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Meeting of the Ecosystem Approach Correspondence Group on Monitoring (CORMON) Biodiversity and Fisheries

Rome, Italy, 21 May 2019

Agenda item 3: Guidance on monitoring concerning the biodiversity and non-indigenous species common indicators

Sub-regional monitoring plan for NIS, for the Eastern Mediterranean for non-indigenous species (outcome of the joint GFCM-UN Environment/MAP sub-regional pilot study for the Eastern Mediterranean for non-indigenous species)

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UNEP/MAP
SPA/RAC - Tunis, 2019

1. Background

Among marine ecosystems altered by invasion, the Eastern Mediterranean Sea underwent the most intense and exceptionally rapid changes in terms of number of arrivals, number of established species and related impacts with respect to other Mediterranean subsectors. These profound alterations are today fostered by climatic changes and other anthropogenic drivers, which are rendering the Eastern Mediterranean (EMED) a more favourable environment to tropical invaders, at the expenses of their native analogues.

The guiding principles on invasive species adopted by key regional, international bodies/legislative frameworks, concerning species introduction and invasive species, such as by the Convention on Biological Diversity, UNEP-MAP and the EU (Regulation 1143/2014) reflect a hierarchical order in which prevention should be the priority, followed by early detection, rapid response and possible eradication when prevention fails.

Beside the fact that, eradication of invasive species in the marine environment is for most of the cases considered as unfeasible, there is currently no comprehensive framework for tackling this emerging issue and monitoring efforts needs to be implemented in a comprehensive manner.

Inside the Mediterranean, present situation reveals that monitoring efforts and available knowledge is unevenly distributed across the region, especially in the EMED and that in EMED countries large gap in knowledge exists for large areas.

At the same time, NIS detection is often an empiric, not planned episode and improved coordination among countries is urgently needed to take action over large spatial and temporal scales. To overcome this gap, the application of harmonized standards and methodologies for monitoring NIS populations have been proposed at both the political and scientific level

In this, Regional Sea Conventions (RSCs) have been playing a key role in the sustainable management of marine (and in case of the Mediterranean, also coastal) resources and have led the way towards the regional application of the ecosystem approach. These efforts would be however insufficient without the Regional Fisheries Management Organizations (RFMOs), as they are the other side of the coin- their primary aim is sustainable management of living marine resources.

As such, FAO administered RFMOs and UN Environment administered RSCs are working towards the same goals and cooperate as much as possible. The first formal, strengthened cooperation between them however is the Mediterranean experience, between the General Fisheries Commission for the Mediterranean (GFCM) and UN Environment/Mediterranean Action Plan (Memorandum of Understanding between GFCM and UN Environment/MAP, so called MoU). In line with their MoU, UN Environment/MAP and GFCM have effectively identified common areas of interest and as such areas, where parallel rules exist under the two regional organizations effecting the same area.

One area, which was found of special interest, was the interlinkage of Non-Indigenous Species (NIS) and Fisheries monitoring, where both UN Environment/MAP and GFCM rules aim to achieve more coordinated monitoring and assessment, both on regional and on sub-regional level.

The Contracting Parties to the Barcelona Convention have been also urging for more focus on sub-regional implementation of the Integrated Monitoring and Assessment Programme (IMAP[2]). With the support of the EcAp-MEDII EU funded project, the opportunity for a sub-regional pilot materialized and GFCM and UN Environment/MAP identified together an interesting pilot idea, a Sub-Regional Pilot Study for the Eastern Mediterranean on Non-Indigenous Species in Relation to Fisheries (the Sub-Regional Pilot).

In line with the above, a concept note for the Sub-Regional Pilot was developed by the two Secretariats and was presented and welcomed both by the GFCM Scientific Advisory Committee on Fisheries (SAC), with the support of its Sub-Regional Committee for Eastern Mediterranean and by the meeting of the Ecosystem Approach Correspondence Group on Monitoring (CORMON) Biodiversity and Fisheries of UN Environment/MAP.

The focus of the Sub-Regional Pilot was agreed to be the testing and the further development of the IMAP NIS Common Indicator: "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)", and identify specific monitoring needs to assess this indicator, towards the development of a sub-regional monitoring programme.

As such, the Sub-Regional Pilot envisaged the development of a sub-regional monitoring programme, both in line with IMAP and the GFCM Data Collection Reference Framework (DCRF), with a focus on the IMAP NIS Common Indicator, in relation to fisheries.

The first meeting of the pilot study, the Meting of the Joint GFCM-UN Environment/MAP Sub-Regional Pilot Study for the Eastern Mediterranean on Non-Indigenous Species in Relation to Fisheries took place in Athens, Greece, 20-21 September 2017 and it delivered important conclusions and recommendations on how to reach the objectives of the pilot study and established an online expert sub-regional NIS/Fisheries working group (hereafter referred as NIS/Fisheries Online Working Group), to continue discussions up until the next meeting of the pilot study (Chania, Greece, 5 March 2018).

The current draft sub-regional monitoring plan builds on the conclusions and recommendations of the above first meeting of the pilot study, which are also annexed to the current draft plan, as well as input, recommendations provided by the NIS/Fisheries Online Working Group members.

This draft sub-regional monitoring plan on NIS/Fisheries aims to be further discussed and developed during the Second Meeting of the Joint GFCM-UN Environment/MAP Sub-Regional Pilot Study for the Eastern Mediterranean on Non-Indigenous Species in Relation to Fisheries which will take place in Chania, Greece, 5 March 2018.

This second meeting will provide technical advice towards establishing a sub-regional monitoring plan and as such the output of the meeting will be a pilot sub-regional monitoring plan.

This pilot sub-regional monitoring plan on NIS/Fisheries, as an outcome of the second meeting, will be as a follow-up submitted for endorsement to the respective relevant bodies of GFCM and UN Environment/MAP and interested Contracting Parties of UNEP/MAP-Barcelona Convention/Members of the GFCM will be invited to test it.

2. Proposed objectives of the pilot sub-regional monitoring plan on NIS Fish

The pilot sub-regional monitoring plan on NIS/Fisheries (here after referred as sub-regional monitoring plan) should facilitate the periodical collection of detailed information for a number of priority species while at the same time allow the early detection of new species and significant changes in abundance of NIS that could have biological or socio-economic impact on the sub-region. The general scope of the sub-regional monitoring plan is therefore to provide a common reference and a standard guidance to monitor NIS species in the EMED area.

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[2] Decision IG.22/7, Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria

The sub-regional monitoring plan will provide information in support of both UN Environment/MAP and GFCM objectives, reinforcing their cooperation towards the achievement of common objectives. Specifically, the sub-regional monitoring plan will:

- Provide information in line with the Common Indicator Guidance Fact Sheet on NIS
- Ensure the collection of information in support of the Mediterranean Quality Status Report 2023 in relation to NIS indicator of UNEP/MAP, as well as the Recommendation GFCM/41/2017/6 in relation to the submission of information on NIS

The possibility to expand the sub-regional monitoring plan to other areas in the Mediterranean and eventually to the whole basin will also be investigated, so to provide support to the implementation of the respective strategies of UNEP/MAP and GFCM.

Information compiled through the sub-regional monitoring plan could provide support to the GFCM mid-term strategy target 4 (*Minimize and mitigate unwanted interactions between fisheries and marine ecosystems and environment*), in relation to the preparation of an adaptation plan to climate change and NIS.

The outcomes of the pilot could be also used as a best practice to be mimicked during the implementation of IMAP in relation to other sub-regions and/or indicators, during 2018-2019, during which period sub-regional cooperation aimed to be strengthened in line with the UNEP/MAP Programme of Work 2018-2019.

The UNEP/MAP (SPA/RAC) developed Information system database on NIS, called MAMIAS serves as resource in developing a trends indicator and for reporting of the assessment at national and regional level. Substantial efforts were deployed to support the Action Plan on species introductions and invasive species, especially by initiating the development of the MAMIAS database, providing technical tools and educational documents, raising awareness on the risks associated with alien species, and funding research projects (i.e. ALBAMONTE, MedMPAnet).

The information gathered through the sub-regional monitoring plan should be sufficient and reliable enough to evaluate the status of the most invasive species in relation to fisheries, to assess their temporal and spatial trends and to provide scientific advice and recommendations on how to manage ecological and socio-economical related impacts.

3. General information

General strategy

As already expressed by the GFCM Data Collection Reference Framework (GFCM 2017), and acknowledged by UNEP/MAP (see UNEP(DEPI)/MED WG.444/6/Rev), the rationale behind the design of common monitoring standards suggests to **reduce data requirements, conceive simple and easy-to-understand protocols and enhance public participation**. The sub-regional monitoring plan should be therefore carried out under the following principles:

Best available knowledge: The provision of advice, including on the status and trends of NIS, should be based on the best available knowledge, including scientific advice and relevant information emanating from a variety of sources and stakeholders;

Objectivity and transparency: The collection, analysis and dissemination of information should contribute to the transparent provision of the best scientific evidence available, while respecting any confidentiality requirements. Uncertainty associated with information on status and trends should be expressed, without detracting from the application of the precautionary approach, when data and information are incomplete;

Timeliness: The collection, analysis and dissemination of information should be provided in as timely a manner as possible;

Participation and cooperation: The collection, analysis and dissemination of information should account for all relevant participants in the preparation, analysis and presentation of scientific advice and conclusions;

Adaptability: The collection, analysis and dissemination of information should be adaptive enough to permit adjustments, as necessary, to ensure their effective support of fisheries management based on the most recent scientific advice available.

Finally, as recalled by the GFCM Data Collection Reference Framework (GFCM 2017), common principles must be set for data sharing and dissemination and to ensure confidentiality protection

Potential sources of data

Different sources of information can be considered to collect periodical data on abundance, occurrence, distribution and socio-ecological impacts of NIS and to provide early detection. These potential sources of information could include:

Literature: Both grey and key scientific literature will be periodically followed up to update the national list of NIS according to a common database

Expert knowledge: National expert knowledge can be elicited to periodically retrieve qualitative information on the status of target species in specific geographical sectors

Traditional surveys: Both fishery related (e.g. trawl) and non-destructive (e.g. visual census) surveys can be performed in specific monitoring areas in each country

Catch and landings: A periodical monitoring of the total landings, as reported either through the GFCM relevant decisions or through respective IMAP common indicators (especially common indicator 6) and be also considered following the guidelines provided by the GFCM DCRF and the indicators guidance factsheet. In addition to landings, additional information from catches (e.g. discards) can be obtained from the GFCM discard monitoring programme, launched within the framework of the GFCM mid-term strategy.

Local Ecological Knowledge (LEK): Interviews with Local Fishermen (both professional and recreational) can be performed according to standard techniques. This activity will capitalize the existence of existing experiences and protocols, which have been successfully tested at the Mediterranean level and used in several transnational programmes (e.g. MED MPA-ADAPT, FAO AdriAmed, FAO MedSudMEd, interreg BALMAS, CIESM Tropical signals).

Other sources of information: The occurrence of NIS is increasingly documented by citizens and observations are usually posted to social networks. Opportunities to monitor this information should be discussed

4. Priority species and selected Indicators

Priority List of NIS to be monitored at sub-regional level

The following species have been selected after a careful examination of a first proposed list of (21) taxa. Both the first proposal and the subsequent evaluation have been carried out through discussion with experts participating in the NIS/Fisheries Online Working Group, and it is based on the criteria of commercial importance, existing and potential impacts, and potential data sources. The final Priority List of NIS to be monitored at sub-regional level consists of seven species of fish:

- ✓ *Saurida lessepsianus* (Russell, Golani & Tikochinski, 2015)*[3]
- ✓ *Lagocephalus sceleratus* (Gmelin, 1789) *
- ✓ *Pterois miles* (Bennett, 1828) *
- ✓ *Siganus rivulatus* (Forsskål & Niebuhr, 1775)
- ✓ *Siganus luridus* (Rüppell, 1829)
- ✓ *Fistularia commersonii* (Rüppell, 1838)
- ✓ *Plotosus lineatus* (Thunberg, 1787)

Indicators

The following indicators can be adopted to report the information compiled from the monitoring plan, including:

i. The ratio between non indigenous species and native species in the catch by métier (or in the assemblage by sampling method) expressed as either number of individuals, number of species and weight, when possible;
ii. The relative value of NIS (e.g. CPUE of all species aggregated) in the catch;
iii. The number of new NIS (as a result of both novel primary introductions and/or secondary spread) for assessment unit by year; and
iv. The relative changes in the abundance of priority species (ideally CPUE or another estimate of abundance, in line with IMAP NIS common indicator guidance as well as the GFCM DCRF).

In addition to the indicators above, it is suggested to regularly assess the appearance of emerging NIS, understood as species significantly increasing in abundance and/or expanding in distribution, as well as perform an assessment of the potential impacts of priority/emerging NIS species. This assessment would require further analysis and developments in the future, as well as the involvement of relevant experts.

5. Potential monitoring approaches

The monitoring programme could include one or a combination of the approaches listed below:

Method 1. Compilation of NIS information from existing data collection mechanisms

Source of data: Data submitted through Recommendation GFCM/41/2017/6 and IMAP monitoring in relation to Ecological Objective 2, Common Indicator Guidance on NIS Common Indicator (as described in UNEP(DEPI)/MED WG.444/6:

UNEP/MAP IMAP related data collection mechanism

In relation to IMAP monitoring, the Common Indicator 6 Monitoring Guidance is to be followed (Appendix 3 / Annex 1), noting overall IMAP timeline, which foresees the establishment of national monitoring programmes, refinement of monitoring and assessment specifics between 2016-2019 (ongoing, with contribution of this pilot study) and the monitoring and data reporting from 2020 on, by all UNEP/MAP-

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[3] Species already on the priority list of GFCM DCRF for monitoring purposes

Barcelona Convention Contracting Parties, following the Common Indicator Monitoring Guidance and the IMAP compatible Information and Data Sharing System[4].

GFCM/DCRF related data collection mechanism

Countries are requested to submit information emanating from fishing activities on a list of selected priority NIS species (i.e. *Saurida lessepsianus, Fistularia commersonii, Lagocephalus sceleratus, Siganus luridus, S. rivulatus, Marsupenaeus japonicus, Metapenaeus stebbingi, Scomberomorus commerson*) through Recommendation GFCM/41/2017/6 (see Appendix 3 / Annex 2). All species, based on criteria relevant to the objectives of the GFCM, such as development, conservation and management, have been separated in three different Groups: Group 1, Group 2 and Group 3. For all the identified species in each group, length data per fleet segment should be collected.

Other individual information on sex and length at maturity are mandatory only for species belonging to G1. This information should be submitted whenever catches of those species represent at least 2% of the total catch.

Data repository: GFCM database and IMAP compatible UNEP/MAP IMAP compatible Information and Data Sharing System

Main outcomes: State of the art, Trends of abundance

Protocols:

In line with Common Indicator Guidance on NIS Common Indicator (as described in UNEP(DEPI)/MED WG.444/6:

List of Guidance documents and protocols available

There are no established standard protocols for the monitoring of NIS. However, sampling methods are used by monitoring activities implemented in many Mediterranean countries, in particular in relation to the Ballast Water Convention, the EU Water Framework Directive, and the Marine Strategy Framework Directive. These methods may be useful for the estimation of Common Indicator 6.

Some guidance on the monitoring of biodiversity (including non-indigenous species) for the needs of the MSFD is provided in: *Zampoukas et al. (2014) Technical guidance on monitoring for the Marine Stategy Framework Directive. JRC Scientific and Policy Reports (EUR collection), Publications Office of the European Union, EUR 25009 EN – Joint Research Centre, doi: 10.2788/70344, ISBN: 978-92-79-35426-7, 166p.*

The EU Project BALMAS has provided guidelines for the monitoring of NIS in ballast water (https://www.balmas.eu/).

In relation to the GFCM, the protocols for collecting data are described in detail in the DCRF (http://www.fao.org/gfcm/data/dcrf/en/).

Method 2. Implementation of GFCM discard monitoring Source of data GFCM

Discard monitoring programme

Brief description to implement/capitalize the GFCM framework for the sub-regional monitoring plan.

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[4] IMAP compatible information and data sharing system is currently being developed, in line with the Common Indicator Guidance and country specific needs. The system is foreseen to be finalized by 2019.

In the framework of the mid-term strategy (2017–2020), towards the sustainability of Mediterranean and Black Sea fisheries (adopted as Resolution GFCM/40/2016/2), the GFCM Secretariat has finalized a manual for the collection of harmonized data on discards. The main scope of this manual is to suggest appropriate discards sampling approaches and methods (e.g. data sources, selection of vessels, species, stratification, mandatory and optional variables) to collect fisheries data which meet requirements related to stock assessment and ecosystem approach. Furthermore, the on-board discards programmes offer also the opportunity to collect important data on the distribution and on the quantitative and qualitative impact of non-indigenous species. In this view, countries should collect and report information on the presence of NIS through an *ad hoc* template together with a minimum set of parameters, such as the number and the weight of individuals caught per fleet segment, gear and area (GSA).

Data repository GFCM database

Main outcomes Trends of abundance, spatial projections, early detection

Protocols: "Monitoring discards in Mediterranean and Black Sea fisheries: Guidelines and methodologies" (GFCM, 2018)

Method 3: Regular or ad-hoc surveys at sea Source of data: scientific surveys at sea

Brief description: Scientific surveys at sea should be provided with a minimal manual to report information on NIS. This should include any survey that has the capability to sample NIS, including surveys done with the objective of analysing the abundance and distribution of commercially exploited species (e.g. GFCM surveys, but also national surveys) as well as biodiversity-oriented surveys.

Comprehensive studies of the biological status of most of demersal and pelagic fish stocks in some Mediterranean areas are lacking and there is a need for survey data for tuning the application of analytical models for stock assessment. To address this issue, the GFCM within its mid-term strategy has promoted such studies and one way of doing so is by establishing international surveys covering the main demersal and pelagic stocks. The first step was to prepare a GFCM common protocols for the execution of regional pelagic/acoustic and demersal/trawl surveys. Through this protocol, countries are invited to collect and report also biological information (e.g. length, weight sex and maturity) on non-indigenous species using standard data entry sheets and reporting templates. Surveys information on non-indigenous species could contribute in understanding their roles in the benthic and pelagic ecosystems, the impacts on their new environment including restructuring established food webs, and competition with native organisms for food and space.

Data repository: GFCM database, national survey databases, UNEP/MAP Information platform (InfoMAP) and Data Sharing System (MAMIAS)

Main outcomes: Quantitative data on NIS abundance

Protocols: Surface visual census (Snorkelling) on standard transects, Trawls survey, Traps, Nets_Scientific Surveys in the Mediterranean and Black Sea: Demersal and pelagic Acoustic protocol (GFCM, 2018)

Method 4. LEK periodical survey Source of data local fishermen (both

professional and recreational)

Brief description interviews with local fishermen, but also with recreational fishermen and divers, as appropriate. The full protocol is already available. This consists in 'LEK_2 protocol' (source INTERREG

MED MPA-Adapt Project) for periodical monitoring. Note that, after cross-validation the LEK_2 protocol is expected to provide complementary data to commercial data sampling. Actions to ensure appropriate science-policy interface with the MPA-Adapt project and partners such as CIESM, FAO should be taken into account.

Data repository to be defined

Main outcomes Trends of abundance, time series, spatial projections, socio-ecological evaluation, early detection.

Protocols: LEK survey form (Appendix 3 / Annex 3)

Method 5. Presence-only records

Source of data different sources, including social networks after appropriate validation.

Brief description searching, extracting, checking for validation and geo-referencing opportunistic observations of NIS. These data can be used to feed MAMIAS and other possible interested partners. The work can be manually done by contracted personnel, on a regular basis and in synergy with other databases and groups (e.g. 'Mediterranean Marine Life'; 'Lion Fish in Cyprus'; 'Oddfish'…) to be identified.

Data repository UNEP/MAP Information and Data Sharing System (MAMIAS),

Main outcomes database implementation with geo-referenced observations, early detection

Protocols: *under development*

Method 6. National expert evaluation

Source of data: expert working group with experts of different countries/literature

Brief description A permanent network of experts will be established to periodically provide expert evaluation on the status of target NIS in relation to fishery and update qualitative information on distribution and abundance at a given spatial resolution. It probably represents the most immediate way to combine information from different countries, which rely on different information sources. To be performed through scientifically recognized techniques (e.g. Delphi method) and cross checked with the available literature. Cost effective.

Data repository: UNEP/MAP Information and Data Sharing System (MAMIAS)

Main outcomes Trends of abundance (qualitative), trend in spatial distribution, socio-ecological evaluation, documentation of new and emerging bio-invasions.

Protocols: The Online questionnaire (Appendix 3 / Annex 4) could be implemented and used as a periodical (once a year) tool to collect data from each participating country. The survey can be replicated within the country (more than one independent expert *per* country).

6. General suggestions for implementation

Required means

1. Scientific coordinator: to filter/validate the data, assist database implementation/elaborate periodical results following a reporting requirements/obligation.
2. Sub regional coordinator: to assist the organization of group activities and follow/stimulate data recovery and sharing…

3. IT tools (Web platform to facilitate the process of data input/recovery/elaboration)
4. Periodical (once/year) in person meeting of the group advisable

Possible constraints and solutions

CONSTRAINT	**POSSIBLE SOLUTION**
Low level of engagement and participation, scarce motivation, too ambitious targets	Engage motivated experts, simplify procedures; provide a minimum protocol to be followed by ALL the participants
Reluctance in data sharing	Provide a minimum protocol, request elaborated info (for example ranks of abundance through the geographical grid), promote collaborative scientific publications
Poor data interoperability due to the heterogeneity of data sources, methods and measures.	Standardize the data; use rank variables; focus on only few standard methodologies.

Annex I
Common Indicator Guidance on NIS Common Indicator
(as described in UNEP(DEPI)/MED WG.444/6)

Indicator Title	*Common Indicator 6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species (NIS)*	
Relevant GES definition	Related Operational Objective	Proposed Target(s)
Decreasing abundance of introduced NIS in risk areas	Invasive NIS introductions are minimized	Abundance of NIS introduced by human activities reduced to levels giving no detectable impact

Indicator analysis methods

General definitions (according to UNEP(DEPI)/MED WG.420/4)

‘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), socioeconomic 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.

Indicator Definition

For the needs of Common Indicator 6, the following definitions apply:

‘Trend in abundance’ is defined as the interannual change in the estimated total number of individuals of a non-indigenous species population in a specific marine area.

‘Trend in temporal occurrence’ is defined as the interannual change in the estimated number of new introductions and the total number of non-indigenous species in a specific country or preferably the national part of each subdivision, preferably disaggregated by pathway of introduction.

‘Trend in spatial distribution’ is defined as the interannual change of the total marine ‘area’ occupied by a non-indigenous species.

Methodology for indicator calculation

To estimate Common Indicator 6, a trend analysis (time series analysis) of the available monitoring data needs to be performed, aiming to extract the underlying pattern, which may be hidden by noise. A formal regression analysis is the recommended approach to estimate such trends. This can be done by a simple linear regression analysis or by more complicated modelling tools (when rich datasets are available), such as generalized linear or additive models.

To monitor trends in temporal occurrence, 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 that was not present at T_{n-1}. To calculate this parameter the non-indigenous species lists of both years are compared to check which species were recorded in year *n*, but were not recorded in year *n-1* regardless of whether or not these species was present in earlier years. To calculate this parameter the total number of non-indigenous species is used in the comparison.

Indicator Title	*Common Indicator 6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species (NIS)*
[B]: The total number of known non-indigenous species at T_n minus the corresponding number of non-indigenous species at T_{n-1}. Hereby T_n stands for the year of reporting.	
Indicator units 'Trends in abundance': % change per year 'Trends in temporal occurrence': % change in new introductions or % change in the total number of alien species per year or per decade 'Trends in spatial distribution': % change in the total marine surface area occupied or % change in the length of the occupied coastline (in the case of shallow-water species that are present only in the coastal zone)	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols 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. in rocky shores, port areas and marinas, offshore areas and aquaculture areas. As a complimentary measure and in the absence of an overall NIS targeted monitoring programme, rapid assessment studies may be undertaken, usually but not exclusively at marinas, jetties, and fish farms (e.g. Pederson et al. 2003). The compilation of citizen scientists input, validated by taxonomic experts, can be useful to assess the geographical ranges of established species or to early record new species. For the estimation of Common Indicator 6, it is important that the same sites are surveyed each monitoring period, otherwise the estimation of the trend might be biased by differences among sites. Standard methods for monitoring marine populations include plot sampling, distance sampling, mark-recapture, removal methods, and repetitive surveys for occupancy estimation (see Katsanevakis et al. 2012 for a review specifically for the marine environment). *Katsanevakis S, et al., 2012. Monitoring marine populations and communities: review of methods and tools dealing with imperfect detectability. Aquatic Biology 16: 31–52.* *Pederson J, et al., 2003 Marine invaders in the northeast: Rapid assessment survey of non-native and native marine species of floating dock communities, August 2003 (available in* https://dspace.mit.edu/bitstream/handle/1721.1/97032/MITSG_05-3.pdf?sequence=1*)*	
Available data sources Marine Mediterranean Invasive Alien Species database (MAMIAS) - http://www.mamias.org/ European Alien Species Information Network (EASIN) - http://easin.jrc.ec.europa.eu/ CIESM Atlas of Exotic Species in the Mediterranean - http://www.ciesm.org/online/atlas/ World Register of Introduced Marine Species (WRIMS) - http://www.marinespecies.org/introduced/	
Spatial scope guidance and selection of monitoring stations The monitoring of NIS generally should start on a localized 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. It is important to establish a network of monitoring sites at regional level in which common protocols are applied so that Common Indicator 6 can be assessed at both national and regional level.	

<table>
<tr><td>Indicator Title</td><td colspan="2"><i>Common Indicator 6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species (NIS)</i></td></tr>
<tr><td colspan="3">The use of Habitat Suitability Models and Ecological Niche Modelling (ENM) may be considered at a later stage of IMAP to identify priority monitoring sites and to predict the spread of NIS.</td></tr>
<tr><td colspan="3">Temporal Scope guidance
Monitoring at “hot-spots” and “stepping stone areas” for alien species introductions would typically involve more intense monitoring effort, e.g. sampling at least once a year at ports and their wider area and once every two years in smaller harbours, marinas, and aquaculture sites.</td></tr>
<tr><td colspan="3">Data analysis and assessment outputs</td></tr>
<tr><td colspan="3">Statistical analysis and basis for aggregation
Standard statistics for regression analysis should be applied to estimate trends and their related uncertainties.</td></tr>
<tr><td colspan="3">Expected assessments outputs
- Graphs of the time series of the calculated metrics (abundance, occurrence, etc), including confidence intervals
- Distribution maps of the selected species, depicting temporal changes in their spatial distribution
- National inventories (and also by the national part of each marine subdivision, if relevant) of non-indigenous species by year</td></tr>
<tr><td colspan="3">Known gaps and uncertainties in the Mediterranean
NIS identification is of crucial importance, and the lack of taxonomical expertise has already resulted in several NIS having been overlooked for certain time periods. The use of molecular approaches including bar-coding are sometimes needed to confirm traditional species identification.
Sampling effort currently greatly varies among Mediterranean countries and thus on a regional basis current assessments and comparisons may be biased.</td></tr>
<tr><td colspan="3">Contacts and version Date</td></tr>
<tr><td colspan="3">Key contacts within UNEP for further information</td></tr>
<tr><td>Version No</td><td>Date</td><td>Author</td></tr>
<tr><td>V.1</td><td>20/07/2016</td><td>SPA/RAC</td></tr>
<tr><td>V.2</td><td>14/04/2017</td><td>SPA/RAC</td></tr>
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Annex II

Acquisition of biological data through DCRF

In the context of the GFCM-Data Collection Reference Framework-DCRF (GFCM, 2018), based on criteria relevant to the objectives of the GFCM (i.e. development, conservation and management) a set of priority species have been identified. Their identification has been based not only abundance, but also on other selection criteria such as price and/or market demand and ecological importance. The use of different parameters to identify the priority species has been helpful in assigning the correct importance to some species, which may not be very abundant, but which, for example, fetch a high market price.

According to these criteria, three different groups have been established, whereby species are listed at sub-regional level (for complete list see DCRF – Appendix L): the first group (G1) concerns the frequency of assessments (i.e. species that are regularly assessed); the second one (G2) concerns the fishery's importance (i.e. landing, catch and/or economic value); the third group (G3) is based on conservation criteria (i.e. endangered species) or impact of their presence on the ecosystem (i.e. non-indigenous species).

The non-indigenous species identified under the three mentioned groups of species, together with the variables, which should be collected, are reported in the table below.

*As reported in the DCRF, countries are also kindly invited to provide this information for species belonging to G2 and G3, if available.

Non-indigenous species	DCRF Group	Length	Mean individual weight (kg) by length class	Sex	Maturity
Saurida lessepsianus	G1	X	X	X	X
Siganus luridus	G2	X	X	*	*
Siganus rivulatus	G2	X	X	*	*
Fistularia commersonii	G3	X	X	*	*
Lagocephalus sceleratus	G3	X	X	*	*
Metapenaeus stebbingi	G3	X	X	*	*
Scomberomorus commerson	G3	X	X	*	*
Marsupenaeus japonicus	G3	X	X	*	*

Countries are requested to collect biological information for all the species identified in all GFCM sub-regions where their fisheries take place. For all the selected species in G1, G2 and G3, length data per fleet segment should be collected. Individual information on sex and length at maturity is mandatory for species belonging to G1. Exceptions can be applied for the collection of biological data related to certain species, according to the following criteria:

1st the species is/are not present in the country;

2nd the species is present in the country, but its weight accounts for less than 2% of total landings of the country.

Annex III
LEK Survey Form

INTERVIEW NUMBER……………… Compiled by…………….. DATE…… LOCATION……………………… GRID…….

CODE INTERVIEW (name) ……………………… Age……………… SINCE (year)…………………… PROFESSIONAL ☐ RECREATIONAL ☐

Set nets ☐ *Purse seine* ☐ *Traps* ☐ *Longlines* ☐ *Angling* ☐ *Trawl* ☐ *Scuba diver* ☐ *Spear fishing* ☐ *Others …………*

CONFIDENCE
High ☐
Medium ☐
Low ☐

	SPECIES	**Trend** I Increase; D Decrease; F Fluctuant; S Stable; Nk Not known	**Current abu** 0=ABSENT; 1=RARE (once in a year); 2= OCCASIONAL (sometimes in a year); 3= COMMON (regurarly in a year); 4=ABUNDANT (regularly in captures and abundant); 5=DOMINANT (always in captures and with great abundances)	**Current ave catch in a fi DAY**		**Best day-c the past MONTHS**		**N fishin days in the pas 12 mon**	**Gear**	**Good for fishery?** Good/ Ver good/don know/ bad very bad	**Good for Environm t?** Good/ Very good/don know/ bad very bad		**NOTES**
		I/ D/ F/ S/ Nk	**0/ 1/ 2/ 3/ 4/ 5**	Kg	N.	Kg	N.						
Med Tar	*S. lessepsianus*												
	L. sceleratus												
	P. miles												
	S. rivulatus												
	S. luridus												
	F. commersonii												
	P. lineatus												

Do you know species that have appeared only recently and/or are significantly increasing in abundance in your area?

Emerging													

The original version of the protocol has been originally conceived within the project MPA-Adapt

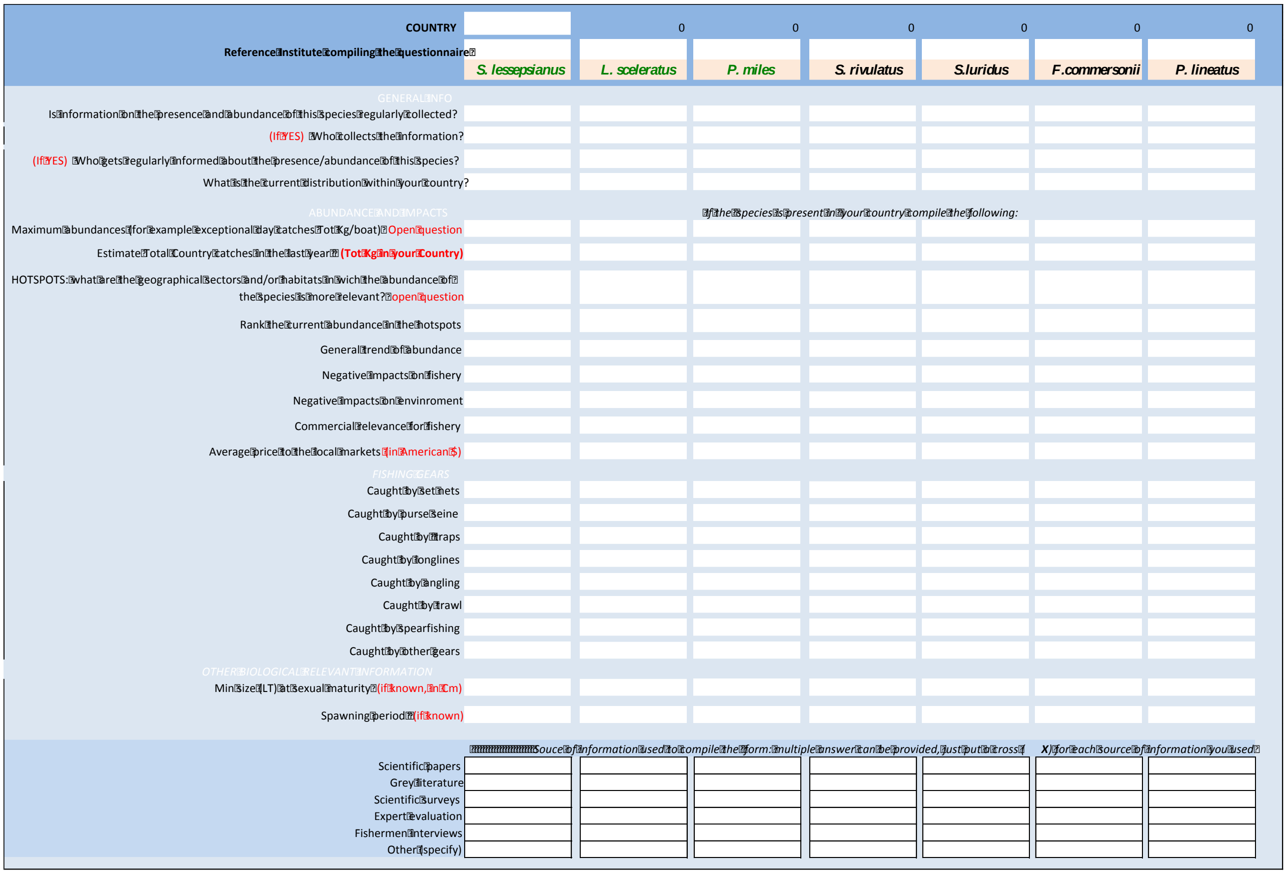
Insert privacy statementxxxxx

Rationale: this protocol is intended to be used on a periodical basis, **every 12 months**. Objectives: Retrieve, on a yearly basis, qualitative information on NIS species, provide early detection on new NIS species emerging in new areas. Field work instructions: Interviews can be performed by researcher experienced with local fishery resources. Generally, fishermen can be met during their land activities, while for example cleaning the nets in the harbours or fixing their boats. Small scale fishermen, sportive fishermen, also scuba divers and spear fishermen (possibly with more than 10 years of experience) can be interviewed. Considering the periodical use of the protocol, it will be important to maintain trustful long-lasting relationships with a number of local fishermen. A minimum of 20 interviews/location every 12 month is suggested. Target species: note that additional targets, represented by **emerging species** perceived by the respondent as new or increasing in abundance and/geographical distribution in the area, can be added to the list. Privacy: Be careful in respecting privacy law, which deal with regulating, storing, and using of personally identifiable information of people. Credits:

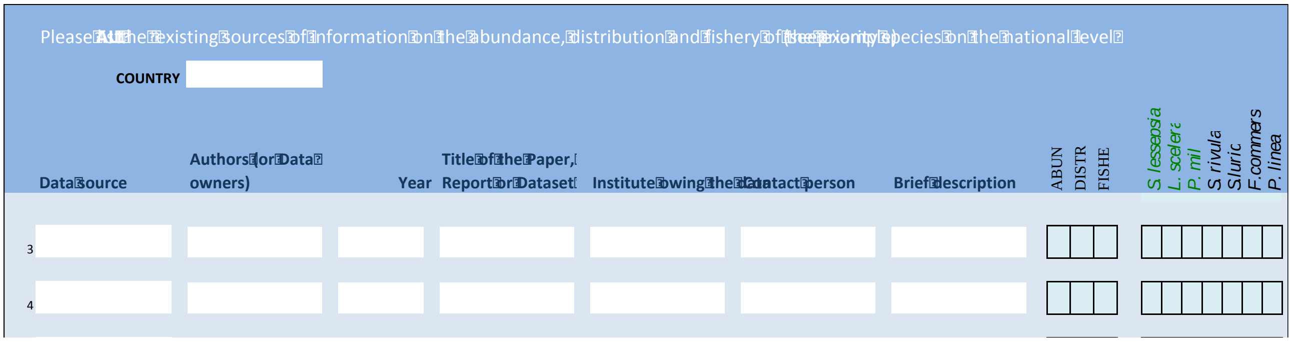
The original version of this protocol is an official product of the European project MPA-Adapt, with improvements made through the FAO AdriaMed and MedSudMEd projects.

Annex IV

The Online Questionnaire



COUNTRY		0	0	0	0	0	0
Reference Institute compiling the questionnaire	*S. lessepsianus*	*L. sceleratus*	*P. miles*	*S. rivulatus*	*S.luridus*	*F.commersonii*	*P. lineatus*
GENERAL INFO							
Is information on the presence and abundance of this species regularly collected?							
(If YES) Who collects the information?							
(If YES) Who gets regularly informed about the presence/abundance of this species?							
What is the current distribution within your country?							
ABUNDANCE AND IMPACTS		*If the species is present in your country compile the following:*					
Maximum abundances (for example exceptional day catches Tot Kg/boat) Open question							
Estimate Total Country catches in the last year **(Tot Kg in your Country)**							
HOTSPOTS: what are the geographical sectors and/or habitats in wich the abundance of the species is more relevant? open question							
Rank the current abundance in the hotspots							
General trend of abundance							
Negative impacts on fishery							
Negative impacts on envinroment							
Commercial relevance for fishery							
Average price to the local markets (in American $)							
FISHING GEARS							
Caught by set nets							
Caught by purse seine							
Caught by traps							
Caught by longlines							
Caught by angling							
Caught by trawl							
Caught by spearfishing							
Caught by other gears							
OTHER BIOLOGICAL RELEVANT INFORMATION							
Min size (LT) at sexual maturity (if known, in Cm)							
Spawning period (if known)							
	Souce of information used to compile the form: multiple answer can be provided, just put a cross (X) for each source of information you used						
Scientific papers							
Grey literature							
Scientific surveys							
Expert evaluation							
Fishermen interviews							
Other (specify)							



Please list all the existing sources of information on the abundance, distribution and fishery of the priority species on the national level (see example)

COUNTRY

	Data source	**Authors (or Data owners)**	**Year**	**Title of the Paper, Report or Dataset**	**Institute owning the data**	**Contact person**	**Brief description**	ABUN	DISTR	FISHE	*S. lessepsia*	*L. sceler*	*P. mil*	*S. rivula*	*S.luric*	*F.commers*	*P. linea*
3																	
4																	

Rationale: This questionnaire provides a basis to collect periodical (every 12 months) information from a permanent network of experts. It probably represents the most immediate way to combine information from different countries, which rely on different information sources. To be performed through scientifically recognized techniques (e.g. Delphi method) and cross checked with the available literature. Cost effective. Objectives: Trends of abundance of NIS socio-ecological evaluation, documentation of new and emerging bio-invasions.

Annex VI

Conclusions and Recommendations of the Report of the joint GFCM-UN Environment/MAP sub-regional pilot study for the Eastern Mediterranean on non-indigenous species in relation to fisheries

(Chania, Greece, 5 March 2018)

1. Participants highlighted the importance to work towards a sub-regional monitoring plan for NIS, in line with the objectives of the joint GFCM-UN Environment/MAP sub-regional pilot study for the Eastern Mediterranean for non-indigenous species and the mid-term strategies of both the GFCM and UN Environment/MAP.

2. They acknowledged the information already available on NIS at the country level and the monitoring efforts carried out from the 1980s, even though they have been undertaken on an irregular basis. It was highlighted that the monitoring plan should revise and incorporate available information whenever possible, in order to preserve as much as possible, the time series on the presence and abundance of NIS in the subregion.

3. Participants also highlighted the dynamic situation related to the presence, abundance and interactions of NIS within Eastern Mediterranean ecosystems, including the recurring arrival of new species and changes in abundance of both indigenous and NIS observed in the ecosystem.

4. The meeting noted the predominance of fisheries-dependent sources of information in relation to NIS/fisheries, as well as fisheries-related surveys at sea, as the basis of analysis for the presence, abundance and distribution of NIS fisheries. Participants stressed the need to integrate other sources of information in a future monitoring plan.

5. The importance of using existing data and information sharing systems, such as MAMIAS and the Data Collection Reference Framework (DCRF) database was highlighted.

6. In addition, it was underlined that fishing operations vary according to countries in the subregion (e.g. different target species, different fleet capabilities, coastal or deep-sea fishing) and that this may introduce some bias in the observations provided by fisheries. Experts agreed on the need to analyse the information in the most harmonized way, including through the identification of simple indicators that could be comparable among countries of the subregion.

7. Participants stressed the importance of consolidating a network of experts on NIS, including previous initiatives such as the ones promoted by the FAO regional project EastMed and the European Union project PERSEUS, and to be continued in the future. In addition, they encouraged experts to participate in the network and share information and knowledge.

8. Participants discussed a number of aspects to be taken into account in the proposal for a monitoring plan, including:

   a. the need to take into account the spatial dimension when designing the plan, including through:

      i. ensuring adequate coverage around potential introduction or entry points for NIS; and

      ii. ensuring coverage of contrasting areas (e.g. areas of higher/lower fishing pressure, coastal/deep sea areas).

b. The need to include indicators to report the information compiled from the monitoring plan, including:

    i. The ratio between non-indigenous species and native species in the catch by fleet segment (or in the assemblage by sampling method) expressed as either number of individuals, number of species or weight, when possible;

    ii. The relative abundance of NIS (e.g. catch per unit effort [CPUE] of all NIS species aggregated) in the catch by assessment unit (GSA or subdivision) and fleet segment;

    iii. The number of newly introduced NIS (as a result of both novel primary introductions and/or secondary spread) for assessment unit by year; and

    iv. The temporal trend in the abundance of priority species (ideally CPUE or another estimate of abundance, in line with IMAP NIS common indicator guidance as well as the DCRF).

c. In addition to the indicators above, participants also agreed on the importance to regularly assess the appearance of emerging NIS, understood as species significantly increasing in abundance and/or expanding in distribution, as well as perform an assessment of the potential impact of priority/emerging NIS species. It was noted that this assessment would require further analysis and developments in the future, as well as the involvement of relevant experts.

9. On the basis of the above discussion and on the draft sub-regional monitoring plan prepared in advance of the meeting in line with the conclusions of the first NIS meeting, participants agreed to update the draft as included in Appendix 3, including proposals on: i) the sources of data; ii) the main observation platforms; and iii) proposed indicators.

10. Participants agreed to submit this proposal, as included in Appendix 3 to the GFCM (including the Sub-regional Committee for Eastern Mediterranean and the Scientific Advisory Committee on Fisheries) and to the relevant body of UN Environment/MAP.