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**Agenda Item 7: Status of implementation of the Ecosystem Approach (EcAp) Roadmap**

**7.1. Implementation of the second phase (2019-2021) of the Integrated Monitoring and Assessment Programme (IMAP - Biodiversity and non-indigenous species) in the framework of the EcAp Roadmap**

**Implementation of the second phase (2019-2021) of the Integrated Monitoring and Assessment Programme (IMAP - Biodiversity and non-indigenous species) in the framework of the EcAp Roadmap**

**Appendix F: Progress in the Development of the Baseline Values for the IMAP Common Indicator 6 related to Non-Indigenous Species**

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## 1. Introduction

1. Non-indigenous, invasive species are globally acknowledged as one of the major threats to biodiversity, ecosystems and the services they provide (CBD, 2010; EU, 2011). Therefore, they constitute one of the elements that are taken into consideration when assessing the health of the environment and formulating management strategies to achieve and sustain good ecological status (EU, 2008; UNEP/MAP, 2016). In the framework of the Integrated Monitoring and Assessment Programme for the Mediterranean Sea (IMAP), NIS are addressed with Common Indicator 6 (CI6), which assesses “Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species 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)”. The national implementation and harmonization of IMAP across all Mediterranean countries requires the elaboration of several parameters, among which the establishment of a refined and authoritative baseline of the NIS present at the national and regional level is fundamental as a starting point for any further evaluations.

2. The present work aims to collect the available material on the presence of marine NIS in the Mediterranean countries in the form of existing national inventories, combine it with new and up-to-date information on new species records, the taxonomy and biogeography of the registered species and agreed methodological standards, to arrive at refined NIS baselines at the national and regional level. The outcome will be the result of a collaborative process at national and regional levels, involving detailed exchange of information between designated experts and the building of consensus on the final lists, as these will constitute a tool for the determination of thresholds for CI6 and will have management implications for the Contracting Parties.

## 2. Methodology for the elaboration of the NIS Baseline in the Mediterranean

### National Inventories – species records

3. SPA/RAC requested the Contracting Parties to designate national expert(s) on NIS that will be in charge of the development of national list of NIS. Designated national experts exchanged information and agreed to use a template, commonly endorsed by EU member states in the framework of the MSFD. National lists received from the main Contracting Parties are detailed here after.

4. The national inventories of EU Mediterranean countries submitted to JRC in January 2021 for the purposes of the 2012-2017 assessment cycle, were made available and formed the starting point for the revision process of these 8 countries. These included data up until 2017 and were further updated with collated data up to 2020, based on major national/regional reviews (Zenetos et al., 2017 and Zenetos & Galanidi, 2020 for the whole Mediterranean, Katsanevakis et al., 2020 for previously unpublished records, Servello et al., 2019 for Italy, Zenetos et al., 2020 for Greece and publications of individual records for Croatia, Cyprus, France, Malta, Slovenia, Spain). For the rest of the Mediterranean countries, national NIS inventories were provided by national experts as per the request of SPA/RAC, for Albania, Algeria, Egypt, Israel, Lebanon, Libya, Morocco, Tunisia and Turkey. For a small number of countries that had not submitted national inventories (see Table 1 in Section 4), national baselines were created based on literature with data retrieved from the HCMR offline database.

5. Revisions of these inventories were made according to recently published literature and checklists, e.g. Algeria: Grimes et al., 2018; Libya: Shakman et al., 2019; Israel: Galil et al. 2020; Tunisia: Ounifi-Ben Amor et al., 2016; Lebanon: Bitar et al., 2017 marine plants, Bariche et al., 2020 fishes; Turkey: series

of publications on Turkish marine fauna and flora in 2014, Turan et al., 2018 for fishes, Çınar et al., 2021 for the most recent comprehensive update; Montenegro: Petović et al., 2019 and/or Pešić et al., 2020; Egypt: reviews by taxonomic group, e.g. Zakaria, 2015 for zooplankton, Akel & Karachle, 2017 for fishes; Halim & Abdel Messeih, 2016 for ascidians; Syria: Ammar, 2019 for zoobenthos, Ali, 2018 for fishes, and individual publications.

6. Additional records were sought in global biodiversity databases, i.e., Global Biodiversity Information Facility (GBIF) and Ocean Biodiversity Information System (OBIS) as appropriate and validated through personal communications with local and taxonomic experts where necessary.

#### Taxonomic groups

7. Unicellular plankton species were not included in the inventories, as most of the recent checklist on Mediterranean NIS have excluded them (Zenetos et al., 2017; Galil et al, 2018) because their origin is in doubt and subject to revisions. In exceptional cases they will be listed (case by case).

8. Parasites on the other hand were included in accordance with the latest recommendations (UNEP/MED WG. 500/7 - Zenetos, 2021) and recent literature (at the basin level see Zenetos et al., 2008 and at country level e.g., Libya: Shakman et al., 2019; Tunisia: Ounifi-Ben Amor et al., 2016; Israel: Galil et al., 2020).

#### Other Assessment Criteria

9. Preparing the baseline inventories needs to consider assessment criteria regarding alien status and establishment success as well as pathway of introduction (Tsiamis et al., 2021, UNEP/MED WG. 500/7). Each species entry is followed by two classifications, namely Alien Status and Establishment Success.

10. The establishment success of each species is reported as

- Established: Species with >2 records distributed in space and time, indicating self-sustaining populations, according to recent literature. Includes locally established species.
- Casual: Species with 1 or 2 records of live specimens.
- Invasive: Species with evidence of large populations, extensive spread and impacts on biodiversity and ecosystem services.
- Unknown: Species with 1 or 2 records of live specimens after 2010, where reporting lags may conceal their true establishment status.
- Excluded: records of species based on non-living animals (applies mostly to Mollusca) and records of species not reported in the wild (e.g., polychaeta, bryozoa found only on ship hulls).

11. The alien status is reported as

- Alien: species with clear evidence of their non-native origin and strong indication of an anthropogenic mode of introduction.
- Partly native: i.e., species that are native in a Mediterranean country while they are non-indigenous in other Mediterranean countries.
- Cryptogenic i.e., species that cannot be demonstrably classified as native or non-indigenous in a particular region.
- Range-expanding: i.e., species that may have entered the Mediterranean through natural range expansion. Crypto-expanding: species with some evidence on their non-indigenous status but

with uncertainty due to unclear mode of introduction from the native range (natural spread vs human mediated).

- Questionable: Species with insufficient information (e.g., no voucher or description provided) or with uncertain identification. Species complexes also fall under this category. Questionable species will be reported in a separate Annex/Worksheet in the final regional baseline (following Tsiamis et al., 2019).

12. Native and range-expanding species were excluded from the inventories during the validation process.

### Geographic scales

13. Following the compilation of the national inventories, the regional baseline will be developed and submitted both at the pan-Mediterranean level and at the sub-regional level (4 marine subregions, according to the EcAp/IMAP and the MSFD, i.e., Eastern Mediterranean, Central Mediterranean, Adriatic Sea and Western Mediterranean). Establishment success will also be determined at these scales.

### **3. Reference year**

14. The reference year for the baseline was selected based on two parameters. The first is related to the trends of new introduction of non-indigenous species in the Mediterranean, as revealed by preliminary analysis of the relevant data in recent publications [e.g., Algeria (Grimes et al., 2018; Bensari et al., 2020; Bakalem et al., 2020, Libya (Shakman et al., 2019); Montenegro (Petović et al., 2019; Pešić et al., 2020); Israel (Galil et al., 2020)] and the HCMR database (UNEP/MED WG. 500/7; Zenetos & Galanidi, 2021). The second is motivated by the need to harmonise with the timeframe of similar work carried out for the purposes of MSFD. Trends in new marine NIS introductions between 1950 and 2019 are consistently increasing throughout the Mediterranean and, in many countries, this is the result of increased scientific effort, thus the reference year should be the most recent year practical. Following the assessment and reporting 6-year periods already established for EU countries under the MSFD, where the next assessment will cover the 2018-2023 period, it was recommended that the reference year to set national NIS baselines for the Mediterranean should be 2017.

15. Nevertheless, national inventories, as well as the regional and subregional datasets were prepared and will be submitted with data until 2020, i.e., species detected until December 2020 and published until April 2021. This facilitates the updating of regional platforms (i.e. MAMIAS and EASIN) with the most up-to-date information and enables the publication of a truly authoritative work on the current state of marine NIS in the Mediterranean. Furthermore, it contributes to the continuous work necessary to carry out the forthcoming status assessment (2023) in the framework of IMAP, as well as reporting for the MSFD for the subset of EU Mediterranean countries.

### **4. National NIS inventories**

16. National inventories of Non-indigenous species are delivered for 19 Mediterranean countries. These are listed in Table 1, along with the original data source and the status of the validation process. By the 13<sup>th</sup> of May, 12 countries had returned validated the revised spreadsheets. 9 inventories are finalised, 3 are in progress, with continuous communication with the national experts, while 6 national inventories are still pending validation, awaiting a status update by the national experts responsible.

**Table 1.** Status of revisions of the NIS national inventories (table updated on 10<sup>th</sup> May 2021).

| Country            | Revision | Validation  |
|--------------------|----------|-------------|
| Albania (AL)       | Yes      | Yes         |
| Algeria (DZ)       | Yes      | Yes         |
| Bosnia-Herzegovina | No       | NA          |
| Croatia (HR)       | Yes      | pending     |
| Cyprus (CY)        | Yes      | Yes         |
| Egypt (EG)         | Yes      | pending     |
| France (FR)        | Yes      | In progress |
| Greece (GR)        | Yes      | Yes         |
| Italy (IT)         | Yes      | In progress |
| Israel (IL)        | Yes      | pending     |
| Lebanon (LB)       | Yes      | Yes         |
| Libya (LY)         | Yes      | Yes         |
| Malta (MT)         | Yes      | Yes         |
| Monaco             | NA       | NA          |
| Montenegro (ME)    | No       | Yes         |
| Morocco (MA)       | Yes      | Yes         |
| Slovenia (SI)      | Yes      | In progress |
| Spain (ES)         | Yes      | In progress |
| Syria (SY)         | No       | NA          |
| Tunisia (TN)       | Yes      | pending     |
| Turkey (TR)        | No       | In progress |

17. Major changes relevant for all countries include:

Updating all lists with species records detected until December 2020, published to April 2021.

- ✓ The addition of Foraminifera following Stulpinaite et al., 2020.
- ✓ The revision of Isopoda following Castello et al., 2020.
- ✓ The revision of Polychaeta following Zenetos et al., 2017 and Langeneck et al., 2020.
- ✓ The revision of macroalgae based on Verlaque et al., 2015.
- ✓ The revision of Mollusca based on Albano et al., 2021.
- ✓ Removing molluscan records based exclusively on empty shell e.g., single records of:
  - *Canarium mutabile*, *Cerithium nesioticum*, *Conus arenatus arenatus* from Israel (pers commun with H. Mienis, the investigator who has reported them).
  - *Anadara broughtonii* from Turkey (based on pers comm with S. Albayrak).
  - *Doxander vittatus* from Turkey.
- ✓ Removing records not in the wild. e.g,
  - the polychaete *Hydroides albiceps* (Grube, 1870) from ship hull only (France- Zibrowius, 1979)
  - the bryozoan *Celleporaria pilaefera* (Canu & Bassler, 1929) recorded once on oyster baskets and cages off Malta (Agius et al., 1977).

- the molluscs *Hyotissa hyotis*, *Planostrea pestigris*, recorded from a gas platform in Israel towed from Australia (Mienis, 2004).
- ✓ Removing records which recently are widely accepted as cryptogenic e.g the nimble spray crab *Percnon gibbesii*.
- ✓ Inserting a new category for alien status, namely crypto-expanding, i.e. those species with no definite evidence of their native or non-indigenous status due to unclear mode of introduction from the native range (natural spread or human mediated). The term fits best species of Atlantic origin with a disjunct distribution.

18. For EU countries, the Tsiamis et al. (2021) baseline lists up to 2017 were updated to include recent records as well as parasites.

19. Nomenclature was revised for the species listed in Table 2 following WoRMS.

**Table 2.** Species whose nomenclature was recently revised and where they were encountered.

| Old name   | Valid name                                       | Countries      |
|--|--|----------------|
| <i>Chelidonura fulvipunctata</i>                       | <i>Biuve fulvipunctata</i>                       | IL, TR         |
| <i>Flabellina rubrolineata</i>                         | <i>Coryphellina rubrolineata</i>                 | IL, TR         |
| <i>Hippocampus fuscus</i>                              | <i>Hippocampus kuda</i>                          | IL             |
| <i>Melicertus hathor</i>                               | <i>Penaeus hathor</i>                            | IL             |
| <i>Musculista perfragilis</i>                          | <i>Arcuatula perfragilis</i>                     | IL             |
| <i>Pillucina vietnamica</i>                            | <i>Rugalucina angela</i>                         | IL             |
| <i>Erosaria turdus</i> (Lamarck, 1810)                 | <i>Naria turdus</i> (Lamarck, 1810)              | TN, LY         |
| <i>Polysiphonia fucoides</i> (Hudson) Greville         | <i>Vertebrata fucoides</i> (Hudson) Kuntze, 1891 | TN             |
| <i>Hamimaera hamigera</i> (Haswell, 1879)              | <i>Linguimaera caesaris</i> Krapp-Schickel, 2003 | TN, LY, DZ, TR |
| <i>Haminoea cyanomarginata</i> Heller & Thompson, 1983 | <i>Lamprohaminoea ovalis</i> (Pease, 1868)       | LY, ES, CY, TR |
| <i>Apoglossum gregarium</i>                            | <i>Phrix spatulata</i>                           | ES, IT         |
| <i>Gonioinfradens paucidentatus</i>                    | <i>Gonioinfradens giardi</i>                     | CY, TR         |
| <i>Grateloupia lanceolata</i>                          | <i>Pachymeniopsis lanceolata</i>                 | IT             |
| <i>Garveia franciscana</i>                             | <i>Calyptospadix cerulea</i> Clarke, 1882        | IT             |
| <i>Synagrops japonicus</i> (Döderlein, 1883)           | <i>Acropoma japonicum</i> Günther, 1859          | IT             |
| <i>Parviturbo dibellai</i>                             | <i>Conradia eutormisca</i>                       | TR             |
| <i>Pyrgulina maiae</i>                                 | <i>Pyrgulina pupaeformis</i>                     | TR             |
| <i>Miliolinella fichteliana</i>                        | <i>Triloculina fichteliana</i>                   | TR, GR         |
| <i>Sillago sihama</i> (Forsskal, 1775)                 | <i>Sillago suzensis</i>                          | EG             |

20. A number of discrepancies concerning the alien status of some cryptogenic and/or questionable species arose as a result of experts' differing opinions. These need to be discussed and resolved, preferably at the pan-Mediterranean level, as the validation process continues. Some examples include:

- The polychaetes *Metasychis gotoi* (Izuka, 1902) and *Neopseudocapitella brasiliensis* Rullier & Amoureux, which are considered cryptogenic in the most recently updated JRC catalogue (present in Italy, Spain and Cyprus – see Tsiamis et al., 2021) but are accepted as alien species in Turkey

(Çinar et al., 2021). In the current work they were retained as questionable, following Langeneck et al. (2020) and Eduardo López (pers. comm.).

- Taxonomic groups for which recent revisions point to possible misidentifications or to doubts about the alien origin of certain species. Such is the case e.g., for Foraminifera, where this work follows the revision by Stulpinaite et al (2020), which is only partially accepted by Çinar et al. (2021). As a result, there is a large number of discrepancies regarding foraminifera species. Similarly, the work of Schuchert (2007, 2009, 2010) highlights our poor knowledge of the global distribution of hydrozoan species and indicates a number of possible misidentifications for Mediterranean records. Other authors however accept as alien some of these and other, inadequately documented, records (e.g., see Gravili et al., 2013).
- Newly described species with the Mediterranean as the type locality. This typically occurs in taxonomic groups that are generally poorly studied and have seen a recent surge in the collection of new material and the discovery of new species. For example, several new species of Porifera have been recently described from the eastern Mediterranean (Vacelet et al., 2007; Idan et al., 2021), among which only *Niphates toxifera* Vacelet, Bitar, Carteron, Zibrowius & Pérez, 2007 was highlighted as a possible Lessepsian migrant by Vacelet et al. (2007). Nevertheless, the species was not included in the national inventories of Lebanon or Israel, where it was also recorded (Idan et al., 2018), but is included as an alien in the Turkish inventory (Çinar et al., 2021; see also Evcen et al., 2020).

Following Chapman & Carlton's (1991) criteria, the lack of previous records on a basin scale, the mentioned occurrences from confined areas such as lagoons and harbors, the notably poor capabilities of active or passive spreading by natural means of the genus, and its likely exotic evolutionary origin, cumulatively support the hypothesis of a human-mediated introduction. On the other hand, genetic studies of world-wide material, when it is available, may be the only way to truly determine the phylogenetic relationships and origins of the new species/populations (e.g. Belmaker et al., 2021 for an interesting hypothesis on *Brachidontes rodriguezii* (d'Orbigny, 1842)).

21. No changes were made to the establishment success of species at the national level, even when there were differences with the provided data, assuming that the countries have potentially better and more diverse information on the establishment status of NIS in their coastal waters.

22. Furthermore, no changes were made in the pathway column when it was supplied. A species can be introduced via different pathways in different areas, and it is up to each country to fill in.

23. In contrast with the JRC baselines for EU countries, which only partially cover cryptogenic species, a full list of cryptogenic species is included for each Mediterranean country, as recommended by the document on assessment criteria (UNEP/MED WG. 500/7; Zenetos & Galanidi, 2021), for future reference and for use in MAMIAS and EASIN. This increases the contribution of the current work to national and Mediterranean/European databases. The other important contribution is the significant number of updates to the 2017 JRC baselines, which will be used in the framework of the MSFD to set thresholds for D2 indicators and perform the status assessments for the 2018-2023 assessment period.

## 5. Next steps

24. Step 1. Finalisation of the remaining national inventories. The inventories of Spain, Turkey and Slovenia are currently in progress, with ongoing discussions with the national experts to clarify differences and changes made. It is anticipated that these 3 countries will be finalised by the end of May, depending on the availability of the national experts. The same steps will be followed for the inventories of Croatia, Egypt, Italy, Israel and Tunisia, who are in the process of validating the revised spreadsheets. The timeline for completion is difficult to predict as it is important to achieve a consensus on the changes implemented, with detailed exchange of information between national and regional experts. Nevertheless, the agreed deadline of July 15th for the submission of the final regional baseline is expected to be met.

25. Step 2. As records of non-indigenous species are continuously published in the literature some additions have been made after the validation of national inventories had been completed. This process will continue until the final regional baseline is submitted and considered closed, whereby any species additions will be shared with national experts. Currently these species are:

*Synanceia verrucosa* – Cyprus in 2020: Akbora et al., 2021

*Terapon puta* – Turkey in 2020: Manasırılı & Mavruk, 2021

*Pterois miles* – Albania in 2019: Di Martino & Stancanelli, 2021

New NIS for the Mediterranean: *Sargocentron spinosissimum* and *Sargocentron tiereoides* – Egypt: Deef, 2021

26. Step 3. Compilation of the subregional and regional baselines. Once all national inventories are completed, data will be aggregated at two levels, the EcAp subdivision level and the pan-Mediterranean level. Year of first detection and establishment success of each species will be adjusted accordingly. Regarding pathway of introduction, at the regional and subregional level, pathways will be assigned according to the most likely means of primary introduction of the first record in the region/each subregion respectively.

27. The finalised spreadsheet will contain the following information: Species name and authority, taxonomic classification (Kingdom, Phylum, Class, Order, Family), origin, year of first detection, country of first detection, citation for the first record, alien status, overall establishment success in the Mediterranean, primary pathway of introduction. Separate spreadsheets will be prepared with similar information per each EcAp subdivision. The establishment success of the recorded species is not included in the supplementary data files of Tsiamis et al. (2021) for EU Member States D2 reporting, it will be included however in the Mediterranean baseline as it offers valuable information that can inform the implementation of CI6. Any unresolved differences with regards to alien status of species or the validity of specific records will be explicitly presented. A report will accompany the final baseline, containing descriptive statistics at different geographic scales and detailing the major changes made during the validation process.

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