WP3: APPLICATION OF RISK-BASED APPROACH TO NON-INDIGENOUS SPECIES (DESCRIPTOR 2)

Deliverable 3.5 - Report coordinated sub-regional approaches to risk management and recommendations for sub-regional monitoring and measures

Version 1

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Introduction

This document constitutes RAGES Deliverable 3.5 - Report coordinated sub-regional approaches to risk management and recommendations for sub-regional monitoring and measures, of task 3.5 - “Risk management: common targets and coordinated monitoring and measures.” The objective of this task is to propose coordinated actions for D2 risk management to be implemented at sub-regional/national (Member State -MS)/ Marine Reporting Unit (MRU)/ local levels (articles 10, 11 and 13), in areas of concern, based on the administrative framework established at WP2. Deliverable 3.1 (D3.1; Bartilotti et al. 2020a) reported the available information on non-indigenous, cryptogenic and data-deficient species (definitions according to Tsiamis et al. 2019), hereinafter referred as NIS, occurring in two sub-regions of the North-East Atlantic Ocean region, as defined under the Marine Strategy Framework Directive (MSFD), and considered in the RAGES project: the Bay of Biscay and the Iberian Coast (ABI), and the Macaronesia (AMA). Deliverable 3.2 (D3.2; Bartilotti et al. 2020b) established the risk context, including the management objectives, assessment scales and risk parameters and categories. In addition, a list of potential pressures was defined as relevant criteria elements for the assessment of D2 Good Environmental Status (GES), which includes the NIS with known adverse effects and highlights those classified as having a high impact in the European Alien Species Information Network (EASIN), the database that provides technical and scientific support to the relevant European Union policies on biodiversity. Deliverable 3.3 (D3.3; Bartilotti et al. 2020c) defined risk criteria and aggregation methods, and elaborated risk scales for D2 risk evaluation. Deliverable 3.4 performed the risk assessment based on the methodology set in the previous steps to determine if there is a risk of not achieving GES. A particular focus was placed on data regarding major drivers, which act as pathways for NIS, including maritime transport, recreational yachting and aquaculture (Hollatz et al. 2021a). The outcomes of the risk assessment performed in D3.4 aimed to inform the priorities for treatment, and the number and types of pathways that should be worked on, considering the understanding of risk obtained during the analysis. The risk treatment is achieved via the revision of the environmental targets (Article 10) and the subsequent implementation of Monitoring Programmes (MoP; Article 11) and Programmes of Measures (PoM; Article 13). The environmental targets, MoP and PoM, were reported by the MS after the first implementation phase covering the initial assessment of their marine waters (Article 8) and the determination of GES (Article 9).

In this report, a comparative analysis is performed for the environmental targets, MoP and PoM set by each MS at the MSFD 1st and 2nd implementation cycles. The

environmental targets established by France (FR), Portugal (PT) and Spain (ES) and the MoP are publicly available for the 1st and 2nd cycles, except for PT whose MoP for the 2nd cycle is not yet available for public consultation. Reports on PoM are available for the 1st cycle only. The results from this analysis and the risk assessment inform the revision of these elements, enabling the definition of common targets and coordinated measures and MoP for future MSFD cycles.

Review of the environmental targets

The MSFD defines an environmental target as "a qualitative or quantitative statement on the desired condition of the different components of, and pressures and impacts on, marine waters" regarding each marine region or sub-region [Article 3(7)]. Article 10 of the MSFD requires that MS establish a comprehensive set of environmental targets and associated indicators for their marine waters based on their initial assessment. The aim of targets and indicators is to provide an operational tool for managing human activities and their pressures, and for actions, which should lead to improvements in the environmental status of marine waters and ultimately to GES (EC, 2020). In addition, environmental targets should assure their compatibility with objectives to which MS have committed themselves under relevant international and regional agreements, making use of those most relevant for the marine region or sub-region.

The environmental targets established for each marine subdivision are classified in state, pressure, impact, and operational targets. State-based targets provide an indication of the physical, chemical and biological properties of the environment. Pressure-based targets relate to the acceptable or desired level of a particular pressure for the achievement or maintenance of GES, while impact-based targets indicate the acceptable level of impact on the components of the marine environment arising from a pressure or range of pressures. The operational targets imply concrete implementation measures to facilitate the achievement of the other targets. Therefore, they are directly related to the nature of the action required to achieve or maintain GES without establishing the specific measure (Annex IV of Law 41/2010). It is important to note that the environmental targets are associated with the GES descriptors and with indicators that will enable evaluating the achievement levels of those targets.

Each MS must establish clear environmental targets and MoP and draw up a programme of cost-effective measures to achieve GES. Following the initial evaluation results, new environmental targets can be defined to maintain or achieve GES. These targets are

reviewed on a six-year basis. The environmental targets established for D2 by FR, PT and ES in the 1st cycle (2012 - 2017) and 2nd cycle (2018 - 2023) are presented below.

France, Bay of Biscay

In the 1st cycle, FR established one pressure-based target and one impact-based target for D2. In addition, FR highlighted specific needs of knowledge to optimize the definition of the environmental targets for the Bay of Biscay, which include knowledge improvement on the sensitivity and resilience capacities of different components, the establishment of a monitoring network, and the mobilization of a marine environment observation network through users of the environment, such as scientists, naturalists, professionals and citizens. The revision of the environmental targets was reported for the 2nd cycle in 2020, with the main goal to reduce the introduction and/or spread of NIS by various maritime activities, in particular maritime transport and aquaculture. Also, the environmental targets aim, as much as possible, to limit the spread of NIS already present in the environment. Table 1 presents the summary of environmental targets and associated indicators reported by FR for both cycles.

Table 1. Environmental targets proposed by France (Bay of Biscay) for D2 in the first and second cycles of the MSFD.

FR/Bay of Biscay	
1st cycle (2012)	**2nd cycle (2020)**
Pressure-based target To reduce the risks related to the accidental (involuntary) introduction to the voluntary introduction and the spread of NIS. **Associated indicator** 2.1.1: trends in abundance, temporal occurrence and spatial distribution in the wild of NIS, particularly invasive NIS, notably in risk areas in relation to the main vectors and pathways leading to the spread of such species.	**Target D02-OE01** To reduce the risk of the introduction of NIS associated with the importation of flora and fauna. **Associated indicator** D02-OE01-ind1: Number of inspections revealing the presence of level 2 species during border controls, under Article 15 of the regulation of 22 October 2014 and Article L. 411-7 of the French Environmental Code.
Impact-based target To reduce the impacts from NIS. **Associated indicator** 2.2.2: Impact of invasive NIS at the level of species, habitats and ecosystems where feasible.	**Target D02-OE02** To reduce the transfer of NIS from heavily impacted areas. **Associated indicator** An indicator concerning the limitation of NIS transfer from heavily impacted areas remains to be developed.
	Target D02-OE03 To reduce the risk of introduction and spread of NIS associated with the ship's ballast water and sediments. **Associated indicator**

	D02-OE03-ind1: Number of ships in compliance with the current regulations in terms of ballast water management.
	Target D02-OE04 To reduce the risk of the spread of NIS during the introduction and the transfer of aquaculture species. **Associated indicator** D02-OE04-ind1: Proportion of the number of permit applications related to the introduction of NIS for aquaculture purposes.
References: https://dcsmm.milieumarinfrance.fr/content/download/4880/file/PAMM_GDG_OE2012.pdf (1st cycle) https://dcsmm.milieumarinfrance.fr/content/download/6460/file/Fichedetaillee_OE_SA_D2%20Esp%C3%A8ces%20non%20indig%C3%A8nes.pdf (2nd cycle)	

Mainland Portugal

In the 1st cycle, a single operational target was established for D2 in mainland PT. The initial evaluation of marine waters highlighted little or no data available, requiring additional or continued actions to gather more data and support the temporal and spatial patterns of the results. This target was considered in the 2nd cycle as partially achieved. In the 2nd cycle, two new operational targets were established, and actions such as identifying hotspots of NIS introductions and implementing an early warning system, as well as mechanisms for the early detection of NIS were established under operational target ABIPT-T2-D2Cont. The environmental targets established by mainland PT are presented in Table 2.

Table 2. Environmental targets established by Portugal Mainland for D2 in the first and second cycles of the MSFD.

PT/Mainland	
1st cycle (2012)	**2nd cycle (2020)**
Operational target To study, restructure and manage the monitoring networks that enable the collation of information to support the characterization of the marine environment, especially in situations requiring more attention to maintain or achieve GES and for the situations that can reveal the relationship between monitoring results and human activities. **Associated indicators** All	**Operational target (new)** **ABIPT-T1-D2Cont** To establish lists of NIS, especially invasive ones, in the ABI sub-region, by 2021. **Associated indicator** Approved lists for the sub-region. **Evaluation area** A, B, C.
	Operational target (new) **ABIPT-T2-D2Cont** To reduce the risk of NIS introductions by 2021.

	Associated indicator The number of actions aiming at the reduction of NIS implemented until 2021.
References: https://www.dgrm.mm.gov.pt/documents/20143/43971/EstrategiaMarinha_subdv_Continente.pdf/3f9a7135-5084-d556-51e8-837c1a72c450 https://www.dgrm.mm.gov.pt/documents/20143/43971/Doc8.+Parte+D_Continente.pdf/947797e7-1e4e-cc5f-a0f4-8d2b1eaf4f08	

Portugal, Autonomous Region of Azores

For the Azores, one state-based target and one pressure-based target were established for D2 in the 1st cycle. For the 2nd cycle, the Azores established three new targets; the pressure-based target covers Santa Maria Island, while the others refer to the Azores area (Table 3).

Table 3. Environmental targets established by the Azores, Portugal, for D2 in the first and second cycles of the MSFD.

PT/Azores	
1st cycle (2014)	**2nd cycle (2020)**
Pressure-based target To prevent the introduction of marine species in order to mitigate possible marine bioinvasions through the monitoring of the main pathways of introduction.	**Pressure-based target (new)** **D2-AZO-M1** To reduce the population of the species *Phorcus sauciatus* on the Santa Maria Island, promoting the regulated exploitation of this invasive resource. **Associated indicator** The legal diploma regulates the exploitation of the resource.
State-based target Monitoring the population dynamics of *Caulerpa webbiana* and other invasive marine species occupying restricted areas in the region. **Associated indicator** 2.1.1: trends in abundance, temporal occurrence and spatial distribution in the wild of NIS, particularly invasive NIS, notably in risk areas in relation to the main vectors and pathways leading to the spread of such species.	**Operational target (new)** **D2-AZO-M2** Improved monitoring and surveillance for the early detection of new NIS introductions, particularly at high-risk locations identified.
	State-based target (new) **D2-AZO-M3** The number of new introductions is minimized and, where possible, reduced to zero in the following evaluation cycle. **Associated indicator** Number of NIS introduced in each cycle (6 years).
References:	

https://www.dgrm.mm.gov.pt/documents/20143/43971/RelatorioInicial_AZO_FINAL_2014+%282%29.pdf/a0b43add-3ba3-6e52-e660-11189ef15ad7 (1st cycle)

https://www.dgrm.mm.gov.pt/documents/20143/43971/Doc9.+Parte+D_A%C3%A7ores.pdf/64303d97-fda1-2eba-53b6-505d512f40b8 (2nd cycle)

Portugal, Autonomous Region of Madeira

For Madeira, one state-based target and three operational targets were established for D2 in the 1st cycle. The goal of the state-based target was to use, as a reference, population trends obtained through already existing species monitoring programmes and others to be implemented. As for mainland PT, Madeira highlighted situations of lack of data and/or situations for which additional or continued action was necessary to gather more data in order to support the temporal and spatial patterns of the results. In the 2nd cycle, two targets established in the 1st cycle were considered partially achieved (one state and one operational target), while two targets were considered not achieved. Therefore, in the 2nd cycle, two existing targets were maintained (one new pressure and one operational target; Table 4).

Table 4. Environmental targets established by Madeira, Portugal, for D2 in the first and second cycles of the MSFD.

PT/Madeira	
1st cycle (2014)	**2nd cycle (2020)**
State-based target To promote knowledge of marine habitats and biocenoses, in particular, those existing in coastal strips, in order to obtain quantitative and qualitative information allowing the definition of the initial state and occurrence areas (mapped). To establish monitoring programs to maintain and/or restore coastal habitats. **Associated indicator** Appropriate indicators for evaluation. Existence of monitoring programs. 1.1.1. Distribution area; 1.2.1 Population abundance and/or biomass; 1.4.1. Habitat distribution; 1.5.1. Habitat extension; 1.6. Condition of habitats.	**State-based target (existing)** **AMAPT-T001-D2MAD** To promote knowledge of marine habitats and biocenoses, in particular, those existing in coastal strips, in order to obtain quantitative and qualitative information allowing the definition of the initial state and occurrence areas (mapped). To establish monitoring programs to maintain and/or restore coastal habitats. **Associated indicator** BIOMAD project indicators (MEMAD01-D1 measurement sheet - Study, identify, characterize and georeference coastal habitats and marine biocenoses). SEDPLAT project indicators (MEMAD02-D6 measurement sheet - Survey characterization of the sedimentary deposits on island platforms).
Operational target To study, restructure and manage the monitoring networks that enable the collation of information to support the characterization of the marine environment, especially in situations requiring more attention to maintain or achieve GES and for the situations that can reveal the relationship between monitoring results and human activities.	**Pressure or impact-based target (new)** **AMAPT-T015-D2MAD** To establish monitoring programs for species or functional groups whose proliferation indicates a clear change or threat to the local trophic networks (ex: *Diadema* aff. *antillarum*, escapees from marine aquaculture facilities). **Associated indicator**

Associated indicator All	The number of programs.
Operational target To monitor and systematize the results of scientific studies regarding causes and effects between marine litter, biota and the marine environment, selecting for Madeira subdivision the most appropriate biological indicator to assess the impact of marine litter on biota and establish appropriate protocols to assess the indicator 10.2. **Associated indicator** 10.2.1 Trends in terms of quantity and composition of litter ingested by marine animals (for example, through stomach content analysis).	**Operational target (existing)** **AMAPT-T003-D2MAD** To study, restructure and manage the monitoring networks that enable the collation of information to support the characterization of the marine environment, especially for situations requiring more attention to maintain or achieve GES and for the situations that can reveal the relationship between monitoring results and human activities. **Associated indicator** DATA-ATLÂNTICO project indicators (MEMAD04-DV measurement sheet - Accommodation and data sharing in RAM). DQEMdata project indicators (Measure sheet M06-DT - Implement and manage network system for monitoring data sharing).
Operational target To assess the potential of the Selvagens Islands as an area of excellence for the monitoring of marine litter in the Atlantic and their transport mechanisms, seeking to create an indicator of the status and functioning of ocean currents. **Associated indicator** Associated indicators of Descriptor 10.	**Operational target (new)** **AMAPT-T016-D2MAD** To effectively control NIS introduction in protected areas of the subdivision of Madeira. **Associated indicator** Ongoing management plans.
References: https://www.dgrm.mm.gov.pt/documents/20143/43971/RelatorioInicial_MAD_FINAL__2014.pdf/0f2783be-bf81-5d26-83cd-15830cff998c (1st cycle) https://www.dgrm.mm.gov.pt/documents/20143/43971/Doc10.+PARTE+D_Madeira.pdf/a5574d46-aa3b-b3b2-ba18-dfa459e6f87e (2nd cycle)	

Spain

ES established general targets applied across all Spanish waters, although specific environmental targets are only applied within a marine subdivision. These targets come up from the Spanish Law 41/2010 for the Protection of the Marine Environment. The environmental targets related to D2 are:

- Environmental target A. To protect and preserve the marine environment, including its biodiversity, avoid its degradation and restore marine ecosystems in areas that have been adversely affected.
  - *A.1. To ensure the conservation and recovery of marine biodiversity through effective measures and instruments.*
- Environmental target C. To ensure that the activities and uses in the marine environment are compatible with the conservation of its biodiversity.
  - *C.1. To ensure that sectoral policies and administrative actions with an impact on the marine environment are compatible with the achievement or maintenance of GES defined in marine strategies.*

- *C.3. To promote a better knowledge of Spanish marine ecosystems and their responses to human activities, as well as better access to environmental information.*

In the 1st cycle, three pressure-based targets and five operational targets were established for all marine subdivisions of ES. In the 2nd cycle, ES defined 13 environmental targets, of which three are pressure-based targets, and ten are operational targets (one new). Also, two operational targets related to environmental target B were included:

- Environmental target B. To prevent and reduce inputs into the marine environment to progressively phasing out its pollution, to ensure that no impacts or risks to marine biodiversity, marine ecosystems, human health or permitted uses at sea appear.

A summary of the environmental targets and associated indicators established by ES in the 1st cycle (all subdivisions) and 2nd cycle (North Atlantic, South Atlantic and the Canary Islands) are presented in Table 5.

Table 5. Environmental targets established by Spain for D2 in the first and second cycles of the MSFD. NA: North Atlantic, SA: South Atlantic and CAN: Canary Islands.

ES	
1st cycle (2012)	**2nd cycle (2020)**
Pressure-based target **A.1.1** To minimize the introduction or expansion of NIS focusing on the man-induced pathways of translocation (to avoid releases from aquaculture facilities or aquariums; to avoid the transportation and release into the environment of species associated to cultivated species in areas outside their natural range of distribution; to control the ballast water, the use of live baits, the discharges of sediments, the boat anchoring or the cleaning of ship hulls). **Associated indicator** Number of pathway management measures.	**Pressure-based target** **A.N.9 (NA), A.S.9 (SA) and A.C.9 (CAN)** To manage, in an integrated way, the invasion processes of NIS, especially in the demarcation area, including the development of early detection networks and their coordination on a national scale. **Associated indicator** Percentage of the demarcation area covered by detection and quantification networks of NIS. Existence of action protocols in the event of detection of NIS; Number of marine species that are catalogued in the lists of invasive NIS species; Percentage/number of invasive species subject to management measures or actions; Percentage/number of habitats affected by invasive species that have been subject to management measures or actions.
Pressure-based target **A.1.3** To eradicate or decrease, preferably in the early stages of invasive processes, the abundance of invasive species in order to reduce the pressure on the habitats, in those cases in which the economic or biodiversity losses are significant, when technically feasible and no collateral damage is caused.	**Operational target** **A.N.10 (NA), A.S.10 (SA) and A.C.13 (CAN)** Ensure compliance with regulations. **Associated indicator** Surveillance estimate in hours. • Identified infractions *vs* imposed sanctions; • Human resources available for surveillance and materials available.

Associated indicator Number of invasive species and area subject to treatment for their eradication or decrease.	
Pressure-based target **A.1.5** To prevent the impacts produced by cultivated species on the food webs, focusing on the cultivation of NIS and non-common cultivated species. **Associated indicator** Existence of control programs.	**Operational target** **B.N.14 (NA), B.S.14 (SA) and B.C.13 (CAN)** To promote scientific studies, initiatives and projects regarding the impacts of the introduction of substances, litter and energy in the marine environment; respond to the knowledge gaps detected in the initial assessment and the successive phases of the Marine Strategies. **Associated indicator** Knowledge gaps related to impacts produced by the introduction of substances, litter and energy into the marine environment are addressed by scientific studies and projects.
Operational target **A.1.9** To ensure adequate marine surveillance using both remote and *in-situ* systems. **Associated indicator** Existence of surveillance systems.	**Operational target (new)** **B.N.15 (NA), B.S.15 (SA) and B.C.14 (CAN)** To integrate the results and knowledge acquired through scientific studies, initiatives and projects on the impacts of the introduction of substances, litter and energy into the marine environment into decision-making and management of the marine environment. **Associated indicator** Criteria for the evaluation and monitoring, for which the results of scientific projects and studies have been taken into account. Management objectives and measures planned based on the results of scientific projects and studies.
Operational target **C.1.3** To ensure public participation in the North Atlantic marine strategy through public awareness, environmental education, volunteering activities and marine environment stakeholder's initiatives. **Associated indicator** The number of public participation initiatives and outcome assessments.	**Pressure-based target** **C.N.2 (NA), C.S.2 (SA) and C.C.2 (CAN)** To minimize the possibilities of secondary introduction or expansion of NIS due to human-mediated translocations. **Associated indicator** Number of action/control measures on introduction pathways and translocations. The number of routes and pathways of introduction and translocation addressed by action or regulated measures, such as escapes in aquaculture facilities, ballast water, anchoring, biofouling", live baits, and all kinds of discharges; The number of introduction events of invasive NIS by pathway/route.
Operational target **C.1.4** To achieve proper coordination between administrations, institutions and marine environmental sectors to avoid duplicities and take advantage of synergies within the subdivision. **Associated indicator** The number of initiatives, projects and coordination meetings.	**Pressure-based target** **C.N.5 (NA), C.S.5 (SA) and C.C.9 (CAN)** To prevent the impacts on trophic networks of the cultivated marine species, with special attention to the cultivation of NIS and rare species. **Associated indicator** Existence of prevention measures within control programs.
Operational target **C.3.1** To improve access to environmental information on the marine environment, in particular concerning qualitative descriptors for determining	**Operational target** **C.N.6 (NA), C.S.6 (SA) and C.C.11 (CAN)** To guarantee social participation in the marine strategy of the demarcation through initiatives of dissemination, awareness, voluntary environmental

GES, pressures and impacts and the socioeconomic aspects, as well as to ensure the good quality of this information. **Associated indicator** Level of access and quality of the available information on the marine environment.	education and involvement of sectors interested in the marine environment. **Associated indicator** Number of social participation initiatives and evaluation of their results.
Operational target **C.3.7** To improve the understanding of the presence, spatial distribution, abundance and impact of NIS, especially those with invasive potential, promoting specific studies and developing monitoring programmes coordinated at national level. **Associated indicator** The number of studies and percentage of the subdivision area covered by regular programs for the detection and quantification of NIS.	**Operational target** **C.N.7 (NA), C.S.7 (SA) and C.C.12 (CAN)** To achieve adequate coordination of public administrations, institutions and sectors in each demarcation that carry out work related to the marine environment to avoid duplication while taking advantage of synergies. **Associated indicator** The number of initiatives, projects and coordination meetings; The number of topics for which coordination initiatives are adopted.
	Operational target **C.N.8 (NA), C.S.8 (SA) and C.C.13 (CAN)** To promote through the Maritime Spatial Management Plan of the marine demarcation or other management tools that human activities are developed sustainably, not compromising the achievement of GES. **Associated indicator** The number of human activities contemplated in the management plan.
	Operational target **C.N.15 (NA), C.S.15 (SA) and C.C.19 (CAN)** To improve access to the available information on the marine environment, particularly related to descriptors of GES, pressures and impacts, and socioeconomic aspects, as well as ensuring the quality of this information, both for sea-related administrations and institutions, as for the general public. **Associated indicator** Existence of platforms for access and exchange of information on the marine environment, facilitating management for public administrations. Means of access and available information quality on the marine environment for citizens; The number of available metadata.
	Operational target **C.N.16, C.S.16 and C.C.20** To promote scientific studies and projects in order to respond to the knowledge gaps identified in the initial assessment regarding the impact of human activities on marine and coastal ecosystems. **Associated indicator** Number of scientific studies and projects promoted by public administrations addressing these matters; Gaps of knowledge addressed by scientific studies and projects.
	Operational target **C.N.17 (NA), C.S.17 (SA) and C.C.21 8CAN)** To improve knowledge concerning the effects of climate change on marine and coastal ecosystems, with the aim to integrate the climate change variable,

	in a transversal way, in all phases of Marine Strategies. **Associated indicator** Number of scientific studies and projects promoted by public administrations addressing this matter; Number of monitoring indicators addressing climate change aspects; Percentage of phases of Marine Strategies that take into account climate change.
	Operational target **C.N.18 (NA), C.S.18 (SA) and C.C.22 (CAN)** To integrate the results and knowledge acquired through scientific studies, initiatives and projects on the impact of human activities on habitats, species, populations and communities into decision-making and management of the marine environment. **Associated indicator** Criteria for the evaluation and monitoring, for which the results of scientific projects and studies have been taken into account (considering the references in the documents). Management objectives and measures planned based on the results of scientific projects and studies.
References: https://www.miteco.gob.es/es/costas/temas/proteccion- medio- marino/environmentaltargetsfirstcycle2012-2018_tcm30-501226.pdf (1st cycle) https://www.miteco.gob.es/es/costas/temas/proteccion- medio- marino/anexoacuerdoccmmobjetivosambientaleseemm_web_tcm30-497743.pdf (2nd cycle)	

Review of the Monitoring Programmes and Programmes of Measures

The MoP provide the data and information needed to assess whether GES has been achieved or maintained, thus assessing progress towards delivering the environmental targets and effectiveness of measures. Therefore, the PoM is defined based on the initial assessment of the marine waters and the environmental targets already established, considering the types of measures listed in Annex IV of the MSFD (EU, 2008). In addition, existing measures derived from other legislation or international agreements may be considered, especially those relevant to the MSFD environmental targets. The MoP and PoM reported by FR, PT and ES for the 1st cycle are available at:

FR: https://dcsmm.milieumarinfrance.fr/

PT: https://www.dgrm.mm.gov.pt/as-pem-diretiva-quadro-estrategia-marinha

ES: https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/estrategias-marinas/default.aspx

For the 2nd cycle, ES and FR submitted their MoP, while PT's MoP is not yet available for public consultation. A summary of the MoP and PoM reported by FR, PT and ES for D2 is presented below.

Monitoring Programmes and Programme of Measures - France

FR submitted its MoP report and reporting sheets for the 1st cycle in 2015. For the ABI sub-region, it includes three sub-programmes:

1. Sub-programme no. 1 - Introduction of NIS via the main pathways: ballast water and sediments, biofouling and imports and transfers of living organisms.
2. Sub-programme no. 2 - Dedicated monitoring in areas at risk and areas sensitive to bio-pollutions.
3. Sub-programme no. 3 - Characterization of the status and impacts of NIS ("bio-polluted" areas and "reservoir of NIS" areas).

FR reported that its monitoring would be implemented in a two-step approach with the 1st cycle of monitoring collecting data to develop a methodology for the 2nd cycle (future monitoring). The sub-programmes would monitor the following elements: introduction of NIS and pathways of introduction (covering ballast water and sediments, biofouling and introduction of living species) as well as the impacts of NIS. Parameters monitored were quantity and type of NIS (EC, 2015a).

Environmental targets addressed by sub-programmes 1, 2 and 3:

- Reduce the risks related to the accidental (involuntary) introduction, to the voluntary introduction and the spread of NIS (pressure).
- Reduce the impacts of NIS (impact).

The conclusion drawn up by the EC was that the MoP did not ensure coverage of the monitoring needs for the assessment of progress towards the achievement of GES. Only a small number of NIS was monitored in each sub-region. Moreover, the MoP did not cover impacts on the environment, which is part of the French GES definition (EC, 2015a).

The MoP report for the 2nd cycle is available at: https://www.merlittoral2030.gouv.fr/donnez-votre-avis. For the ABI sub-region, it includes the same three sub-programmes reported in the 1st cycle. In the second cycle, priority will be given to the operationalization of sub-programme 2 and the development of sub-programmes 1 and 3.

FR reported its PoM for the 1st cycle by 2016. It includes six existing measures, based on existing regulatory frameworks to provide measures, and one new measure:

- M208-NAT1a (existing) - Regulatory framework for the introduction of NIS and the preservation of ecosystems by the governing authorities (applicable to North-East Atlantic sub-regions).
- M209-NAT1a (existing) - Combating invasive NIS and promoting a plan at the national scale (applicable to North-East Atlantic sub-regions).
- M211-NAT1a (existing) - Regulatory framework for the transfer of NIS for aquaculture activities (applicable to North-East Atlantic sub-regions).
- M010-NAT1b (existing but not yet implemented) - Contributing to the monitoring and alert systems within the scope of the European regulation on invasive NIS and improving its regulation (applicable to all sub-regions).
- M012-NAT1b (existing but not yet implemented) - Implementing a ballast water management control procedure for ships, following the International Convention for the Control and Management of Ships' Ballast Water and Sediments (applicable to all sub-regions).
- M210-NAT1b (existing but not yet implemented) - Exploitation of invasive NIS in order to limit their spread (applicable to North-East Atlantic sub-regions).
- M011-NAT2 (new) - Promoting good practices in fisheries to limit the spread of invasive NIS (applicable to all sub-regions).

Overall, the PoM addressed the MSFD needs to progress towards GES in the Bay of Biscay. The measures addressed pressures identified in their Article 8 reporting, covering NIS introductions caused by various pathways such as aquaculture, shipping and fishing. The measures addressed the D2 GES and targets. They covered the risk of new introductions, NIS spread and impacts, by focusing on essential pathways (EC, 2018a).

Monitoring Programme and Programme of Measures - Portugal

PT completed its reporting on both MoP and the PoM for the 1st cycle in 2014. The text report provides the explanation of the strategy and methodology followed, and includes the monitoring sub-programmes sheets and the measures sheets.

The MoP for D2 in PT consists of two sub-programmes:

1. Sub-programme MO06-III - DIVTROFICA – Monitoring pelagic and benthic habitats and food webs (applicable to mainland and Madeira).

The sub-programme MO06-III monitors biological components by describing the biological communities associated with the predominant seabed habitats and the water column, including species composition, biomass, distribution, size and annual variability. Monitoring include human-activities, such as fishing, dredging, aquaculture, urban effluents, organic contamination, navigation and nautical tourism. The impacts monitored include physical damage (abrasion and selective extraction) and biological disturbance (selective extraction of species).

Environmental targets addressed by MO06-III:

Mainland and Madeira sub-divisions:

- To study, restructure and manage the monitoring networks that enable the collation of information to support the characterization of the marine environment, especially in situations requiring more attention to maintain or achieve GES and for the situations that can reveal the relationship between monitoring results and human activities (operational).

2. Sub-programme MO07-III - MONIEXOTICAS/NISPOR – Monitoring of abundance and impact of NIS on the Portuguese coast (applicable to mainland, the Azores and Madeira). This sub-programme focuses on monitoring NIS in harbours and marinas.

Environmental targets addressed by MO07-III:

Mainland and Madeira sub-divisions:

- To study, restructure and manage the monitoring networks that enable the collation of information to support the characterization of the marine environment, especially for situations requiring more attention to maintain or achieve GES and for the situations that can reveal the link between monitoring results and human activities (operational).

Azores sub-division:

- Prevent the introduction of marine species to mitigate possible marine bioinvasions, by monitoring the main pathways of introduction (operational).
- Monitor the population dynamics of *Caulerpa webbiana* and other invasive marine species occupying restricted areas in the Azores region (operational).

The EC concluded that the MoP ensured partial coverage of the monitoring needs for assessing progress towards the achievement of GES. PT's MoP covered pelagic and benthic habitats, food webs, as well as monitoring of human activities in harbours and marinas (EC, 2015b).

The MoP report for the 2nd cycle in mainland PT is currently in preparation by IPMA (C. Bartilotti, personal communication, May 2021), it proposes four sub-programmes:

1. Monitoring of NIS in Marine Protected Areas (MPA).
2. Monitoring of NIS in areas at higher risk of NIS introductions, through the monitoring of the main introduction pathways and spread.
3. Monitoring of NIS focusing on specific taxa of the phytoplankton, zooplankton, benthic and nekton communities.
4. Creation of a freely available NIS database for mainland PT.

The PoM reported in 2014 addresses two measures:

- MEA04-D2 – Identify the main pathways of introduction of NIS and the environmental conditions that may facilitate the appearance of NIS (applicable to the Azores).

The measure aims at identifying the main drivers behind the introduction of NIS and the environmental conditions that can facilitate the appearance of such species. The measure also aims to create an alert system to detect NIS and test the hypotheses on the conditions favouring this phenomenon by preparing a management plan to monitor and mitigate the effects of the invasion of the green seaweed *Caulerpa webbiana* in the region (EC, 2018b).

- ME08-DV - DQEMsat – Implement the use of satellite images to acquire knowledge about the marine environment (applicable to mainland and Madeira).

Measure ME08-DV plans to use satellite images to fill knowledge gaps and identify the areas subjected to pressures considered of priority importance. PT identified the pressure 'introduction of NIS' as relevant for its waters and identified shipping and aquaculture as the main activities causing this pressure.

Overall, the EC report indicates that in all subdivisions, the PoM did not address MSFD needs to progress towards GES. The measures did not address the key pressures identified in their Article 8 reporting: NIS introductions through shipping and aquaculture. There were no measures on ballast water management or hull fouling. The measures partially addressed the D2 GES and targets (EC, 2018b).

Monitoring Programme and Programme of Measures - Spain

ES submitted its MoP report and reporting sheets for the 1st cycle in 2015, including one monitoring programme reporting sheet and a series of monitoring sub-programme sheets, similar for all subdivisions.

The MoP for D2 consisted of five sub-programmes in the ES/North Atlantic (ES/NA), ES/South Atlantic (ES/SA) and Canary Islands. Also, four monitoring activity sub-programmes (i.e., specific sub-programmes to monitor human activities), were established, and one sub-programme describing operational objectives. Some of the measures are applied to all subdivisions. However, we present those related to the RAGES area solely.

ES/NA, ES/SA and Canary Islands subdivisions:

1. Sub-programme EAI-1 - Detect and quantify NIS in sensitive or MPA.

The elements monitored are NIS, and the parameters covered include trends in abundance, temporal occurrence and spatial distribution of NIS, the ratio of NIS to native species, NIS impacts and NIS introduction rate (over a defined period).

2. Sub-programme EAI-2 - Detect NIS in areas of high risk of introduction such as ports, marinas and aquaculture facilities

The elements monitored are NIS, and the parameters covered are NIS introduction rate (in a defined period), trends in abundance, temporal occurrence and NIS spatial distribution.

3. Sub-programme EAI-3 - Monitoring of already established invasive NIS, which also have the potential to spread further

The elements monitored are NIS, and the parameters measured are trends in abundance, temporal occurrence and NIS spatial distribution, the ratio of NIS to native species and NIS impacts.

4. Sub-programme EAI-4 - Data gathering on NIS abundance or biomass

The main goal of this sub-programme is the use of all sources of information on NIS derived from available biodiversity projects or programs in order to integrate this information into a common database.

5. Sub-programme EAI-5 - Additional data gathering

The main goal of this sub-programme is the compilation and integration of all relevant NIS information in a common database derived from other research projects and not included in other programs.

Data gathered through the EAI-4 and EAI-5 sub-programmes will complement the monitoring activities undertaken in the EAI-1, EAI-2 and EAI-3 sub-programmes.

The monitoring activity sub-programmes aim to contribute with NIS data by monitoring aquaculture activities, tourism and shipping in marinas and ports.

Environmental target addressed by all sub-programmes:

ES/NA, ES/SA and Canary Islands sub-divisions:

- To improve the understanding of the presence, spatial distribution, abundance and impact of NIS, especially those with invasive potential, through promoting specific studies and developing MoP, coordinated at a national level.

Environmental target addressed by EAI-1 and EAI-2 sub-programmes:

ES/NA, ES/SA and Canary Islands sub-divisions:

- To minimize the introduction or expansion of NIS focusing on the man-induced pathways of translocation (to avoid releases from aquaculture facilities or aquariums; to avoid the transportation and release into the environment of species associated to cultivated species in areas outside their natural range of distribution; to control the ballast water, the use of live baits, the discharges of sediments, the boat anchoring or the cleaning of ship hulls).
- To eradicate or decrease, preferably in the early stages of the invasive processes, the abundance of invasive species in order to reduce the pressure on the habitats, in those cases in which the economic or biodiversity losses are significant, whenever technically feasible and no collateral damage is caused.

The conclusion made by the EC was that the MoP most likely ensures coverage of the monitoring needs for the assessment of progress towards GES. The elements and parameters being monitored were considered as appropriate by the EC (EC, 2015c).

The MoP reported by ES for the 2nd cycle includes the five sub-programmes defined in the 1st cycle, with some modifications. The updated sub-programmes EAI-1, EAI-3, EAI-4 and EAI-5 focus on newly introduced and established NIS, including a list of NIS that should be monitored.

Spain submitted its PoM in 2017, that includes 12 existing measures and three new measures:

- M340 (existing) - OSPAR-HELSINKI-BARCELONA General Guidance on Voluntary Provisional Application of D1 Standard on ballast water exchange by vessels operating between the Mediterranean Sea and the North-East Atlantic and/or the Baltic Sea (applicable to ES/NA and ES/SA).
- M343 (existing) - Regulation (EU) 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive NIS (applicable to ES/NA, ES/SA and the Canary Islands).

- M344 (existing) - Royal Decree 630/2013, of August 2, which regulates the Spanish Catalogue of Invasive NIS (applicable to ES/NA, ES/SA and the Canary Islands).
- M345 (existing) - Council Regulation (EC) No 708/2007 of 11 June 2007 concerning the use of NIS and locally absent species in aquaculture (applicable to ES/NA, ES/SA and the Canary Islands).
- M346 (existing) - EU Strategy on invasive NIS (applicable to ES/NA, ES/SA and the Canary Islands).
- M347 (existing) - Working Group on Regulation (EU) 1143/2014 on NIS and invasive species (applicable to ES/NA, ES/SA and the Canary Islands).
- M350 (existing) - Early detection and experiences of eradication of NIS and invasive NIS (applicable to ES/NA and ES/SA).
- M351 (existing) - Measures to improve knowledge of NIS and invasive NIS in the marine environment (applicable to ES/NA, ES/SA and the Canary Islands).
- M352 (existing) - Awareness-raising actions on NIS and invasive NIS (applicable to ES/NA, ES/SA and the Canary Islands).
- M338 (existing but not yet implemented) - International Convention for the Control and Management of Ships' Ballast Water and Sediments (applicable to ES/NA, ES/SA and the Canary Islands).
- M284 (existing but not yet implemented) - Measures to prevent or control the negative impacts of invasive NIS and NIS in aquatic ecosystems (applicable to ES/NA, ES/SA and the Canary Islands).
- M349 (existing but not yet implemented) - Autonomous Action Plans on invasive species (applicable to ES/NA).
- EAI1 (new) - Improving knowledge on invasive NIS and related issues (applicable to ES/NA, ES/SA and the Canary Islands).
- EAI2 (new) - Alert systems, early detection and rapid eradication of invasive NIS (applicable to ES/NA, ES/SA and the Canary Islands).
- EAI3 (new) - Mobile application for alert and early detection of NIS and invasive NIS in National Parks (applicable to ES/NA).

Overall, the PoM addressed the MSFD needs to progress towards GES. ES's PoM combined measures that tackle NIS introductions and address important pathways, including aquaculture, fisheries and shipping (ballast water and fouling), as well as existing NIS management and eradication efforts. In addition, GES and target components are addressed by the reported PoM (EC, 2018).

Summary of the overall assessment of adequacy and coherence among MS reports

MS reported their initial assessments (Article 8), the determination of GES (Article 9) and the identification of environmental targets and associated indicators (Article 10) to the EC in 2012, and the following MoP in 2014 (PT) and 2015 (ES, FR), the PoM reports were completed in 2014 (PT), 2016 (FR) and 2017 (ES). The EC assessed the adequacy of each Article reports, their coherence within and between the regions and the consistency between the reports for those articles. The assessment of these elements highlighted a lack of coherence and consistency in applying Decision 2010/477/EU amongst MS. A summary of the assessment of RAGES MS performance for D2 is shown in Table 6.

Table 6. Summary of the assessments of the adequacy of MS's reports for MSFD Articles for D2, and coherence in the North-East Atlantic (NEA) region and the Bay of Biscay and Iberian Coast (ABI) and Macaronesia (AMA) sub-regions. Results of the assessment are shown for the RAGES study area (FR: France; PT: Portugal; ES: Spain). Adequacy/Coverage – A: Adequate; IN: Inadequate; PA: Partially adequate; N: Not reported; NO: No coverage; PC: Partly coverage; FC: Full coverage; Ad: Addressed; PAd: Partially addressed; NAd: Not addressed; "-": not assessed. Coherence - H: High; M: Moderate; L: Low. ET: Environmental target; P: Pressure.

MSFD Article	Adequacy/Coverage			Coherence		
	FR	PT	ES	NEA	ABI	AMA
Initial Assessment (Article 8)	A	A	PA	H	H	-
GES determination (Article 9)	IN	IN	PA	L	L	-
Environmental targets (Article 10)	IN	N*	PA	L	L	-
Monitoring Programmes (Article 11)	NO (GES) NO (ET)	PC (GES) PC (ET)	FC (GES) PC (ET)	M	M	M
Programme of Measures (Article 13)	Ad (P) Ad (GES/ Targets)	NAd (P) PAd (GES/ Targets)	Ad (P) Ad (GES/ Targets)	M to H		

**Portugal submitted updated targets by 2017, which were taken into account in subsequent assessments. The regional coordination was addressed, but the EC did not reassess coherence. Note: The assessment of coherence regarding the three first phases of the MSFD implementation was not carried out for the AMA sub-region since the reports from the Azores and Madeira Island were only produced in 2014.*

Based on the assessments of MS reports for the first phase of the MSFD implementation (EC, 2014), MoP (EC, 2017) and PoM (EC, 2018d), the EC set out a number of recommendations to improve the adequacy and coherence of GES. These recommendations can be implemented at the regional level through the following actions (EC, 2014):

- Further develop region- and ecosystem-specific criteria for GES (or related targets and indicators) which are compatible with the MSFD, in particular for those descriptors or parameters where no EU legislation exists.
- Stimulate further coordination at regional or sub-regional level between EU MS in the region.
- Ensure that the results of the regional work benefit from the progress made at the EU level and are systematically used in the national implementation process.
- Systematically identify the gaps in knowledge that prevent a more ambitious, risk-based setting of GES, and collaborate to close these gaps whilst applying the precautionary principle in the meantime.

Development of RAGES Risk-Based Approach

The GES Decision (Commission Decision (EU) 2017/848) makes explicit reference to the risk-based approach (RBA), which can reduce efforts, particularly for monitoring and assessment. The document sets out how an RBA can be used in the context of the GES Decision and implementation of Articles 8, 9, 10, 11 and 13 (EC, 2020). A summary of the actions that MS should focus on under each Article is presented below:

- **Article 8** - assessments can focus on areas (firstly using a map of human activities, if appropriate) that are subject to anthropogenic pressure.
- **Article 9** - identification of the elements (e.g., species and habitats) and parameters (e.g., population size, species composition, biomass) which will most effectively indicate environmental status in relation to a specific pressure.
- **Article 10** - environmental targets should focus on the predominant pressures, in terms of their intensity, frequency or extent, as identified based on the initial assessment.
- **Article 11** - monitoring should focus on priority areas affected by the predominant pressures, also focus on gathering data regarding pressure-impact relationships to improve confidence in assessments.
- **Article 13** - measures should focus on actions, to reduce or mitigate the pressures and their impacts identified as contributing most to poor status.

In this context, the RAGES project can effectively support the implementation of these efforts and of the decision-making process towards achieving/maintaining GES in the context of the MSFD. The project developed a common framework, which is detailed in Deliverable 2.3 (RAGES, 2021), to address risk in the marine environment based on the ISO 31000 (2009) (replaced by ISO 31000, 2018) and the DAPSI*(W)*R*(M)* conceptual model. The RAGES RBA is summarized in Figure 1.

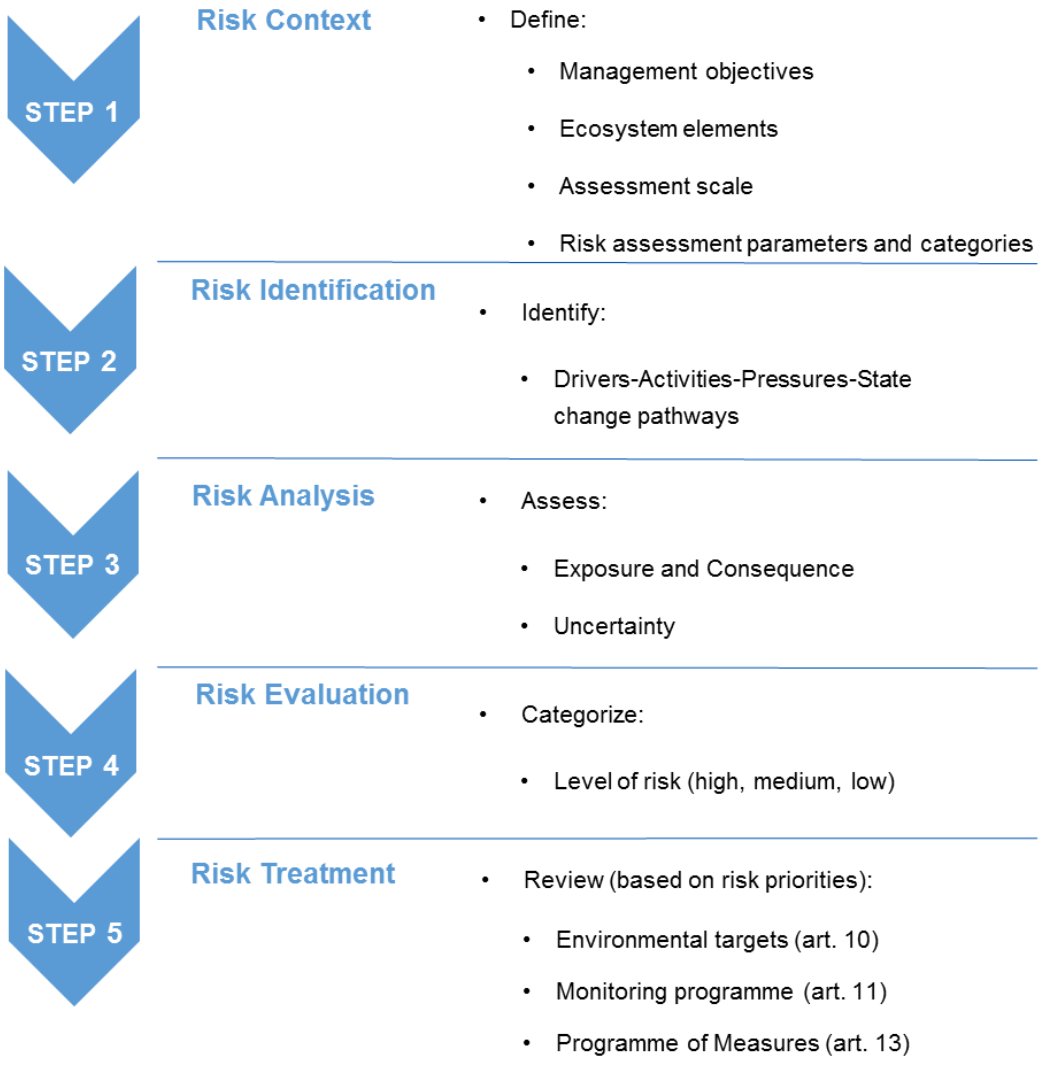

Figure 1. The Risk-Based Approach as developed by the RAGES project.

The full development of the RAGES RBA for D2 is given in Deliverables 3.1 (Bartilotti et al. 2020a), 3.2 (Bartilotti et al. 2020b), 3.3 (Bartilotti et al. 2020c) and 3.4 (Hollatz et al. 2021a). Here, we summarize the main outcomes of the RBA applied to D2 at the sub-regional scale.

It is important to note that the analytical steps of the RBA may change depending on the descriptor, criteria and data availability. In this context, the RBA applied to D2 focused

primarily on criterion D2C1, established by the Commission Decision (EU) 2017/848 (EU, 2017) - "*The number of NIS which are newly introduced via human activity into the wild, per assessment period (6 years), measured from the reference year as reported for the initial assessment under Article 8(1) of Directive 2008/56/EC, is minimized and where possible reduced to zero*." which is the only mandatory one for the assessment of GES within the MSFD context.

For D2, two different types of pressures are listed in the Commission Decision 2017/848 (EU, 2017), i.e., input (newly introduced NIS - D2C1) or spread (established NIS, particularly invasive ones - D2C2). In the first steps of the RBA, the relevant anthropogenic pressures were compiled for the sub-regions ABI and AMA, producing a comprehensive NIS reference base with 454 species. The NIS data included their geographical distribution (native and non-native), population status, probable pathways of introduction, socioeconomic and environmental impacts, life cycle, EASIN check and bibliographic references used in the compilation process, such as peer-reviewed literature, scientific-technical reports and quality assurance databases (Bartilotti et al. 2020a). Moreover, a list of potential priority pressures was defined, including the NIS with known adverse effects highlighting those reported as high impact species in the European Alien Species Information Network (EASIN). The analytical work of the RBA consisted of two main steps: (1) preliminary analysis, including the development of a ranking system, using a pilot Horizon-Scanning (HS) and an alternative decision-support system for ranking NIS based on ELECTRE III method (Martin & Legret, 2005, Brignon et al. 2018) to identify NIS that should be of high priority for risk assessment; (2) exposure analysis, including the identification of areas at higher risk of NIS introductions (e.g. marinas, ports, terminals and aquaculture facilities) as well as the most susceptible areas to NIS introductions, based on the spatial distribution of established NIS per MRU. In the final step, the risk levels associated with NIS and their introduction pathways were estimated by assessing which species were more likely to be introduced based on their biological traits and introduction pathways *vs* the number of MRU where NIS were established and through the assessment of areas where a higher number of established NIS have been reported *vs* the intensity of the results of pathway activity (based on shipping data and distribution of aquaculture facilities). Therefore, the results of the RBA applied to D2 aim to contribute to the risk management of NIS in the marine environment by providing the following decision tools: (1) list of ranked NIS associated with their distribution, population status and probable pathways of introduction, providing components to identify those to target for early detection efforts and (2) map of the coastal areas at higher risk of new NIS introductions, based on the information of

shipping densities and the distribution of aquaculture facilities, which can be used to inform surveillance and monitoring of the introduction pathways in specific areas of both ABI and AMA sub-regions.

Recommendations

The revision of targets, MoP and PoM revealed that the coherence of the reporting of MS during the 1st cycle of implementation was in general low to moderate, making the analysis and the implementation of coordinated actions difficult (EC, 2020).

For D2, the analysis of the initial reports made by the EC (EC, 2014, 2017 for Azores and Madeira) and by the Joint Research Centre (Tsiamis et al. 2021) led to a number of recommendations to improve consistency, comparability and adequacy of the reported elements, and many of these can benefit from the work developed by RAGES. The project established a common framework for data gathering, analysis and evaluation, thus enabling the comparison of data from different MS. Moreover, the application of the RBA enabled the identification of some practical needs, which may contribute to a more harmonized and effective coordination at the sub-regional/regional levels. Currently, the major issues preventing further progress in the implementation of the MSFD are related to the availability of data or insufficient knowledge base.

One of the major issues identified in the assessment of the initial reporting list of NIS was the significant differences in detail and focus of the approach followed by each MS. The level of coherence is critical since the list of NIS constitutes the basis for assessing the first criterion D2C1 (newly introduced NIS), allowing for the determination of new introductions in each MSFD cycle, which will in turn inform D2 GES assessment. In this sense, this project provided a structured framework for data collection, resulting in a comprehensive NIS reference base for the ABI and AMA sub-regions (Bartilotti et al. 2020a), which facilitated the definition of a list of potential pressures, including NIS with known adverse effects and those reported in EASIN as high impact NIS (Bartilotti et al. 2020b). While it is recommended to avail of existing information sources for D2 assessment, the application of the RBA revealed some inconsistencies and information gaps in NIS databases. For instance, it was observed that several NIS are not reported in EASIN, particularly in the AMA sub-region. In addition, the taxonomy of some species is outdated, indicating that efforts must be made to update this database on a regular basis.

Other issues related to the reported lists of NIS concern the lack of coherence on the inclusion of oligohaline NIS. These species were included in some MS reports (e.g., PT) whenever they have also been found in their transitional waters. This situation may be

reflected in the assessment of risks posed by NIS, whereby they may be considered high-risk in the reported MS while being present but not reported (and therefore not risk-assessed) by others. This highlights the need for common standards among MS concerning their NIS reporting, which is essential to inform monitoring programmes and measures (Tsiamis et al. 2021).

Considering the assessment of areas at higher risk of NIS introduction, the shipping density data were fully retrieved from the EMOdnet portal, while data regarding the distribution of aquaculture facilities were acquired from different sources. For example, for PT and ES, the information was obtained through reports and interactive maps developed by their respective Governments, presented with varying levels of detail and only available in the official language of the country. Therefore, creating the pressure maps, and combining the information on shipping densities and the aquaculture facilities distribution, was a very time-consuming process.

Moreover, the information pertinent to the assessment of D2 is currently scattered in multiple online databases derived from different initiatives (e.g. EASIN, AquaNIS, DAISIE, InvasIBER, NOBANIS, GISD, CABI), demanding considerable efforts by users to identify and compile all the required data and information. In light of this, efforts should be made to integrate, harmonize and make this information readily accessible to risk managers in an efficient and structured manner. A public NIS database containing comprehensive and curated NIS data, including their distribution (native and non-native), population status, probable pathways of introduction, socioeconomic and environmental impacts (negative and positive), life cycle, as well as pressure maps, can significantly aid the risk assessment, improving coordinated actions at the subregional/regional level.

Furthermore, the application of an HS approach combined with an alternative decision-support system for ranking NIS can be an effective tool in the framework of a dedicated MoP. The outcome of this approach (Hollatz et al. 2021a) showed that this system was able to capture and prioritize most of the high-impacting NIS while providing a rank of NIS that may not pose an immediate threat, but cannot be disregarded in the MoP.

A further challenge was assembling experts to perform the HS exercise to identify priority NIS for the risk assessment. The NIS reference base was later proved very useful as the HS could be nearly completed by any trained assessor with access to the NIS data, reducing the need for expert elicitation at the initial phase. Nonetheless, the inclusion of expert judgment to fill existing knowledge gaps and ultimately derive final decisions on high-risk NIS is an essential part of the process. However, the effective application of the HS relies on the input of experts on several taxonomic groups. Such an expert group does not currently exist at the EU level and could be established as a coordinated initiative between OSPAR and the European Commission.

Finally, the main constraints impeding the full realization of the RBA relate to the lack of information to support a scientifically and well-informed assessment. In the light of this, MS must make decisions based on limited data and information, leading to the application of the precautionary principle (Shine et al. 2010). These gaps must be addressed by MS in order to strengthen the risk assessment protocols and point out the need for further investments in research to improve the knowledge base on NIS and their impacts.

In summary, the most pressing needs identified in this work are highlighted in Box 1.

BOX 1. Recommendations

- Establishment of common standards on NIS terminology and reporting.

- Regular updating of NIS data on the EASIN database (at least on a 6-year basis, following Article 17 of the MSFD, but ideally every year) in order to provide reliable and accurate information to support risk assessments at the sub-regional/regional scales.

- A freely available map of the main NIS introduction pathways, updated yearly, at the sub-regional/regional scales to promptly inform monitoring of areas at higher risk of NIS introductions.

- Application of the Horizon-Scanning approach to rank and identify top-priority NIS at sub-regional/regional level.

- Assembling a panel of experts to effectively assist the Horizon-Scanning approach.

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References

Bartilotti, C., Canning-Clode, J., Carbonell, A., Cardoso, I., Carreira, G., Chainho, P., Gaudêncio, M. J., Gizzi, F.; Lobo Arteaga, J., Macedo, J., Massé, C., Monteiro, J., Png-Gonzalez, L., Tuaty-Guerra, M., Zaragoza, N. (2020a). WP3 Application of Risk-Based Approach to Non-Indigenous Species (Descriptor 2). Project RAGES: Risk-Based Approaches to Good Environmental Status. EU Grant Agreement No. 110661/2018/794607/SUB/ENV.C.2. Deliverable 3.1 - Sub-regional data of non-indigenous species, 13 p + 2 annexes.

Bartilotti, C., Brignon, J.M, Bartilotti, C., Cardoso, I., Carreira, G., Chainho, P., Chapon, V., Gaudêncio, M. J., Gizzi, F., Hollatz, C., Lobo Arteaga, J., Macedo, J. Monteiro, J., Tuaty-Guerra, M. (2020b). WP3 Application of Risk-Based Approach to Non-Indigenous Species (Descriptor 2). Project RAGES: Risk-Based Approaches to Good Environmental Status. EU Grant Agreement No. 110661/2018/794607/SUB/ENV.C.2. Deliverable 3.2 - Shortlist of regional specific criteria elements and integration rules, 29p.

Bartilotti, C., Brignon, J.M, Bartilotti, C., Cardoso, I., Carreira, G., Chainho, P., Chapon, V.; Gaudêncio, M. J., Gizzi, F., Hollatz, C.; Lobo Arteaga, J., Macedo, J. Monteiro, J., Tuaty-Guerra, M. (2020c). WP3 Application of Risk-Based Approach to Non-Indigenous Species (Descriptor 2). Project RAGES: Risk-Based Approaches to Good Environmental Status. EU Grant Agreement No. 110661/2018/794607/SUB/ENV.C.2. Deliverable 3.3 – Report on risk criteria and significance levels (version 2), 29p + 1 annex.

Brignon J.-M., Chapon V., Brach-Papa C., Lecomte J.-P., Guerin L., Masse C. et Tew-Kai E. (2018). Rapport d'étude -Aide au choix de zones propices au renouvellement des eaux de ballast en Méditerranée entre la région PACA et la Corse. Ministère de la Transition Ecologique et Solidaire / Direction de l'Eau et de la Biodiversité, Direction des Affaires Maritimes, Réf INERIS : DRC -18-168889-03854A, 78p.

European Commission (2014). Commission Staff working document - Annex Accompanying the document Commission Report to the Council and the European Parliament The first phase of implementation of the Marine Strategy Framework Directive (2008/56/EC) - The European Commission's assessment and guidance. COM (2014) 97 final. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0049&from=EN

European Commission (2015a). Article 12 Technical Assessment of the MSFD 2014 reporting on monitoring programmes. France Report. Available at: https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm

European Commission (2015b). Article 12 Technical Assessment of the MSFD 2014 reporting on monitoring programmes. Portugal Report. Available at: https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm

European Commission (2015c). Article 12 Technical Assessment of the MSFD 2014 reporting on monitoring programmes. Spain Report. . Available at: https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm

European Commission (2017). Report from the Commission to the European Parliament and the council assessing Member States' monitoring programmes under the Marine Strategy Framework Directive. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2017:3:FIN

European Commission (2018a). Article 16 Technical Assessment of the MSFD 2015 reporting on Programme of Measures. France Report. . Available at: https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm

European Commission (2018b). Article 16 Technical Assessment of the MSFD 2015 reporting on Programme of Measures. Portugal Report. . Available at: https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm

European Commission (2018c). Article 16 Technical Assessment of the MSFD 2015 reporting on Programme of Measures. Spain Report. Available at: https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm

European Commission (2018d). Report from the Commission to the European Parliament and the council assessing Member States' programmes of measures under the Marine Strategy Framework Directive. Available at: https://eur- lex.europa.eu/legal- content/EN/TXT/?uri=COM:2018:562:FIN&qid=1533034580736

European Commission (2020). Commission Staff working document - Background document for the Marine Strategy Framework Directive on the determination of good environmental status and its links to assessments and the setting of environmental target - Accompanying the Report from the Commission to the European Parliament and the Council on the implementation of the Marine Strategy Framework Directive (Directive 2008/56/EC). Available at: https://ec.europa.eu/info/sites/default/files/swd202062final.pdf

European Union (2008). Directive 2008/ 56/EC of the European Parliament and the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). Official Journal of the European Union L 164 (19) (22 pp).

Hollatz, C., Brignon, J.M, Bartilotti, C., Chapon, V., Bartilotti, C., Tuaty-Guerra, M., Lobo Arteaga, J., Cardoso, I., Chainho, P., Gizzi, F., Monteiro, J., Macedo, J., Gaudêncio, M. J., Canning-Clode, J., Carreira, G. (2021a). WP3 Application of Risk-Based Approach to Non-Indigenous Species (Descriptor 2). Project RAGES: Risk-Based Approaches to Good Environmental Status. EU Grant Agreement No. 110661/2018/794607/SUB/ENV.C.2. Deliverable 3.4 - Sub-regional risk assessment for Descriptor 2, 81p + 2 annexes.

Martin, C., & Legret, M. (2005). La méthode multicritère ELECTRE III: définitions, principe et exemple d'application à la gestion des eaux pluviales en milieu urbain. *Bulletin des laboratoires des ponts et chaussées*, 258-259.

RAGES (2021). Developing a Risk-based Approach to Good Environmental Status. Risk Based Approaches to Good Environmental Status (RAGES) Project Deliverable 2.3. GRANT AGREEMENT Nº 110661/2018/794607/SUB/ENV.C.2.

Tsiamis, K., Boschetti, S., Palialexis, A., Somma, F. and De Jesus Cardoso, A., Marine Strategy Framework Directive – Review and analysis of EU Member States' 2018 reports – Descriptor 2: Non-Indigenous Species, EUR 30520 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-27700-2, doi:10.2760/7897, JRC123179.