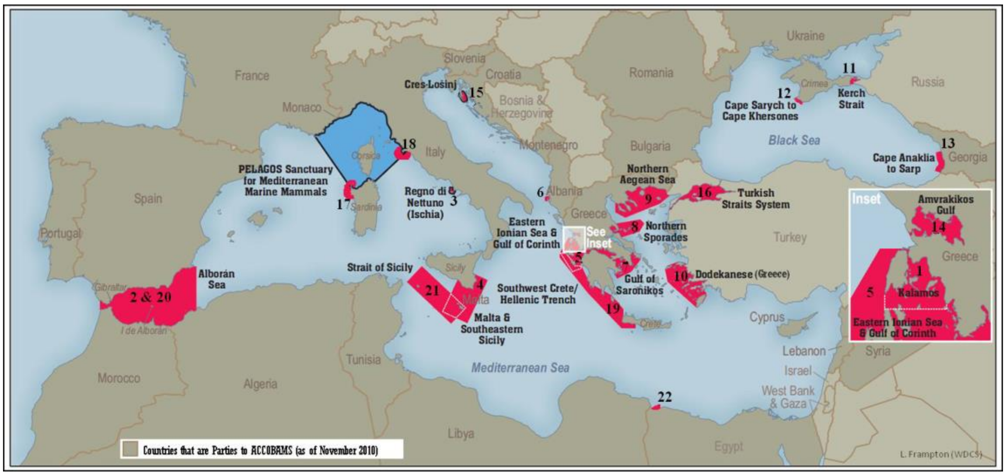


Figure 1. Areas of special importance for cetaceans in the ACCOBAMS area (ACCOBAMS Resolution 4.15, 2010)

- **Frequency range issues**

MSFD indicator 11.2.1 specifies narrow frequency bands where noise from shipping is most likely to dominate over other sources, i.e. they are chosen to be most representative of the environmental pressure from shipping noise. These are the third-octave band centred at 63 Hz and 125 Hz. For the purposes of the UNEP/MAP, an approach considering a wider range of frequencies is proposed, considering the potential masking effect of anthropogenic noise on biological signal used by fin whales and sperm whales.

The JNWG advices to include the two third-octave bands recommended by TSG-Noise (63 and 125 Hz) and also 250 Hz and 500 Hz, in order to expand the coverage for shipping noise. This is justified by the results obtained in the Mediterranean (e.g. Castellote, 2010; Pulvirenti *et al.*, 2014) where shipping noise spectrum typically peaked at higher bands than the ones proposed by TSG-Noise. Also, two more third-octave bands are proposed, focussing on key frequencies for fin whale and the sperm whale communication. The band centered at 20 Hz for fin whales, and the band centered at 2000 Hz for sperm whales. These two bands are selected based on the peak frequency of the vocalizations of both species (fin whale: Watkins 1981, sperm whale: Madsen *et al.*, 2002 ; Watkins et al. 1980). Even if sperm whale click peak frequency has been identified in 5000 Hz, its lower peak frequency limit has been defined in 2000 Hz. It seems more relevant to use the lower peak frequency limit because it is more likely to be affected by anthropogenic noise and it requires lower sampling rates to be recorded, reducing the cost of monitoring equipment and data archiving volume. Therefore third-octave bands proposed by the JNWG are:

- **20 Hz**, based fin whale biological significance

- **63 Hz**, based on the frequency bands where noise from shipping is most likely to dominate over other sources according to Tasker et al. (2010)
- **125 Hz**, based on frequency bands where noise from shipping is most likely to dominate over other sources according to Tasker et al. (2010)
- **250 Hz**, based on frequency bands where noise from shipping is most likely to dominate over other sources according to Mediterranean data (Pulvirenti *et al*. 2014)
- **500 Hz**, based on frequency bands where noise from shipping is most likely to dominate over other sources according to Mediterranean data (Pulvirenti *et al*. 2014)
- **2000 Hz**, based sperm whale biological significance

▪ **What metrics and summary statistics?**

The metric recommended for calculating ambient noise levels for the D11 is the annual average of the squared sound pressure in third octave bands expressed as a level in decibels, in units of dB re 1 μPa. Such a metric can be adopted for the ambient noise indicator of the EO11.

With regards to summary statistics, PART III of the last available report from TSG Noise (Dekeling et al., 2013) widely discusses the relevance of different averaging methods for calculating the value in decibels of the squared sound pressure over a period (1 year for the MSFD objectives). TSG Noise supports the use of the arithmetic mean of the sample units, as this is robust to changes or differences in sample duration while sensitive to significant increments in noise levels. In addition the JNWG consider that values in percentile appear very useful to convey information about how much time noise levels are maintained (e.g. Merchant *et al.*, 2013). **Figure 2** shows an example of 3 years of measurements in the 63 Hz third octave band made at the CTBTO Cape Leeuwin station (Dekeling et al, 2013).

In order to account with biological significance of ambient noise monitoring, a biologically relevant threshold in decibel for GES assessment has to be defined. Further, we should define how much time we can accept levels above that threshold. As stated above, information about how much time noise levels are maintained is given by levels in percentile. In aerial acoustics, a noise level exceeded N% of time is commonly written L_N, e.g. L_{10} means the noise level exceeded 10% of sampled time; L_{50} means the noise level exceeded 50% of time and so on. This is in accordance with the International Standard for aerial environmental noise ISO 1996-1:2003(E) (*Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures*). The same notation is used in this report[44]. Therefore, while the annual arithmetic mean could be within GES, a certain percentile (e.g. L_{10}) could exceed the GES level. This would mean that a proportion (e.g. 10%) of the sampled time GES would not be met, even if the annual arithmetic mean is within GES. Hence, one could argue whether this is acceptable or not. In conclusion, both statistics (annual arithmetic mean and percentile values) should be employed to evaluate whether an area is within GES or not.

[44] Standard ISO 1996-1:2003(E) requires using subscripts specifying whether the percent exceedance level is weighted, and what weighting function is used, e.g. for aerial acoustics L_{A10} means A-weighted 10% Exceedance Level. In the present document weighting functions are not used and hence all levels, including percent exceedance levels, are unweighted.

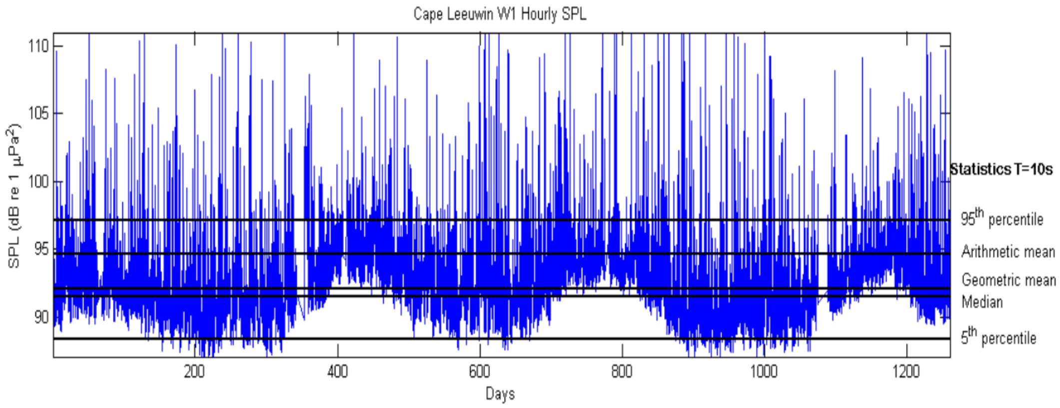


Figure 2. Monitoring noise in the 63 Hz third-octave band with different summary statistics over three year measurements in cape Leuween (taken from Dekeling et al, 2013). **N.B.**: in this figure, 95th percentile means L_5 and 5th percentile means L_{95}.

From a general point of view, if the only purpose of the indicator is monitoring the trend over time (years) for shipping noise as is requested by the MSFD, the annual mean SPL and variance could be sufficient. However, the ACCOBAMS reasoning for monitoring ambient noise is driven by the potential negative effect in sensitive cetaceans. Therefore, a finer temporal resolution is needed to better monitor seasonal departure from GES and hence the use of percent exceedance levels is necessary. In practice, if the annual arithmetic mean is above the noise threshold, GES is not met that year for that region while if the mean is below, then percentiles need to be inspected to figure out how much time the threshold was exceeded that year. If the percent used is proportional of the duration of the season of concern then this accounts with acute increases during specific seasons. Assuming that the strongest seasonal effect on ambient noise during a year is recreational craft occurring from June to September (4 out of 12 months), we should consider the $L_{33.3}$ index. In conclusion, in a situation where the annual arithmetic mean is below the threshold, the $L_{33.3}$ is inspected, and whether is higher than the threshold, therefore GES is not met that year.

3.3. Approaches for the achievement and maintenance of GES

For both indicators (impulsive and ambient noise), three different approaches can be implemented for GES determination:

- Setting thresholds
- Setting a downward trend in indicator values
- Using both thresholds and trends

Taking into account the basic concepts for developing the present monitoring strategy, the best option seems to be the use of thresholds for both indicators. Considering the impulsive noise indicator, two thresholds are required, i.e. number of days over a year and number of cells over a grid. The exceedance of either of the two threshold means that GES is not met. However, the temporal and spatial coverage at which the use of loud impulsive noise sources occurs across a sea area is unknown in the Mediterranean region. Also, it is unknown to us what values of this indicator, considering both the spatial and temporal component, could be considered as threshold values for GES achievement. In order to face such lack of knowledge, a preliminary task could be to review what thresholds have been selected by EU Countries for implementing D11 and evaluate if these are appropriate to be proposed for the whole Mediterranean region. Further, dedicated research projects should be carried out to provide new baseline information on both the temporal and spatial coverage, i.e. number of days over a year and number of cells over a grid respectively, at which activities using impulsive noise sources occur.

On the other hand, baseline knowledge about ambient noise levels throughout the Mediterranean is limited, and the effects of noise are not sufficiently known to robustly determine whether existing levels are too high, or if GES is being achieved. Therefore, the JNWG propose to identify a conservative SPL threshold, and define that the arithmetic annual mean and the $L_{33.3}$ index must be below that threshold in order to meet GES. Subsequently, a thorough review of available literature on ambient noise in the Mediterranean Sea is needed to identify the threshold for ambient noise.

It is noteworthy that during the period 2014-2016 ACCOBAMS has planned to carry out a considerable work to provide the necessary baseline information. The achievement of noise-related tasks contained in the 2014-2016 Work Plan will enable the full implementation of both impulsive and ambient noise indicator.

Table 2. List of tasks to be carried out to enable the implementation of the Mediterranean Strategy on Noise Monitoring.

Issue	Objective	TASK
Impulsive noise	Define thresholds for number of days over a year and number of cell over a grid.	Review what thresholds have been selected by EU Countries for implementing D11 Request ACCOBAMS to accomplish with action CA 2b1 of 2014-2016 Work Plan (“Identifying Noise Hotpots for cetaceans in the ACCOBAMS area”)
Ambient noise	Define a threshold for ambient noise in **dB re 1µPa (rms)**	Request ACCOBAMS to review the ambient noise data available for the Mediterranean Sea as a follow up of the present work in order to identify the threshold.

4. Further issues

4.1. Requirements for research in acoustics of interest for ambient noise monitoring

For research purposes, and with a view to robustly support the implementation of mitigation policies, it is recommended to increase time resolution to describe fine scale temporal variations of noise levels to be possibly correlated with human activities (e.g. ship traffic). For example, the following data appear necessary to understand in depth ambient noise patterns over a give area:

- Monthly mean SPL and variance to possibly reveal seasonal patterns
- Additional percent exceedance levels: L_{95}, L_{90}, L_{75}, $L_{66.6}$, L_{50}, $L_{33.3}$, L_{25}, L_{10}, L_{5}, for each third-octave band, calculated monthly and annually

4.2. Acoustic comfort

By analogy with human environments, the “acoustic comfort” is a useful concept that can be recalled with a view to attain the good environmental status. Research effort aimed at defining acoustic comfort for marine mammals are very likely to help in defining and/or updating thresholds needed for implementing the ambient noise indicator.

Annex I
Indicators Monitoring Fact Sheets

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

Common Indicator Description (including parameters, matrix)	Guidelines, Methodologies, QA/QC available	Initial phase of IMAP
Common Indicator 1 (COP 18 Indicator 1.4.1) **Habitat distributional range** State indicator Sub-indicator (for benthic habitats) is: Area of habitat loss Key coastal and marine habitats are not being lost Key parameters Parameter/metric is the surface area of lost/damaged habitat.	Mapping of habitat areal extent and assessment of change (loss/permanent damage) in relation to natural habitat areal extent /reference state Trend in areal extent of habitat for each habitat type For seabed habitat mapping Recommended Operating Guidelines under MESH Project[45] This information could be complemented by the upcoming implementation of the RAC/SPA Project "Med Key Habitats" on habitat cartography. For estimating cumulative anthropogenic impacts see Halpern at al., 2008, 2009; Selkoe at al., 2009; Ban et al., 2010; Kapel and Halpern, 2012; Korpinen at al., 2012, 2013; Andersen et al., 2013; Coll et al., 2012; Micheli et al., 2013. In addition EMODnet: http://www.emodnet.eu/ human-activities and http://www.emodnet-mediterranean.eu/ project/ For a review of standards and protocols for seabed habitat mapping: Cogan et al., 2007 Information on pressure and other relevant data available form Environmental Impact Assessments, VMS and fisheries log-book data.	Further quantitfy GES Define baselines/ threshold for assessment Develop QA/QC Establish monitoring areas (minimum 2 per country)
Common Indicator 2 (COP 18 Indicator 1.4.3) **Condition of the habitat-defining species and communities** State indicator Sub-indicator: Typical Species Composition (benthic habitats) Typical-key benthic species composition comprising of both macro-zoobenthos and	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. UNEP/DEPI/MED WG 342/3 recommendations on benthic biotic indices and on the application of metrics developed under the Water Framework Directive for use by all Contracting Parties for habitats within coastal area of 1 nautical mile; MEDGIG Suggested sampling and treatment: ISO 16665:2014. Water quality - Guidelines for quantitative sampling and sample processing of marine soft-bottom macrofauna.	Further quantitfy GES Define baselines/ threshold for assessment Develop QA/QC Establish monitoring areas

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

Common Indicator Description (including parameters, matrix)	Guidelines, Methodologies, QA/QC available	Initial phase of IMAP
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 2 replicates at each monitoring station	ISO 19493:2007 Water quality - Guidance on marine biological surveys of hard-substrate communities	(minimum 2 per country)
Common Indicator 2 (COP 18 Indicator 1.4.3): **Condition of the habitat-defining species and communities** State/Impact indicator Proposed sub-indicator: Benthic Biotic Indices Depending on the biotic index: For macrozoobenthos and macroalgae indices: composition of species per habitat type in the specific biogeographic region. For seagrass indices selected sensitive species (*Posidonia oceanic or Cymodocea nodosa*) and metrics related to structural, functional and physiological attributes of the system	Depending on the biotic index: For macrozoobenthos and macroalgae indices: generally a sensitivity/tolerance classification, combining the percentages of ecological groups of species in a formula. For one macroinvertebrate index: combining the frequency or ratio of opportunistic polychaetes to frequency (ratio) of the amphipods group 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 (E/L ratio) - Leaf length distribution asymmetry of *Cymodocea nodosa* See respective references listed in Table 1 of the main monitoring guidance document Suggested reference methods for sampling and treatment: 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-substrate communities See also annex III for recommended guidelines for sampling and treatment Recommended sampling frequency once per year at assessed sites and once every 5 years at reference-baseline condition sites 2 replicates at each monitoring station	Further quantitfy GES Define baselines/ threshold for assessment Develop QA/QC Establish monitoring areas (minimum 2 per country)

Common Indicator Description (including parameters, matrix)	Guidelines, Methodologies, QA/QC available	Initial phase of IMAP
Common Indicator 2 (COP 18 Indicator 1.4.3.) **Condition of the habitat-defining species and communities** State/Impact indicator Proposed optional sub-indicator: Changes in plankton functional types Plankton abundance or biomass per taxa For plankton lifeform pairs diatoms and dinoflagellates; large copepods and small copepods; holoplankton and meroplankton.	Comparison of ratios of plankton abundance in life form pairs with respect to baseline conditions Guideline: Gowen et al., 2011; Tett et al., 2008 Suggested reference methods for sampling and treatment: See Annex III for recommended guidelines for sampling and treatment Recommended bi-weekly sampling for coastal or at least monthly, monthly for shelf and offshore	Further quantify GES Better definer water column habitats for the Mediterranean Define baselines/ threshold for assessment Develop QA/QC Establish monitoring areas(minimum 2 per country)
Common Indicator 3 (COP 18 Indicator 1.1.1.) **Species distributional range**[46][47] State Indicator **<u>Marine mammals, Birds and Sea Turtles</u>** **<u>1/ Cetaceans</u>** Proposed sub indicators: - Range of breeding areas (location, geo-referencing and characterization of breeding areas)	For cetaceans Panigada, S; 2015. Monitoring guidelines to assess cetaceans' distributional range, population abundance and population demographic characteristics. UNEP(DEPI)/MED WG.408/Inf.27 <u>Guidelines for seals:</u> Cave surveys reports being done by RAC/SPA within the Monk seal management plan Annual comparison of distributional ranges. Range trends on the grid maps. <u>Guidelines for birds:</u>	Further quantify GES Define baselines/ threshold for assessment Develop QA/QC Establish monitoring areas (minimum 2 per country)

[46] Noting that we know species distribution may change as a result of oceanographic conditions, for example, and this is not a negative thing.
[47] Noting that sea turtle feeding and wintering areas are not yet well defined

Common Indicator Description (including parameters, matrix)	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
- Range of feeding areas (location, geo-referencing and characterization of feeding areas) - Range of wintering areas[48] (location, geo-referencing and characterization of wintering areas) **2/ Monk seals** Proposed sub indicators: - Range of breeding areas (location, geo-referencing and characterization of breeding colonies) **3/Birds** Proposed sub indicators: - Range of breeding areas (location, geo-referencing and characterization of breeding colonies) - Range of wintering areas (location, geo-referencing and characterization of wintering areas) - Range of feeding areas (location, geo-referencing and characterization **4/ Sea Turtle**	Seabird monitoring handbook for Britain and Ireland (JNCC[49], RSPB[50], ITE[51], SBG[52]. Guidelines for management and monitoring threatened population of marine and coastal bird species and their important areas in the Mediterranean (www.rac-spa.org) Suggested reference methods for sampling and treatment for birds: Marine e-Atlas[53] (BirdLife International) Annual comparison of distributional ranges. Range trends on the grid maps. Guidelines for sea turtles: For an overview (occurrence, threats, status per country) see: Casale P. and Margaritoulis D. (Eds.) 2010. Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities. IUCN/SSC Marine Turtle Specialist Group. Gland, Switzerland: IUCN, 294 pp. http://iucn-mtsg.org/publications/med-report/ Gerosa, G. (1996). Manual on Marine Turtle Tagging in the Mediterranean. – Mediterranean Action Plan - UNEP, RAC/SPA, Tunis, 48 pp. SWOT Scientific Advisory Board. 2011. The State of the World's Sea Turtles (SWOT) Minimum Data Standards for Nesting Beach Monitoring, version 1.0. Handbook, 28 pp Gerosa, G. and M. Aureggi. 2001. Sea Turtle Handling Guidebook for Fishermen. UNEP Mediterrane- an Action Plan, Regional Activity Centre for Specially Protected Areas. Tunis. http://www.rac-spa.org Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and Donnelly, M. (Eds.) 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC	Take part in the ACCOBAMS Survey Initiative Generate /update datatbases and maps of known and new sites Identify monitoring cpacaities and gaps Standardise protocols Identify techniques to monitor and assess the impact/shift of range due to climate change

[48] Noting that cetaceans in the Mediterranean do not really have wintering areas, apart for some specific species in some localized places (*e.g.* the fin whales in the Strait of Sicily)
[49] JNCC: Joint Nature Conservation Committee
[50] RSPB: Royal Society for the Protection of Birds
[51] ITE: Institute of Terrestrial Ecology
[52] SBG: Seabird Group
[53] http://www.fameproject.eu/en/

Common Indicator Description (including parameters, matrix)	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
- Range of breeding areas (location, geo-referencing and characterization of breeding colonies) - Range of feeding areas (location, geo-referencing and characterization - Range of wintering areas (location, geo-referencing and characterization of wintering areas)	Marine Turtle Specialist Group Publication No. 4. Washington, DC: 235 pp. https://mtsg.files.wordpress.com/2010/11/techniques-manual-full-en.pdf McClellan DB. 1996. Aerial surveys for sea turtles, marine mammals and vessel activity along the south east Florida coast 1992-1996. NOAA Technical Memorandum NMFS-SEFSC-390 42pp	
Common Indicator 4 (COP 18 Indicator 1.2.1.) **Population abundance of selected species related to marine mammals, seabirds, marine reptiles** State indicator **Marine mammals** **1/ Cetaceans** Population Census in wintering areas - Number of individuals Population Census in feeding areas - Number of individuals Migration counts Number of individuals **2/ Monk seals** Proposed sub indicators: Census of rookeries and whelping events Number of offspring in cave.	Trend monitoring	Further quantify GES Define baselines/ threshold for assessment Develop QA/QC Establish monitoring areas (minimum 2 per country) Take part in the ACCOBAMS Survey Initiative

Common Indicator Description (including parameters, matrix)	Guidelines, Methodologies, QA/QC available	Initial phase of IMAP
Birds Proposed sub indicators: Census of rookeries Number of nesting pairs Population Census in wintering areas Number of individuals Population Census in Foraging areas - Number of individuals Migration counts Number of individuals	Trend monitoring Guideline for birds: Seabird monitoring handbook for Britain and Ireland (JNCC,RSPB,ITE,SBG) Suggested reference methods for sampling and treatment: International Waterbird Census (IWC)[54] FAME project Guidelines for management and monitoring threatened population of marine and coastal bird species and their important areas in the Mediterranean (www.rac-spa.org)	
Turtles Proposed sub indicators: Census of nesting beaches - Number of nests - Number of females or adults Population Census in wintering areas - Number of individuals Population Census in feeding areas - Number of individuals	Trend monitoring Guidelines for sea turtles: Gerosa, G. (1996). Manual on Marine Turtle Tagging in the Mediterranean. – Mediterranean Action Plan - UNEP, RAC/SPA, Tunis, 48 pp. Gerosa, G. and M. Aureggi. 2001. Sea Turtle Handling Guidebook for Fishermen. UNEP Mediterrane- an Action Plan, Regional Activity Centre for Specially Protected Areas. Tunis. http://www.rac-spa.org Casale and Margaritoulis (Eds.) 2010. (See above) Eckert et al. 1999. (See above) SWOT Scientific Advisory Board. 2011. (See above) Balazs, G.H. 1999. Factors to consider in the tagging of sea turtles, p.101-109. In: Eckert et al. 1999. (See above)	

[54] Wetland International (http://www.wetlands.org/)

Common Indicator Description (including parameters, matrix)	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
Common Indicator 5 (COP 18 Indicator 1.3.1.) **Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival, mortality rates)** State Indicator **<u>Marine mammals</u>** **<u>1/ Cetaceans</u>** Proposed sub indicators: - Number of individuals in relation to population estimates per population range or management unit, per year, per age (new-born/juvenile/adult) and per sex[55] - Mortality rate from by-catch, stranding, ship strikes **<u>2/ Monk seals</u>** Proposed sub indicators: - Number of individuals in relation to population estimates per population range or management unit, per year, per age and per sex - Mortality rate from by-catch, stranding - Fecundity rate of monk seal	Trends	Further quantitfy GES Define baselines/ threshold for assessment Develop QA/QC Establish monitoring areas (minimum 2 per country)

[55] Visual identification of sex is possible for only some species

<table>
<tr><th>Common Indicator Description (including parameters, matrix)</th><th>Guidelines, Methodologies, QA/QC available</th><th>Initial phase of IMAP</th></tr>
<tr><td>Monk seal pup production (number of counts per colony with respect to the size of the colony</td><td></td><td></td></tr>
<tr><td><u>Birds</u>

- Number of individuals in relation to population estimates per population range or management unit, per year, per age and per sex[56]
- Mortality rate from by-catch, stranding
- Breeding success/failure of seabird species

Annual seabird colony failure rate (percentage of colonies failing per year, per species)

<u>Turtles</u>
Proposed sub indicators:

- Number of individuals in relation to population estimates per population range or management unit, per year, per age and per sex
- Mortality rate from by-catch, stranding
- Breeding success/failure of marine turtles</td><td>Trends

<u>Guidelines for birds:</u>

Seabird monitoring handbook for Britain and Ireland (JNCC,RSPB,ITE,SBG)

Audubon Coastal Bird Survey[57]

RSPB Beached Bird Survey[58], or ICAO

SEO/BirdLife

Trends

<u>Guidelines for sea turtles:</u>

RAC/SPA[59] guideline

Casale and Margaritoulis (Eds.) 2010. (See above)
Eckert et al. 1999. (See above)

SWOT Scientific Advisory Board. 2011. (See above)

Phelan, Shana M. and Karen L. Eckert. 2006. Marine Turtle Trauma Response Procedures: A Field Guide. Wider Caribbean Sea Turtle Conservation Network (WIDECAST) Technical Report No. 4. Beaufort, North Carolina.71 pp</td><td></td></tr>
</table>

[56] Visual identification of sex is possible for only some species
[57] www.audubon.org
[58] RSPB: Royal Society for Protection of Birds (www.rspb.org.uk)
[59] RAC/SPA: Regional Activity Center for Specially Protected Areas, UNEP/MAP (http://rac-spa.org/)

Common Indicator Description (including parameters, matrix)	Guidelines, Methodologies, QA/QC available	Initial phase of IMAP
- Annual survival probability of turtles - Sex ratio of turtles - Number of eggs that fail to hatch at marine turtle nesting sites per year. Number of emergences versus successful nests - Annual survival probability of adults and juvenile age classes of turtles - Hatchling and juvenile sex ratio of turtle		

ECOLOGICAL OBJECTIVE 02: Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem

Common Indicator **Description (including parametres, matrix)**	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
Common Indicator 6 COP 18 Indicator 2.1.1. (2.1.2 combined)[60]: **Trends in the abundance, temporal occurrence and spatial distribution of non-indigenous species, particularly invasive non indigenous species, notably in risk areas in relation to the main vectors and pathways of spreading of such species** Pressure indicator Presence/absence of NIS focusing especially on IAS Focusing on high risk locations monitored at least annually with lower risk sites less frequently i.e. every two years	Temporal trends between years will be assessed Guidelines: Guide for risk analysis assessing the impacts of the introduction of non-indigenous species (www.rac-spa.org) Guidelines for controlling the vectors of the introduction into the Mediterranean of non-indigenous species and invasive marine species (www.rac-spa.org) For Rapid Assessment Surveys (RAS): Aston et al., 2006; Minchin, 2007; Pedersen et al., 2003 For Mediterranean marine protected areas: Otero et al., 2013. For exemptions under the IMO Ballast Water Management Convention (BWC): IMO Guidelines for Risk Assessment under Regulation A-4 of the BWC. Reference Methods: Considering the broad range of taxonomic groups that will need to be covered sampling protocols will be very varied. Which sampling protocol should be employed and where should in part be driven by risk analysis. Hewitt, C.L., Martin, R.B., 2001. Revised protocols for baseline port surveys for introduced marine species (Hewitt and Martin, 2001) and HELCOM/OSPAR guidelines developed for the assessment of exemptions under the IMO BWC could provide a useful source of sampling protocols for some taxa.	Establish monitoring areas (minimum 2 per country, which can be combined with biodiversity monitoring stations) Guidance on developing IAS national lists and a regional and or sub regional reference lists Further develop MAMIAS Develop citizen Survey guidance for NIS Set reference levels Develop QA/QC

[60] Indicators 2.1.1 and 2.1.2 of the COP 18 Decision have been combined into one indicator with the numbering 2.1.1, and adopted as an ECAP common indicator at the CORGEST Meeting, Athens 17-19 February 2014. (UNEP(DEPI)/MED WG.390/4)

ECOLOGICAL OBJECTIVE 05: Human- induced eutrophication is prevented, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters

Common Indicator Description (including parametres, matrix)	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
Common Indicator 13 (COP 18 Indicator 5.1.1.) **Concentration of key nutrients in the water column** Pressure Indicator Key parameters: Total Nitrogen (N µmol/L), Nitrate (NO_3-N µmol/L)*, Ammonium (NH_4-N µmol/L)*, Nitrite (NO_2 - N µmol/L)*, Orthophosphate (P-PO_4 µmol/L), Total Phosphorus*, Silicate (SiO_2 µmol/L)	UNEP/MAP MED POL State and Temporal Trend Monitoring Programme For coastal stations minimum sampling 4/year, 6-12 /year re-commended Guideline : Eutrophication Monitoring Strategy of UNEP/MAP MED POL UNEP(DEC) MED WG.231/14 Reference Methods : Sampling and Analysis Techniques for the Eutrophication Monitoring Strategy of UNEP/MAP MED POL (MAP Technical Reports Series No. 163) QA/QC : UNEP/MAP MED POL Inter-calibration exercises in agreement with QUASIMEME	For open waters sampling frequency to be determined on a sub-regional level following a risk based approach Further specify geographical scale of monitoring and assessment Each CP determine optimum frequency per year and optimum sampling locations
Common Indicator 13 COP 18 Indicator 5.1.1 : **Concentration of key nutrients in the water column** Sub-indicator (COP 18 Indicator 5.1.2) Nutrient ratios (silica, nitrogen and phosphorus) where appropriate	Nutrient monitoring under UNEP/MAP MED POL State and Temporal Trend Monitoring Programme For coastal stations minimum sampling 4/year, 6-12 /year recommended Simple mathematical derivation of ratios of nutrient concentrations	For open waters sampling frequency to be determined on a sub-regional level following a risk based approach Further specify geographical scale of monitoring and assessment

Common Indicator **Description** **(including parametres, matrix)**	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
Key parameters: Si:N, N:P, Si:P	Guideline : Eutrophication Monitoring Strategy of UNEP/MAP MED POLUNEP(DEC)MED WG.231/14 Reference Methods : Sampling and Analysis Techniques for the Eutrophication Monitoring Strategy of UNEP/MAP MED POL (MAP Technical Reports Series No. 163)	Each CP determine optimum frequency per year and optimum sampling locations
Common Indicator 14 (COP 18 Indicator 5.2.1) **Chlorophyll-a concentration in the water column** State, Impact indicator Key parameters: Chlorophyll –a concentration in seawater (µg/l)*	UNEP/MAP MED POL State and Temporal Trend Monitoring Programme For coastal stations minimum sampling 4/year, 6-12 /year recommended Guideline : Eutrophication Monitoring Strategy of UNEP/MAP MED POL UNEP(DEC)MED WG.231/14 Reference Methods : Sampling and Analysis Techniques for the Eutrophication Monitoring Strategy of UNEP/MAP MED POL (MAP Technical Reports Series No. 163) UNEP/MAP MED POL Inter-calibration exercises in agreement with QUASIMEME	For open waters sampling frequency to be determined on a sub-regional level following a risk based approach Further specify geographical scale of monitoring and assessment Each CP determine optimum frequency per year and optimum sampling locations
Common Indicator 14 (COP 18 Indicators 5.2.1.) **Chlorophyll-a concentration in the water column** State, Impact Indicator Sub-Indicator of Water Transparency where relevant Key parameters:	UNEP/MAP MED POL State and Temporal Trend Monitoring Programme Guideline : Eutrophication Monitoring Strategy of UNEP/MAP MED POL UNEP(DEC)MED WG.231/14 Reference Methods :	For open waters sampling frequency to be determined on a sub-regional level following a risk based approach Further specify geographical scale of monitoring and assessment

Common Indicator **Description** **(including parametres, matrix)**	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
Water transparency measured as i.e. Secchi depth or according to ISO 7027:1999 Water Quality- Determination of Turbidity	Sampling and Analysis Techniques for the Eutrophication Monitoring Strategy of UNEP/MAP MED POL (MAP Technical Reports Series No. 163) ISO standard 7027:1999 Water quality -- Determination of turbidity	Each CP determine optimum frequency per year and optimum sampling locations
Common Indicator 14 (COP 18 Indicator 5.2.1.) **Chlorophyll-a concentration in the water column** Pressure, Impact indicator Sub-Indicator 5.3.1 : Dissolved oxygen near the bottom, i.e. changes due to increased organic matter decomposition and size of the area concerned Key parameters: Dissolved Oxygen concentration (mg/l) and Saturation (%)*	UNEP/MAP MED POL State and Temporal Trend Monitoring Programme Guideline : Eutrophication Monitoring Strategy of UNEP/MAP MED POL UNEP(DEC)MED WG.231/14 Reference Methods : Sampling and Analysis Techniques for the Eutrophication Monitoring Strategy of UNEP/MAP MED POL (MAP Technical Reports Series No. 163)	For open waters sampling frequency to be determined on a sub-regional level following a risk based approach Further specify geographical scale of monitoring and assessment Each CP determine optimum frequency per year and optimum sampling locations

ECOLOGICAL OBJECTIVE 09: Contaminants cause no significant impact on coastal and marine ecosystems and human health

Common Indicator description **(including parameters, matrix)**	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
Common Indicator 17 (COP 18 indicator number 9.1.1.) **Concentrations of key harmful contaminants in the relevant matrix (biota, sediment, seawater)** Pressure indicator Key parameters: Hg, Cd, Pb, PCBs, halogenated pesticides (aldrin, dieldrin, HCB, lindane, ΣDDTs), PAH. In sediment and representative biota (bivalves i.e. *Mytilus galloprovincialis*, fish i.e. *Mullus barbatus*) Aluminum (AL) and Organic Carbon(OC) measurements in sediment for normalization purposes pH in seawater to measure acidification Monitoring of contaminants in seawater presents specific challenges and therefore recommended to be carried out on a country by country decision basis	UNEP/MAP MED POL State and Temporal Trend Monitoring Programme Annually, for biota (for mussels at the pre-spawning period) and every 4-6 years for sediments in low sedimentation areas, (annually for sediments in high sedimentation areas including estuaries and harbours), at the most stable hydrographic conditions. UNEP/MAP MED POL Programme for the Assessment and Control of Pollution in the Mediterranean Region MAP Technical Reports Series No. 120 QA/QC through UNEP/MAP MED POL/IAEA MESL Sampling Analysis Reference Methods are listed the Integrated Monitoring Guidance document. Two fold approach in initial phase.	Further develop biological effects methods. Further harmonise monitoring ..... within assessment (sub) regions. Develop suites of assessment criteria integrating chemical and biological assessment methods. Contracting Parties to include (minimum 1 per country) offshore sampling station. Develop an adapted manual establishing BAC and where possible formulation of EAC for selected biomarkers. Develop assessment criteria for hazardous substances.
Common Indicator 18 **(COP 18 indicator number 9.2.1)** **Levels of pollution effects of key contaminants where a cause and effect relationship has been established** **Impact indicator** **Lysosomal Membrane Stability (LMS) Tier 1 mandatory biomarker on the basis of the 2-Tier approach**	UNEP/MAP MED POL State and Temporal Trend Monitoring Programme Sampling minimum annually Or semi-annually in pre-spawning period MTS 120 UNEP/MAP MED POL State and Temporal Trend Monitoring Programme Sampling minimum annually or semi-annually in the pre-spawning period	Further develop biological effects methods. Further harmonise monitoring . within assessment (sub) regions. Develop suites of assessment criteria integrating chemical and biological assessment methods.

Common Indicator description **(including parameters, matrix)**	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
Reduction of survival in air or Stress on Stress (SoS) Tier 2 mandatory biomarker on the basis of the 2-Tier approach. **Acetylcholinesterase (AChE) assay as a method for assessing neurotoxic effects in aquatic organisms.** **Tier 2 optional biomarker on the basis of the 2-Tier approach.** **Micronucleus assay as a tool for assessing cytogenetic/DNA damage in marine organisms. Tier 2 optional biomarker on the basis of the 2-Tier approach.** **In bivalves (i.e. mussels *Mytilus galloprovincialis*)**	UNEP/RAMOGE: Manual on the Biomarkers Recommended for the UNEP/MAP MED POL Biomonitoring Programme. UNEP, Athens, 1999. UNEP/MAP, 2005. Fact sheets on Marine Pollution Indicators. WGUNEP(DEC) / MED/ WG.264 / Inf.14. Background document: stress on stress (SoS) in bivalve molluscs. *Concepción Martínez-Gómez and John Thain.* In ICES Cooperative Research Report No 315. Background document: Acetylcholinesterase assay as a method for assessing neurotoxic effects in aquatic organisms *Thierry Burgeot, Gilles Bocquené, Joelle Forget-Leray, Lùcia Guilhermino, Concepción Martínez-Gómez, and Kari Lehtonen.* In ICES Cooperative Research Report No 315. Background document: micronucleus assay as a tool for assessing cytogenetic/DNA damage in marine organisms *Janina Baršienė, Brett Lyons, Aleksandras Rybakovas, Concepción Martínez-Gómez, Laura Andreikenaite, Steven Brooks, and Thomas Maes.* In ICES Cooperative Research Report No 315. QA/QC through UNEP/MAP MED POL Inter-calibration exercises in agreement with University of Piemonte Orientale Italy (DiSAV) In ICES Cooperative	Contracting Parties to include (minimum 1 per country) offshore sampling station. Develop an adapted manual establishing BAC and where possible formulation of EAC for selected biomarkers.
Common Indicator 19, COP 18 indicator number 9.3.1 **Occurrence, origin (where possible, extent of significant acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution** Pressure, Impact indicator	Quantification of oil and other chemical spills and their size by observation and reporting. Optional utilization of: • Satellite radar images, plane observation and imaging approaches	Further analyse links between pollution events and their effects on biota, with the aim to develop specific assessment criteria on this.

Common Indicator description **(including parameters, matrix)**	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
All accidents causing or likely to cause pollution of the sea by oil and other harmful substances The presence, characteristics and extent of spillages of oil or other harmful substances observed at sea which are likely to present a serious and imminent threat to the marine environment or to the coast or related interests of one or more of the Parties; Their assessments and any pollution combating actions taken or envisaged to be taken The evolution of the situation.	• Backtracking of oil spills to their source by hind cast modelling; • Fingerprinting using chemical analysis (Gas Chromatography-Mass Spectrometry) and comparison with possible sources UNEP MAP Emergency Protocol Reporting Guidelines available through REMPEC Report available through REMPEC (POL REP) for reporting to REMPEC spills in excess of 50 m^3 For lower levels reporting should be at the discretion of the countries. Sampling analysis, reference methods are available through REMPEC/IMO.	
Common indicator 20 (COP 18 Indicator 9.4.1.) **Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood** Pressure, Impact indicator	Assessment of the results of monitoring executed/commissioned by the pertinent authorities responsible for health monitoring for cases for which monitoring of contaminants under indicator 9.1.1 (and possibly 9.2.1) show cause for concern . Monitoring executed/commissioned by the authorities responsible for health monitoring, of contaminants in fish and other seafood used for human consumption. At least the following contaminants for which regulatory levels have been laid down: Heavy metals (Pb, Cd, Hg), PAH, dioxins including dioxin-like PCBs)	
Common indicator 21 (COP 18 Indicator 9.5.1.) **Percentage of intestinal enterococci measurements within established standards** Pressure, Impact indicator	UNEP/MAP MED POL/WHO Bathing and Recreational Water Monitoring Programme Sampling fortnightly in spring and summer to autumn	Further define GES, based on Decision IG.20/9

Common Indicator description (including parameters, matrix)	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
Intestinal enterococci in seawater in bathing and other recreational areas	Criteria and Standards for Bathing Waters in the Mediterranean Region. COP 17 Decision IG 20/9 QA/QC available through UNEP/MAP MED POL/ WHO ISO 7899-2 based on membrane filtration technique or any other approved technique	

ECOLOGICAL OBJECTIVE 10: Marine and coastal litter do not adversely affect the coastal and marine environment

Common Indicator description (including parameters, matrix)	Guidelines, Methodologies, QA/QC available	Initial phase of IMAP
Common indicator 22 (COP 18 Indicator 10.1.1.) **Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source.)** Pressure, Impact indicator Counts of litter items minimum lower limit 0.5 cm in the longest dimension on at least 1 section of coastline of 100m on lightly to moderately littered beaches (optimum 2 sections) and 2 sections of 100m on heavily littered beaches (exceptionally 50m section with a normalization factor of up to 100m to ensure coherence)	UNEP/MAP MED POL Trend Monitoring Programme At least 2 surveys per year in spring and autumn (Ideally 4 surveys per year in spring, summer, autumn and winter) As Guideline, with reference methods: UNEP DEPI (MED) WG 394. Inf.5 Reduced master list of litter categories of the Integrated monitoring and assessment guidance. QA according to recommended Quality Assurance Protocols (i.e. Ocean Conservancy National Marine Debris Monitoring Programme (Sheavly, 2007, see text of ECAP monitoring guidelines)	
Common indicator 23 (COP 18 Indicator 10.1.2.) **Trends in amounts of litter in the water column, including micro-plastics* and on the seafloor** Pressure, Impact Litter in the water column: Items of floating litter, 2.5 to 50cm, per km^2 Litter on the seafloor shallow coastal waters(0-20m): visually surveyed litter items size above 2.5cm Litter on the seafloor 20-800m: items/ha or items/km^2 of litter collected in bottom trawl surveys	For floating litter visual ship-based monitoring of floating litter 2.5cm to 50cm as items/km^2 For litter on the seafloor shallow coastal waters (0-20m): minimum annual, maximum quarterly underwater visual surveys with SCUBA/snorkelling based on line transect surveys in use for evaluation of benthic fauna For seafloor 20-800m collection of litter data through on-going and continuous bottom trawl fish stock survey programmes (such as MEDITS) For Guideline and reference methods: UNEP DEPI (MED) WG 394. Inf.5 For floating litter: approaches for inter-comparison and calibration are to be developed at regional level and implemented	Develop floating litter Protocol.

	For shallow seafloor: Data on litter in shallow sea-floor are collected through protocols already validated for benthic species. For Litter on the seafloor 20-800m, the adoption of a common fish stock survey benthic- trawl protocol will lead to a significant level of standardization among the countries that apply it as their benthic litter sampling strategy.	

Common Indicator description (including parameters, matrix)	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
Candidate Indicator 24 (COP 18 Indicator 10.2.1.) **Trends in the amount of litter ingested by or entangling marine organisms focusing on marine turtles.** Quantities of ingested litter (minimum size 1mm) by mass (weight in grams) in the stomach contents of stranded Loggerhead sea turtles (*Caretta caretta*)	Continuous sampling of dead sea turtles collected from beaches or at sea from accidental mortalities such as victims of long-line fishing (by-catch) or of boat collisions. For Guidelines and reference methods: UNEP DEPI (MED) WG 394. Inf.5	Pilot monitoring Further development of candidate indicator (possible inclusion of it as common indicator to the revised IMAP at COP 20) During the initial phase focus is on sea turtles. Develop QA/QC for see- turtles.

ECOLOGICAL OBJECTIVE 07: Alteration of hydrographical conditions does not adversely affect coastal and marine ecosystems

Common Indicator **Description (including parameters, matrix)**	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
Common Indicator 15 COP 18 Indicator 7.2.2: **Location and extent of the habitats[61] impacted directly by the alterations and/or the circulation changes induced by them: footprints of impacting structures** Parameter: Area (e.g. km^2) where alterations in hydrographical conditions may be expected to occur (modeling or Semi-quantitative estimation). Area of habitat and the proportion of the total habitat if that type is expected to be affected by the permanent alteration in hydrographicalconditions (modeling or semi - quantitative estimation.	Mapping of area where human activities may cause permanent alterations of hydrographical conditions (using i.e. existing EIA, SEA and Maritime Spatial Planning -MSP) and subsequent use of models. Modelling potential changes in the spatial extent of habitats affected by permanent alterations, using field data and validated model data. Main aim of the models is to assess changes in the condition and extent of areas affected by permanent alterations. Models should be calibrated and continuously supported and validated with “in situ” monitoring datasets.	

[61] To be chosen on the basis of the list determined under Ecological Objective 01

ECOLOGICAL OBJECTIVE 08: The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved

Common Indicator description (including parameters, matrix)	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
Common Indicator 16 (COP 18 Indicator 8.1.4) **Length of coastline subject to physical disturbance due to the influence of manmade structures** Impact indicator Key Parameters: i. Length of manmade coastline (e.g. km) ii. Total surface area reclaimed (ha) iii. Length of sandy coastline influenced by manmade structures	MSSD, indicator[62] nº23: "Share of artificialised coastline" i. Length of manmade coastline: Mapping of human structures along the coastline (linear or area representation). Measuring the dimensions of the structures along the coast (their length for longitudinal ones, their width for transversal ones, projection of their length on the coastline for nor connected to shore ones when they are part of the 100 meter area on sea side) Dimensions of the structures can be assessed by satellite data or aerial photos (mainly for their length) and by field measurements (for their width (groins), or submerged and buried structures for instance) ii. Total surface area reclaimed Mapping of manmade areas currently on land which were submerged areas before the 80's. Assessing the coastline position previous to land claim or the coastline position of the 80's. Once this initial coastline position is known (before land claim), the land claim area is the area between this initial and the present coastline. This area could be expressed by depth reclaimed (surface between 0 and -10 m; surface between -10 and -20 m, for instance) to link it with the kind of marine habitats lost. Position of the initial coastline can be assessed using: • Reliable historical maps • Old documents (pictures, photos, post card, plans,…) • Design plans for recent structures • Satellite or aerial images prior to the landclaim with sufficient precision iii. Length of sandy coastline influenced by manmade structures. This parameter is linked to the parameter 8.1.1. (length of coastal erosion and/or instability) as structures can modified the natural erosion/accretion rate. Mapping of coastline around structures where its evolution (erosion/accretion) or shape (slope, curvature…) is modified by the presence of structures.	Establish baseline

[62] Methodological sheets of the 34 priority indicators for the Mediterranean Strategy for Sustainable Development (2006). Plan Blue

	Depending on the cases (hydrodynamic conditions, kind of structures and time since installation, sediment supply), this length can be assessed around the considered structure: - by analyzing the shape of the present position of the coastline, using satellite or aerial photos (increase of erosion/accretion in the upstream/downstream of the littoral drift) - using topo-bathymetric data around the structure showing non natural evolution/state of the coast	
Common Indicator description (including parameters, matrix)	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
Candidate common indicator (COP 18 Indicator 8.2.1) **Land use change**	Guidelines and methodologies should be proposed from the first results of the pilot site in Adriatic	

ECOLOGICAL OBJECTIVE 11: **noise from human activities causes no significant impact on marine and coastal ecosystems.**

Common Indicator description (including parameters, matrix)	**Guidelines, Methodologies, QA/QC available**	**Initial phase of IMAP**
Candidate Indicator 26 COP 17 indicator number of 11.1.1: **Proportion of days and geographical distribution where loud, low and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animals** With Operational Objective 11.1 Energy inputs into the marine environment, especially noise from human activities is minimized Pressure indicator **Number of days over a year and number of cells over a grid** in which activities using loud source levels occur	GES is not achieved or maintained if either the temporal or spatial thresholds are exceeded Guidelines: Monitoring Guidance for Underwater Noise in European Seas (Dekeling et al, 2013)	Implement pilot monitoring activities, support additional expert knowledge and scientific developments
Candidate Indicator 27 COP 17 indicator number of 11.1.2: **Levels of continuous** **low frequency sounds levels with** **the use of models as appropriate** Pressure indicator **Arithmetic mean SPL over a year** (dB re 1µPa rms) and **$L_{33.3}$, i.e. 33% exceedance level (**dB re 1µPa rms**)** in the 1/3 octave bands centred at: 20, 63, 125, 250, 500 and 2000 Hz	GES is not achieved or maintained if the $L_{33.3}$ index, calculated over a year, is above the threshold Guidelines: Monitoring Guidance for Underwater Noise in European Seas (Dekeling et al, 2013)	Implement pilot monitoring activities, support additional expert knowledge and scientific developments

ANNEX II

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

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.

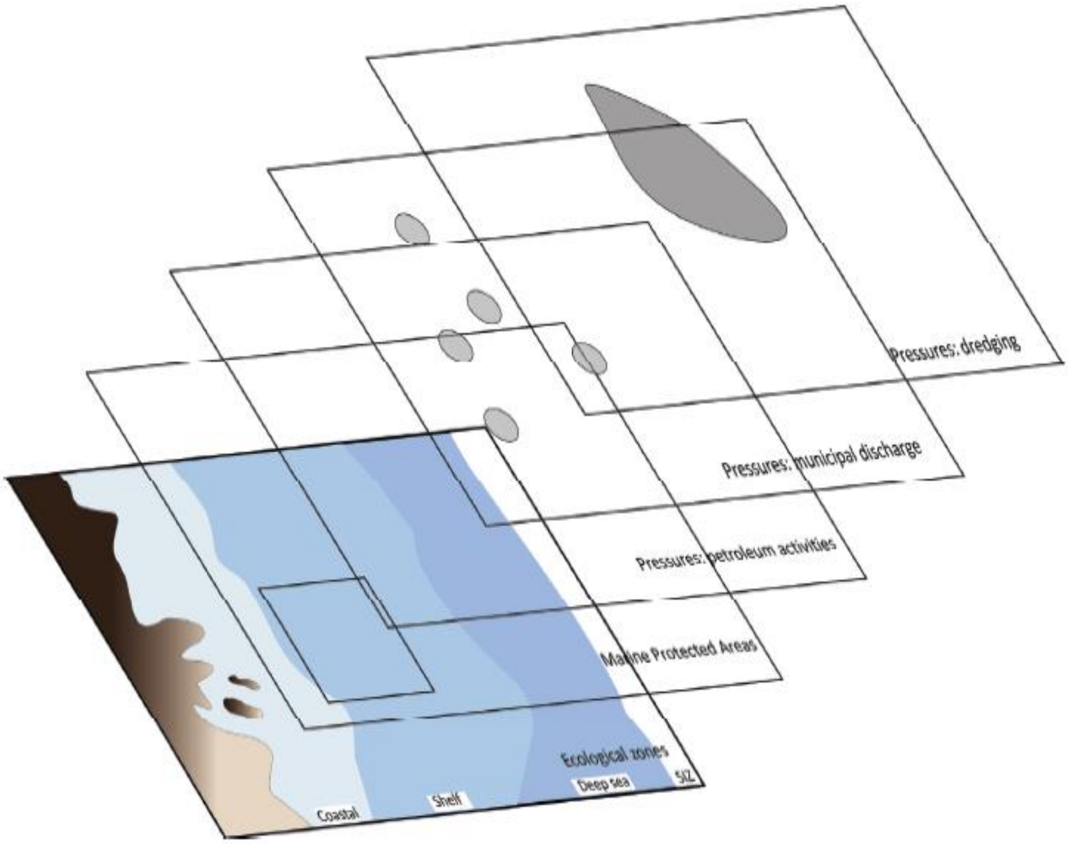


Figure A-1 Illustration of different types of information layers compiled in a Geographical Information System (GIS).

<u>Task 3: Define ecologically-relevant assessment areas</u>

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

<u>Task 4: Define reference state (condition)</u>

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). Note: The layer on protected coastline is not included in the monitoring strategy, as it can be misleadi ng regarding the specifics of the coastal common indicator.

ANNEX III

BIODIVERSITY
Overview of standards and methods for biodiversity monitoring

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. (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. (2013), while there is an ever increasing information resource available on the internet[63]. Another promising approach is the use of high definition cameras hanging from aircraft or drones for the monitoring of cetaceans and seabirds, and potentially sea turtles under specific circumstances. The method has been developed by several research projects[64].

[63] 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
http://www.ncbi.nlm.nih.gov/pubmed/22151771

[64] 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. (Adapted 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 with dedicated on-board observers	Shipboard or aerial line transects with on-board observers	Photo identification from natural markings on flukes or dorsal fins Genetic mark-racapture	Shipboard or aerial (potential)	CPUE (bycatches), simple removal	Movement patters Time-Depth-Recorder tags
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 (including drone) strip transects	Aerial or boat surveys (line transects) under specific circumstances, with the appropriate modelling techniques to account for missed animals (i.e. due to low surfacing time and low frequency of time spent at the surface)	Artificial external flipper tagging (metal and plastic on flippers), Photo-identification PIT tagging of flippers, Telemetry (satellite, GPS/GSM, radio telemetry) and loggers, capture-mark-recapture studies	Shipboard, aerial (including drone), or diver-based/video/acoustic (potential) Swimming/snorkelling surveys with photo-id and GPS in densely populated areas (e.g. certain breeding sites)	CPUE (bycatch), Direct mortality rate Post-release mortality rate	Nest counts Photo-id Time-Depth-Recorder tags

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 IV

NON INDIGENOUS SPECIES
Essential websites and databases on facts and distribution of invasive species

Essential websites and databases on facts and distribution of invasive species

Global Coverage

CABI Invasive Species Compendium (ISC)
http://www.cabi.org/isc/

Food and Agriculture Organization (FAO), database on Introductions of Aquatic Species (DIAS)
http://www.fao.org/figis/servlet/static?dom=collection&xml=dias.xml

FISHBASE
http://www.fishbase.org/

Global Invasive Species Programme (GISP)
http://www.gisp.org

Global Invasive Species Database (GISD)
http://www.invasivespecies.net/

Global Invasive Species Information Network (GISIN)
http://www.gisinetwork.org

GloBallast Partnerships: To implement sustainable, risk-based mechanisms for the management and control of ships' ballast water and sediments to minimize the adverse impacts of aquatic invasive species transferred by ships.
http://globallast.imo.org/

The IUCN Invasive Species Specialist Group and IUCN Global Invasive Species Database (GISD),
http://www.issg.org/#ISSG
http://www.issg.org/database/welcome/

The Nature Conservancy (TNC)
http://www.nature.org/invasivespecies
http://tncinvasives.ucdavis.edu/

European Coverage

European Alien Species Information Network (EASIN)
http://easin.jrc.ec.europa.eu/

European Information System for Alien Species (COST TD1209)
http://www.cost.eu/domains_actions/fa/Actions/TD1209

North European and Baltic Network on Invasive Alien Species European (NOBANIS) Database
http://www.nobanis.org/

European Environment Agency 'Signals':
http://www.eea.europa.eu/pressroom/newsreleases/killer-slugs-and-otheraliens

Delivering Alien Invasive Species Inventories for Europe
(DAISIE)
http://www.europe-aliens.org/

Information system on aquatic non-indigenous and cryptogenic species (AquaNIS)

http://www.corpi.ku.lt/databases/index.php/aquanis
Mediterranean records are based on DAISIE. Will be updated.

Mediterranean Coverage

CIESM Atlas of Exotic Species in the Mediterranean Sea is linked to NISbase, a distributed database managed by the Smithsonian Institute, aiming at a census of all non-indigenous aquatic species introduced around the world.
http://www.nisbase.org/nisbase/index.jsp

MAMIAS Database from Regional Activity Centre For Specially Protected Areas (RAC/SPA) of the UNEP/MAP Barcelona Convention
http://www.rac-spa.org/
http://www.mamias.org

ESENIAS East and South European Network for Invasive Alien Species. Regional data portal on invasive alien species (IAS) in East and South Europe (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Kosovo under UNSC Resolution 1244/99, FYR Macedonia, Montenegro, Serbia, Romania (invited country) and Turkey.
http://www.esenias.org/

National Coverage

InvasiBer, Especies ExσticasInvasoras de la PenνnsulaIbιrica (Spain)
http://invasiber.org/

Ellenic Network on Aquatic Invasive Species (ELNAIS) - Greece
https://services.ath.hcmr.gr/

SIDIMAR, Italy
http://www.sidimar.tutelamare.it/distribuzione_alieni.jsp

National Biodiversity Information Facilities - BIFs;
http://www.gbif.org/participation/participant-nodes/bif/

Other Relevant Documents

Assessing Large Scale Environmental Risks for Biodiversity with Tested Methods (ALARM)
http://www.alarmproject.net

EU website:
http://ec.europa.eu/environment/nature/invasivealien/index_en.htm

Scope for EU action:
http://ec.europa.eu/environment/nature/invasivealien/docs/2006_06_ias_scope_options.pdf

ANNEX V

EUTROPHICATION
Indicators of interest for monitoring eutrophication

Indicators of interest for monitoring eutrophication

Chlorophyll

There is general agreement about the link between mean value of nutrients and mean values of chlorophyll in the coastal waters, to the extent that satellite chlorophyll maps are usually used as maps of marine eutrophication (European Environment Agency, Technical Report, 2002).

Many studies use Chl-a as an indicator of eutrophication or water quality (Harding and Perry 1997, Boyer et al. 2009) due to its very simple and integrative analysis.

In addition, as pointed out (Boyer et al., 2009), “the Chl-a indicator has three specific components, bloom magnitude (incidence of Chl-a concentrations that exceed the baseline value per zone per month), bloom frequency (number of months per year when Chl-a concentrations in each zone exceed the specific threshold value for that zone), and bloom spatial extent (area-weighted Chl-a concentrations within a region per month exceeding the threshold concentration for the region)”.

Other advantages of using Chl-a as a metric:

1) Chl-a integrates all the phytoplankton community.

“Phytoplankton biomass is a direct measurement of phytoplankton abundances. Chlorophyll concentration represents a very simple and integrative measure of phytoplankton community response to nutrient enrichment” (in: Devlin et al. 2007)

2) Chl-a is an indicator of eutrophication.

“There is generally a good agreement between planktonic primary production and algal biomass, and algal biomass is an excellent trophic state indicator. Furthermore, algal biomass is associated with the visible symptoms of eutrophication, and it is usually the cause of the practical problems resulting from eutrophication” (in: Boyer et al. 2009).

3) Chl-a is easily to sample and analyze.

“Chl-a is relatively easy to measure compared to algal biomass” (in: Boyer et al. 2009). Specialization for Chl-a analysis is not required. It is easily comparable between different laboratories. It is cost effective even for a very large number of samples (even replicates, if necessary).

Nutrients

Nutrients naturally present in the sea include compounds of silicon (Si) as well as those of nitrogen (N) and phosphorus (P). Concentrations of the main nutrients vary seasonally, as a result of natural processes in the sea. Eutrophication is the result of import-driven enrichment of the 'pristine' seasonal cycle, increasing the stock of nutrient- nitrogen and/or phosphorus in a water body and thus allowing a greater annual primary production of organic material and a greater standing stock of algae. The concentrations of plant nutrients reflect the balance between a large number of physical and biotic processes. Therefore nutrient concentrations (N, P, Si) in every form (organic, inorganic, dissolved, particulate) are extremely useful indicators of eutrophication. However they may not be very meaningful at the outer boundaries where the nutrients are completely taken up by phytoplankton. Although phosphorus has been the most popular nutrient determined in fresh water systems, there are good reasons to believe that nitrogen in any of its forms may play a more important role in most, though not all, marine systems. Silicate is a good indicator of fresh water dispersion and of the potential for diatom blooms.

Nutrient ratios

Anthropogenic nutrient enrichment is mainly confined to N and P, whereas Si supply remains constant or decreases as a consequence of increased diatom production and subsequent increased deposition and retention of Si in the sediments. Increased nutrient concentrations are not the only result of anthropogenic influence. The stoichiometric ratios of nutrients, Si:N, N:P and Si:P have also changed. By applying the Redfield ratio (Si:N:P= 16:16:1) as a criterion for the stoichiometric nutrient balance, the atomic Si:N:P ratio of marine diatoms, which are abundant constituents of coastal phytoplankton, is about 16:16:1, when nutrient levels are sufficient (Redfield, 1934, Redfield et al., 1963; Brzezinski, 1985). Studies on nutrient uptake kinetics have pointed out that ambient ratios of dissolved N/P<10 and Si/N>1 indicate stoichiometric N limitation, Si/N<1 and Si/P<3 indicate Si limitation and N/P>20-30 suggests P limitation (Dortch & Whitledge, 1992; Justic et al., 1995).
Early on, Smayda (1990) suggested that long-term decline in Si:P ratios was associated with significant blooms of non-siliceous algae in coastal waters worldwide. Conley et al. (1993) presented an extensive summary of the modifications of the biogeochemical cycle of Si with eutrophication. Essentially Si limitation could diminish the importance of diatoms in the phytoplankton population and replace it by noxious and toxic forms such as dinoflagellates. Therefore, marine and coastal ecosystems impacted by nutrient enrichment show changes in resource supply ratios that can cause changes in microplankton population.

Dissolved oxygen

Oxygen deficiency can result from the sinking and decomposition of the excess organic matter produced as a result of eutrophication. It can also come about from other causes, including discharges of allochthonous organics and from decreases in the ventilation of deep water caused for example by climate change. The benthic domain is therefore much more subject to the effect of oxygen deficiency. Various degrees of oxygen deficiency may be distinguished. Oxic or aerobic conditions refer to the normal state of oxygenation (4.5ml/l in the western Mediterranean basin and 4.2 ml/l in the eastern Mediterranean basin). Hypoxic conditions usually taken as below 2ml/l denote significantly reduced oxygen levels and cause important harm to the higher benthic organisms. Anoxic or anaerobic conditions indicate total lack of dissolved oxygen. The formation of H_2S under anoxic conditions further reduces the tolerance of those species capable of surviving temporary anoxia. The rate of depletion of oxygen from the lower layers depends of course to a large degree on the hydrodynamics of the region.

Turbidity

Light penetration, an inverse function of water turbidity, may also be a good measure of eutrophication, except near river mouths, where inert suspended solids may be extremely abundant. Although sometimes criticized because of its simplicity, the Secchi disk is an important tool in marine studies on eutrophication, and the determination of seawater colour (Forell scale, Wernard and van der Woerd, 2010) in conjunction with the Secchi disk is also useful as an indication of the transparency of the water and thus an aid to classify gross biological activity. Other tools such as those described in the ISO standard 7027:1999 on Water quality - Determination of turbidity, may equally be used for measurement of turbidity.

Aquatic macrophytes[65]

The presence or absence of macrophytes affects the entire estuarine or coastal marine biota, because of the combined high productivity and habitat function of this plant community. The main advantage of using aquatic macrophytes in a monitoring plan is that they are a sessile community. There is essentially no mobility to rooted vascular or holdfast-established algal plant communities, so expansion or contraction of seagrass beds can be readily measured as an environmental indicator; measurement of macrophyte community extent and relative density can be fairly easily accomplished by remote means, such as aerial photography, if the water is clear or shallow. Sampling frequency is reduced because of the relatively low community turnover compared to other biota such as benthic invertebrates or fish. Taxonomic identification in a given area is generally consistent and straightforward. The dominant species and its coverage are without any doubt relevant information for the assessment of environmental state.

Macrozoobenthos[66]

Benthic macro-invertebrates are appropriate assemblages for all biological assessments of water bodies, because they respond to water, sediment, and habitat qualities, are not very mobile, and consequently, integrate long-term changes in community structure and function. Benthic infauna is typically sedentary and therefore is most likely to respond to local environmental impacts; they are sensitive to disturbances of habitat such that the communities respond fairly quickly with changes in species composition and abundance. Individual macro-invertebrate species have sensitive life stages that respond to stress and integrate effects of short-term environmental variations, whereas community composition depends on long-term environmental conditions.

[65] Not currently included in the ECAP Decision however important indicator to be possibly considered for future eutrophication monitoring.
[66] Not currently included in the ECAP Decision however important indicator to be possibly considered for future eutrophication monitoring.

ANNEX VI

CONTAMINANTS
UNEP Reference methods for selected chemical contaminants

UNEP Reference methods for selected chemical contaminants.

UNEP/FAO/IAEA (1984). Sampling of selected marine organisms and sample presentation for the analysis of chlorinated hydrocarbons. Reference Methods for Marine Pollution Studies No. 12 Rev.1, 19 p.

UNEP/FAO/IAEA/IOC (1984a). Determination of total mercury in selected marine organisms by cold vapour atomic absorption spectrophotometry. Reference Methods for Marine Pollution Studies No. 8 Rev. 1, 17 p.

UNEP/FAO/IAEA/IOC (1984b). Determination of total cadmium, zinc, lead and copper in selected marine organisms by flameless atomic absorption spectrophotometry. Reference Methods for Marine Pollution Studies No. 11 Rev. 1, 21 p.

UNEP/FAO/IAEA/IOC (1984c). Sampling of selected marine organisms and sample preparation for trace metal analysis. Reference Methods for Marine Pollution Studies No. 7, Rev. 2, 19 p.

UNEP/FAO/IOC/IAEA (1986). Determination of DDTs and PCBs in selected marine organisms by packed column gas chromatography. Reference Methods for Marine Pollution Studies No. 14, Rev. 1, 20 p.

UNEP/FAO/IOC/IAEA (1993). Guidelines for monitoring chemical contaminants in the sea using marine organisms. Reference Methods for Marine Pollution Studies No. 6, 28 p.

UNEP/IAEA (1985a). Determination of total mercury in marine sediments and suspended solids by cold vapour atomic absorption spectrophotometry. Reference Methods for Marine Pollution Studies No. 26, 15 p.

UNEP/IAEA (1985b). Determination of total cadmium in marine sediments by flameless atomic absorption spectrophotometry. Reference Methods for Marine Pollution Studies No. 27, 13 p.

UNEP/IAEA/IOC/FAO (1996). Sample work-up for the analysis of chlorinated hydrocarbons in the marine environment. Reference Methods for Marine Pollution Studies No. 71

UNEP/IOC/IAEA (1988). Determination of DDTs and PCBs by capillary gas chromatography and electron capture detection. Reference Methods for Marine Pollution Studies No. 40, 18 p.

UNEP/IOC/IAEA (1992). Monitoring of petroleum hydrocarbons in sediments. Reference Methods for Marine Pollution Studies No. 20, 72 p.

UNEP/IOC/IAEA (1995). Manual for the geochemical analyses of marine sediments and suspended particulate matter. Reference Methods for Marine Pollution Studies No. 63, 74 p.

UNEP/IOC/IAEA/FAO (1989). Contaminant monitoring programmes using marine organisms: Quality Assurance and Good Laboratory Practice. Reference Methods for Marine Pollution Studies No. 57, 23 p.

UNEP(DEPI)MED WG.365/Inf.9. (2011). Manual on sediment sampling and analysis

ANNEX VII

MARINE LITTER
Master List of Categories

10.1. - TSG-ML Master List of Categories of Litter Items[67]

Master List of Categories of Litter Items										
TSG_ML General-	**OSPAR-Code**	**UNEP- Code**	**General Name**	**Level 1 - Materials**	**Core**	**Beach**	**Seafloor**	**Floating**	**Biota**	**Micro**
G1	1	PL05	4/6-pack yokes, six-pack rings	Artificial polymer materials	x	x				
G2		PL07	Bags	Artificial polymer materials	x		x	x		
G3	2	PL07	Shopping Bags incl. pieces	Artificial polymer materials		x				
G4	3	PL07	Small plastic bags, *e.g.* freezer bags incl. pieces	Artificial polymer materials		x				
G5	112		Plastic bag collective role; what remains from rip-off plastic bags	Artificial polymer materials		x				
G6	4	PL02	Bottles	Artificial polymer materials	x		x	x		
G7	4	PL02	Drink bottles <=0.5l	Artificial polymer materials		x				
G8	4	PL02	Drink bottles >0.5l	Artificial polymer materials		x				
G9	5	PL02	Cleaner bottles & containers	Artificial polymer materials	x	x				
G10	6	PL06	Food containers incl. fast food containers	Artificial polymer materials	x	x	x			
G11	7	PL02	Beach use related cosmetic bottles and containers, *e.g.* Sunblocks	Artificial polymer materials		x				
G12	7	PL02	Other cosmetics bottles & containers	Artificial polymer materials	x	x				
G13	12	PL02	Other bottles & containers (drums)	Artificial polymer materials	x	x				
G14	8		Engine oil bottles & containers <50 cm	Artificial polymer materials		x				
G15	9	PL03	Engine oil bottles & containers >50 cm	Artificial polymer materials		x				

[67] Chapter 8 of the TSG-ML Report refers to Litter Categories, providing information on how to use the Master List of Categories of Litter Items.

Master List of Categories of Litter Items

TSG_ML General-	OSPAR-	UNEP- Code	General Name	Level 1 - Materials	Core	Beach	Seafloor	Floating	Biota	Micro
G16	10	PL03	Jerry cans (square plastic containers with handle)	Artificial polymer materials		x				
G17	11		Injection gun containers	Artificial polymer materials		x				
G18	13	PL13	Crates and containers / baskets	Artificial polymer materials		x	x	x		
G19	14		Car parts	Artificial polymer materials		x				
G20		PL01	Plastic caps and lids	Artificial polymer materials			x			
G21	15	PL01	Plastic caps/lids drinks	Artificial polymer materials		x				
G22	15	PL01	Plastic caps/lids chemicals, detergents (non-food)	Artificial polymer materials	x	x				
G23	15	PL01	Plastic caps/lids unidentified	Artificial polymer materials		x				
G24	15	PL01	Plastic rings from bottle caps/lids	Artificial polymer materials		x				
G25			Tobacco pouches / plastic cigarette box packaging	Artificial polymer materials		x				
G26	16	PL10	Cigarette lighters	Artificial polymer materials	x	x				
G27	64	PL11	Cigarette butts and filters	Artificial polymer materials		x	x			
G28	17		Pens and pen lids	Artificial polymer materials		x				
G29	18		Combs/hair brushes/sunglasses	Artificial polymer materials		x				
G30	19		Crisps packets/sweets wrappers	Artificial polymer materials		x				
G31	19		Lolly sticks	Artificial polymer materials		x				
G32	20	PL08	Toys and party poppers	Artificial polymer materials	x	x				

Master List of Categories of Litter Items

TSG_ML General-	OSPAR-	UNEP- Code	General Name	Level 1 - Materials	Core	Beach	Seafloor	Floating	Biota	Micro
G33	21	PL06	Cups and cup lids	Artificial polymer materials	x	x				
G34	22	PL04	Cutlery and trays	Artificial polymer materials		x				
G35	22	PL04	Straws and stirrers	Artificial polymer materials		x				
G36	23		Fertiliser/animal feed bags	Artificial polymer materials		x				
G37	24	PL15	Mesh vegetable bags	Artificial polymer materials		x				
G38			Cover / packaging	Artificial polymer materials				x		
G39		PL09	Gloves	Artificial polymer materials			x	x		
G40	25	PL09	Gloves (washing up)	Artificial polymer materials	x	x				
G41	113	RB03	Gloves (industrial/professional rubber gloves)	Artificial polymer materials	x	x				
G42	26	PL17	Crab/lobster pots and tops	Artificial polymer materials		x				
G43	114		Tags (fishing and industry)	Artificial polymer materials		x				
G44	27	PL17	Octopus pots	Artificial polymer materials		x				
G45	28	PL15	Mussels nets, Oyster nets	Artificial polymer materials		x				
G46	29		Oyster trays (round from oyster cultures)	Artificial polymer materials		x				
G47	30		Plastic sheeting from mussel culture (Tahitians)	Artificial polymer materials		x				
G48			Synthetic rope	Artificial polymer materials			x	x		
G49	31	PL19	Rope (diameter more than 1cm)	Artificial polymer materials	x	x				

Master List of Categories of Litter Items

TSG_ML General-	OSPAR- Code	UNEP- Code	General Name	Level 1 - Materials	Core	Beach	Seafloor	Floating	Biota	Micro
G50	32	PL19	String and cord (diameter less than 1cm)	Artificial polymer materials	x	x				
G51		PL20	Fishing net	Artificial polymer materials			x	x		
G52		PL20	Nets and pieces of net	Artificial polymer materials	x	x				
G53	115	PL20	Nets and pieces of net < 50 cm	Artificial polymer materials		x				
G54	116	PL20	Nets and pieces of net > 50 cm	Artificial polymer materials		x				
G55		PL18	Fishing line (entangled)	Artificial polymer materials			x			
G56	33	PL20	Tangled nets/cord	Artificial polymer materials		x				
G57	34	PL17	Fish boxes - plastic	Artificial polymer materials		x		x		
G58	34	PL17	Fish boxes - expanded polystyrene	Artificial polymer materials		x		x		
G59	35	PL18	Fishing line/monofilament (angling)	Artificial polymer materials	x	x	x			
G60	36	PL17	Light sticks (tubes with fluid) incl. packaging	Artificial polymer materials		x				
G61			Other fishing related	Artificial polymer materials			x			
G62	37	PL14	Floats for fishing nets	Artificial polymer materials	x	x				
G63	37	PL14	Buoys	Artificial polymer materials		x		x		
G64			Fenders	Artificial polymer materials		x				
G65	38	PL03	Buckets	Artificial polymer materials		x				
G66	39	PL21	Strapping bands	Artificial polymer materials	x	x	x			

Master List of Categories of Litter Items

TSG_ML General-Code	OSPAR-Code	UNEP- Code	General Name	Level 1 - Materials	Core	Beach	Seafloor	Floating	Biota	Micro
G67	40	PL16	Sheets, industrial packaging, plastic sheeting	Artificial polymer materials		x	x	x		
G68	41	PL22	Fibre glass/fragments	Artificial polymer materials		x				
G69	42		Hard hats/Helmets	Artificial polymer materials		x				
G70	43		Shotgun cartridges	Artificial polymer materials		x				
G71	44	CL01	Shoes/sandals	Artificial polymer materials		x				
G72			Traffic cones	Artificial polymer materials		x				
G73	45	FP01	Foam sponge	Artificial polymer materials		x				
G74			Foam packaging/insulation/polyurethane	Artificial polymer materials				x		
G75	117		Plastic/polystyrene pieces 0 - 2.5 cm	Artificial polymer materials		x				
G76	46		Plastic/polystyrene pieces 2.5 cm > < 50cm	Artificial polymer materials		x				
G77	47		Plastic/polystyrene pieces > 50 cm	Artificial polymer materials		x				
G78			Plastic pieces 0 - 2.5 cm	Artificial polymer materials		x				
G79			Plastic pieces 2.5 cm > < 50cm	Artificial polymer materials		x		x		
G80			Plastic pieces > 50 cm	Artificial polymer materials		x		x		
G81			Polystyrene pieces 0 - 2.5 cm	Artificial polymer materials		x				
G82			Polystyrene pieces 2.5 cm > < 50cm	Artificial polymer materials		x		x		
G83			Polystyrene pieces > 50 cm	Artificial polymer materials		x		x		

Master List of Categories of Litter Items

TSG_ML General-Code	OSPAR-Code	UNEP- Code	General Name	Level 1 - Materials	Core	Beach	Seafloor	Floating	Biota	Micro
G84			CD, CD-box	Artificial polymer materials		x				
G85			Salt packaging	Artificial polymer materials		x				
G86			Fin trees (from fins for scuba diving)	Artificial polymer materials		x				
G87			Masking tape	Artificial polymer materials		x				
G88			Telephone (incl. parts)	Artificial polymer materials		x				
G89			Plastic construction waste	Artificial polymer materials		x				
G90			Plastic flower pots	Artificial polymer materials		x				
G91			Biomass holder from sewage treatment plants	Artificial polymer materials		x				
G92			Bait containers/packaging	Artificial polymer materials		x				
G93			Cable ties	Artificial polymer materials		x	x			
G94			Table cloth	Artificial polymer materials				x		
G95	98	OT02	Cotton bud sticks	Artificial polymer materials	x	x	x			
G96	99	OT02	Sanitary towels/panty liners/backing strips	Artificial polymer materials		x	x			
G97	101	OT02	Toilet fresheners	Artificial polymer materials		x				
G98		OT02	Diapers/nappies	Artificial polymer materials		x	x			
G99	104	PL12	Syringes/needles	Artificial polymer materials		x	x			
G100	103		Medical/Pharmaceuticals containers/tubes	Artificial polymer materials		x				

Master List of Categories of Litter Items

TSG_ML General-	OSPAR-Code	UNEP- Code	General Name	Level 1 - Materials	Core	Beach	Seafloor	Floating	Biota	Micro
G101	121		Dog faeces bag	Artificial polymer materials	x	x				
G102		RB02	Flip-flops	Artificial polymer materials		x				
G103			Plastic fragments rounded <5mm	Artificial polymer materials						x
G104			Plastic fragments subrounded <5mm	Artificial polymer materials						x
G105			Plastic fragments subangular <5mm	Artificial polymer materials						x
G106			Plastic fragments angular <5mm	Artificial polymer materials						x
G107			cylindrical pellets <5mm	Artificial polymer materials						x
G108			disks pellets <5mm	Artificial polymer materials						x
G109			flat pellets <5mm	Artificial polymer materials						x
G110			ovoid pellets <5mm	Artificial polymer materials						x
G111			spheruloids pellets <5mm	Artificial polymer materials						x
G112		PL23	Industrial pellets	Artificial polymer materials	x				x	
G113			Filament <5mm	Artificial polymer materials						x
G114			Films <5mm	Artificial polymer materials						x
G115			Foamed plastic <5mm	Artificial polymer materials						x
G116			Granules <5mm	Artificial polymer materials						x
G117			Styrofoam <5mm	Artificial polymer materials						x

Master List of Categories of Litter Items

TSG_ML General-Code	OSPAR-Code	UNEP- Code	General Name	Level 1 - Materials	Core	Beach	Seafloor	Floating	Biota	Micro
G118			Small industrial spheres (<5mm)	Artificial polymer materials					x	
G119			Sheet like user plastic (>1mm)	Artificial polymer materials					x	
G120			Threadlike user plastic (>1mm)	Artificial polymer materials					x	
G121			Foamed user plastic (>1mm)	Artificial polymer materials					x	
G122			Plastic fragments (>1mm)	Artificial polymer materials					x	
G123			Polyurethane granules <5mm	Artificial polymer materials				x		
G124	48	PL24	Other plastic/polystyrene items (identifiable)	Artificial polymer materials		x	x	x		
G125	49	RB01	Balloons and balloon sticks	Rubber	x	x	x	x		
G126		RB01	Balls	Rubber		x		x		
G127	50		Rubber boots	Rubber		x	x	x		
G128	52	RB04	Tyres and belts	Rubber	x	x	x	x		
G129		RB05	Inner-tubes and rubber sheet	Rubber		x				
G130			Wheels	Rubber	x	x				
G131		RB06	Rubber bands (small, for kitchen/household/post use)	Rubber		x				
G132			Bobbins (fishing)	Rubber		x	x			
G133	97	RB07	Condoms (incl. packaging)	Rubber		x	x			
G134	53	RB08	Other rubber pieces	Rubber		x	x	x		
G135		CL01	Clothing (clothes, shoes)	Cloth/textile				x		

Master List of Categories of Litter Items

TSG_ML General-	OSPAR-Code	UNEP- Code	General Name	Level 1 - Materials	Core	Beach	Seafloor	Floating	Biota	Micro
G136		CL01	Shoes	Cloth/textile			x			
G137	54	CL01	Clothing / rags (clothing, hats, towels)	Cloth/textile	x	x	x			
G138	57	CL01	Shoes and sandals (*e.g.* Leather, cloth)	Cloth/textile		x				
G139		CL02	Backpacks & bags	Cloth/textile		x				
G140	56	CL03	Sacking (hessian)	Cloth/textile		x				
G141	55	CL05	Carpet & Furnishing	Cloth/textile		x	x	x		
G142		CL04	Rope, string and nets	Cloth/textile		x	x	x		
G143		CL03	Sails, canvas	Cloth/textile		x		x		
G144	100	OT02	Tampons and tampon applicators	Cloth/textile	x	x				
G145	59	CL06	Other textiles (incl. rags)	Cloth/textile		x	x	x		
G146			Paper/Cardboard	Paper/Cardboard			x			
G147	60		Paper bags	Paper/Cardboard		x				
G148	61	PC02	Cardboard (boxes & fragments)	Paper/Cardboard	x	x	x	x		
G149		PC03	Paper packaging	Paper/Cardboard				x		
G150	118	PC03	Cartons/Tetrapack Milk	Paper/Cardboard	x	x				
G151	62	PC03	Cartons/Tetrapack (others)	Paper/Cardboard	x	x				
G152	63	PC03	Cigarette packets	Paper/Cardboard		x				
G153	65	PC03	Cups, food trays, food wrappers, drink containers	Paper/Cardboard	x	x				

Master List of Categories of Litter Items										
TSG_ML General-	**OSPAR-Code**	**UNEP- Code**	**General Name**	**Level 1 - Materials**	**Core**	**Beach**	**Seafloor**	**Floating**	**Biota**	**Micro**
G154	66	PC01	Newspapers & magazines	Paper/Cardboard		x		x		
G155		PC04	Tubes for fireworks	Paper/Cardboard		x				
G156			Paper fragments	Paper/Cardboard		x				
G157			Paper	Paper/Cardboard					x	
G158	67	PC05	Other paper items	Paper/Cardboard		x	x	x		
G159	68	WD 01	Corks	Processed/worked wood		x				
G160	69	WD 04	Pallets	Processed/worked wood	x	x	x	x		
G161	69	WD 04	Processed timber	Processed/worked wood		x				
G162	70	WD 04	Crates	Processed/worked wood	x	x		x		
G163	71	WD 02	Crab/lobster pots	Processed/worked wood		x				
G164	119		Fish boxes	Processed/worked wood	x	x				
G165	72	WD 03	Ice-cream sticks, chip forks, chopsticks, toothpicks	Processed/worked wood	x	x				
G166	73		Paint brushes	Processed/worked wood		x				
G167		WD 05	Matches & fireworks	Processed/worked wood		x				
G168			Wood boards	Processed/worked wood				x		
G169			Beams / Dunnage	Processed/worked wood				x		
G170			Wood (processed)	Processed/worked wood			x			
G171	74	WD 06	Other wood < 50 cm	Processed/worked wood		x				
G172	75	WD 06	Other wood > 50 cm	Processed/worked wood		x				
G173		WD 06	Other (specify)	Processed/worked wood	x		x	x		

Master List of Categories of Litter Items										
TSG_ML General-	**OSPAR-Code**	**UNEP- Code**	**General Name**	**Level 1 - Materials**	**Core**	**Beach**	**Seafloor**	**Floating**	**Biota**	**Micro**
G174	76		Aerosol/Spray cans industry	Metal	x	x				
G175	78	ME03	Cans (beverage)	Metal	x	x	x	x		
G176	82	ME04	Cans (food)	Metal	x	x	x			
G177	81	ME06	Foil wrappers, aluminium foil	Metal		x				
G178	77	ME02	Bottle caps, lids & pull tabs	Metal	x	x				
G179	120		Disposable BBQ's	Metal		x				
G180	79	ME10	Appliances (refrigerators, washers, etc.)	Metal		x	x			
G181		ME01	Tableware (plates, cups & cutlery)	Metal		x				
G182	80	ME07	Fishing related (weights, sinkers, lures, hooks)	Metal		x	x	x		
G183		ME07	Fish hook remains	Metal					x	
G184	87	ME07	Lobster/crab pots	Metal	x	x				
G185			Middle size containers	Metal			x			
G186	83	ME10	Industrial scrap	Metal		x				
G187	84	ME05	Drums, *e.g.* oil	Metal		x	x			
G188		ME04	Other cans (< 4 L)	Metal		x				
G189		ME05	Gas bottles, drums & buckets (> 4 L)	Metal		x				
G190	86	ME05	Paint tins	Metal		x				
G191	88	ME09	Wire, wire mesh, barbed wire	Metal		x		x		

Master List of Categories of Litter Items

TSG_ML General-Code	OSPAR-Code	UNEP- Code	General Name	Level 1 - Materials	Core	Beach	Seafloor	Floating	Biota	Micro
G192		ME05	Barrels	Metal				x		
G193			Car parts / batteries	Metal		x	x			
G194			Cables	Metal		x	x			
G195		OT04	Household Batteries	Metal		x				
G196			Large metallic objects	Metal			x			
G197			Other (metal)	Metal			x	x		
G198	89	ME10	Other metal pieces < 50 cm	Metal		x				
G199	90	ME10	Other metal pieces > 50 cm	Metal		x				
G200	91	GC02	Bottles incl. pieces	Glass/ceramics	x	x	x			
G201		GC02	Jars incl. pieces	Glass/ceramics		x	x			
G202	92	GC04	Light bulbs	Glass/ceramics	x	x				
G203		GC03	Tableware (plates & cups)	Glass/ceramics		x				
G204	94	GC01	Construction material (brick, cement, pipes)	Glass/ceramics		x				
G205	92	GC05	Fluorescent light tubes	Glass/ceramics	x	x				
G206		GC06	Glass buoys	Glass/ceramics		x				
G207	95		Octopus pots	Glass/ceramics		x				
G208		GC07	Glass or ceramic fragments >2.5cm	Glass/ceramics		x	x			
G209			Large glass objects (specify)	Glass/ceramics			x			
G210	96	GC08	Other glass items	Glass/ceramics	x	x	x			

Master List of Categories of Litter Items

TSG_ML General-	OSPAR-Code	UNEP- Code	General Name	Level 1 - Materials	Core	Beach	Seafloor	Floating	Biota	Micro
G211	105	OT05	Other medical items (swabs, bandaging, adhesive plaster etc.)	unidentified		x				
G212			Slack / Coal						x	
G213	181, 109, 110	OT01	Paraffin/Wax	Chemicals		x			x	
G214			Oil/Tar	Chemicals					x	
G215			Food waste (galley waste)	Food waste					x	
G216			various rubbish (worked wood, metal parts)	Undefined					x	
G217			Other (glass, metal, tar) <5mm	unidentified						x

ANNEX VIII

MARINE LITTER
Categories and sub-categories of litter items for Sea-Floor

10.2. - Categories and sub-categories of litter items for Sea-Floor
Litter categories from MEDITS litter for Mediterranean and Black Sea

A. Plastic	B. Rubber	C. Metals	D: Glass/ Ceramics	E. textiles / natural fibers	F. Wood (processed)	G. Paper / cardboard	H. Other (specify)	I. Unspecified
A1.Bags	B1. Tyres	C1. Beverage cans	D1. Bottles	E1. Clothing (clothes, shoes)				
A2. Bottles	B2. Other (gloves, shoes, etc.)	C2. Other food cans/wrappers	D2. Pieces of glass	E2. Large pieces (carpets, etc)				
A3. Food wrappers		C3. Middle size containers	D3. Ceramic jars	E3. Natural ropes				
A4. Sheets		C4. Large metallic objects	D4. Large objects (specify)					
A5. Other plastic objects		C5. Cables						
A6. Fishing nets		C6. Fishing related						
A7. Fishing lines								
A8. Other fishing related								
A9. Ropes/strapping bands								
A10. Sanitaries (diapers, etc.)								

Related size category

A: <5*5 cm= 25 cm^2

B: <10*10 cm= 100 cm^2

C: <20*20 cm= 400 cm^2

D: <50*50 cm= 2500 cm^2

E: <100*100 cm= 10000 cm^2= 1 m^2

F: >100*100 cm = 10000 cm2= 1 m2

10.3. - Categories for contents of digestive tract (oesophagus, stomach(s), intestine) in biota

BIOTA categories for contents of digestive tract *(oesophagus, stomach(s), intestine)*			
PLA	**PLASTIC**	**acronym**	all plastic or synthetic items: note number of particles and dry mass for each category
IND	**pellets**	**ind**	industrial plastic granules (usually cylindrical but also oval spherical or cubical shapes exist
	probab ind?	**pind**	suspected industrial, used for the tiny spheres (glassy, milky, ...) occasionally encountered
USE	**sheet**	**she**	remains of sheet, eg from bag, cling-foil, agricultural sheets, rubbish bags etc
	thread	**thr**	threadlike materials, eg pieces of nylon wire, net-fragments, woven clothing; includes 'balls' of compacted such material
	foam	**foam**	all foamed plastics so polystyrene foam, foamed soft rubber (as in matras filling), PUR used in construction etc
	fragments	**frag**	fragments, broken pieces of thicker type plastics, can be bit flexible, but not like sheetlike materials
	other	**Poth**	any other, incl elastics, dense rubber, sigarette-filters, balloon-pieces, softairgun bullets; objects etc. DESCRIBE!!
RUB	**OTHER RUBBISH**	**acronym**	any other non synthetic consumer wastess: note number of particles and (in principle) dry mass for each category
RUB	**paper**	**pap**	newspaper, packaging, cardboard, includes multilayerd material (eg Tetrapack pieces) and aluminium foil
	kitchenfood	**kit**	human food remains (galley wastes) like oinion, beans, chickenbones, bacon, seeds of tomatoes,grapes, peppers, melon etc
	other user	**rva**	other consumber waste, like processed wood, pieces of metal, metal air-gun bulletes; leadshot, painchips. DESCRIBE
	FISHHOOK	**hoo**	fishing hook remains (NOT FOR HOOKS ON WHICH LONGLINE VICTIMS WERE CAUGHT - THOSE UNDER NOTES)
POL	**POLLUTANTS (INDUS/CHEM WASTE)**	**acronym**	other non synthetic indusrial or shipping wastes (number of items and mass per category (wet for paraffin)
POL	**slag/coal**	**sla**	industrial oven slags ('looks like non-natural pumice) or coal remains
	oil/tar	**tar**	lumps of oil or tar (also not n=1 and g=0.0001g if other particles smeared with tar but cannot be sampled separately)
	paraf/chem	**che**	lumps or mash of unclear paraffin, wax like substances (NOT stomach oil!) if needed subsample and estimate mass
	featherlump	**rva**	lump of feathers from excessive preening of fouled feathers (n=1 with drymass) (NOT for few normal own feathers)
FOO	**NATURAL FOOD**	**foo**	various categories, depends on the species studied, and aims of study
NFO	**NATURAL NON FOOD**	**nfo**	anything natural, but which can not be considered as normal nutritious FOOD for the individual

10.4. Sea Turtle Necropsy Data Sheet

Identification Data	
Species, Tag/chip number	
Date of finding	
Circumstances (stranded, interaction with human activity (precise, and precise gear when interaction with fishing activity, death at rescue center)	
Date of necropsy (after or before freezing, if freezed indicate at which temperature)	
Trophic status atrophy of the pectoral muscles (None, Moderate, Severe) fat thickness in the articular cavities and on the coelomic membrane (Abundant, Normal, Low, None)	
Fresh/Decomposition status (categories to be explained)	
Date of turtle death	
Cause of death, if determined	
Location	
Coordinates	
Identification number (code) (International CITES code)	
Finder personal details (name, telephone, mel)	

Measurements	**Unit (cm)**
Carapace length (CCL)	
Overcurve width (CCW)	
Plastron length (CPL)	
Plastron width (CPW)	

External observation	**Comments**	**Photo (if relevant)**
Head		
Flipper		
Carapace		
Plastron		
Tail		
Sex-maturity		
Skeletal-damage		
Foreign bodies		
Cause of death		
Other		

Gastrointestinal tract	**Observation/Comments**	**Photo** **(if relevant)**
Oesophagus		
Stomach		
Intestine		

10.5. - Data Sheet for recording of ingested items in sea-turtles

Oesophagus, Stomach or Intestine						
Type of Litter	**Presence yes/no**	**Abundance (items number)**	**Volume (ml H_2O)**	**Color (number)**	**Dry Weight (g)**	**Microlitter abundance (number items <5mm)**
IND ind						
IND Pind						
USE she						
USE thr						
USE foa						
USE fra						
USE Poth						
RUB pap						
RUB kit						
RUB rva						
RUB hoo						
POL sla						
POL tar						
POL che						
FOO						
NFO						

For litter categories see Annex VII

ANNEX IX

Alternative monitoring approaches that could be of value for an effective monitoring of the spatial scale relevant to the Integrated Monitoring and Assessment Programme

Alternative monitoring approaches that could be of value for an effective monitoring of the spatial scale relevant to the Integrated Monitoring and Assessment Programme

1. Moorings and buoys

Moored and free-floating buoys have a long history of use in oceanography and coastal sciences, measuring a large variety of important physical, chemical and biological variables such as salinity, temperature, turbidity, dissolved oxygen, trace metals, pCO2 and others, depending on the number of instruments they can handle.
Data can be measured at high frequency at strategic sites and at different depths owing to sophisticated profiling equipment. Data are then transmitted in real-time to land-based observatories via communication satellites. The efficiency of buoys has been considerably increased owing to advanced technology including solar storage batteries, data logging controller, environment-friendly antifouling coatings. The ARGO buoy network provides data from buoys which are periodically sinking to depth and transmit the data when surfacing.

Offshore spatial coverage is provided. Periodic visits for maintenance and cleaning of instruments is required. Provides point measurements over the water column.

2. Ships of opportunity / FerryBox system

The use of volunteer merchant vessels to gather oceanographic data can be an important cost-effective component of any monitoring programmes. As for the moorings, ships of opportunity can be fitted with various instrumentations to collect data related to physical, chemical and biological oceanography. As an alternative to often expensive and time-consuming research vessels, merchant fleet and specifically ferries offer a regular line sampling frequency across a wide range of water types. The so-called FerryBox system consists of an automatic flow-through system pumping sea water on the side of the ship and propelling it in an internal loop at constant velocity to conduct the various measurements. The FerryBox community is continuously increasing. More details on the system and the operating companies can be found at http://www.ferrybox.org.

Offshore spatial coverage is provided. Transect measurements at one depth level (surface or sub-surface), use of fishery vessels for sampling.

3. Continuous Plankton Recorder (CPR)

The CPR is a plankton sampling instrument designed to be towed from ships. The CPR is towed at a depth of approximately 10 metres. Water passes through the CPR and plankton is filtered onto a slow-moving band of silk. In the laboratory CPR samples are analyzed in two ways. The Phytoplankton Colour Index (PCI), a semi-quantitative estimate of phytoplankton biomass, is determined for each sample. Then, microscopic analysis is undertaken for each sample, and individual phytoplankton and zooplankton taxa are identified and counted. CPR can sample larger areas than other phytoplankton and zooplankton devices such as bottles and nets. Data on biomass that are needed for many indicators can easily be taken while taxonomic identification needed for other indicators needs the same skills and human power as with any other sampling method.

CPR has also been used to monitor micro-litter in the water column. However the CPR samples at approximately 10m depth and so will not sample floating debris.

Offshore spatial coverage is provided. The device needs to be towed from a special vessel with a specific speed.

4. Underwater video & Imagery

Video can be used to take images of both the sea-bed and the water column. Video cameras can be tethered to oceanographic vessels as well as other non-research vessels (ferries, fishing vessels, ships of opportunity). Depending on the quality of the images recorded they can provide information on the structure of the seabed, the composition and abundance of macroscopic benthic biota and the composition and abundance of macroscopic pelagic biota. Non-living items, such as litter, can also be recorded. The technique performs well in terms of resolution and information content but not so good in relation to workload and areal coverage.

Offshore spatial coverage is provided. This is better applied to benthic habitats and biota. Taxonomic resolution is not always comparable to the one achieved by traditional tools (e.g. grabs, corers, divers), applicable to surveys of marine litter including image acquisition and recognition technology.

4.1. Underwater acoustics

Hydroacoustics (echo sounding or sonar), is commonly used for detection, assessment, and monitoring of underwater physical and biological characteristics. The very efficient transmission of sound in water makes this remote-sensing technique highly effective in most aquatic ecosystems and under many environmental conditions providing a valuable complement to capture-based sampling techniques.

Sonars can be used for the detection of animal and plant populations and provide some information on their abundance, size, behavior and distribution. They are already widely in use in the marine environment both by fishermen and by fisheries scientists for the investigation of fish populations. Hydro-acoustic surveys provide for non-intrusive methods for quantifying the abundance and distribution of fish. Advances in acoustic technology, and especially data analysis software, have made this survey method even more powerful in recent years. While there are limitations in terms of species identification, acoustic surveys used in conjunction with other methods or as a relative measure, provide a quantifiable metric over the years.

Validation should occur simultaneously through the use of high resolution sonar imaging, underwater cameras, and other methods.

Sonars are also used for habitat mapping (mainly depth, bottom roughness and hardness reflecting differences in sub-stratum types). More recently, the combination of different hydro-acoustic methods (i.e. single beam echo-sounder, multi-beam sonar and side scan sonar) enables the spatial classification of the seafloor and its biota. The resulting 3 D images are of the same quality and precision as those found in the field of biomedicine.

Recording of sounds produced by marine animals (mainly mammals) could possibly provide info on their population abundance, their movements and location of their habitats. A related project is running in Catalonia, Spain: http://listentothedeep.com/.

Hydrographic surveys use side scan sonar systems for both object detection and object recognition. Side scan sonar is typically used in conjunction with a single beam or multi-beam sonar system to meet full bottom coverage specifications. Field units may use various models of side scan sonar in both hull mounted and towed configurations for hydrographic survey operations. In addition mutli-beam echo sounder systems may be used by hydrographic units to acquire full- and partial- bottom bathymetric coverage throughout a survey area, to determine least depths over critical items such as wrecks, obstructions, and dangers-to-navigation, and for general object detection. Field units may use various models of swath-type multibeam systems both hull and pole mounted for hydrographic survey operations.

Offshore spatial coverage provided. Taxonomic identification is not always at the species level.

4.2. LIDAR

“Light Detection And Ranging” or LIDAR is a method used inter alia in hydrographic surveys to measure distance or depth by analyzing pulses of laser light reflected off an object. These survey systems are typically aircraft-mounted and provide seamless coverage between land and sea.

Bathymetric LIDAR refers to its use to determine water depth. Bathymetric LIDAR systems use laser pulses received at two frequencies. Water depths are determined by measuring the time delay between the transmission of a pulse and its return signal detecting the seafloor. A lower frequency infrared pulse is reflected off the sea surface, while a higher frequency green laser penetrates through the water column and reflects off the bottom. Analyses of these two distinct pulses are used to establish water depths and shoreline elevations. Depending on water clarity, these systems can reach depths of 50 meters.

Bathymetric LIDAR is used to acquire data in areas with complex and rugged shorelines. Surface vessels often cannot operate efficiently or safely in these areas due to rocks, kelp or breaking surf.

4.3. Remote sensing

Earth Observation (EO) from satellite provides information at increased frequency compared with tradition observation systems, over large and distant areas of the marine and coastal areas in a real cost-effective way, where only few observations can be conducted by traditional methods using oceanographic vessels. Satellite remote sensing techniques also grant consistent methodologies while capturing the regional and local variability at a frequency nearly compatible with the dynamics of marine and coastal processes. Such kind of synoptic observations have made important contributions to monitor the state of the marine environment in terms of its physical and biological properties and is increasingly used to foster sustainable management of the marine and coastal resources, including fisheries.

Optical sensors on-board satellite (e.g. MERIS on ENVISAT; http://envisat.esa.int/instruments/meris) relates to the 'color' of the sea surface, which varies with the concentration and composition of a large variety of living and non-living material in suspension. An important quantity is the concentration of chlorophyll, an omnipresent pigment in all phytoplankton species commonly used as an index of phytoplankton biomass. Other products of interest include total suspended matter, pigmented fraction of dissolved organic matter, as well as some indication of phytoplankton functional groups. Data can be accessed freely through space agencies or via specific web sites such as the Environmental Marine Information System from the Joint Research Centre (http://emis.jrc.ec.europa.eu).

Physical changes of the coastal ecosystems and habitats in particular terrestrial can be surveyed by the use of satellite images or aerial photography. For the changes of land use, sediment dynamics and alike the use of CORINE Land Cover datasets are available for specific time series which allows to follow trends for instance. Land cover products are created by GlobCorine or other, e.g. MODIS multispectral data, following descrete Corine land cover categories.

Offshore spatial coverage is provided here. Passive optical and thermal sensors are of limited use under cloud cover and low sun angle. The taxonomic resolution is restricted to phytoplankton functional groups.

4.4. Autonomous Underwater Vehicles (AUVs) and Gliders

The development of AUV technology for marine and coastal studies has increased considerably over the last decade as an alternative to costly and heavy logistic demand of research vessels. AUVs are free-swimming torpedo-shaped devices remotely operated from the surface within the range of the telemetry system onboard.

Owing to a number of propulsion techniques most often powered by rechargeable batteries, AUVs can cover large distance (ca. 10 miles) at various depths to provide a 3D view of the water column. Gliders are specific AUVs propelling themselves using buoyancy-based techniques, increasing the underwater autonomy of the vehicle for observations of longer time-scale features. The scientific payload of AUVs and gliders can be set with physical and bio-optical instruments measuring water quality variables (such as nutrients and contaminants), phytoplankton biomass, in addition to physical and geochemical properties such as temperature, oxygen, conductivity. They can also transport video-cameras to get pictures of organisms (mostly pelagic) and/or debris and also detectors of passive acoustic signals.

Offshore spatial coverage is provided. The cost depends on the onboard instrumentation. Considerable technical expertise is required.

5. Quality Assurance and Quality Control

The accuracy and comparability of the data collected is a key requirement for status assessment and description and for the assessment of anthropogenic influences and required measures. Quality assurance (QA) and quality control (QC) measures ensure that monitoring results of stated quality are obtained across the Mediterranean Region and at any time.

QA/QC should provide confidence in the whole analytical process, from sampling to reporting, for all monitoring parameters, from monitoring at national, sub-regional as well as at Regional scale. Monitoring should provide data, which are representative of the location and time of sampling. For temporal trend monitoring in particular, it is extremely important to perform reliable and reproducible high-quality analyses over decades. Therefore, such analyses require well-documented procedures and experienced analysts.

QA/QC seems to be limited to methods and technical specifications. However, it is important for the whole monitoring chain: from defining targets to achieve GES, related indicators and parameters in order to determine the monitoring requirements to designing and performing the monitoring programme in order to collect and assess the monitoring data. The monitoring data should enable meaningful assessment of status in time and space. Beginning with an assessment of the existing monitoring programme, an iterative process will enable a further modification and revision of the monitoring programme. Monitoring programmes should be adapted to new insights by ensuring that time series remain as much intact as possible. Exchange of best practices, intercalibration and harmonisation activities will forward this process and highlight any deficiencies and inadequacies. This will result in comparable monitoring approaches based on commonly agreed monitoring principles.

QA and QC also apply to data storage and exchange. This includes common data management standards and technical and semantic interoperability between data management systems.

ANNEX X

Common typology of pressures on the natural environment resulting from anthropogenic activities and their interlinking impacts

Common typology of pressures on the natural environment resulting from anthropogenic activities and their interlinking impacts

Pressures		Impacts on marine environment			
		Physical	**Hydrological**	**Chemical**	**Biological**
Physical	Alteration of sea-floor/water body morphology	Seabed, substrate, topography	Water movement changes(wasvers, currents, river flows), turbidity	Salinity changes	Habitat for species (mobile) and communities (seabed); barriers to species movements
	Change of sea-floor substrate	Seabed substrate, topography	Water movement changes (waves, currents, river flows), turbidity		Habitat for species (mobile) and communities (seabed) barriers to species movements
	Disturbance/damage to sea-floor	Seabed habitat structure	Water clarity, turbidity		Community changes
	Extraction of sea-floor and subsoil minerals (e.g. sand, gravel, rock, oil, gas)	Seabed habitat structure	Water clarity, turbidity		Community changes
Hydrological	Water discharges (with/without contaminants		Sea temperature	Chemical balance	
	Water movement changes				Species movements
	Water extraction		Turbidity, water volume	Salinity changes	
Energy	Input of sound				Displacement of species, behavioural changes
	Input of electromagnetic & seismic waves				Behavioural changes
	Input of heat			Sea temperature	Species distributional changes
	Input of light				Behavioural changes
Chemicals and other pollutants	Nutrient enrichment (N, P, organic matter)		Water clarity	Deoxygenation, nutrient balance	Plankton blooms
	Input of contaminants (synthetic substances, non-synthetic			Chemical balance	Sub-lethal effects

Pressures		Impacts on marine environment			
		Physical	Hydrological	Chemical	Biological
	substances, radionuclides) - diffuse sources, point sources, acute events				Death/injury to species, health of species
	Input of CO_2 and other greenhouse gases		Sea temperature, wave action, currents, sea level	pCO2/ acidification	Species distribution, behaviour, reproductive capacity
	Input of litter (solid waste matter)	Smothering of habitat			
Biological	Removal of species (targeted, non-targeted)				Population changes, community changes
	Injury/death to species				Population changes
	Disturbance of species				Behavioural changes
	Translocation of (native) species				Genetic changes
	Introduction of genetically modified species				Genetic changes
	Introduction or spread of non-indigenous species				Community changes
	Introduction of microbial pathogens				Shellfish health, human health
	Cultivation/artificialisation of natural habitat				Community changes

ANNEX XI
Common Indicator Assessment Model Fact Sheet

Common Indicator Assessment Model Fact Sheet

The Quality Status Report of 2017 will be a web-based product based on common indicators assessment fact sheets that will allow assessments to be linked via metadata to the underlying datasets, methods, authors, increasing transparency, and repeatability. It will be linked and published on the UNEP/MAP Barcelona Convention Integrated Data and Information System.

The following template will serve as a basis for the future development of this web-based common indicator assessment fact sheet.

I. Access and Use	**Information on access right, usage rights related to the data products**	
Conditions applying to access and use	i.e. Copyright, data policy	Text or URL
II. Assessment findings	**Key messages, assessment results, trend analysis and conclusions presented primarily as text**	
1. Key assessment	Description of assessment results by geographical scope/assessment units	Text
2. Key messages	Short descriptions of trends	Text
3. Results and Status	Summary of assessment results, max 3 pages, could include graphics	Text and figures
Assessment methods	**Methodologies, aggregation methods, indicator specifications, references to other relevant methods**	
1. Common Indicator Definition	Short description of indicator aimed at general audience	Text
2. Methodology for indicator calculation	Text and tabular information on the process of aggregation and selection	Text
3. Indicator units	Units used for indicator	Text
Contact and Ownership	**Contact details for assessment indicator, including authorship and organizational contact points**	
1. Citation	Full citation	Text
2. Contact point	Organisational contact	Text
Data inputs and outputs	**Data sources, assessment datasets, assessment results (tabular and dataset), snapshots etc.**	
1. Data sources	Underlying datasets	Text and/or URL
2. Assessment dataset	Snapshot dataset that was derived from underlying data	URL
3. Assessment result	Summary results dataset/table/figure	File or Web service
Geographical Scope	**Assessment units, other geographical information, countries**	
1. Geographical scope	Countries, sub-region, region that the common indicator assessment covers	Text
Labelling and Classification	**Identification and classification systems**	
1. GES description	GES description as agreed in IG. 21/3 in relation to the specific common indicator	Text

2. Common Indicator title	Full title of common indicator	Text
Quality Aspects	**Explicit information content on quality of assessment, including data and methods, i.e. Uncertainty, gaps in coverage etc.**	
1. Data confidence	Adequateness of spatial and temporal coverage, quality of data collection etc.	Text
2. Indicator methodology confidence	Knowledge gaps and uncertainty in methods/knowledge	Text
Version Control	**Publishing dates, references to previous indicator versions, URI's etc.**	
Published date	Publish date of indicator	Data time

Note on geographic reporting scales

A scale of reporting units needs to be defined taking into account both ecological considerations and management purposes, following a **nested approach**.

The nested approach that is adopted to accommodate the needs of the above is to take into account 5 main reporting scales:

(1) Whole region (i.e. Mediterranean Sea);

(2) Mediterranean sub-regions, as presented in the Initial Assessment of the Mediterranean Sea, UNEP (DEPI)/MED IG.20/Inf.8;

(3) Offshore areas and areas of coastal influence;

(4) Subdivisions of coastal waters provided by Contracting Parties.

Spatial scales are likely to be dependent on the issue and need to be further refined in the CORMONs during the initial phase of IMAP.

ANNEX XII

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