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Agenda item 6: Science-policy interface (SPI) strengthening related to Marine Pollution

Enhancing the Science Policy Interface in the Mediterranean for marine pollution based on ecosystem approach

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Enhancing the Science Policy Interface in the Mediterranean for marine pollution based on ecosystem approach

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Introduction

1. Pursuant to several decisions of the meetings of the Contracting Parties, specific efforts were made during the past decade by UNEP/MAP to implement the ecosystem approach (EcAp) with the objective to achieve the good environmental status (GES) of the Mediterranean Sea and Coast.
2. The GES has been defined through eleven Ecological Objectives (EO), listed in and was attended by scientific working in the field of biodiversity. The workshop has resulted in some general and some specific biodiversity and NIS common indicators related scientific recommendations and addressed both overall status or aspects of biodiversity in the Mediterranean, monitoring needs, challenges, methodologies, cost efficiency and feasibility in light of recent scientific developments. As such it provided a key contribution to the development of IMAP.
3. The workshop has resulted in some general and some specific biodiversity and NIS common indicators related scientific recommendations and addressed both overall status or aspects of biodiversity in the Mediterranean, monitoring needs, challenges, methodologies, cost efficiency and feasibility in light of recent scientific developments. As such it provided a key contribution to the development of IMAP.
4. Annex 4: List of EcAp Ecological Objectives and their achievement is being monitored with the help of 27 indicators. These indicators are at the heart of the UNEP/MAP Integrated Monitoring and Assessment Program (IMAP) Decision IG.22/7 - COP 19 February 2016 to be implemented the whole Mediterranean Sea and coast.
5. To enable the implementation of the IMAP, it is crucial to bridge existing gaps between the scientific and policy making spheres. Therefore, one of the key activities of the second phase of EcAp, the EcAp MED II project 2015-2018 supported by the European Union, focuses on the strengthening of the interface between science and policy.
6. Plan Bleu is mandated by UNEP/MAP to coordinate this activity, so a first workshop was organized by Plan Bleu on December 2015. The objective was to bring together key stakeholders (scientists and managers) to discuss the implementation of science-policy interface (SPI) activities for IMAP. During this workshop, a first set of around 15 key cross-cutting and topic-specific knowledge gaps to be filled for the implementation of IMAP has been identified along with proposed actions to be taken to address these gaps. (Plan Bleu, 2016). The participant convened by Plan Bleu have made it clear that SPI is currently a real issue perceived by scientists and decision makers. The workshop opened up perspectives to develop SPI for IMAP, namely by pointing out the need to formalize SPI along with its structure and processes and to identify dedicated resources to support SPI.
7. Until 2018, several other thematic workshops are planned following this model, which aims to identify scientific gaps in programs that contribute to achieving the GES and seek solutions to fill them.
8. In collaboration with MED POL a session on SPI with regards to pollution is being organized back to back with the CorMON on Pollution whose main objective is to identify the scientific needs that could support the full implementation of IMAP at regional and national levels with regards to the component of IMAP addressing contaminants and eutrophication and to propose practical solutions in order to meet them.
9. This working document aims at facilitating proposal of solutions to respond to the identified science needs by the participants. This working document has been prepared by Plan Bleu in view of the next workshop dedicated to the strengthening of SPI on pollution (EO5 - Eutrophication, EO 9 - Contaminants) theme as a specific session within the frame of a CORMON meeting on pollution, in consultation with UNEP/MAP MEDPOL Programme.

10. This working document is supported by four Annexes:
- Annex I: Analysis of the needs to implement IMAP concerning EO5 Eutrophication
 - Annex II: Analysis of the needs to implement IMAP concerning EO9 Contaminants
 - Annex III: The integrated monitoring and assessment programme (IMAP) of UNEP/MAP
 - Annex IV: List of EcAp Ecological Objectives and Common indicators

1. Method

11. The method used to identify the scientific research needs that could support the full implementation of UNEP/MAP IMAP has been adapted from the one used by the EU FP7 STAGES project to identify the future research needs to implement the EU MSFD.

12. The Science and Technology Advancing Governance on Good Environmental Status project or STAGES (Connecting science to policy for healthy seas) aimed to connect science to policy to help achieve GES in the EU marine waters. The project worked towards bridging the EU Marine Strategy Framework Directive (MSFD) science-policy gap and improving the availability of scientific knowledge to allow Member States to achieve GES (Le Moigne et al., 2014). In particular, one specific workshop was organised on the identification of research needs with regards to the implementation of monitoring programme (STAGES, 2013).

13. Regarding the SPI action, the method consisted in analysing the reference document presenting the IMAP process, namely the Decision IG.22/7 “Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria”. The cross cutting issues were also analysed in the Draft Integrated Monitoring and Assessment Guidance (2015) where they are more developed.

14. In practice, sections in the reference documents mentioning further developments for the future implementation of IMAP were selected at first. Each selected section was then analysed in order to identify the relevant EcAp Ecological Objective (EO), or cross cutting scientific issues addressing several EO (e.g. scale issues) and formulate it as a need for scientific action.

15. Then these needs were synthesized and sorted according main thematic challenges (Cross cutting issues, EcAp EOs) in a table giving both the needs and the proposed actions to meet each need, displaying the following items:

- Need formulation,
- Proposed action to address this need,
- Scope or typology of the action
- Level or scale of the action (local, national, regional)
- Estimated duration of the action: Short (less than 2 years) Medium (2-4 years), Large (more than 4 years)
- Opportunities: outputs of research project, partnership with UNEP/MAP, resources of a specific scientific centre that may facilitate the development of this action.

2. Preliminary analysis and results of the Inception SPI workshop

16. This preliminary analysis of the IMAP science needs has been prepared by Plan Bleu. The resulting table was presented as a working document of the SPI inception workshop held in December 2015 in Sophia Antipolis (Plan Bleu, 2016, Annex 9).

17. These results have been reviewed by the scientific experts participating to the inception workshop. One session of this workshop was organized in groups according the three main IMAP clusters: i) Pollution and litter, ii) Biodiversity and fisheries and iii) Coast and Hydrography.

18. During three working sessions in sub-groups and plenary discussions, the workshop participants have identified a number of knowledge gaps that need to be filled for the full implementation of MAP's IMAP. Some of these gaps are cross-cutting and of general interest, whereas others are related to specific topics. The participant's comments have been listed in three categories: general, transversal and thematic, this latter according to the MAP EcAp clusters (biodiversity, pollution and eutrophication, hydrography and coasts). Only comments on the EO5 and EO9 are reported here, in line with the focus of this SPI workshop on Pollution. It should be noted that some of these recommendations issued by participants go beyond the current IMAP definition as agreed by the Decision IG.22/7 - COP 19 February 2016.

General comments

19. General comments include the following:

- ***A recognized lack of knowledge.*** The workshop acknowledges that scientists are not in all areas currently able to provide necessary knowledge to policymakers to support the goal of achieving GES. Participants also recognize that additional efforts for identification, hierarchizing and synthesis of knowledge gaps are currently required.
- ***Heterogeneous spatial distribution of knowledge availability.*** It is highlighted that knowledge availability differs along Contracting Parties. Generally, a gap between Northern and Southern Mediterranean countries which can impact the robustness of regional Mediterranean models and knowledge can be observed.
- ***Monitoring versus obtaining new knowledge.*** Workshop participants point out the difference between routine activity with the purpose of monitoring and scientific activities for obtaining new original knowledge. Furthermore, if new knowledge is considered GES relevant, a sustainable monitoring process should be developed.
- ***Scientific results to inform different processes.*** It is pointed out that the scientific research results produced need to be suitable to cater different purposes integrated in IMAP: (i) monitoring, (ii) integrated environmental assessment and (iii) IMAP further revisions.
- ***Ecosystem functioning.*** Workshop participants consider that currently available knowledge about the functioning of Mediterranean marine and coastal ecosystems is still lacking, although they also acknowledge that the mobilization around EcAp and the MSFD has so far succeeded in developing new knowledge.

Transversal issues:

20. Transversal issues identified include the following:

- ***Mapping results.*** It is recommended that outputs of the integrated assessments be mapped under a GIS for a better understanding of environmental processes.
- ***Cost-benefit analysis.*** Workshop participants bring forward the interest of conducting cost-benefit analyses of monitoring.
- ***Scales.*** The workshop recommends that relevant scales and timelines for the integrated assessment need to be clearly defined for the implementation of the integrated assessment.
- ***Aggregation rules.*** Aggregation rules for the results of monitoring if the GES has been achieved or not need to be clarified.
- ***Guidelines for risk-based approach.*** The IMAP document recommends applying the risk-based approach for the definition of monitoring procedures. The workshop approves this recommendation but calls for the development of guidelines to apply such an approach.
- ***Empowerment of national task forces.*** It is recommended to develop a mechanism for expertise and capacity building aiming at establishing operational national task forces to support IMAP.

- **Filling knowledge gaps with remote sensing.** The workshop recommends making use of the results of remote sensing for monitoring physical elements, especially for establishing baseline data for coast and hydrography issues, where no field data is available. However, in some cases, more detailed data will require field work.

Thematic comments on EO5 and EO9

21. The scientific needs elaborated in Table 1 to support implementation of IMAP can be categorized according to the following:

- **Knowledge need, EO5 Eutrophication: Definition of eutrophication and its ecological impact.** The working group concludes that the observation of chlorophyll-a is not sufficient to characterize eutrophication. In order to assess the natural variability of the basin, long time series are required.
- **Proposed action:** Further use of satellite data and validation with the help of field observations can be useful here. Also, the working group points out that a standard common assessment methodology with more than two indicators should be developed. Thresholds need to be defined for different ecological areas. The scale of sampling needs to be targeted.
- **Knowledge need, EO5 Eutrophication: Concentration of nutrients in water column.** The working group highlights a need to further detail the assessment of the concentration of nutrients in the water column. They also mention that additional information about sources of nutrients such as aquifers and ground water may be useful.
- **Proposed action:** Establish guidelines for hydrographic parameters
- **Knowledge need, EO9 Contaminants: Further development of monitoring and assessment of EO9.**
- **Proposed action:** Participants of the working group advise that the relationship between inputs, concentration and effects needs to be further investigated and taken into account.
- **Proposed action:** The working group advises to cross-enhance the contaminant reference list with the MEDPOL list and suggest additional priorities for each area.
- **Proposed action:** It is recommended to add observation of pathogens not only in bathing waters but also in shellfish. This issue has been identified by the working group to be of cross-cutting interest and should be further discussed.
- **Proposed action:** The working group questions if research data for the extension of monitoring strategies beyond coastal areas, in application of the risk based approach, is needed and suggests to discuss this further.
- **Proposed action:** Participants advocate for a further development of data management at the basin scale.

3. The IMAP scientific needs related to marine pollution

22. The objective is to develop during the workshop practical scientific actions aiming to meet the identified scientific needs that are more focused on pollution issues, and more detailed than those drafted during the inception workshop regarding the whole IMAP scope. (See Table in Annex 1) This updated analysis has been built on the preliminary analysis as reviewed during the SPI inception workshop in December 2015. Some columns are unchanged, as:

- Identified IMAP needs
- Estimated duration of the action: Short (less than 2 years) Medium (2-4 years), Large (more than 4 years)

23. The Table has been improved on several aspects, as:

- A column presenting the “state of play” related to the scientific needs has been added, making reference when possible to specific recent scientific project results.
- Level or scale of the action (local, national, regional) are now specified in the identification of the need.

- The scientific needs have been categorized as far as possible in a more detailed way, following these categories:
 1. Needs in methodologies (to define scales, selection of sites, aggregation)
 2. Needs in guidelines for monitoring (do we have the protocols/guidelines for all indicators?)
 3. Needs in data regarding the ecosystem status (and how research projects can contribute?)
 4. Needs in data on sources of pollution or pressures
 5. Need in additional models and tools to complement and support IMAP implementation
 - The column “Link to Project / initiatives / opportunities”, which will be completed by participants.
24. The resulting Table in annex will be used as a working document to be reviewed, completed, amended and finally approved by the participants during the workshop in order to prepare the UNEP/MAP IMAP Science Agenda. The OSPAR Science agenda could be a source of inspiration in term of methods to set up this agenda.

Annex I
Analysis of the needs to implement IMAP concerning EO5 Eutrophication

Table 1: Analysis of the needs to implement IMAP concerning EO5 Eutrophication

Identified IMAP needs	Category	Current state of play (baseline)	Proposed actions	Duration	Link to projects/initiatives/opportunities
Assessment of spatial and temporal natural variability concerning processes related to eutrophication at basin level	Data / knowledge deficiency	<u>Research - review:</u> - 1 IRIS-SES Project	Continue to develop long time series to assess the natural variability in the basin; Differentiation of water types according to parameters linked to eutrophication phenomena (chl-a, nutrients, primary production, oxygen, turbulence, etc.)	Short (collecting existing data) to long (long time series measurements)	
Assessment of main pressures (and related impacts) concerning eutrophication at national scale or lower if relevant	Data / knowledge deficiency	<u>Research - review:</u> - 2 STAGES Project - 3 VECTORS Project - 4 IRIS-SES Project	Develop methodologies to monitor pressures driving eutrophication phenomena; Assess in detail the concentration of nutrients in the water column; Provide additional information about sources of nutrients such as aquifers and ground water.	Medium	
Research on relationships between inputs, concentration and effects in the Mediterranean	Data / knowledge deficiency	<u>Research:</u> - 5 Thresholds Project - 6 IRIS-SES Project	Develop collaborations, preferably jointly, and the research actions required to assess the quality of the marine environment, to increase knowledge and scientific understanding of the marine environment and, in particular, of the relationship between inputs, concentration and effects.	Medium	
Definition of eutrophication thresholds for different ecological areas at national / sub-national scale	Data / knowledge deficiency			Short	
Definition of scales (temporal and spatial) and areas for the assessment of eutrophication for each Med country	Methods / Guidelines	<u>Research - review:</u> - 1 IRIS-SES Project - 23 HELCOM <u>Policy:</u> - 7 WFD	Delimitation of eco-regions and sub-regions according to water types, pressures and/or management units;	Short / Medium	
			Development of risk based optimal strategies and corresponding guidelines for monitoring eutrophication: sampling frequency, localisation of the stations, acceptable risk, etc.	Medium	

Identified IMAP needs	Category	Current state of play (baseline)	Proposed actions	Duration	Link to projects/initiatives/opportunities
			Expertise to elicit priority issues, hot spots ... And define timelines	Short	
Development of a (minima) common standard assessment methodology for all Med countries based on existing monitoring strategies for eutrophication	Methods / Guidelines	<u>Review of practices:</u> - 8 IRIS-SES Project - 9 JRC <u>Policy:</u> -10 MSFD	Selection of monitoring parameters (nutrients) and monitoring procedures based on existing experiences	Short	
Make best use of available duly validated scientific assessment tools (modelling, remote sensing and progressive risk assessment strategies)	Methods / Guidelines	<u>Research:</u> - 11 PERSEUS Project <u>Guidelines:</u> - 12 JRC	Identification and assessment of existing monitoring/assessment tools in cooperation with their developers. Testing of tools according to areas to be monitored (coastal, open sea, highly or less studied, highly or less impacted by eutrophication, etc.) through Pilot Case projects (e.g. remote sensing especially useful for establishing baseline data where no field data is available).	Short / Medium	
Assess cost efficiency in relation to socio-economic benefits of monitoring	Methods / Guidelines	<u>General guidelines:</u> - 13 UNEP/MAP	Develop Cost Benefit Analysis (CBA) practice for monitoring, and more generally of Environmental Impact Assessment for monitoring. Pilot project recommended.	Short / Medium	
Ensure quality assurance, quality control (QA/QC)	Methods / Guidelines	<u>Guidelines:</u> - 14 PERSEUS Project - 15 Hood et al. (IOCCP) - 23 HELCOM	Development of guidelines to develop standardized eutrophication monitoring to ensure quality assurance, quality control (QA/QC). Capacity building and exchange of good practices.	Short / Medium	
Develop methods for an integrated assessment based on the common indicators	Methods / Guidelines	<u>Guidelines:</u> - 23 HELCOM	Refine aggregation rules enabling to use fine-scale data (individual samples) to assess the environmental status of the broad ecosystem elements for each spatial unit	Short / Medium	

Identified IMAP needs	Category	Current state of play (baseline)	Proposed actions	Duration	Link to projects/initiatives/opportunities
			Develop in detail a method for integrated assessment based on the common indicators and results of the scientific projects.		
Develop common procedures for data collection, management and storage	Models and tools to support IMAP	<u>Research:</u> - 16 OpEc Project - 17 SESAME Project	Collection of reliable data through standardised protocols: development assessment strategies including fact sheets taking into account sub regional differences; Development and testing of data infrastructure(s) to store and access data	Short / Medium?	
Use of marine ecosystem modelling to assess eutrophication	Data / knowledge deficiency Methods / Guidelines	<u>Research:</u> - 18 MEECE Project - 19 OpEc Project <u>Guidelines:</u> - 20 DEVOTES Project	Integrate available modelling tools to assess environmental status	Medium	
Display the environmental status of EO5 across Mediterranean waters using suitable mapping tool based on a nested scale system (such as Helcom)	Models and tools to support IMAP	<u>Research:</u> - 21 OpEc Project - 22 IRIS-SES Project	Development of the mapping tool, building on the HELCOM experience; Elaboration of a pilot project, specification of the tool, development, tests and extension to the basin.	Short / Medium	
Develop coordination at the national and regional level	Scientific Expertise and Network		Setting of a mechanism for expertise and capacity building aiming at establishing operational national task forces to support IMAP regarding monitoring and assessment of Eutrophication.	Short	

References for EO 5 Eutrophication

1 IRIS-SES Project (EU Pilot Project, “Integrated Regional monitoring Implementation Strategy in the South European Seas”, 2013-2014)

Evaluation of ongoing monitoring programmes in EU Mediterranean countries, determination of monitoring gaps to assess GES according to MSFD;

Evaluation of current knowledge on natural variability in terms of both spatial and temporal scales detailed for each of the indicators considered for the EU MSFD Descriptor 5 Eutrophication, as it represents natural processes that could significantly affect the data collected during monitoring of marine ecosystems, and therefore the indicators used to measure D5, which are:

- Variability of the environmental factors (nutrients, dissolved oxygen, transparency);
- Related physical parameters (temperature, salinity, hydrological parameters, rivers’ discharges, currents, waves and winds);
- Biological components of the systems (chlorophyll-a, changes in abundance, population structures, species composition – shift in species dominance, structure, etc.).

Recommendations for designing Joint Monitoring Programs for Eutrophication assessment in the Mediterranean, including its seabasins and sub-seabasins, timing and periodicity, position of sampling stations, use of satellite data, use and storage of generated data;

2 STAGES Project (EU FP7, “Science and Technology Advancing Governance on Good Environmental Status”, 2012-2014)

Assessment of monitoring gaps and formulation of research monitoring needs (including definition of sampling/ monitoring variables and parameters) at the short-mid-long term;

Identification of research needs with regard to the pressures and their impacts on marine ecosystems, namely:

- Updating of the list of the research needed and in particular to seek to identify research needs that would lead to a more holistic and cross-cutting approach to the monitoring and assessment of pressures and impacts;
- Identification of knowledge gaps and uncertainties associated with assessment of cumulative pressures and impacts and potential measures that could be taken to achieve or maintain GES.

3 VECTORS Project (EU FP 7, VECTORS of Change in European Marine Ecosystems and their Environmental and Socio-Economic Impacts, 2011-2015)

Evaluation and review of pressures and impacts related to Eutrophication in European Regional Seas’ coastal waters, including specifically the Mediterranean.

4 IRIS-SES Project (EU Pilot Project, “Integrated Regional monitoring Implementation Strategy in the South European Seas”, 2013-2014)

Development of a review of the available data on pressures exerted on the marine and the coastal ecosystems of the Mediterranean and Black Seas; provision of an analysis of the main human activities affecting the marine and coastal environments, by reference to the needs for an integrated monitoring of pressures.

5 THRESHOLDS Project (EU FP6 “Thresholds of Environmental Sustainability”, 2005-2009)

Assessment of ecological thresholds and points of no return of environmental sustainability in data describing the dynamics of ecosystems, focusing on nutrients (and contaminants). Analysis of nutrient-driven thresholds connected to the anthropogenic pressures contributing to nutrient emissions for use in case studies and integrated assessment models.

6 IRIS-SES Project (EU Pilot Project, “Integrated Regional monitoring Implementation Strategy in the South European Seas”, 2013-2014)

Reference to the threshold values for Eutrophication status (based on scientific literature and/or based on implementation of WFD) that have been defined for a) the Western Mediterranean and b) the Eastern Mediterranean, indicating the ecological status (poor to high with three to five intermediate levels).

7 WFD, [Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.](#)

Provides some guidelines for the minimum operational (for water bodies at risk) monitoring frequency in coastal waters:

- Phytoplankton 6 months
- Other aquatic flora 3 years
- Macro invertebrates 3 years
- Morphology 6 years
- Thermal conditions 3 months
- Oxygenation 3 months
- Nutrient status 3 months
- Other pollutants 3 months
- Priority substances 1 months

8 IRIS-SES Project (EU Pilot Project, “Integrated Regional monitoring Implementation Strategy in the South European Seas”, 2013-2014)

The metadata catalogue developed under the PP project IRIS-SES includes information on monitoring programmes operational in the European seas reported by some Mediterranean countries (Greece, Cyprus, Italy, Spain, Croatia and Turkey). The catalogue includes information relevant to MSFD descriptors 1 to 11. This metadata covers information on: (i) the monitoring that is currently being performed, (ii) spatial and temporal coverage, (iii) monitoring methods, and (iv) the pressures it is linked to.

9 Joint Research Centre (JRC):

Inventory of monitoring methods, their applicability in off-shore areas and their capability to collect data relevant for MSFD indicators

Inventory of monitoring requirements among EU Directives (WFD, HB, BD, CFP, EQS) and the Barcelona Convention (UNEP/MAP)

10 MSFD, Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

Eutrophication is to be assessed via the following indicators:

- 5.1: Nutrient levels
- 5.1.1. Nutrient concentration in the water column
- 5.1.2. Nutrient ratios
- 5.2: Direct effects of nutrient enrichment
- 5.3: Indirect effects of nutrient enrichment

11 PERSEUS Project (FP7, Policy-oriented marine Environmental Research for the Southern European Seas, 2012-2015)

Review and assessment of the existing observational capabilities in the Southern European Seas (i.e. Mediterranean and Black Seas) enabling monitoring at basin, sub-basin and local scale;

Evaluation of deployed monitoring systems and efforts across the Mediterranean, identification of most sampled and understudied areas:

- Argo profilers, surface drifters and expendable sensors (ship of opportunity) (sub-basin and basin);
- Research ships monitoring (basin, sub-basin, local);
- Moorings (deep & coastal).
- Moorings (local, sub-basin)
- Gliders (local, sub-basin)
- Coastal monitoring (buoys, radars, moorings, fixed stations)
- Satellite remote sensing (including spatial and temporal resolutions)

Parameters: water column, physical and biogeochemical parameters (including chl-a, temperature, salinity), except for coastal monitoring systems which also monitor pollution, biological disturbance, marine litter and underwater noise.

12 Joint Research Centre (JRC):

Description and evaluation of some (new) approaches and techniques available for the effective spatial monitoring of Eutrophication in the framework of MSFD – Descriptor 5 (D5):

- Moorings and buoys
- Ship of opportunity/ ferry-box system:
- Continuous Plankton Recorder (CPR)
- Underwater video & imagery
- Remote sensing
- Autonomous underwater vehicles and gliders

13 UNEP/ MAP Guidelines on cost-effectiveness and cost-benefit analysis in selecting the programmes of pollution prevention and reduction measures in the NAP update process, UNEP(DEPI)/MED WG.404/6.

14 PERSEUS Project (FP7, Policy-oriented marine Environmental Research for the Southern European Seas, 2012-2015)

Laying down of protocols and guidelines on Quality Assurance and Quality Control, including training of personnel, testing of instruments, calibration/inter-comparison, and control of data and instruments during acquisition.

15 Hood, E.M., C.L. Sabine, and B.M. Sloyan, eds. 2010. The GO-SHIP Repeat Hydrography Manual: A Collection of Expert Reports and Guidelines. IOCCP Report Number 14, ICPO Publication Series Number 134.

The GO-SHIP program was developed to provide a sustained coordination mechanism for global repeat hydrography. Central to this coordination is ensuring that measurements made by different groups are comparable, compatible, and of the highest quality possible. Under the guidance of the GO-SHIP committee, the following measurement standards have been developed as goals for the data quality desired from GOSHIP reference sections, including standards for salinity, dissolved oxygen, or nutrients.

16 OPEC Project (EU FP7 “Operational Ecology Marine Ecosystem Forecasting”, 2012-2014)

- List of feasible operational ecology applications and benefits by using existing monitoring and data infrastructure
- Recommendations on the potential optimization of the existing monitoring and data infrastructure for future operational ecology application improvements
- Listing of research priorities in order to fully exploit the benefits of using the existing monitoring and data and to optimise future monitoring and data infrastructure for the purpose of improving the variety of operational ecology applications.

17 SESAME Project (EU FP6, Southern European Seas: Assessing and Modelling Ecosystem Changes, 2006-2011)

Data management (i.e. data collection, manipulation and archiving) was a cross-cutting theme for SESAME, which intended to improve data storage, access and manipulation. Appropriate tools have been developed together by experimentalists and modellers to uniform digitization of historical and newly observed data, together with data issued from modelling, in order to suit researchers’ needs.

18 MEECE Project (EU FP7 “Marine Ecosystem Evolution in a Changing Environment”, 2008-2012)

Ecosystem modelling in support of the MSFD Eutrophication Descriptor (D5)

Development of modelling tools to be used in decision making and management around eutrophication in European regional seas:

MEECE Model Library, including a range of current biogeochemical models on impacts of eutrophication, considering CC and policy management.

Eutrophication modelled considering indicators:

- Nutrient concentration in the water column
- Chlorophyll-a concentration or phytoplankton biomass
- Dissolved oxygen

19 OPEC Project (EU FP7 “Operational Ecology Marine Ecosystem Forecasting”, 2012-2014)

Review and assessment of the existing modelling capabilities in the European Regional Seas (i.e. Mediterranean, Black Seas);

Environmental models are used for simulating and analysing the long-term dynamics and stability properties of complex environmental systems;

Research and development efforts include -but are not limited- optimization of monitoring network and models, data assimilation, *in situ* observations and fisheries data;

Regional model systems provided by the OPEC project can be used to provide estimates of recent dynamic and current conditions of selected indicators of ecosystem state: temperature, salinity, phosphate, nitrate, silicate, chlorophyll-a, phytoplankton, zooplankton and fish biomass.

20 DEVOTES Project (EU FP7 “DEvelopment Of innovative Tools for understanding marine biodiversity and assessing good Environmental Status”)

Review and assessment of the possible ecological models useful to assess ecosystem status in support of the European Marine Strategy Framework Directive.

21 OPEC Project (EU FP7 “Operational Ecology Marine Ecosystem Forecasting”, 2012-2014)

The project, aiming at supporting environmental assessment and ecosystem-based management, intended to contribute predicting the future status of the marine environment and ecosystems. It delivered regular quality ensured information products in support of management and decision making via relevant information, in a format which can be easily accessed. The Marine Operation Ecology data portal developed by OPEC displays model simulated ecosystem data for European Regional Seas, including maps and plots.

22 IRIS-SES Project (EU Pilot Project, “Integrated Regional monitoring Implementation Strategy in the South European Seas”, 2013-2014)

A set of GIS tools has been developed to assess the Environmental Status (ES) in respect to eutrophication and contaminants. The concept is to provide a simple yet intelligent tool, to support scientists as well policy makers, managers and stake-holders on the issue. The Eutrophication status toolbox comprises a set of semi-automated commands, in graphic environment, used for the rapid assessment of eutrophication in a water body, in accordance to defined environmental thresholds. User input refers only to an excel file with station based data, comprising nutrients, oxygen and chlorophyll-a data, used for the calculation of various indices.

23 Manual for marine monitoring in the Cooperative Monitoring in the Baltic Marine Environment (COMBINE) programme of HELCOM. This Manual is directed to all performing monitoring in the COMBINE Programme. The Manual defines the contributions made by all Contracting Parties and regulates all methods used.

Annex II
Analysis of the needs to implement IMAP concerning EO9 Contaminants

Table 2: Analysis of the needs to implement IMAP concerning EO9 Contaminants

Identified IMAP needs	Category	Current state of play (baseline)	Proposed actions	Duration	Link to Projects/initiatives Opportunities
Harmonization in the different monitoring programmes existing	Methods / Guidelines	<u>Research:</u> - 1. IRIS-SES Project - 2. STAGES Project	Assessment and critical analysis of the different existing monitoring programmes targeting contaminants: - Harmonization of monitoring targets, taking into account sub regional differences; - Harmonization of the contaminant reference list at sub regional scale; - Setting of priorities for each area	Short	
Assessment of main pressures (and related impacts) concerning contaminants at national scale (or lower if relevant)	Data / knowledge deficiency	<u>Research:</u> - 3. STAGES Project - 4. VECTORS Project - 5. IRIS-SES Project	Develop methodologies to monitor pressures causing contamination; Provide additional information about sources of pollutants; (Continue to assess the concentration of (selected) pollutants in the different matrixes (sediment, water column, biota) in order to identify pollution sources and/or hot spots and provide long time series enabling to assess environmental status and trends.	Short (setting methods) – Long (measurements of long time series)	
Development of risk-based optimal monitoring strategies for pollution based on existing monitoring practices and knowledge	Methods / Guidelines	<u>Research:</u> - 6. PERSEUS Project - 7. IRIS-SES Project <u>Guidelines:</u> - 8. JRC <u>Policy</u> - 9. EQS Directive - 26. WFD	Definition of areas for the assessment of contamination for each Med country Extension of monitoring strategies beyond coastal areas, in application of the risk-based approach. Development corresponding guidelines for pollution monitoring: - sampling frequency, - localisation of the stations, - acceptable risk, etc. Expertise to elicit priority issues;	Short	

Identified IMAP needs	Category	Current state of play (baseline)	Proposed actions	Duration	Link to Projects/initiatives Opportunities
Implementation of Common Indicator 18: “Level of pollution effects of key contaminants where a cause and effect relationship has been established”.	Methods / Guidelines	<u>Review:</u> - 23 OSPAR - 22 CIESM (not recent)	Review and assessment of available data regarding eco-toxicological effects of contaminants	Short	
Research on the relationship between inputs, concentration and effects	Data / knowledge deficiency	<u>Research and technical guidance:</u> - 24 OSPAR	Develop collaborations and research actions to assess the relationship between inputs, concentration and effects of contaminants.	Medium	
Selection of monitoring parameters according to EO9 indicators (key pollutants, contaminant concentrations, pollution effects, etc.) and monitoring procedures based on existing experiences	Methods / Guidelines	<u>Research and technical guidance:</u> - 10. IRIS-SES Project	Development of a (minima) common standard assessment methodology for all Med countries based on existing monitoring strategies for pollution; Development of operational monitoring methods based on biological effects.	Short / medium	
Development of monitoring procedures for acute pollution events	Methods / Guidelines		Development of impact assessment analysis for acute pollution events	Medium	
Definition of GES targets related to the different indicators for EO9	Methods / Guidelines	<u>Research and technical guidance:</u> - 11. IRIS-SES Project - 12. THRESHOLDS Project	- Characterization of baseline and thresholds; - Develop expertise to prepare recommendations for BAC (background assessment concentrations); - Formulation of EAC (environmental assessment criteria) for selected biomarkers in Mediterranean species.	Medium	
		<u>Technical reports</u> - 13. MEDPOL <u>Policy</u> - 14. EQS Directive	Review and critical analysis of the monitored contaminant in biota used for human consumption, considering at least: - Heavy metals (lead, cadmium, and mercury), - Polycyclic Aromatic Hydrocarbons, and - Dioxins (including dioxin-like PCBs),	Short / Medium	

Identified IMAP needs	Category	Current state of play (baseline)	Proposed actions	Duration	Link to Projects/initiatives Opportunities
			with the species selection considerations described in the Integrated Monitoring and Assessment Guidance. Characterization of baseline and thresholds levels		
Inclusion of indicator on pathogens in bathing waters (not directly a need for IMAP, although a requirement for implementation of LBS Protocol)	Methods / Guidelines	<u>Policy:</u> - 15. BWD	Consider inclusion of indicator on pathogens in bathing waters and related definition of GES target, in line with Decision IG.20/9 ¹	Short	
Make best use of available duly validated scientific assessment tools (modelling, remote sensing and progressive risk assessment strategies)	Methods / Guidelines	<u>Guidelines:</u> - 16. JRC	Identification and assessment of existing monitoring/assessment tools in cooperation with their developers. Testing of tools according to areas to be monitored (coastal, open sea, highly or less studied, highly or less impacted by contaminants, etc.) through Pilot Case projects (e.g. remote sensing especially useful for establishing baseline data where no field data is available).	Short / Medium	
Assess cost efficiency in relation to socio-economic benefits of monitoring	Methods / Guidelines	<u>General guidelines:</u> - 17. UNEP/MAP	Develop Cost Benefit Analysis (CBA) practice for monitoring, and more generally of Environmental Impact Assessment for monitoring. May require pilot project.	Short / Medium	
Develop methods for an integrated assessment based on the common indicators	Methods / Guidelines	<u>Research and technical guidance:</u> - 18. IRIS-SES Project	Refine aggregation rules enabling to use fine-scale data (individual samples) to assess the environmental status of the broad ecosystem elements for each spatial unit;	Short / Medium	

¹ 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)

Identified IMAP needs	Category	Current state of play (baseline)	Proposed actions	Duration	Link to Projects/initiatives Opportunities
			Develop in detail a method for integrated assessment based on the common indicators.		
Develop common procedures for data collection, management and storage	Models and tools to support IMAP	<u>Research:</u> - 19. MEECES Project	Further development of data management at the basin scale: - Collection of reliable data through standardised protocols - Development and testing of data infrastructure(s) to store and access data, favouring the management and accessibility of new and existing data in a compatible manner	Short / Medium	
Use of marine ecosystem modelling to assess pollution	Data / knowledge deficiency Methods / Guidelines	<u>Research:</u> - 20. MEECE Project	Consider the integration of available modelling tools to assess environmental status	Short	
Display the environmental status of EO9 across Mediterranean waters using suitable mapping tool based on a nested scale system (such as Helcom)	Models and tools to support IMAP	<u>Research:</u> - 21. IRIS-SES Project	Development of the mapping tool, building on the HELCOM experience; Elaboration of a pilot project, specification of the tool, development, tests and extension to the basin.	Medium	
Develop coordination at the national and regional level	Scientific Expertise and Network	<u>Organisation</u> OSPAR	Setting of a mechanism for expertise and capacity building aiming at establishing operational national task forces to support IMAP regarding monitoring and assessment of contaminants occurrence and effects.	Short	

1. IRIS-SES Project (EU Pilot Project, “Integrated Regional monitoring Implementation Strategy in the South European Seas”, 2013-2014)

Evaluation of ongoing monitoring programmes in EU Mediterranean countries, determination of monitoring gaps to assess GES according to MSFD;

Recommendations for designing Joint Monitoring Programs for the assessment of the Mediterranean status, including:

- design and planning of monitoring networks, matrices, sampling, analytical methodologies, integration of other monitoring approaches (remote sensing devices, buoys, etc) and innovative monitoring systems (satellite imagery, etc.), storage and accessibility of data, integration of ongoing monitoring programmes/ surveys (WFD, MEDITS & MEDIAS surveys)

2. STAGES Project (EU FP7, “Science and Technology Advancing Governance on Good Environmental Status”, 2012-2014)

Assessment of monitoring gaps and formulation of research monitoring needs (including definition of sampling/ monitoring variables and parameters) at the long-mid-short term

3. STAGES Project (EU FP7, “Science and Technology Advancing Governance on Good Environmental Status”, 2012-2014)

Assessment of monitoring gaps and formulation of research monitoring needs (including definition of sampling/ monitoring variables and parameters) at the short-mid-long term

Identification of research needs with regard to the pressures and their impacts on marine ecosystems, namely:

- Updating of the list of the research needed and in particular to seek to identify research needs that would lead to a more holistic and cross-cutting approach to the monitoring and assessment of pressures and impacts;
- Identification of knowledge gaps and uncertainties associated with assessment of cumulative pressures and impacts and potential measures that could be taken to achieve or maintain GES.

4. VECTORS Project (EU FP 7, VECTORS of Change in European Marine Ecosystems and their Environmental and Socio-Economic Impacts, 2011-2015)

Evaluation and review of pressures and impacts related to chemical contamination in European Regional Seas’ coastal waters, including specifically the Mediterranean.

5. IRIS-SES Project (EU Pilot Project, “Integrated Regional monitoring Implementation Strategy in the South European Seas”, 2013-2014)

Development of a review of the available data on pressures exerted on the marine and the coastal ecosystems of the Mediterranean and Black Seas; provision of an analysis of the main human activities affecting the marine and coastal environments, by reference to the needs for an integrated monitoring of pressures.

6. PERSEUS Project (FP7, Policy-oriented marine Environmental Research for the Southern European Seas, 2012-2015)

Review and assessment of the existing observational capabilities in the Southern European Seas (i.e. Mediterranean and Black Seas) enabling monitoring at basin, sub-basin and local scale;

Parameters: water column, physical and biogeochemical parameters (including chl-a, temperature, salinity), except for coastal monitoring systems which also monitor pollution, biological disturbance, marine litter and underwater noise.

7. IRIS-SES Project (EU Pilot Project, “Integrated Regional monitoring Implementation Strategy in the South European Seas”, 2013-2014)

Investigation of new tools for the determination of GES regarding main chemical pollutants;

Assessment of possible monitoring methods/ techniques for organic and inorganic pollutants in different matrix (sediments, seawater).

8. Joint Research Center (JRC):

Inventory/ review of monitoring methods, their applicability in off-shore areas and their capability to collect data relevant for MSFD indicators.

9. EQS Directive, 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water polycys. Long-term trend analysis of concentrations of WFD priority substances that tend to accumulate in sediment and/or biota is advised to be based on data collected in monitoring occurring every three years, unless technical knowledge and expert judgment justify another interval.

10. IRIS-SES Project (EU Pilot Project, “Integrated Regional monitoring Implementation Strategy in the South European Seas”, 2013-2014)

- Assessment of quality values (incl. GES values) set up for organic and inorganic pollutants (HM, PAHs, PCBs, Pesticides) in different matrixes (sediments, seawater, biota);
- Recommendations on sampling of contaminants in seawater (HM, spatially and seasonally; Organic pollutants)

11. IRIS-SES Project (EU Pilot Project, “Integrated Regional monitoring Implementation Strategy in the South European Seas”, 2013-2014)

Project outputs highlight that literature does not provide any widely accepted policy on the assessment of pollution in waters, sediments and seafood. The national legislation thresholds on various contaminants have been listed and a GIS application for the analysis and visualization of pollution status according to ERL-ERM (Long, 1995), Directive 2006/44/EC and EC REGULATION No 1881/2006 has been set. Two main categories of contaminants are considered, PAHs and Metals (Cd, Hg, Cu, Pb, Zn) in sediment, seawater and seafood.

12. THRESHOLDS Project (EU FP6 “Thresholds of Environmental Sustainability”, 2005-2009)

Assessment of ecological thresholds and points of no return of environmental sustainability in data describing the dynamics of ecosystems, focusing on contaminants (and nutrients). Analysis, comparison and assessment of the effects of contaminants in coastal ecosystems.

13. UNEP(DEPI)/MED WG. 365/Inf.8 Development of Assessment Criteria for Hazardous Substances in the Mediterranean

Definition, following the OSPAR approach, of concentration “thresholds” to be defined for the hazardous substances included in the MEDPOL Database, namely trace metals, chlorinated pesticides and PCBs, in sediments and biota, in order to determine the levels that can be considered of concern and to identify hot spots for priority action. Definition of reference concentrations, particularly of Background Assessment Concentrations (BACs) and the Environmental Assessment Criteria (EACs).

14. EQS Directive, 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy: Setting environmental quality standards for priority substances and certain other pollutants in surface waters; Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs:

15. BWD, Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality.

Provisions laid down for monitoring (according to time and space) and classification of bathing waters according to microbiological criteria.

16. Joint Research Center (JRC):

Description and evaluation of some (new) approaches and techniques available for the effective spatial monitoring of Eutrophication in the framework of MSFD – Descriptors 8 and 9:

- moorings and buoys: relevant for D8 and D9

- ship of opportunity/ ferry-box system: relevant for D8 and D9
- remote sensing: relevant for D8
- autonomous underwater vehicles and gliders: relevant for D8

17. UNEP/ MAP Guidelines on cost-effectiveness and cost-benefit analysis in selecting the programmes of pollution prevention and reduction measures in the NAP update process, UNEP(DEPI)/MED WG.404/6.

18. IRIS-SES Project (EU Pilot Project, “Integrated Regional monitoring Implementation Strategy in the South European Seas”, 2013-2014)

Development of intelligent tools and computation of indexes to enable visualization of data for MSFD Descriptors 8 and 9 (Contaminants and Contaminants in seafood).

19. MEECE Project (EU FP7 “Marine Ecosystem Evolution in a Changing Environment”, 2008-2012)

MEECE Model Library, including a range of current biogeochemical models on impacts of contaminants, considering CC and policy management.

Project activities focusing on target contaminants such as heavy metals, alkylphenols, antibiotics and herbicides.

Available scientific information about the fate of key-pollutants and the biological effects on marine organisms collected and collated into structured databases.

20. MEECE Project

Ecosystem modelling in support of the MSFD Descriptors (including D8)

Development of modelling tools to be used in decision making and management, including contaminant concentrations in European regional seas.

Development of a range of decision support tools: a specific expert Decision Support System (DSS), focused on managing contamination data in marine coastal areas and calculating the pollution-related environmental risk on a scale from 0 (no risk) to 1 (maximum risk) integrating a complex set of chemical (concentration of target contaminants) and biological data (ecotoxicological effects on model organisms), and supporting environmental managers in the estimation of environmental quality.

21. IRIS-SES PROJECT (EU Pilot Project, “Integrated Regional monitoring Implementation Strategy in the South European Seas”, 2013-2014)

Methodology and development of visualization tools for the assessment of contamination (HM and PAHs) in seawater, sediment and seafood based on available data, including thresholds for the substances

22. CIESM Monographies

19 - Metal and radionuclides bioaccumulation in marine organisms, Ancona, 27 - 30 October 2002, 126 p. (354 refs)

15 - Mediterranean Mussel Watch. Designing a regional program for detecting radionuclides and trace-contaminants.

Marseille, 18 - 20 April 2002, 133 p. (234 refs)

23. OSPAR

Draft Levels and trends in marine contaminants and their biological effects – CEMP Assessment report 2015 Year: 2016 No: 676

24. OSPAR

Trial application of the OSPAR JAMP Integrated Guidelines for the Integrated Monitoring and Assessment of Contaminants Year: 2016 No: 678

25. OSPAR

OSPAR Science Agenda (publication 642)

26 WFD, Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.

Provides some guidelines for the minimum operational (for water bodies at risk) monitoring frequency in coastal waters:

- Other pollutants 3 months
- Priority substances 1 months

Annex III
The integrated monitoring and assessment programme (IMAP) of UNEP/MAP

The integrated monitoring and assessment programme (IMAP) of UNEP/MAP

Monitoring and assessment, based on scientific knowledge, of the sea and coast is the indispensable basis for the management of human activities, in view of promoting sustainable use of the seas and coasts and conserving marine ecosystems and their sustainable development. The Decision IG.22/7 Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP/MAP, 2015a), prepared to be endorsed by the next Convention of Parties, describes the strategy, themes, and products that the Barcelona Convention Contracting Parties are aiming to deliver, through collaborative efforts inside the UNEP/MAP Barcelona Convention, over the second cycle of the implementation of the Ecosystem Approach Process (EcAp process), i.e. over 2016-2021, in order to assess the status of the Mediterranean sea and coast, as a basis for further and/or strengthened measures.

Background

IMAP builds on the monitoring and assessment related provisions of the Barcelona Convention and its Protocols, previous Decisions of the Contracting Parties related to monitoring and assessment, and to the EcAp process, including on Decision IG. 21/3 and the expert level discussions mobilized based on this Decision, such as the ones taking place in the Correspondence Groups on Good Environmental Status (COR GEST) and Monitoring (CORMON), the On line Working Groups (Eutrophication, Contaminants, Marine litter, Biodiversity and Non-invasive species and Coast and hydrography) as well as the EcAp Coordination Group. In addition, the development of IMAP took due account of the Contracting Parties' existing monitoring and assessment programmes, practices of other Regional Sea Conventions and other Regional bodies, such as GFCMⁱ and ACCOBAMSⁱⁱ.

Timeline

IMAP is aiming to deliver its objectives over 2016-2021. It is introduced first however in an initial phase (in line with Decision IG. 21/3, in between 2016-2019), during which the existing national monitoring and assessment programmes will be integrated, according to the IMAP structure and principles and based on the agreed common indicators. This implies in practice that the existing national monitoring and assessment programmes will be reviewed and revised as appropriate so that national implementation of IMAP can be fulfilled in a sufficient manner. The main outputs during the initial phase of IMAP will include the update of GES definitions, further refinement of assessment criteria and development of national level integrated monitoring and assessment programmes. Furthermore, the Quality Status Report in 2017 and the State of Environment and Development Report in 2019 will build on the structure, objectives and data collected under IMAP. The validity of IMAP should be reviewed once at the end of every EcAp six year cycle, and in addition it should be updated and revised as necessary on a biennial basis, based on lessons learnt of the implementation of IMAP and on new scientific and policy developments.

The SPI for IMAP definition phase

As any UNEP/MAP programme, IMAP has been built using available scientific basis. As presented above, IMAP elaboration has been supported by expert advice issued from the Correspondence Groups, themselves complemented by those of the On-line working groups, under the supervision of the EcAp coordination groups. These multidisciplinary groups were composed of technical and scientific experts designated by the Parties to the Barcelona Convention. Their works were facilitated by the dedicated MAP components, supported by contracted experts.

Moreover scientific expertise issued from ongoing research projects were also mobilized for specific question regarding biodiversity. A workshop was co-organized by UNEP/MAP and the EU PERSEUSⁱⁱⁱ project to follow up the recommendations of February 2014, asking the Secretariat to consult international experts for developing IMAP, especially in relation to biodiversity. This workshop was held on the 28-30 April 2014 in Anavissos HCMR^{iv} premises, Greece, with contribution of several on-going research and pilot EU projects, namely PERSEUS, CoCoNet^v, DEVOTES^{vi} and IRIS SES^{vii} and was attended by scientific working in the field of biodiversity.

The workshop has resulted in some general and some specific biodiversity and NIS common indicators related scientific recommendations and addressed both overall status or aspects of biodiversity in the Mediterranean, monitoring needs, challenges, methodologies, cost efficiency and feasibility in light of recent scientific developments. As such it provided a key contribution to the development of IMAP.

Annex IV
List of EcAp Ecological Objectives and Common Indicators

List of EcAp Ecological Objectives and Common Indicators

This working document focus on the two Ecological objectives: EO 5 Eutrophication and EO 9 Contaminants.

Ecological Objective	IMAP Indicators
EO 1 Biodiversity	
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 1: Habitat distributional range (EO1) to also consider habitat extent as a relevant attribute
	Common Indicator 2: Condition of the habitat's typical species and communities (EO1)
	Common Indicator 3: Species distributional range (EO1 related to marine mammals, seabirds, marine reptiles)
	Common Indicator 4: Population abundance of selected species (EO1, related to marine mammals, seabirds, marine reptiles)
	Common indicator 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)
EO 2 Non-indigenous species	
Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem	Common Indicator 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)
EO 3 Harvest of commercially exploited fish and shellfish	
Populations of selected commercially exploited fish and shellfish are within biologically safe limits, exhibiting a population age and size distribution that is indicative of a healthy stock	Common Indicator 7: Spawning stock Biomass (EO3);
	Common Indicator 8: Total landings (EO3);
	Common Indicator 9: Fishing Mortality (EO3);
	Common Indicator 10: Fishing effort (EO3);
	Common Indicator 11: Catch per unit of effort (CPUE) or Landing per unit of effort (LPUE) as a proxy (EO3)
	Common Indicator 12: Bycatch of vulnerable and non-target species (EO1 and EO3)
EO 4 Marine food webs	
Alterations to components of marine food webs caused by resource extraction or human-induced environmental changes do not have long-term adverse effects on food web dynamics and related viability	<i>To be further developed</i>

EO 5 Eutrophication	
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 13: Concentration of key nutrients in water column (EO5);
	Common Indicator 14: Chlorophyll-a concentration in water column (EO5)
EO 6 Sea-floor integrity	
Sea-floor integrity is maintained, especially in priority benthic habitats	<i>To be further developed</i>
EO7 Hydrography	
Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.	Common Indicator 15: Location and extent of the habitats impacted directly by hydrographic alterations (EO7) to also feed the assessment of EO1 on habitat extent
EO 8 Coastal ecosystems and landscapes	
The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved	Common Indicator 16: Length of coastline subject to physical disturbance due to the influence of man-made structures (EO8);
	Candidate Indicator 25: Land use change (EO8)
EO 9 Pollution	
Contaminants cause no significant impact on coastal and marine ecosystems and human health	Common Indicator 17: Concentration of key harmful contaminants measured in the relevant matrix (EO9, related to biota, sediment, seawater)
	Common Indicator 18: Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)
	Common Indicator 19: Occurrence, origin (where possible), 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);
	Common Indicator 20: Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9);
	Common Indicator 21: Percentage of intestinal enterococci concentration measurements within established standards (EO9)
EO 10 Marine litter	
Marine and coastal litter do not adversely affect coastal and marine environment	Common Indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (EO10);
	Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor (EO10);
	Candidate Indicator 24: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds, and marine turtles (EO10)

EO 11 Energy including underwater noise	
Noise from human activities cause no significant impact on marine and coastal ecosystems	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 animal
	Candidate Indicator 27: Levels of continuous low frequency sounds with the use of models as appropriate

Annex V
References

References

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UNEP/ MAP, 2015 b, Draft Integrated Monitoring and Assessment Guidance

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ⁱ General Fisheries Commission for the Mediterranean (GFCM)

ⁱⁱ Accord sur la Conservation des Cétacés de la Mer Noire, de la Méditerranée et de la zone Atlantique adjacente (ACCOBAMS)

ⁱⁱⁱ <http://www.perseus-net.eu/>

^{iv} Hellenic Centre for Marine Research, coordinator of the PERSEUS and IRIS SES projects

^v <http://www.coconet-fp7.eu/>

^{vi} <http://www.devotes-project.eu/>

^{vii} <http://iris-ses.eu/>