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RESEARCH ARTICLE

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Prioritizing marine invasive alien species in the European Union through horizon scanning

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Abstract

1. The disproportionately low presence of marine species in the list of invasive alien species (IAS) of Union concern of the European Union (EU) Regulation

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1143/2014 does not fully acknowledge the threat they pose to the EU marine environment.
2. In this study, the first EU-scale Horizon Scanning (HS) focusing on marine alien species was performed, aiming to deliver a ranked list of species that should be of high priority for risk assessment (Article 5 of the EU IAS Regulation).
3. Species absent from or with a limited distribution in EU marine waters were targeted. In total, 363 alien species were initially screened for HS by a panel of experts, including a broad range of taxonomic groups. Species were scored for their likelihood of arrival, establishment, spread, and impact in EU waters.
4. A consensus workshop ranked 267 species, including a subset of 26 prioritized species. These species are considered to be mainly introduced by shipping (fouling and ballast water), via the Suez Canal, and aquaculture activities. The 26 priority species were also scrutinized in terms of feasibility of their management; 18 of them were suggested for performing risk assessments on the basis of the EU IAS Regulation.
5. Since biological invasions are dynamic and connected with accelerated globalization and diversified human activities, we recommend HS to be repeated periodically to review the species already listed and assess new ones.

KEYWORDS
biodiversity, coastal, IAS regulation, introduced species, legislation, ocean

1 | INTRODUCTION

Introduction of alien species (as defined in the European Union's Regulation 1143/2014; EU, 2014 [= non-indigenous species included in the EU Marine Strategy Framework Directive 2008/56/EC; EC, 2008]) constitute a major threat to the marine environment. Several of them can be invasive in their new environment, causing biodiversity loss and alterations to ecosystem structure and functions, and may result in socio-economic impacts (Katsanevakis et al., 2014; Molnar, Gamboa, Revenga, & Spalding, 2008; Ojaveer et al., 2015; Wallentinus & Nyberg, 2007). Alien species introductions have increased during recent decades, due to globalization and increases in various activities, such as shipping, fisheries, aquaculture, and aquarium trade (Katsanevakis, Zenetos, Belchior, & Cardoso, 2013; Ojaveer et al., 2018). European seas may host the highest number of alien species worldwide, with 1,411 alien, cryptogenic, and questionable taxa reported (Tsiamis, Zenetos, Deriu, Gervasini, & Cardoso, 2018). Among Europe's seas, the Mediterranean Sea is the most affected in terms of number of introductions, mainly due to the Suez Canal and its heavy shipping traffic, which is widely documented in a long history of marine monitoring (Galil et al., 2014; Zenetos et al., 2017).

There is wide international consensus that holistic, preventive, multi-vector pathways-based management is an absolute priority in effectively combating marine alien species (Ojaveer et al., 2018). The Descriptor 2 of the European Union (EU) Marine Strategy Framework Directive (MSFD) (EC, 2008) and the Biodiversity Strategy (EC, 2014) highlight the importance of managing the introduction pathways, emphasizing the target of decreasing the number of new introductions into EU countries. Additional management concepts, such as a species-based approach, should aim to mitigate the impacts of targeted established invasive species as well as to limit their secondary spread.

The recently published EU Regulation on Invasive Alien Species (IAS) no.1143/2014 (EU, 2014; hereafter referred to as the IAS Regulation) provides a list of IAS of Union concern. This list focuses on priority species, whose inclusion would effectively prevent, minimize, or mitigate their adverse impact in a cost-efficient manner (EU, 2014). EU Member States should undertake appropriate actions to prevent the introduction and further spread of the listed species, enforce effective early detection tools and rapid eradication protocols for new introductions, and adopt management measures for those that are already widely spread (Darling et al., 2017; Darling & Frederick, 2017). However, with the exception of *Plotosus lineatus*, which was recently introduced into the list (EC, 2019), no other marine species are included among the IAS of Union concern. Still, the list has a dynamic character, and additional species can be added based on specific criteria and formal risk assessments meeting the requirements of the IAS Regulation.

Horizon scanning (HS) is an essential tool to prioritize the most threatening new and emerging IAS with the highest potential impact on a target area (Shine et al., 2010; Sutherland et al., 2015). The species examined are usually absent or not yet widely spread within the area investigated. Thus, in the case of the EU marine waters, the HS tool can deliver a ranked list of IAS that are likely to arrive, establish, spread, and have an impact on native biodiversity and associated ecosystem services over the next decade (Roy et al., 2014).

Roy et al. (2015, 2019) performed a large-scale HS proposing high-priority alien species that are not present or with a limited distribution within the EU for risk assessment in relation to the IAS Regulation. Five thematic groups (namely terrestrial and freshwater plants, terrestrial and freshwater vertebrates, terrestrial invertebrates, freshwater invertebrates and fishes, and marine species) were examined. The result was a ranked list of species considered at very high or high risk of introduction, establishment, spread, and impact. However, the need to review the ranking of the identified priority species every 3 years was highlighted. In addition, several phyla were scarcely represented within the marine species group and it was recommended that expertise in these groups should be increased for future assessments.

After 3.5 years from the said first EU-scale HS, a revised assessment following the recommendations of the first assessment of Roy et al. (2015) was performed. The focus of the current HS was exclusively on marine IAS, taking into account their limited coverage in the previous exercise and the fact that only one marine species is currently listed in the Union concern list of the IAS Regulation. The final aim was to deliver a ranked list of marine IAS that should be of high priority for performing a risk assessment (Article 5 of the IAS Regulation), which possibly can lead to future inclusion of the species in the list of IAS of Union concern of the IAS Regulation.

2 | METHODS

In general, the methodology followed the procedure of Roy et al. (2015). To scan a large proportion of marine IAS, seven thematic taxonomic groups of marine organisms were considered, taking into account the known number of alien marine species per group occurring in Europe's seas (Tsiamis et al., 2018): (1) microalgae and foraminiferans; (2) macrophytes; (3) polychaetes; (4) molluscs; (5) arthropods and ascidians; (6) fishes; and (7) bryozoans, cnidarians, and remaining taxonomic groups. In total, 24 experts were involved, with at least three experts assigned to each group (Appendix A). The HS exercise operated in two phases:

2.1 | Phase 1: Identify and score the species

A provisional list of species for HS assessment was created independently by each expert, involving species that fell under his/her thematic group (see Appendix A), based on published literature, IAS worldwide databases (such as NEMESIS: Fofonoff, Ruiz, Steves, Simkanin, & Carlton, 2018) and expert opinion. Marine species examined in the HS exercise by Roy et al. (2015) were included. The species included in the HS satisfied the following criteria:

1. Geographic range: alien species that are absent from EU Member States marine areas (i.e. the marine waters surrounding EU Member States, including UK; the Macaronesia region was not considered) but could be introduced in the future and become invasive, or alien species that currently present a limited distribution across EU countries but expected to further spread and become invasive (if not already). The definition of ‘limited distribution’ was based on expert judgement but, in most cases, it corresponded to presence in up to five EU countries. In any case, species already widespread across EU marine waters were not considered for HS.
2. Temporal range: species likely to arrive or further spread across EU marine waters within the next 10 years.
3. Species status: species that are already or would be alien across the whole EU marine waters. Cryptogenic, questionable taxa and species that are alien in only some regions of EU, but native in others, were excluded. Species that may arrive in Europe by means of natural spread/dispersal without human intervention in response to changing ecological conditions and climate change were also excluded.
4. Impact: species with a potential impact on the native species and habitats of EU marine waters.

In addition, the following species were excluded from the HS exercise: (1) species listed in Annex IV to Regulation (EC) No. 708/2007 when used in aquaculture; (2) genetically-modified organisms; (3) species already included in the list of IAS of Union concern of the IAS Regulation (*P. lineatus*; EC, 2019) or recently risk assessed and submitted to the IAS Regulation (*Homarus americanus;* SwAM, 2016).

Basic information was assembled for each species included in the HS assessment (Appendix B): general taxonomic group, functional group (based on Roy et al., 2015), native range (based on Spalding et al., 2007, as modified by Tsiamis et al., 2018), current presence in European seas and in EU countries, and most likely primary introduction pathway (based on CBD, 2014). Species nomenclature followed WoRMS Editorial Board (2018). Species distribution across the European seas (i.e. the main seas surrounding European countries: Black Sea, Mediterranean Sea, NE Atlantic Ocean, Baltic Sea) when applicable, was based on EASIN (2018), AquaNIS (2018), and published literature. To have full coverage of the four seas, the whole Mediterranean Sea was considered, including North African and Near East Mediterranean countries.

Based on each expert's independent list of species for HS assessment under their thematic group, an aggregated and combined list of species was created for each thematic group. Afterwards, each expert received the combined list corresponding to their group and scored each species on the four following parameters:

1. the likelihood of arrival in EU;
2. the likelihood of establishment in EU;
3. the likelihood of spread post invasion across EU;
4. the potential of environmental impact in EU marine waters.

Scores on a 1–4 scale for each of the parameters (Table 1), coupled with information on the level of confidence (high, medium,

TABLE 1 Overall basis for scoring the likelihood of arrival, establishment, spread, and potential impact of each marine horizon scanning species in EU marine waters

Likelihood of arrival, based on a consideration of previous invasion history of the species in other marine regions worldwide (Spalding et al., 2007; Tsiamis et al., 2018) and its known introduction pathway(s).	
Score 4	species already introduced in EU marine waters, or species introduced in European seas, but still outside EU marine waters (e.g. North Africa Mediterranean coasts) which are expected to reach EU marine waters within the next 10 years;
Score 3	species absent from European seas but with an invasive history in two or more marine realms worldwide, or species native in the Red Sea which are expected to reach EU marine waters within the next 10 years through the Suez Canal (or through shipping via the Suez Canal);
Score 2	species absent from European seas, with an invasive history in one marine realm worldwide only, known to be associated with introduction pathways that commonly apply for primary introductions in the European seas (shipping, aquaculture, aquarium trade);
Score 1	species absent from European seas, with no invasive history or an invasion history in one marine realm worldwide only, associated with uncommon or unknown pathways of introduction.
Likelihood of establishment, based on the life-history characteristics of the species, its reproductive cycle, and its tolerance to a broad range of environmental conditions. It was also considered whether the bioclimatic conditions and habitat types of the native distribution range of the species are comparable to those of the EU marine waters.	
Score 4	species with broad ecological tolerance and high ability of adaptation to new habitats and environmental conditions, being native in marine realms with similar bioclimatic conditions and habitat types compared to the EU marine waters; species already established in EU marine waters;
Score 3	species with broad ecological tolerance and high ability of adaptation to new habitats and environmental conditions, being native in marine realms with different bioclimatic conditions and habitat types compared to the EU marine waters;
Score 2	species with narrow ecological tolerance and low ability of adaptation to new habitats and environmental conditions, being native in marine realms with similar bioclimatic conditions and habitat types compared to the EU marine waters;
Score 1	species with narrow ecological tolerance and low ability of adaptation to new habitats and environmental conditions, being native in marine realms with different bioclimatic conditions and habitat types compared to the EU marine waters.
Likelihood of spread, primarily determined by the dispersal capacity of the species, associated with the reproductive capacity and the ability to achieve a population size/density that would prompt dispersal, and its history and speed of spread in other regions. Dispersal through secondary anthropogenic pathways (e.g. fouling, fishing nets) was also considered.	
Score 4	species with high dispersal capacity, commonly associated with secondary pathways of introduction;
Score 3	species with high dispersal capacity, but not known to be associated with secondary pathways of introduction;
Score 2	species with low dispersal capacity, commonly associated with secondary pathways of introduction;
Score 1	species with low dispersal capacity, but not known to be associated with secondary pathways of introduction.
Potential impact, based on the known history of environmental impact in European seas or in other marine regions of the world.	
Score 4	species that would cause large or massive losses on the population of at least one native species (75–100% of the population is lost), and/or species that would cause large or massive alterations or losses of at least one native habitat type (75–100% of the habitat is altered or lost);
Score 3	species that would cause considerable losses on the population of at least one native species (50–75% of the population is lost), and/or species that would cause considerable alterations or losses of at least one native habitat type (50–75% of the habitat is altered or lost);
Score 2	species that would cause some losses on the population of at least one native species (25–50% of the population is lost), and/or species that would cause some alterations or losses of at least one native habitat type (25–50% of the habitat is altered or lost);
Score 1	species that would cause inconsequential losses on the population of at least one native species (< 25% of the population is lost), and/or species that would cause inconsequential alterations or losses of at least one native habitat type (< 25% of the habitat is altered or lost).

low; Table 2) of the relevant scores, were applied independently by each expert to each species. Scoring was performed taking into consideration and indicating the European sea(s) where the worst-case scenario (highest score) is more applicable on the basis of biological features and likely introduction pathway(s) of the scored species. For each species, experts indicated to which European sea(s) their scoring corresponded to, which could be one, more or all. All scores were summarized in a final list for each thematic group. When the given scores differed among the experts, the median value was used. When the scores were equal but the confidence level differed, the median value was also used. These differences in scoring were discussed and addressed among the experts during the consensus workshop (Phase 2).

2.2 | Phase 2: Review and validate the HS results through a consensus workshop

A dedicated workshop was held on 4–5 October 2018 in the Joint Research Centre (European Commission, Italy). In a first session, a

TABLE 2 Basis for providing the appropriate confidence level for each scoring of the 4 parameters of each marine horizon scanning species

High	there is direct relevant evidence to support the statement, the available evidence is not controversial;
Medium	there is direct relevant evidence to support the statement but it is controversial, and/or there is indirect relevant evidence to support the statement (from other species of the same genus or higher taxonomic group), and/or there is no evidence but statement is supported by expert judgment of good confidence level (degree of confidence in being correct: 50–100%);
Low	there is no direct or indirect relevant evidence to support the statement, and/or statement is supported by expert judgment of poor confidence level (degree of confidence in being correct: 0–50%).

consultation among the experts within each thematic group was performed. Experts had the opportunity to revise their scores and exclude species (Appendix C) that did not fit the HS criteria. Each thematic group arrived at a consolidated and commonly agreed list of species, their scores and their associated confidence levels for each of the four parameters.

The resulting thematic group lists were combined together into a single overall list. The score of each parameter of each species was weighted based on the confidence level, following the principle that higher confidence gives a higher weighted score (Table 3). Then, the sum of the weighted scores of each of the four parameters per species was calculated, based on which the final ranking of the species was made (see Appendix B).

A discussion on the overall list was carried out, involving all workshop participants, in order to better harmonize the assessments presented by each group and reduce as much as possible the bias of single groups. Experts were invited to challenge the rankings in the overall list and the responsible team was asked to defend the ranking of 'their species'. Rankings of individual species were adjusted following the outcome of the discussions. Consensus was reached amongst the workshop participants on a final ranked list of HS species.

Species that obtained the highest sum of the parameters weighted scores (at least a score of 45 points) were classified as 'top-priority HS species'. They were ranked top in the final HS list. In addition, species that have not been introduced yet in any European sea but exhibited high scores (at least a score of 38 points) were also considered as top-priority HS species. All the top-priority HS species were analysed in terms of their potential impact on the marine ecosystem services, following the scheme by Liquete et al. (2013) and Katsanevakis, Wallentinus, et al. (2014).

TABLE 3 Scheme applied for weighting the parameters' scores of each marine horizon scanning species by the confidence level

Parameters' score	Confidence level	Weighted final score
Score 4	High	12
	Medium	11
	Low	10
Score 3	High	9
	Medium	8
	Low	7
Score 2	High	6
	Medium	5
	Low	4
Score 1	High	3
	Medium	2
	Low	1

Finally, a supplementary exercise was performed for the top-priority HS species specifically. In more detail, the feasibility of their management options (i.e. prevention, early eradication, mitigation) was addressed, taking into consideration the following criteria: (1) external morphology/appearance, the ease of species identification in the field; (2) mobility and mode of natural dispersal; (3) management potential of the primary introduction pathway(s) into Europe (for species that are not present yet in any European sea); (4) management potential of the secondary pathway(s) of dispersal to or across EU countries (from already established European populations); and (5) cost-efficiency of eradication or mitigation of the population, bearing in mind the species distribution status and natural dispersal capabilities.

During the final session of the workshop the feasibility of management (Yes or No) for each top-priority HS species was marked. To better suit the practical purposes of the exercise, several species were tagged as 'partially' manageable when it was acknowledged that their pathway could be managed, but that their population cannot be controlled once established (e.g. a foraminifera species introduced by ballast-water), or conversely, when their population in the wild can be mitigated to some extent, but their introduction pathway is impossible to control (e.g. the Suez Canal). Other cases of HS species being labelled as 'partially manageable' included: species whose related management can be possible only at a local extent (e.g. a marine protected area), or species for which there was a debate among the workshop participants regarding their management feasibility.

Since listing a species as IAS of Union concern under the protocols of the IAS Regulation evaluates, among other features, the management options of an IAS, top-priority HS species considered as most suitable for performing risk assessments were those with feasibility of management tagged as 'Yes'. In addition, since there was a debate for several species regarding their management feasibility, and following the worst-case scenario concept, it was decided to include also the 'partially' manageable species in the list of most suitable species for performing risk assessments.

3 | RESULTS

A first set of 363 marine alien species to EU marine waters was initially considered for the HS assessment (Appendix A). Ninety-six of them were later excluded from the HS assessment, either during the assessment phase or based on the discussions during the workshop (Appendices A,C). At the end, 267 taxa were assessed, which included 15 foraminiferans, 21 macrophytes, 68 polychaetes, 21 molluscs, 71 arthropods and ascidians, 36 fishes, and 35 bryozoans, cnidarians and other taxa (Appendices A,B). Most taxa were filter feeders (86 taxa) and predators (64 taxa), while the least represented were the primary producers (32 taxa) and the herbivores (13 taxa; Appendix B).

Among the 267 HS taxa, 44 of them have not been reported from any European sea yet, 67 have been found in a European sea but not yet in EU marine waters (e.g. taxa found along the southern and eastern coasts of the Mediterranean Sea), while the remaining 156 taxa have been already reported from EU countries (Appendix B).

Experts considered that the Mediterranean Sea appeared to be the most threatened European sea, as it is likely to be affected by the arrival or further spread of the highest number of HS marine species considered (232 taxa) and their (potential) impact. These 232 taxa included mostly polychaetes, arthropods, and fishes (Figure 1), representing 56% of the total number of species of all groups. The NE Atlantic is expected to be affected by 86 HS taxa, most of them polychaetes, molluscs, and arthropods, representing 72% of the total number of HS species of all groups in the NE Atlantic. By contrast, very few taxa are expected to affect the Baltic Sea (17 taxa) and the Black Sea (13 taxa; Figure 1). Most of the HS taxa have their native distribution range in the western and central Indo-Pacific, temperate northern Pacific, and tropical Atlantic (Figure 2).

As far as pathways are concerned, it is useful to distinguish between HS species currently absent from Europe and HS species already present in Europe. New arrivals of HS species into Europe are expected to be introduced mainly through (1) transport-stowaway: ship/boat hull fouling (hereafter referred to as shipping fouling); (2) transport-stowaway: ship/boat ballast (hereafter referred to as shipping ballast); (3) transport-contaminant: contaminant on animals (except parasites, species transported by host/vector; hereafter referred to as aquaculture); and (4) corridor: interconnected waterways/basins/seas (hereafter referred to as the Suez Canal) (Figure 3).

Primary introductions of HS species already introduced in Europe have been associated mainly with (1) the Suez Canal; (2) shipping fouling; (3) shipping ballast; and (4) aquaculture (Figure 3). These species are expected to further spread within Europe through secondary pathways of introduction. These pathways may include natural expansion through the mobility of the species or through sea water currents transporting propagules, or else dissemination assisted by human activities, such as recreational boating.

The top-priority HS species included 26 species (Tables 4, 5). These are having or are expected to have negative impacts mainly on: (1) food provision; (2) habitat lifecycle maintenance; (3) recreation and

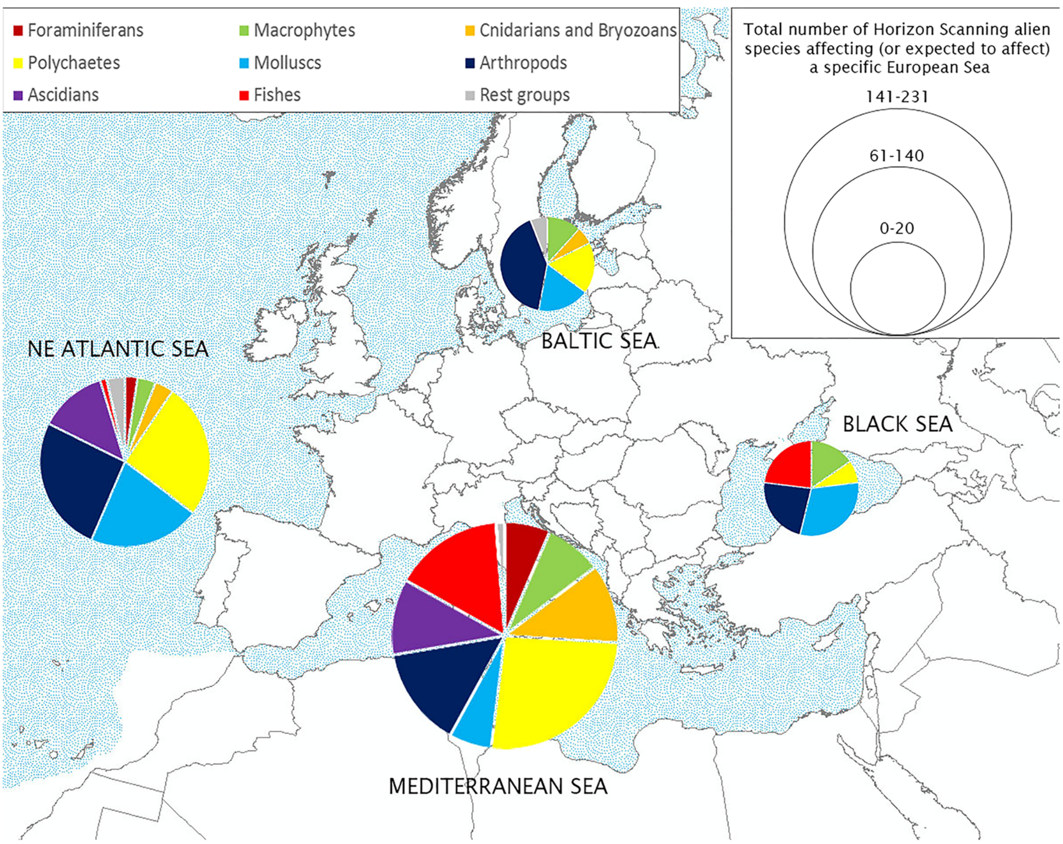

FIGURE 1 Threatened European seas likely to be affected by the arrival, establishment, spread and impact of the marine alien species, listed through the current horizon scanning, within the next 10 years. The size of each pie chart represents the total number of the horizon scanning species expected to affect a specific European sea. Each species can affect one or more European seas. The proportion of the species groups is given for each sea

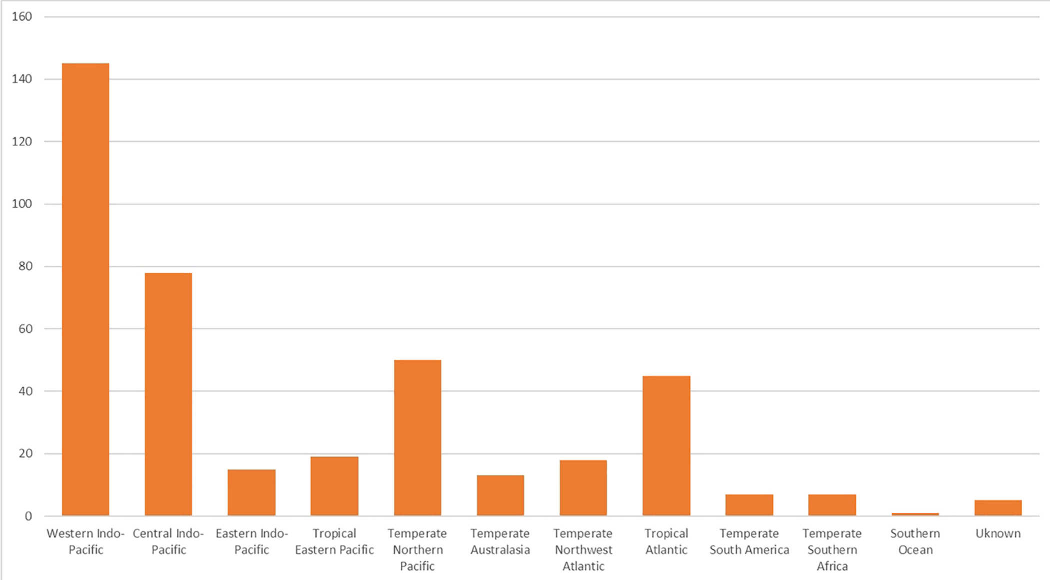

FIGURE 2 Native distribution range of marine alien species listed through the current horizon scanning expected to (further) affect EU marine waters. Each species can have a native distribution range extending to one or more marine realms

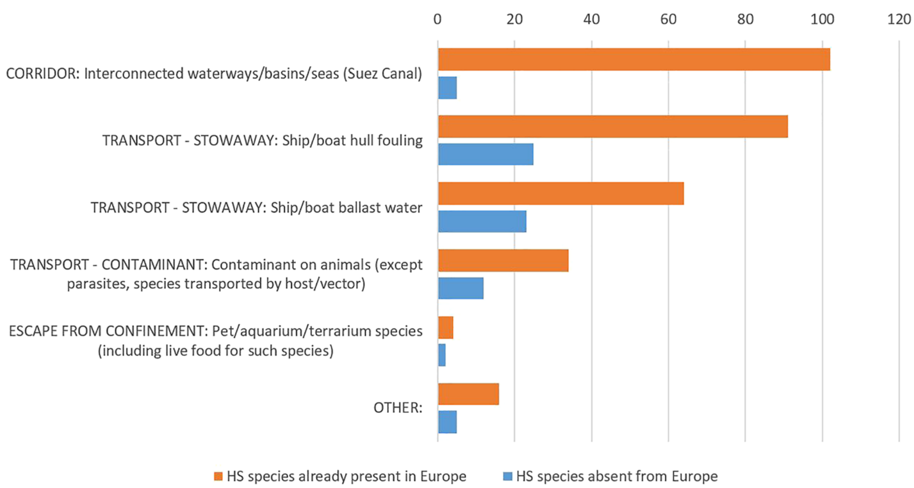

FIGURE 3 Number of marine alien species listed through the current horizon scanning, which are already introduced or expected to arrive in Europe's seas through primary introduction pathways. Several species are linked to more than one pathway

tourism; and (4) ocean nourishment in the EU marine waters (Table 4). Their native distribution range encompasses mainly the western and central Indo-Pacific and temperate northern Pacific. They are primarily introduced into Europe (or expected to be introduced) mainly through the Suez Canal, shipping fouling and shipping ballast (Table 5).

Finally, based on the feasibility of management, the 26 top-priority marine HS species were categorized as follows (see also Table 5):

1. three species not yet introduced in European seas, with feasible pathway management (*Caulerpa serrulata*, *Kappaphycus alvarezii*, *Zostera japonica*);
2. 15 species with partially feasible management, three yet unknown from any European sea (i.e. *Didemnum perlucidum*, *Hydroides sanctaecrucis*, *Perna viridis*), others already present (i.e. *Pterois miles*, *Lagocephalus sceleratus*, *Siganus luridus*, *Siganus rivulatus*, *Chama pacifica*, *Xenostrobus securis*, *Matuta victor*, *Hemigrapsus sanguineus*, *Portunus segnis*, *Spirobranchus kraussii*, *Microcosmus exasperatus*, *Herdmania momus*);
3. eight species with no feasible management (*Codium parvulum*, *Halimeda incrassata*, *Erugosquilla massavensis*, *Penaeus pulchricaudatus*, *Charybdis (Goniohellenus) longicollis*, *Pseudodiaptomus marinus*, *Amphistegina lobifera*, *Rhopilema nomadica*), all of which have been already introduced in at least one European sea.

Among the 26 top-priority marine HS species, those with feasibility of management tagged as 'Yes' and 'partially manageable' were considered as most suitable for performing risk assessments, i.e. 18 species in total (Table 5).

TABLE 4 Top-priority marine invasive alien species listed through the current horizon scanning for EU marine waters, their final ranking score, and their negative impacts on ecosystem services

		Provisional services			Regulating and maintenance services			
	Ranking score points	Food provision	Water storage and provision	Biotic materials and biofuels	Water purification	Air quality regulation	Coastal protection	Climate regulation
A. Horizon scanning species present in Europe that gathered the highest scoring:								
Codium parvulum	48	×						
Halimeda incrassata	48							
Erugosquilla massavensis	48							
Hemigrapsus sanguineus	48	×					×	
Penaeus pulchricaudatus	48	×						
Portunus segnis	48	×						
Pterois miles	48	×						
Amphistegina lobifera	48						×	
Xenostrobus securis	48	×						
Rhopilema nomadica	47	×	×					
Lagocephalus sceleratus	47	×						
Chama pacifica	47	×						
Spirobranchus kraussii	47	×			×			
Microcosmus exasperatus	45							
Charybdis longicollis	45	×						
Herdmania momus	45							
Matuta victor	45	×						
Pseudodiaptomus marinus	45	×						
Siganus luridus	45	×		×	×			×
Siganus rivulatus	45	×		×	×			×
B. Horizon scanning species absent from European seas that gathered the highest scoring:								
Didemnum perlucidum	44	×						
Hydroides sanctaecrucis	42	×			×			
Zostera japonica	42							
Caulerpa serrulata	41							
Perna viridis	39	×						
Kappaphycus alvarezii	38							

(Continues)

TABLE 4 (Continued)

	Regulating and maintenance services				Cultural services		
	Weather regulation	Ocean nourishment	Life cycle maintenance	Biological regulation	Symbolic and aesthetic values	Recreation and tourism	Cognitive effects
A. Horizon scanning species present in Europe that gathered the highest scoring:							
Codium parvulum		×	×			×	
Halimeda incrassata		×	×				
Erugosquilla massavensis			×				
Hemigrapsus sanguineus							
Penaeus pulchricaudatus							
Portunus segnis							
Pterois miles			×		×	×	
Amphistegina lobifera							
Xenostrobus securis					×		
Rhopilema nomadica						×	
Lagocephalus sceleratus							
Chama pacifica		×					
Spirobranchus kraussii						×	
Microcosmus exasperatus						×	
Charybdis longicollis							
Herdmania momus						×	
Matuta victor							
Pseudodiaptomus marinus				×			
Siganus luridus			×		×	×	×
Siganus rivulatus			×		×	×	×
B. Horizon scanning species absent from European seas that gathered the highest scoring:							
Didemnum perlucidum						×	
Hydroides sanctaecrucis						×	
Zostera japonica		×	×				
Caulerpa serrulata		×	×				
Perna viridis							
Kappaphycus alvarezii		×					

TABLE 5 Top-priority marine invasive alien species listed through the current horizon scanning (HS) for EU marine waters. For each species, information is given on their distribution in EU, the taxonomic group, the native distribution range, the most likely primary and secondary introduction pathway(s) into and within Europe respectively, and the feasibility of their management. Hull = shipping-fouling; Ballast = shipping-ballast; Aquarium = Pet/aquarium/terrarium species (including live food for such species)

Species	Present in EU	Taxonomic group	Native distribution range	Primary pathway(s) into Europe	Secondary pathway(s) within Europe	Feasibility of management
A. HS species already present in Europe that attained the highest scoring:						
Codium parvulum	-	Macrophyte	Western Indo-Pacific	Suez Canal	Natural	**No:** established in Israel, Lebanon, Syria and Turkey, difficult taxonomy, prevention of dispersal to EU impossible
Halimeda incrassata	ES	Macrophyte	Tropical Atlantic	Hull, aquarium	Natural, hull	**No:** effective prevention of secondary dispersal to other EU countries and mitigation of established populations are impossible
Erugosquilla massavensis	EL, IT, CY	Arthropod	Western Indo-Pacific	Suez Canal	Natural	**No:** effective prevention of secondary dispersal to other EU countries and mitigation of established populations are impossible
Hemigrapsus sanguineus	FR, NL, BE, DE, SE, HR	Arthropod	Temperate northern Pacific	Ballast	Natural, ballast	**Partially:** effective mitigation of established populations difficult but secondary dispersal to other EU countries could be prevented through ballast management and early-warning eradication; risk assessed by IUCN (Galanidi & Zenetos, 2017)
Penaeus pulchricaudatus	CY, EL	Arthropod	Western Indo-Pacific	Suez Canal	Natural	**No:** effective prevention of secondary dispersal to other EU countries and mitigation of established populations are impossible
Portunus segnis	CY, EL, IT, MT	Arthropod	Western Indo-Pacific	Suez Canal	Natural, ballast	**Partially:** secondary dispersal to other EU countries (mostly to non-Mediterranean EU marine waters) could be prevented through ballast management; population control and mitigation of ecological impacts could be attempted through targeted fisheries, and by promoting its consumption
Pterois miles	CY, EL, IT	Fish	Western Indo-Pacific, temperate southern Africa	Suez Canal, aquarium	Natural	**Partially:** effective prevention of secondary dispersal to other EU countries is impossible; population control and mitigation of ecological impacts could be attempted through targeted fisheries, engaging recreational divers in removal actions, and by promoting its consumption
Amphistegina lobifera	CY, EL, IT, MT	Foraminiferan	Western-Central Indo-Pacific	Ballast, Suez Canal,	Natural, ballast	**No:**

(Continues)

TABLE 5 (Continued)

Species	Present in EU	Taxonomic group	Native distribution range	Primary pathway(s) into Europe	Secondary pathway(s) within Europe	Feasibility of management
				parasites on animals		microscopic, effective prevention of secondary dispersal to other EU countries and mitigation of established populations are impossible
Xenostrobus securis	IT, ES, FR, SI	Mollusc	Central Indo-Pacific	Hull, aquaculture	Natural	**Partially:** prevention of secondary dispersal to other EU countries is rather impossible; mitigation of established populations could be attempted through targeted collections
Rhopilema nomadica	CY, EL, IT, MT	Cnidarian	Western Indo-Pacific	Suez Canal	Natural	**No:** effective prevention of secondary dispersal to other EU countries and control of established populations are impossible; however, potential mitigation of local impacts could be investigated through targeted fisheries and Blue Growth exploitation of jellyfish biomass for nutritional, cosmeceutical and pharmaceutical applications
Lagocephalus sceleratus	CY, EL, HR, IT, MT, ES	Fish	Western Indo-Pacific	Suez Canal	Natural	**Partially:** effective prevention of secondary dispersal to other EU countries is impossible; population control and mitigation of ecological impacts could be attempted through targeted fisheries; risk of tetradotoxin poisoning can be reduced through public awareness initiatives
Chama pacifica	CY, EL	Mollusc	Western–central–eastern Indo-Pacific, temperate northern Pacific	Suez Canal	Natural, hull	**Partially:** effective mitigation of established populations impossible but secondary dispersal to other EU countries (mostly to non-Mediterranean EU marine waters) could be prevented through hull management and early-warning eradication
Spirobranchus kraussii	-	Polychaete	Western Indo-Pacific, temperate southern Africa	Suez Canal, hull	Natural, hull	**Partially:** established in the Levantine Sea, secondary dispersal to the EU might be prevented through hull management and early-warning eradication
Microcosmus exasperatus	CY	Ascidian	Western–central Indo-Pacific	Suez Canal, hull	Natural, hull	**Partially:** effective mitigation of established populations impossible but secondary dispersal to other EU countries (mostly to non-Mediterranean EU marine waters) could be prevented through hull management and early-warning eradication
Charybdis longicollis	CY, EL	Arthropod	Western Indo-Pacific	Suez Canal	Natural	**No:** effective prevention of secondary dispersal to other EU countries and mitigation of established populations are impossible

(Continues)

TABLE 5 (Continued)

Species	Present in EU	Taxonomic group	Native distribution range	Primary pathway(s) into Europe	Secondary pathway(s) within Europe	Feasibility of management
Herdmania momus	CY, EL, MT	Ascidian	Western–central Indo-Pacific	Suez Canal, hull	Natural, hull	**Partially:** effective mitigation of established populations impossible but secondary dispersal to other EU countries (mostly to non-Mediterranean EU marine waters) could be prevented through hull management and early-warning eradication
Matuta victor	EL, CY	Arthropod	Western–central Indo-Pacific	Suez Canal	Natural, ballast	**Partially:** established in the Levantine Sea, secondary dispersal to the EU (mostly to non-Mediterranean EU marine waters) could be prevented through ballast management and early-warning eradication
Pseudodiaptomus marinus	BE, DE, FR, IT, ES, SI, HR	Arthropod	Temperate northern Pacific	Ballast	Natural	**No:** microscopic, difficult identification, effective prevention of secondary dispersal to other EU countries and mitigation of established populations are impossible
Siganus luridus	CY, EL, HR, IT, FR, MT	Fish	Western Indo-Pacific	Suez Canal	Natural	**Partially:** effective prevention of secondary dispersal to other EU is impossible; population control and mitigation of ecological impacts could be attempted through targeted fisheries and promoting consumption
Siganus rivulatus	CY, EL, HR, IT	Fish	Western Indo-Pacific	Suez Canal	Natural	**Partially:** effective prevention of secondary dispersal to other EU is impossible; population control and mitigation of ecological impacts could be attempted through targeted fisheries and promoting consumption
B. HS species absent from European seas that attained the highest scoring:						
Didemnum perlucidum	-	Ascidian	Unknown	Hull, ballast	Not applicable	**Partially:** difficult identification, effective prevention could be achieved by managing shipping and applying early-warning eradication
Hydroides sanctaecrucis	-	Polychaete	Tropical Atlantic	Hull	Not applicable	**Partially:** effective prevention could be achieved by managing shipping and applying early-warning eradication
Zostera japonica	-	Macrophyte	Temperate northern Pacific, central Indo-Pacific	Aquaculture	Not applicable	**Yes:** effective prevention can be achieved by managing oyster imports into Europe
Caulerpa serrulata	-	Macrophyte	Western–central Indo-Pacific, Tropical Atlantic	Aquarium	Not applicable	**Yes:** effective prevention can be achieved by managing aquarium trade

(Continues)

TABLE 5 (Continued)

Species	Present in EU	Taxonomic group	Native distribution range	Primary pathway(s) into Europe	Secondary pathway(s) within Europe	Feasibility of management
Perna viridis	-	Mollusc	Western–central Indo-Pacific	Hull, ballast	Not applicable	**Partially:** effective prevention could be achieved by managing shipping and applying early-warning eradication
Kappaphycus alvarezii	-	Macrophyte	Temperate northern Pacific, central Indo-Pacific	Other intentional release	Not applicable	**Yes:** effective prevention can be achieved by managing seaweed species imported for aquaculture cultivation in Europe

4 | DISCUSSION

Horizon scanning approaches to alien species, including marine ones, have been already adopted at a country-level scale in some European countries, such as in Ireland (Minchin, 2014) and the UK (Roy et al., 2014). Roy et al. (2015, 2019) performed the first EU-scale HS, considering species from all environmental realms, including 24 marine species. In the current study, the first EU-scale HS assessment exclusively addressing marine alien species was provided. As a result, the number of species addressed for HS analysis reached 267, a much higher number if compared to the work of Roy et al. (2019). This is attributed to the higher number of marine experts engaged and the broader coverage of taxonomic groups, ranging from foraminiferans to fishes. Moreover, 96 additional taxa were initially considered in the current HS assessment but were subsequently excluded during the HS exercise or the workshop. In particular, all diatoms, dinoflagellates, and other microalgae were excluded due to the high uncertainty concerning their status as alien in European seas (Gómez, 2008, 2019).

Most marine HS species considered in the current study are native to the western and central Indo-Pacific, the temperate northern Pacific, and the tropical Atlantic, following the overall pattern of marine aliens in Europe (Tsiamis et al., 2018). When it comes to their primary introduction pathways of species expected to arrive into Europe, these include mainly shipping fouling, shipping ballast, aquaculture, and the Suez Canal, which correspond to the most common primary pathways for the totality of alien species in Europe's seas (Katsanevakis et al., 2014; Nunes, Katsanevakis, Zenetos, & Cardoso, 2014). To this end, the recent adoption by the International Maritime Organization of the '*International Convention for the Control and Management of Ships' Ballast Water and Sediments*' is encouraging. shipping fouling has an important role for introductions, which also applies to secondary spread of already introduced alien populations (Davidson et al., 2016; Foster, Giesler, Wilson, Nall, & Cook, 2016; Gewing & Shenkar, 2017; Simard et al., 2017; Ulman et al., 2017, 2019). The related guidance developed in the context of the Marine Environmental Protection Committee (MEPC, 2011) is a step forward, but we would stress the need for more enforceable control of this pathway. Finally, the recent enlargement of the Suez Canal is worrying for a potential increase for Lessepsian introductions into the Mediterranean Sea (Galil et al., 2015; Galil, Marchini, Occhipinti-Ambrogi, & Ojaveer, 2017).

Based on the current study, the Mediterranean Sea is by far the most threatened European regional sea as very likely to be affected by the arrival, establishment, spread, and impact of the highest number of HS species. This is in agreement both with Roy et al. (2015, 2019), and with several studies revealing that the Mediterranean Sea is the one of the most heavily impacted marine areas worldwide in terms of bioinvasions based on current knowledge, attributed to the Suez Canal and the intense human activities within it (Boudouresque et al., 2017; Galil, 2008; Katsanevakis, Coll, et al., 2014; Langer, 2008; Tsiamis et al., 2018; Zenetos et al., 2010). In contrast, lower number of HS species are expected to primarily arrive into the Baltic and Black

Seas. However, these marine areas are vulnerable to secondary introductions of IAS from infested neighbouring areas (e.g. many species introduced in the North Sea spread secondarily into the Baltic Sea, either by natural or human intervention – Ojaveer et al., 2017).

The majority of the HS species considered in the current study have been already introduced, even if generally not widespread, in at least one European sea. Consequently, these species were overrepresented in the final ranking list, especially at higher ranking since they were given the score of '4' for the parameters of the likelihood of arrival and establishment. In order to overcome this bias, we chose to highlight also the top scoring species that are not present yet in Europe, such as *Didemnum perlucidum* and *Zostera japonica*, despite their lower ranking position (lower overall score) compared to other IAS that already exist in Europe. The assessment ultimately resulted in a top-priority list of HS species, including species both present and absent from Europe.

Roy et al. (2019) identified eight marine HS species of very high or high risk of arrival, establishment, spread, and potential impact; our investigation, by contrast, resulted in identification of 26 top-priority marine HS species. Only two species – *Codium parvulum* and *Perna viridis* – are in common for these two lists. Although Roy et al. (2019) considered *Crepidula onyx*, *Mytilopsis sallei*, *Acanthophora spicifera*, *Potamocorbula amurensis*, and *Symplegma reptans* as very high- or high-risk HS species, these species scored lower in our ranking and were not included in the top-priority HS group. *Plotosus lineatus*, ranked as a very high-risk species by Roy et al. (2019), was excluded from our analysis since it is already included in the list of IAS of Union concern of the IAS Regulation (EC, 2019). Finally, several species included in our top-priority HS list either scored low (*Didemnum perlucidum*, *Zostera japonica*) or were not considered at all (e.g. *Kappaphycus alvarezii*, *Hemigrapsus sanguineus*, *Lagocephalus sceleratus*, *Spirobranchus kraussii*, *Microcosmus exasperatus*, *Matuta victor*, *Siganus luridus*, *S. rivulatus*) by Roy et al. (2019). The above discrepancies on the lists of species between the two studies could be attributed to methodological differences, such as the consideration of the confidence level in weighting the scores given by the experts in our study, which was absent in Roy et al. (2019) study. In addition, the latter authors excluded from their analysis species with distribution wider than three European countries, instead of five countries as was followed by our work. This can explain the exclusion/non consideration in Roy et al. (2019) assessment of species such as *Siganus* spp. and *Lagocephalus sceleratus*, which have distribution wider than three European countries. Finally, the wider geographic coverage of the expertise involved in the current exercise and the engagement of a much higher number of marine experts specialized in specific taxonomic groups in this study – allowing for a more accurate scoring of species – could also explain the differences on the outcomes between the two lists of species.

Carboneras et al. (2018) performed a pan-European prioritization exercise for alien species to be risk assessed and possibly listed in the list of IAS of Union concern of the IAS Regulation. This work investigated 1,323 alien species from diverse environments (terrestrial, fresh water, marine) focusing on their spread and impact, including species both absent and already widespread across Europe. In their top priority list (urgent need for a risk assessment by 2018) marine species were poorly represented, with only eight marine species listed from a total of 59. Among them, *Crepidula fornicata*, *Didemnum vexillum*, *Gammarus tigrinus*, *Lophocladia lallemandi*, and *Mnemiopsis leidyi* are species already widespread across Europe, which was the reason for their exclusion from our HS list. The remaining three species by Carboneras et al. (2018) were *Homarus americanus*, *Pterois miles*, and *Rapana venosa*. *Homarus americanus* was excluded from our study since it has been already risk assessed and submitted to the IAS Regulation, while the other two species have been included in our HS list.

Based on Article 4 of the IAS Regulation, one of the criteria set for inclusion of species in the list of IAS of Union concern is that "*it is likely that the inclusion on the Union list will effectively prevent, minimize or mitigate their adverse impact*" (EU, 2014). Therefore, an HS species can be more suitable for performing a risk assessment for the IAS Regulation if its associated management can offer effective prevention and/or mitigation of its population. Widespread species place an unrealistic challenge to management (Lehtiniemi et al., 2015; Ojaveer et al., 2018). Managing species that are as yet absent or have a limited distribution across the EU marine waters should be more realistic. Under that concept, the HS species taken into consideration in the current study are all in principle suitable for performing a risk assessment and possibly to be listed in the Union list.

The ranking and prioritization of the HS species examined in our study resulted in 26 top-priority marine HS species. Considering those, a further screening based on the feasibility of their management resulted in a list of 18 species. The management of these 18 species seems at least partially feasible, and we believe that they are the most suitable species for performing risk assessments for the IAS Regulation. Among the 18 species, six of them are not present yet in any European sea: the macrophytes *Caulerpa serrulata*, *Kappaphycus alvarezii*, *Zostera japonica*, the mollusc *Perna viridis*, the polychaete *Hydroides sanctaecrucis*, and the ascidian *Didemnum perlucidum*, which can all have serious impacts on the marine native communities (Baker, Fajans, & Bergquist, 2003; Chandrasekaran, Arun Nagendran, Pandiaraja, Krishnankutty, & Kamalakannan, 2008; Posey, 1988; Simpson, Wernberg, & McDonald, 2016; Vranken et al., 2018). Thus, an effective control of their possible primary introduction pathways into Europe (ship fouling, ballast, aquaculture, aquarium trade) should be applied.

Among the 18 species proposed as suitable for performing risk assessments, 12 of them are already introduced into Europe. The fishes *Pterois miles*, *Lagocephalus sceleratus*, *Siganus luridus*, and *S. rivulatus*, already quite widespread in Cyprus and Greece and reaching the Italian coasts, pose a severe threat to native marine ecosystems (Azzurro, Fanelli, Mostarda, Catra, & Andaloro, 2007; Bariche, Letourneur, & Harmelin-Vivien, 2004; Kalogirou, 2011; Morris, 2012; Sala, Kizilkaya, Yildirim, & Ballesteros, 2011; Salomidi et al., 2016; Vergés et al., 2014), highlighting the need for management action. Their conspicuous size and easily identifiable morphology could facilitate efficient removal, helping actions for controlling established populations through targeted fisheries or by the involvement of motivated citizens (such a recreational divers and spear-fishers). The arthropods *Matuta victor*, *Hemigrapsus sanguineus*, and *Portunus segnis* can have negative effects on native benthic invertebrates through predation (Galil & Mendelson, 2013; Gerard, Cerrator, & Larson, 1999; Rabaoui, Arculeo, Mansour, & Tlig-Zouari, 2015); their dispersal to other EU countries could be prevented through vessel-ballast management and early-warning eradication at the local level. The molluscs *Xenostrobus securis* and *Chama pacifica* can smother native fauna (Mienis, 2003; Russo, 2001), while the former can be a key host favouring the spread of parasites (*Marteilia refringens*) to native bivalve populations (Pascual et al., 2010). Mitigation of established populations of *X. securis* could be achieved through targeted population control, while prevention of secondary dispersal of *C. pacifica* to other EU countries could be prevented through hull management and early-warning alert and local eradication. Finally, biofouling species such as the polychaete *Spirobranchus kraussii* and the ascidians *Microcosmus exasperatus* and *Herdmania momus* may outcompete native species and overgrow on cultured bivalves, as well as on man-made structures, such as ropes, floating pontoons, pipes, buoys, mooring blocks, and fish cages, hence compromising their functioning (Eno, Clark, & Sanderson, 1997; Lambert, 2007; Mineur et al., 2012). Their dispersal to other EU countries could be prevented through vessel-fouling management (MEPC, 2011) and early-warning alert and local eradication.

It has to be noted, however, that most of above species (see also Table 5) entered the Mediterranean Sea through the Suez Canal (a pathway of introduction unmanaged, and unlikely to be managed in the foreseeable future). The large populations established in the Levantine Sea by species such as *L. sceleratus*, *S. luridus*, *S. rivulatus*, *M. victor*, *P. segnis*, *C. pacifica*, *S. kraussii*, *M. exasperatus*, and *H. momus*, and the presence of their planktonic larval stages, argue to the difficulty of control/mitigation attempts – as propagules pressure will continue, and perhaps increase with the continued warming of the water. In addition, localized mitigation efforts have proven impractical for the lionfish (*Pterois volitans*) in the west Atlantic Ocean (Dahl, Patterson, & Snyder, 2016; Johnston & Purkis, 2015). These concerns should be addressed in depth in the upcoming listing process of IAS of Union concern.

Horizon scanning assessments usually include high levels of uncertainty (Roy et al., 2015), and this definitely applies when assessing marine invasions in EU waters. The relevant details of life-history characteristics, invasion history and associated pathways of marine IAS, useful for assessing the likelihood of arrival, establishment and spread, are not always available (Minchin, Gollasch, Cohen, Hewitt, & Olenin, 2009; Ojaveer et al., 2018). Similarly, the worldwide information on the impacts of marine invasive species is often very limited (Ojaveer et al., 2015; Ojaveer & Kotta, 2015). Therefore, expert judgement was applied in many cases, which often resulted in variation among the experts scoring of the species parameters. This problem was addressed by the use of the confidence level on the scoring and the consensus among the experts of the same thematic group. However, bias was also observed among the different thematic groups of evaluators. The overall consensus workshop mitigated this bias, although we do acknowledge that the complete elimination of the experts' bias is rather difficult.

Expert bias was even more evident in the evaluation of the management feasibility of the top-priority marine HS species, due to the limited number of applied management efforts against marine IAS worldwide (Bax et al., 2001; Thresher & Kuris, 2004). Therefore, the attributed feasibility of management for the current top-priority HS species must be considered with caution and should be further investigated under the listing process of IAS of Union concern. For the same reason, we would encourage, ideally, the performance of risk assessments for all the 26 top-priority HS species of our study. The HS participants concur that region-wide, multi-vector pathways-based management is most effective in preventing the introduction of marine IAS.

5 | CONCLUSIONS

Almost 4 years after the publication of the IAS Regulation, the list of IAS of Union concern includes only one fully marine species. This under-representation of marine species from the Union list does not acknowledge the magnitude of their threat to the EU marine environment. The current HS exercise provides 26 top-priority marine HS species, 18 of which are considered as most suitable to perform risk assessments in the frame of the IAS Regulation: *Caulerpa serrulata*, *Chama pacifica*, *Didemnum perlucidum*, *Hemigrapsus sanguineus*, *Herdmania momus*, *Hydroides sanctaecrucis*, *Kappaphycus alvarezii*, *Lagocephalus sceleratus*, *Matuta victor*, *Microcosmus exasperates*, *Perna viridis*, *Portunus segnis*, *Pterois miles*, *Siganus luridus*, *S. rivulatus*, *Spirobranchus kraussii*, *Xenostrobus securis*, and *Zostera japonica*.

In-depth assessment should consider the feasibility of management of the species, since the subjectivity of the issue on certain species is quite evident. Indeed, although the panel of experts of the current HS exercise had a consensus in the final list of the top-priority HS species, there was a strong debate among them on the feasibility of management of certain species already established in Europe. However, all experts agreed that preventive measures aiming at holistic management of the introduction pathways of the species are to be privileged.

Biological invasions are dynamic, and the HS should be performed periodically, in order to review listed species and assess new ones. To this end, knowledge on marine biological invasions as well as on the taxonomy and biogeography across the wide range of marine phyla are crucial for successfully assessing HS assessments on marine species, and this kind of expertise should be encouraged.

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REFERENCES

AquaNIS Editorial Board. (2018). Information system on Aquatic Non-Indigenous and Cryptogenic Species. World Wide Web electronic publication. www.corpi.ku.lt/databases/aquanis; version 2.36+ [16 August 2018].

Azzurro, E., Fanelli, E., Mostarda, E., Catra, M., & Andaloro, F. (2007). Resource partitioning among early colonizing *Siganus luridus* and native herbivorous fish in the Mediterranean: An integrated study based on gut content analyses and stable isotope signatures. *Journal of Marine Biological Association of the United Kingdom*, *87*, 991–998. https://doi.org/10.1017/S0025315407056342

Baker, P., Fajans, J., & Bergquist, D. (2003). Invasive green mussels, *Perna viridis*, on mangroves and oyster reefs in Florida. La Jolla, California, USA: Proceedings of the Third International Conference on marine Bioinvasions, 16-19 March.

Bariche, M., Letourneur, Y., & Harmelin-Vivien, M. (2004). Temporal fluctuations and settlement patterns of native and Lessepsian herbivorous fishes on the Lebanese coast (eastern Mediterranean). *Environmental Biology of Fishes*, *70*, 81–90. https://doi.org/10.1023/B:EBFI.0000022928.15148.75

Bax, N., Carlton, J. T., Mathews-Amos, A., Haedricj, R. L., Howarth, F. G., Purcell, J. E., … Gray, A. (2001). The control of biological invasions in the world's oceans. *Conservation Biology*, *15*, 1234–1246. https://doi.org/10.1046/j.1523-1739.2001.99487.x

Boudouresque, C. F., Blanfune, A., Fernandez, C., Lejeusne, C., Perez, T., Ruitton, S., … Verlaque, M. (2017). Marine Biodiversity - Warming vs. Biological Invasions and overfishing in the Mediterranean Sea: Take care, 'One Train can hide another'. *MOJ Ecology & Environmental Science*, *2*, 1–13.

Carboneras, C., Genovesi, P., Vilà, M., Blackburn, T. M., Carrete, M., Clavero, M., … Wynde, R. (2018). A prioritised list of invasive alien species to assist the effective implementation of EU legislation. *Journal of Applied Ecology*, *55*, 539–547. https://doi.org/10.1111/1365-2664.12997

CBD. (2014). Pathways of introduction of invasive species, Their Prioritization and Management. UNEP/CBD/SBSTTA/18/9/add.1, Montreal, Canada, June 2014, 18 pp.

Chandrasekaran, S., Arun Nagendran, N., Pandiaraja, D., Krishnankutty, N., & Kamalakannan, B. (2008). Bioinvasion of *Kappaphycus alvarezii* on corals in the Gulf of Mannar, India. *Current Science*, *94*, 1167–1172.

Dahl, K. A., Patterson, W. F., & Snyder, R. A. (2016). Experimental assessment of lionfish removals to mitigate reef fish community shifts on northern Gulf of Mexico artificial reefs. *Marine Ecology Progress Series*, *558*, 207–221. https://doi.org/10.3354/meps11898

Darling, J. A., & Frederick, R. M. (2017). Nucleic acids-based tools for ballast water surveillance, monitoring, and research. *Journal of Sea Research*, *133*, 43–52.

Darling, J. A., Galil, B. S., Carvalho, G. R., Rius, M., Viard, F., & Piraino, S. (2017). Recommendations for developing and applying genetic tools to assess and manage biological invasions in marine ecosystems. *Marine Policy*, *85*, 54–64. https://doi.org/10.1016/j.marpol.2017.08.014

Davidson, I., Scianni, C., Hewitt, C., Everett, R., Holm, E., Tamburri, M., & Ruiz, G. (2016). Mini-review: Assessing the drivers of ship biofouling management-aligning industry and biosecurity goals. *Biofouling*, *32*, 411–428. https://doi.org/10.1080/08927014.2016.1149572

EASIN. (2018). European Commission - Joint Research Centre - European Alien Species Information Network (EASIN). https://easin.jrc.ec.europa.eu/ [16 August 2018].

EC. (2008). Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). *Official Journal of the European Union*, *L164*, 19–40.

EC. (2014). Report from the Commission to the European Parliament and the Council. The mid-term review of the EU Biodiversity Strategy to 2020. Brussels, Belgium: European Commission Report.

EC. (2019). Commission Implementing Regulation (EU) 2019/1262 of 25 July 2019 amending Implementing Regulation (EU) 2016/1141 to update the list of invasive alien species of Union concern. *Official Journal of the European Union*, *L199*, 1–4.

Eno, N.C., Clark, R.A., & Sanderson, W.G. (1997). Non-native marine species in British waters: A review and directory. Peterborough: Joint Nature Conservation Committee.

EU. (2014). Regulation (EU) No 1143/2014 of the European Parliament and of the Council on the prevention and management of the introduction and spread of invasive alien species. *Official Journal of the European Union*, *L315*, 35–55.

Fofonoff, P.W., Ruiz, G.M., Steves, B., Simkanin, C., & Carlton, J.T. (2018). National Exotic Marine and Estuarine Species Information System. http://invasions.si.edu/nemesis/ [30 October 2018].

Foster, V., Giesler, R. J., Wilson, A. M. W., Nall, C. R., & Cook, E. J. (2016). Identifying the physical features of marina infrastructure associated with the presence of non-native species in the UK. *Marine Biology*, *163*, 173. https://doi.org/10.1007/s00227-016-2941-8

Galanidi, M., & Zenetos, A. (2017). EU non-native species risk analysis – risk assessment for *Hemigrapsus sanguineus* (De Haan, 1853). Technical note prepared by IUCN for the European Commission.

Galil, B. S. (2008). Alien species in the Mediterranean Sea – which, when, where, why? *Hydrobiologia*, *606*, 105–116. https://doi.org/10.1007/s10750-008-9342-z

Galil, B. S., Boero, F., Campbell, M. L., Carlton, J. T., Cook, E., Fraschetti, S., … Ruiz, G. M. (2015). 'Double trouble': The expansion of the Suez Canal and marine bioinvasions in the Mediterranean Sea. *Biological Invasions*, *17*, 973–976. https://doi.org/10.1007/s10530-014-0778-y

Galil, B. S., Marchini, A., Occhipinti-Ambrogi, A., Minchin, D., Narščius, A., Ojaveer, H., & Olenin, S. (2014). International arrivals: Widespread bioinvasions in European Seas. *Ethology Ecology & Evolution*, *26*, 152–171. https://doi.org/10.1080/03949370.2014.897651

Galil, B. S., Marchini, A., Occhipinti-Ambrogi, A., & Ojaveer, H. (2017). The enlargement of the Suez Canal—Erythraean introductions and management challenges. *Management of Biological Invasions*, *8*, 141–152. https://doi.org/10.3391/mbi.2017.8.2.02

Galil, B. S., & Mendelson, M. (2013). A record of the moon crab *Matuta victor* (Fabricius, 1781) (Crustacea; Decapoda; Matutidae) from the Mediterranean coast of Israel. *BioInvasions Records*, *2*, 69–71. https://doi.org/10.3391/bir.2013.2.1.12

Gerard, V. A., Cerrator, R. M., & Larson, A. A. (1999). Potential impacts of a western Pacific grapsid crab on intertidal communities of the northwestern Atlantic Ocean. *Biological Invasions*, *1*, 353–361. https://doi.org/10.1023/A:1010093329077

Gewing, M. T., & Shenkar, N. (2017). Monitoring the magnitude of marine vessel infestation by non-indigenous ascidians in the Mediterranean. *Marine Pollution Bulletin*, *121*, 52–59. https://doi.org/10.1016/j.marpolbul.2017.05.041

Gómez, F. (2008). Phytoplankton invasions: Comments on the validity of categorizing the non-indigenous dinoflagellates and diatoms in European Seas. *Marine Pollution Bulletin*, *56*, 620–628. https://doi.org/10.1016/j.marpolbul.2007.12.014

Gómez, F. (2019). Comments on the non-indigenous microalgae in the European seas. *Marine Pollution Bulletin*, *148*, 1–2. https://doi.org/10.1016/j.marpolbul.2019.07.048

Johnston, M. W., & Purkis, S. J. (2015). A coordinated and sustained international strategy is required to turn the tide on the Atlantic lionfish invasion. *Marine Ecology Progress Series*, *533*, 219–235. https://doi.org/10.3354/meps11399

Kalogirou, S. (2011). Alien fish species in the eastern Mediterranean Sea: Invasion biology in coastal ecosystems (PhD Thesis). University of Gothenburg, Sweden.

Katsanevakis, S., Coll, M., Piroddi, C., Steenbeeck, J., Ben Rais Lasram, F., Zenetos, A., & Cardoso, A. C. (2014). Invading the Mediterranean Sea: Biodiversity patterns shaped by human activities. *Frontiers in Marine Science*, *1*, 1–11. https://doi.org/10.3389/fmars.2014.00032

Katsanevakis, S., Wallentinus, I., Zenetos, A., Leppakoski, E., Çinar, M. E., Ozturk, B., … Cardoso, A. C. (2014). Impacts of marine invasive alien species on ecosystem services and biodiversity: A pan-European review. *Aquatic Invasions*, *9*, 391–423. https://doi.org/10.3391/ai.2014.9.4.01

Katsanevakis, S., Zenetos, A., Belchior, C., & Cardoso, A. C. (2013). Invading European Seas: Assessing pathways of introduction of marine aliens. *Ocean and Coastal Management*, *76*, 64–74. https://doi.org/10.1016/j.ocecoaman.2013.02.024

Lambert, G. (2007). Invasive sea squirts: A growing global problem. *Journal of Experimental Marine Biology and Ecology*, *342*, 3–4. https://doi.org/10.1016/j.jembe.2006.10.009

Langer, M. R. (2008). Foraminifera from the Mediterranean and the Red Sea. In F. D. Por (Ed.), *Aqaba-Eilat, the improbable gulf. Environment, biodiversity and preservation* (pp. 396–416). Jerusalem: Magnes Press.

Lehtiniemi, M., Ojaveer, H., David, M., Galil, B. S., Gollasch, S., McKenzie, S., … Pederson, J. (2015). Dose of truth - Monitoring marine non-indigenous species to serve legislative requirements. *Marine Policy*, *54*, 26–35. https://doi.org/10.1016/j.marpol.2014.12.015

Liquete, C., Piroddi, C., Drakou, E. G., Gurney, L., Katsanevakis, S., Charef, A., & Egoh, B. (2013). Current status and future prospects for the assessment of marine and coastal ecosystem services: A systematic review. *PLoS ONE*, *8*, e67737. https://doi.org/10.1371/journal.pone.0067737

MEPC. (2011). *Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species*. London, UK: Marine Environment Protection Committee.

Mienis, H. K. (2003). Native marine molluscs replaced by Lessepsian migrants. *Tentacle*, *11*, 15–16.

Minchin, D. (2014). Risk assessment of non-indigenous marine species, Ireland: including those expected in inland waters. Ireland: Centre for Environmental Data and Recording (CEDaR), Department of Natural Sciences, National Museums, Northern Ireland (NMNI) and the department of arts, Heritage and the Gealtacht.

Minchin, D., Gollasch, S., Cohen, A. N., Hewitt, C. L., & Olenin, S. (2009). Characterizing vectors of marine invasions. In G. Rilov, & J. Crooks (Eds.), *Biological invasions in marine ecosystems: Ecological, management and geographic perspectives ecological studies* (pp. 109–116). Heidelberg: Springer.

Mineur, F., Cook, E. J., Minchin, D., Bohr, K., MacLeod, A., & Maggs, C. A. (2012). Changing coasts: Marine aliens and artificial structures. *Oceanography and Marine Biology: an Annual Review*, *50*, 189–234.

Molnar, J. L., Gamboa, R. L., Revenga, C., & Spalding, M. D. (2008). Assessing the global threat of invasive species to marine biodiversity. *Frontiers in Ecology and the Environment*, *6*, 458–492.

Morris, J.A. Jr. (2012). Invasive Lionfish: A guide to control and management. Marathon, Florida, USA: Gulf and Caribbean Fisheries Institute Special Publication Series Number 1.

Nunes, A. L., Katsanevakis, S., Zenetos, A., & Cardoso, A. C. (2014). Gateways to alien invasions in the European Seas. *Aquatic Invasions*, *9*, 133–144. https://doi.org/10.3391/ai.2014.9.2.02

Ojaveer, H., Galil, B. S., Campbell, M. L., Carlton, J. T., Canning-Clode, J., Cook, E. J., … Ruiz, G. (2015). Classification of non-indigenous species based on their impacts: Considerations for application in marine management. *PLoS Biology*, *13*, e1002130. https://doi.org/10.1371/journal.pbio.1002130

Ojaveer, H., Galil, B. S., Carlton, J. T., Alleway, H., Goulletquer, P., Lehtiniemi, M., … Zaiko, A. (2018). Historical baselines in marine bioinvasions: Implications for policy and management. *PLoS ONE*, *13*, e0202383. https://doi.org/10.1371/journal.pone.0202383

Ojaveer, H., & Kotta, J. (2015). Ecosystem impacts of the widespread nonindigenous species in the Baltic Sea: Literature survey evidences major limitations in knowledge. *Hydrobiologia*, *750*, 171–185. https://doi.org/10.1007/s10750-014-2080-5

Ojaveer, H., Olenin, S., Narščius, A., Florin, A. B., Ezhova, E., Gollasch, S., … Strake, S. (2017). Dynamics of biological invasions and pathways over time: A case study of a temperate coastal sea. *Biological Invasions*, *19*, 799–813. https://doi.org/10.1007/s10530-016-1316-x

Pascual, S., Villalba, A., Abollo, E., Garci, M., Gonzalez, A. F., Nombela, M., … Guerra, A. (2010). The mussel *Xenostrobus securis*: A well-established alien invader in the Ria de Vigo (Spain, NE Atlantic). *Biological Invasions*, *12*, 2091–2103. https://doi.org/10.1007/s10530-009-9611-4

Posey, M. H. (1988). Community changes associated with the spread of an introduced seagrass, *Zostera japonica*. *Ecology*, *69*, 974–983. https://doi.org/10.2307/1941252

Rabaoui, R., Arculeo, M., Mansour, L., & Tlig-Zouari, S. (2015). Occurrence of the lessepsian species *Portunus segnis* (Crustacea: Decapoda) in the Gulf of Gabes (Tunisia): First record and new information on its biology and ecology. *Cahiers de Biologie Marine*, *56*, 169–175.

Roy, H. E., Adriaens, T., Aldridge, D. C., Bacher, S., Bishop, J. D. D., Blackburn, T. M., … Zenetos, A. (2015). *Invasive alien species - Prioritising prevention efforts through horizon scanning ENV.B.2/ETU/2014/0016*. Brussels, Belgium: European Commission.

Roy, H. E., Bacher, S., Essl, F., Adriaens, T., Aldridge, D. C., Bishop, J. D. D., … Rabitsch, W. (2019). Developing a list of invasive alien species likely to threaten biodiversity and ecosystems in the European Union. *Global Change Biology*, *25*, 1032–1048. https://doi.org/10.1111/gcb.14527

Roy, H. E., Peyton, J., Aldridge, D. C., Bantock, T., Blackburn, T. M., Britton, R., … Walker, K. J. (2014). Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain. *Global Change Biology*, *20*, 3859–3871. https://doi.org/10.1111/gcb.12603

Russo, P. (2001). Great concentration of *Xenostrobus securis* (Lamarck, 1819) in different areas of the Po River Delta. *La Conchiglia*, *298*, 45–49.

Sala, E., Kizilkaya, Z., Yildirim, D., & Ballesteros, E. (2011). Alien marine fishes deplete algal biomass in the eastern Mediterranean. *PLoS ONE*, *6*, e17356. https://doi.org/10.1371/journal.pone.0017356

Salomidi, M., Giakoumi, S., Gerakaris, V., Issaris, Y., Sini, M., & Tsiamis, K. (2016). Setting an ecological baseline prior to the bottom-up establishment of a marine protected area in Santorini Island, Aegean Sea. *Mediterranean Marine Science*, *17*, 720–737. https://doi.org/10.12681/mms.1802

Shine, C., Kettunen, M., Genovesi, P., Essl, F., Gollasch, S., Rabitsch, W., … ten Brink, P. (2010). Assessment to support continued development of the EU Strategy to combat invasive alien species. Brussels, Belgium: Institute for European Environmental Policy (IEEP).

Simard, N., Pelletier-Rousseau, M., Clarke Murray, C., McKindsey, C. W., Therriault, T. W., Lacoursière-Roussel, A., … McKenzie, C. H. (2017). *National risk assessment of recreational boating as a vector for marine non-indigenous species. Research document 2017/006*. Ottawa: Canadian Science Advisory Secretariate.

Simpson, T. S., Wernberg, T., & McDonald, J. I. (2016). Distribution and localised effects of the invasive ascidian *Didemnum perlucidum* (Monniot 1983) in an urban estuary. *PLoS ONE*, *11*, e0154201. https://doi.org/10.1371/journal.pone.0154201

Spalding, M. D., Fox, H. E., Allen, G. R., Davidson, N., Ferdaña, Z. A., Finlayson, M., … Robertson, J. (2007). Marine ecoregions of the world: A bioregionalization of coast and shelf areas. *Bioscience*, *57*, 573–583. https://doi.org/10.1641/B570707

Sutherland, W. J., Clout, M., Depledge, M., Dicks, L. V., Dinsdale, J., Entwistle, A. C., … Wintle, B. C. (2015). A horizon scan of global conservation issues for 2015. *Trends in Ecology & Evolution*, *30*, 17–24. https://doi.org/10.1016/j.tree.2014.11.002

SwAM. (2016). *Risk assessment of American lobster (*Homarus americanus*)*. Björn Sjöberg, Sweden: Swedish Agency for Marine and Water Management Report.

Thresher, R. E., & Kuris, A. M. (2004). Options for managing invasive marine species. *Biological Invasions*, *6*, 295–300. https://doi.org/10.1023/B:BINV.0000034598.28718.2e

Tsiamis, K., Zenetos, A., Deriu, I., Gervasini, E., & Cardoso, A. C. (2018). The native distribution range of the European marine non-indigenous species. *Aquatic Invasions*, *13*, 187–198. https://doi.org/10.3391/ai.2018.13.2.01

Ulman, A., Ferrario, J., Forcada, A., Arvanitidis, C., Occhipinti-Ambrogi, A., & Marchini, A. (2019). A hitchhiker's guide to Mediterranean marina travel for alien species. *Journal of Environmental Management*, *241*, 328–339. https://doi.org/10.1016/j.jenvman.2019.04.011

Ulman, A., Ferrario, J., Occhipinti-Ambrogi, A., Arvanitidis, C., Bandi, A., Bertolino, M., … Marchini, A. (2017). A massive update of non-indigenous species records in Mediterranean marinas. *PeerJ*, *5*, e3954. https://doi.org/10.7717/peerj.3954

Vergés, A., Tomas, F., Cebrian, E., Ballesteros, E., Kizilkaya, Z., Dendrinos, P., … Sala, E. (2014). Tropical rabbitfish and the deforestation of a warming temperate sea. *Journal of Ecology*, *102*, 1518–1527. https://doi.org/10.1111/1365-2745.12324

Vranken, S., Bosch, S., Pena, V., Leliaert, F., Mineur, F., & De Clerck, O. (2018). A risk assessment of aquarium trade introductions of seaweed in European waters. *Biological Invasions*, *20*, 1171–1187. https://doi.org/10.1007/s10530-017-1618-7

Wallentinus, I., & Nyberg, C. D. (2007). Introduced marine organisms as habitat modifiers. *Marine Pollution Bulletin*, *55*, 323–332. https://doi.org/10.1016/j.marpolbul.2006.11.010

WoRMS Editorial Board. (2018). World Register of Marine Species. Available from http://www.marinespecies.org at VLIZ [16 October 2018].

Zenetos, A., Çinar, M. E., Crocetta, F., Golani, D., Rosso, A., Servello, G., … Verlaque, M. (2017). Uncertainties and validation of alien species catalogues: The Mediterranean as an example. *Estuarine, Coastal and Shelf Science*, *191*, 171–187. https://doi.org/10.1016/j.ecss.2017.03.031

Zenetos, A., Gofas, S., Verlaque, M., Çinar, M. E., García Raso, J. E., Bianchi, C. N., … Streftaris, N. (2010). Alien species in the Mediterranean Sea by 2010. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part I. Spatial distribution. *Mediterranean Marine Science*, *11*, 381–493. https://doi.org/10.12681/mms.87

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APPENDIX A

Thematic taxonomic groups of marine alien species examined in the horizon scanning (HS) exercise and workshop and the corresponding experts involved in each of them. The initial number of species considered for each group, the number of species excluded during the exercise and workshop, and the final number of HS species agreed for each group after the consensus workshop are also given

Taxonomic groups	Total number of species preliminary considered for HS	Number of species excluded from HS during the exercise and workshop	Final number of HS species considered, after workshop consensus	Experts
Microalgae and Foraminiferans	44	29	15	Martin Langer Fernando Gómez Ana Cristina Cardoso Konstantinos Tsiamis
Macrophytes (seaweeds and seagrasses)	33	12	21	Ante Žuljević Razy Hoffman Ollivier De Clerck Konstantinos Tsiamis
Molluscs	28	7	21	Argyro Zenetos Fabio Crocetta Kathe Jensen
Polychaetes	79	11	68	Melih Ertan Çinar Marco Lezzi Joachim Langeneck
Fishes	49	13	36	Michel Bariche Maria Yankova Ernesto Azzurro
Arthropods & Ascidians	84	13	71	Noa Shenkar Ya'arit Levitt-Barmats Lyudmila Kamburska Agnese Marchini Bella Galil
Bryozoans, Cnidarians and remaining taxonomic groups	46	11	35	Anna Occhipinti Henn Ojaveer Bella Galil Konstantinos Tsiamis Stefano Piraino

APPENDIX B

Ranked list of species addressed for horizon scanning and their associated scores (after the consensus workshop) per each parameter: (i) the likelihood of each species arrival in EU; (ii) the likelihood of establishment in EU; (iii) the likelihood of spread post invasion across EU; (iv) the potential environmental impact in EU waters. Corresponding confidence levels (after consensus), weighted final score (based on Table 3 of the manuscript) per each parameters' score as well as the corresponding European Sea(s) per each species are given. Basic information is provided for each species: already presence in European seas and European Union countries (Yes/No), taxonomic group, functional group (based on Roy et al., 2015), native distribution range (based on Spalding et al., 2007, and Tsiamis et al., 2018), and most likely primary introduction pathway(s) into Europe (following CBD, 2014 scheme). MED = Mediterranean Sea

	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
Horizon Scanning Species	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Codium parvulum (Bory de Saint Vincent ex Audouin) P.C. Silva	4	High	12	4	High	12	4	High	12	4	High	12
Halimeda incrassata (J.Ellis) J.V. Lamouroux	4	High	12	4	High	12	4	High	12	4	High	12
Erugosquilla massavensis (Kossmann, 1880)	4	High	12	4	High	12	4	High	12	4	High	12
Hemigrapsus sanguineus (De Haan, 1835)	4	High	12	4	High	12	4	High	12	4	High	12
Penaeus pulchricaudatus Stebbing, 1914	4	High	12	4	High	12	4	High	12	4	High	12
Portunus segnis (Forskål, 1775)	4	High	12	4	High	12	4	High	12	4	High	12
Pterois miles (Bennett, 1828)	4	High	12	4	High	12	4	High	12	4	High	12
Amphistegina lobifera Larsen, 1976	4	High	12	4	High	12	4	High	12	4	High	12
Xenostrobus securis (Lamarck, 1819)	4	High	12	4	High	12	4	High	12	4	High	12
Rhopilema nomadica Galil, 1990	4	High	12	4	High	12	4	High	12	4	Medium	11
Lagocephalus sceleratus (Gmelin, 1789)	4	High	12	4	High	12	4	High	12	4	Medium	11
Chama pacifica Broderip, 1835	4	High	12	4	High	12	4	High	12	4	Medium	11
Spirobranchus kraussii (Baird, 1865)	4	High	12	4	High	12	4	High	12	4	Medium	11
Microcosmus exasperatus Heller, 1878	4	High	12	4	High	12	4	High	12	3	High	9
Charybdis (Goniohellenus) longicollis Leene, 1938	4	High	12	4	High	12	3	High	9	4	High	12

(Continues)

Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Herdmania momus (Savigny, 1816)	4	High	12	4	High	12	4	High	12	3	High	9
Matuta victor (Fabricius, 1781)	4	High	12	4	High	12	3	High	9	4	High	12
Pseudodiaptomus marinus Sato, 1913	4	High	12	4	High	12	4	High	12	3	High	9
Siganus luridus (Rüppell, 1829)	4	High	12	4	High	12	3	High	9	4	High	12
Siganus rivulatus Forsskål & Niebuhr, 1775	4	High	12	4	High	12	3	High	9	4	High	12
Dictyota acutiloba J.Agardh	4	High	12	4	High	12	4	High	12	3	Medium	8
Boccardia proboscidea Hartman, 1940	4	High	12	4	High	12	4	Medium	11	3	High	9
Balanus glandula Darwin, 1854	4	High	12	4	High	12	4	High	12	3	Medium	8
Didemnum perlucidum Monniot F., 1983	3	Medium	8	4	High	12	4	High	12	4	High	12
Penaeus semisulcatus De Haan, 1844 [in De Haan, 1833-1850]	4	High	12	4	Medium	11	4	High	12	3	High	9
Styela plicata (Lesueur, 1823)	4	High	12	4	High	12	4	High	12	3	Medium	8
Trachysalambria palaestinensis (Steinitz, 1932)	4	High	12	4	High	12	4	High	12	3	Medium	8
Macrorhynchia philippina Kirchenpauer, 1872	4	High	12	4	High	12	3	Medium	8	4	High	12
Phyllorhiza punctata Lendenfeld, 1884	4	High	12	4	High	12	4	High	12	3	Medium	8
Dendostrea folium (Linnaeus, 1758)	4	High	12	4	High	12	4	High	12	3	Medium	8
Megabalanus coccopoma (Darwin, 1854)	4	High	12	4	High	12	4	High	12	3	Low	7
Phallusia nigra Savigny, 1816	4	Medium	11	4	High	12	4	High	12	3	Medium	8
Schizoporella japonica Ortmann, 1890	4	High	12	4	High	12	4	Medium	11	3	Medium	8
Torquigener flavimaculosus Hardy & Randall, 1983	4	High	12	4	High	12	3	Medium	8	4	Medium	11
Hydroides sanctaecrucis Krøyer in Mörch, 1863	3	High	9	4	High	12	4	High	12	3	High	9
Microcosmus squamiger Michaelsen, 1927	4	High	12	4	High	12	4	High	12	2	High	6

(Continues)

Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Galaxaura rugosa (J.Ellis & Solander) J.V. Lamouroux	4	High	12	4	High	12	3	High	9	3	High	9
Chrysonephos lewisii (W.R. Taylor) W.R.Taylor	4	High	12	4	High	12	3	High	9	3	High	9
Codium pulvinatum M.J.Wynne & R.Hoffman	4	High	12	4	High	12	4	High	12	2	High	6
Rugulopteryx okamurae (E.Y. Dawson) I.K.Hwang, W.J.Lee & H.S.Kim	4	High	12	4	High	12	3	High	9	3	High	9
Zostera japonica Ascherson & Graebner	2	High	6	4	High	12	4	High	12	4	High	12
Hydroides ezoensis Okuda, 1934	4	High	12	4	High	12	4	High	12	2	High	6
Hydroides operculata (Treadwell, 1929)	4	High	12	4	High	12	3	High	9	3	High	9
Charybdis (Charybdis) hellerii (A. Milne-Edwards, 1867)	4	High	12	4	High	12	3	High	9	3	High	9
Polyandrocarpa zorritensis (Van Name, 1931)	4	High	12	4	High	12	4	High	12	2	High	6
Watersipora arcuata Banta, 1969	4	High	12	4	High	12	4	Medium	11	3	Low	7
Amphisorus hemprichii Ehrenberg, 1839	4	High	12	4	High	12	4	High	12	2	High	6
Amphistegina lessonii d'Orbigny in Guérin-Méneville, 1832	4	High	12	4	High	12	4	High	12	2	High	6
Spirolina acicularis (Batsch, 1791)	4	High	12	4	High	12	3	High	9	3	High	9
Heterostegina depressa d'Orbigny, 1826	4	High	12	4	High	12	4	High	12	2	High	6
Spondylus spinosus Schreibers, 1793	4	High	12	4	High	12	3	High	9	3	High	9
Caulerpa serrulata (Forsskål) J. Agardh	3	High	9	4	High	12	4	High	12	3	Medium	8
Branchiomma bairdi (McIntosh, 1885)	4	High	12	4	High	12	4	High	12	2	Medium	5
Hydroides brachyacanthus Rioja, 1941	4	High	12	4	High	12	4	High	12	2	Medium	5
Hydroides heterocerus (Grube, 1868)	4	High	12	4	High	12	4	High	12	2	Medium	5

(Continues)

Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Hydroides homoceros Pixell, 1913	4	High	12	4	High	12	4	High	12	2	Medium	5
Hydroides minax (Grube, 1878)	4	High	12	4	High	12	4	High	12	2	Medium	5
Ecteinascidia thurstoni Herdman, 1890	4	High	12	4	Medium	11	4	High	12	2	High	6
Penaeus hathor (Burkenroad, 1959)	4	High	12	4	High	12	4	High	12	2	Medium	5
Styela canopus (Savigny, 1816)	4	High	12	4	High	12	4	High	12	2	Medium	5
Aurelia coerulea von Lendenfeld, 1884	4	High	12	4	High	12	4	Medium	11	2	High	6
Aurelia solida Browne, 1905	4	High	12	4	High	12	4	Medium	11	2	High	6
Celtodoryx ciocalyptoides (Burton, 1935)	4	High	12	4	Medium	11	3	Low	7	4	Medium	11
Callionymus filamentosus Valenciennes, 1837	4	Medium	11	4	High	12	3	Medium	8	4	Low	10
Fistularia commersonii Rüppell, 1838	4	High	12	4	Medium	11	4	Medium	11	3	Low	7
Lagocephalus guentheri Miranda Ribeiro, 1915	4	High	12	4	High	12	3	High	9	3	Medium	8
Stephanolepis diaspros Fraser-Brunner, 1940	4	High	12	4	High	12	3	Medium	8	3	High	9
Upeneus pori Ben-Tuvia & Golani, 1989	4	High	12	4	High	12	3	Medium	8	3	High	9
Coscinospira hemprichii Ehrenberg, 1839	4	High	12	4	High	12	4	High	12	2	Medium	5
Parasorites sp.	4	High	12	4	High	12	4	High	12	2	Medium	5
Haminoea japonica Pilsbry, 1895	4	High	12	4	High	12	3	High	9	3	Medium	8
Rapana venosa (Valenciennes, 1846)	4	Medium	11	4	High	12	3	High	9	3	High	9
Symplegma reptans (Oka, 1927)	4	High	12	4	High	12	4	High	12	2	Medium	5
Boccardiella hamata (Webster, 1879)	4	High	12	4	High	12	4	Medium	11	2	Medium	5
Actaea savignii (H. Milne Edwards, 1834)	4	High	12	4	Medium	11	3	High	9	3	Medium	8
Atergatis roseus (Rüppell, 1830)	4	High	12	4	High	12	3	Medium	8	3	Medium	8

(Continues)

Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Corella eumyota Traustedt, 1882	4	High	12	4	High	12	4	High	12	2	Low	4
Paranthura japonica Richardson, 1909	4	High	12	4	High	12	4	High	12	2	Low	4
Textularia agglutinans d'Orbigny, 1839	4	High	12	4	High	12	4	High	12	2	Low	4
Rangia cuneata (G. B. Sowerby I, 1832)	4	High	12	4	High	12	3	Medium	8	3	Medium	8
Streblospio gynobranchiata Rice & Levin, 1998	4	High	12	4	High	12	4	High	12	1	High	3
Ascidia cannelata Oken, 1820	4	High	12	4	High	12	4	High	12	1	High	3
Carupa tenuipes Dana, 1852	4	High	12	4	High	12	4	High	12	1	High	3
Macrophthalmus (Macrophthalmus) indicus Davie, 2012	4	High	12	4	High	12	3	High	9	2	High	6
Rhodosoma turcicum (Savigny, 1816)	4	High	12	4	High	12	4	High	12	1	High	3
Symplegma bahraini Monniot C. & Monniot F., 1997	4	High	12	4	High	12	4	High	12	1	High	3
Pempheris rhomboidea Kossmann & Räuber, 1877	4	High	12	4	High	12	3	High	9	2	High	6
Sargocentron rubrum (Forsskål, 1775)	4	High	12	4	High	12	3	High	9	2	High	6
Perna viridis (Linnaeus, 1758)	3	High	9	3	High	9	4	High	12	3	High	9
Kappaphycus alvarezii (Doty) Doty ex P.C.Silva	2	High	6	4	High	12	4	High	12	3	Medium	8
Palola valida (Gravier, 1900)	4	High	12	4	High	12	3	High	9	2	Medium	5
Saurida lessepsianus Russell, Golani & Tikochinski, 2015	4	High	12	4	High	12	2	Medium	5	3	High	9
Upeneus moluccensis (Bleeker, 1855)	4	High	12	4	High	12	2	Medium	5	3	High	9
Ocinebrellus inornatus (Récluz, 1851)	4	High	12	4	High	12	2	High	6	3	Medium	8
Urosalpinx cinerea (Say, 1822)	4	High	12	4	High	12	2	High	6	3	Medium	8
Avrainvillea amadelpha (Montagne) A.Gepp & E.S. Gepp	4	High	12	4	High	12	2	Medium	5	3	Medium	8
Neodexiospira brasiliensis (Grube, 1872)	4	High	12	4	High	12	4	High	12	1	Low	1

(Continues)

Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Neodexiospira steueri (Sterzinger, 1909)	4	High	12	4	High	12	4	High	12	1	Low	1
Polydora colonia Moore, 1907	4	High	12	4	High	12	4	High	12	1	Low	1
Spirobranchus tetraceros (Schmarda, 1861)	4	High	12	4	High	12	4	High	12	1	Low	1
Ampithoe valida Smith, 1873	4	High	12	4	High	12	4	High	12	1	Low	1
Anilocra pilchardi Bariche & Trilles, 2006	4	High	12	4	High	12	3	Medium	8	2	Medium	5
Aoroides longimerus Ren & Zheng, 1996	4	High	12	4	High	12	4	Medium	11	1	Medium	2
Cymothoa indica Schioedte & Meinert, 1884	4	High	12	4	High	12	3	Medium	8	2	Medium	5
Grandidierella japonica Stephensen, 1938	4	High	12	4	High	12	4	High	12	1	Low	1
Ianiropsis serricaudis Gurjanova, 1936	4	High	12	4	High	12	4	High	12	1	Low	1
Melita nitida Smith, 1873	4	High	12	4	High	12	4	High	12	1	Low	1
Stenothoe georgiana Bynum & Fox, 1977	4	High	12	4	High	12	4	High	12	1	Low	1
Atherinomorus forskalii (Rüppell, 1838)	4	High	12	4	High	12	3	Medium	8	2	Medium	5
Parupeneus forsskali (Fourmanoir & Guézé, 1976)	4	High	12	4	High	12	3	High	9	2	Low	4
Sorites marginalis (Lamarck, 1816)	4	High	12	4	High	12	3	Medium	8	2	Medium	5
Gracilaria salicornia (C.Agardh) E.Y.Dawson	3	High	9	3	Medium	8	3	Medium	8	4	Medium	11
Bispira polyomma Giangrande & Faasse, 2012	4	High	12	4	High	12	3	Medium	8	2	Low	4
Eurythoe complanata (Pallas, 1766)	4	High	12	4	High	12	3	High	9	1	High	3
Leodice antennata Savigny in Lamarck, 1818	4	High	12	4	High	12	3	High	9	1	High	3
Naineris setosa (Verrill, 1900)	4	High	12	4	High	12	4	Medium	11	1	Low	1
Prionospio sexoculata Augener, 1918	4	High	12	4	High	12	3	High	9	1	High	3
Ascidia sydneiensis Stimpson, 1855	3	High	9	4	High	12	4	High	12	1	High	3

(Continues)

Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Ericthonius pugnax (Dana, 1852)	4	High	12	4	High	12	4	Medium	11	1	Low	1
Polyclinum constellatum Savigny, 1816	4	High	12	4	High	12	3	Medium	8	2	Low	4
Diadema setosum (Leske, 1778)	4	High	12	4	High	12	3	Medium	8	2	Low	4
Pararotalia calcariformata McCulloch, 1977	4	High	12	3	High	9	3	High	9	2	High	6
Mytilopsis sallei (Récluz, 1849)	3	Medium	8	3	Medium	8	4	High	12	3	Medium	8
Lithophyllum yessoense Foslie	4	High	12	4	High	12	3	High	9	1	Medium	2
Ceratonereis mirabilis Kinberg, 1865	4	High	12	4	High	12	3	Medium	8	1	High	3
Laonome calida Capa, 2007	4	High	12	4	High	12	3	High	9	1	Medium	2
Laonome triangularis Hutchings & Murray, 1984	4	High	12	4	High	12	3	High	9	1	Medium	2
Leonnates persicus Wesenberg-Lund, 1949	4	High	12	4	High	12	3	High	9	1	Medium	2
Linopherus canariensis Langerhans, 1881	4	High	12	4	High	12	3	High	9	1	Medium	2
Callinectes exasperatus (Gerstaecker, 1856)	4	High	12	3	Medium	8	4	High	12	1	High	3
Clavelina oblonga Herdman, 1880	4	High	12	4	High	12	3	High	9	1	Medium	2
Pyura praeputialis (Heller, 1878)	2	High	6	3	Medium	8	3	High	9	4	High	12
Marivagia stellata Galil & Gershwin, 2010	4	High	12	4	Medium	11	4	Medium	11	1	Low	1
Scarus ghobban Forsskål, 1775	4	High	12	4	Medium	11	3	Medium	8	2	Low	4
Potamocorbula amurensis (Schrenck, 1861)	2	Medium	5	3	High	9	4	High	12	3	High	9
Pseudocodium okinawense E.J. Faye, M.Uchimura & S. Smimada	4	High	12	4	High	12	3	Medium	8	1	Medium	2
Dipolydora socialis (Schmarda, 1861)	4	Low	10	4	Low	10	4	Low	10	2	Low	4
Dorvillea similis (Crossland, 1924)	4	High	12	4	High	12	3	High	9	1	Low	1
Leonnates decipiens Fauvel, 1929	4	High	12	4	Medium	11	3	High	9	1	Medium	2
Leonnates indicus Kinberg, 1866	4	High	12	4	Medium	11	3	High	9	1	Medium	2

(Continues)

Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Lepidonotus tenuisetosus (Gravier, 1902)	4	High	12	4	High	12	3	High	9	1	Low	1
Notomastus mossambicus (Thomassin, 1970)	4	High	12	4	High	12	3	High	9	1	Low	1
Perinereis linea (Treadwell, 1936)	4	High	12	4	High	12	3	High	9	1	Low	1
Prionospio depauperata Imajima, 1990	4	High	12	4	High	12	3	High	9	1	Low	1
Prionospio pulchra Imajima, 1990	4	High	12	4	High	12	3	High	9	1	Low	1
Botrylloides anceps (Herdman, 1891)	4	High	12	4	High	12	2	Medium	5	2	Medium	5
Charybdis (Charybdis) feriata (Linnaeus, 1758)	4	High	12	4	High	12	3	Low	7	1	High	3
Incisocalliope aestuarius (Watling & Maurer, 1973)	4	High	12	4	High	12	3	High	9	1	Low	1
Paracaprella pusilla Mayer, 1890	4	High	12	4	High	12	3	High	9	1	Low	1
Conopeum tenuissimum (Canu, 1908)	3	High	9	4	High	12	4	High	12	1	Low	1
Corymorpha bigelowi (Maas, 1905)	3	High	9	4	High	12	4	High	12	1	Low	1
Synaptula reciprocans (Forsskål, 1775)	4	High	12	4	High	12	3	High	9	1	Low	1
Hemiramphus far (Forsskål, 1775)	4	High	12	4	High	12	3	High	9	1	Low	1
Planiliza haematocheila (Temminck & Schlegel, 1845)	4	High	12	4	High	12	1	Medium	2	3	Medium	8
Crepidula onyx G. B. Sowerby I, 1824	3	High	9	3	Medium	8	4	High	12	2	Medium	5
Sargassum horneri (Turner) C. Agardh	2	High	6	3	Medium	8	4	Medium	11	3	Medium	8
Glycinde bonhourei Gravier, 1904	4	High	12	4	High	12	3	Medium	8	1	Low	1
Nereis persica Fauvel, 1911	4	High	12	4	High	12	3	Medium	8	1	Low	1
Polycirrus twisti Potts, 1928	4	High	12	4	High	12	3	Medium	8	1	Low	1
Prionospio krusadensis Fauvel, 1929	4	High	12	4	High	12	3	Medium	8	1	Low	1
Prionospio paucipinnulata Blake & Kudenov, 1978	4	High	12	4	High	12	3	Medium	8	1	Low	1

(Continues)

Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Prionospio saccifera Mackie & Hartley, 1990	4	High	12	4	High	12	3	Medium	8	1	Low	1
Syllis ergeni Çinar, 2005	4	High	12	4	High	12	3	Medium	8	1	Low	1
Syllis pectinans Haswell, 1920	4	High	12	4	High	12	3	Medium	8	1	Low	1
Timarete punctata (Grube, 1859)	4	High	12	4	High	12	3	Medium	8	1	Low	1
Ampithoe bizseli Özaydinli & Coleman, 2012	4	High	12	4	High	12	3	Medium	8	1	Low	1
Ptilohyale littoralis (Stimpson, 1853)	4	High	12	4	High	12	3	Medium	8	1	Low	1
Cephea cephea (Forskål, 1775)	3	Medium	8	3	Medium	8	4	Medium	11	2	High	6
Etrumeus golanii DiBattista, Randall & Bowen, 2012	4	High	12	4	High	12	3	Medium	8	1	Low	1
Nemipterus randalli Russell, 1986	4	High	12	3	High	9	3	Medium	8	2	Low	4
Pteragogus trispilus Randall, 2013	4	High	12	4	High	12	2	Medium	5	2	Low	4
Sphyraena chrysotaenia Klunzinger, 1884	4	High	12	4	High	12	2	Medium	5	2	Low	4
Sphyraena flavicauda Rüppell, 1838	4	High	12	4	High	12	2	Medium	5	2	Low	4
Geukensia demissa (Dillwyn, 1817)	3	High	9	3	Medium	8	4	Medium	11	2	Medium	5
Phyllodoce longifrons Ben-Eliahu, 1972	4	High	12	4	High	12	3	Low	7	1	Low	1
Timarete caribous (Grube, 1859)	4	High	12	4	High	12	3	Low	7	1	Low	1
Achelia sawayai Marcus, 1940	4	High	12	4	Medium	11	3	Medium	8	1	Low	1
Distaplia bermudensis Van Name, 1902	4	High	12	4	High	12	2	Medium	5	1	High	3
Monocorophium uenoi (Stephensen, 1932)	4	High	12	4	High	12	3	Low	7	1	Low	1
Nematostella vectensis Stephenson, 1935	4	High	12	4	High	12	2	Low	4	2	Low	4
Parexocoetus mento (Valenciennes, 1847)	4	High	12	4	High	12	3	Low	7	1	Low	1
Scomberomorus commerson (Lacepède, 1800)	4	High	12	4	Medium	11	2	Medium	5	2	Low	4

(Continues)

Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Borelis schlumbergeri (Reichel, 1937)	4	High	12	3	High	9	3	Low	7	2	Low	4
Siphonaperta pittensis (Albani, 1974)	4	Medium	11	3	High	9	3	Medium	8	2	Low	4
Branchiomma coheni Tovar-Hernandez & Knight-Jones, 2006	2	High	6	3	Medium	8	4	High	12	2	Medium	5
Aoroides semicurvatus Ariyama, 2004	4	High	12	4	High	12	2	Medium	5	1	Medium	2
Aplidium accarense (Millar, 1953)	4	High	12	4	High	12	2	Medium	5	1	Medium	2
Ascidia curvata (Traustedt, 1882)	4	High	12	4	High	12	2	Medium	5	1	Medium	2
Asterias amurensis Lutken, 1871	3	Medium	8	3	Medium	8	3	Low	7	3	Medium	8
Miliolinella fichteliana (d'Orbigny, 1839)	4	Medium	11	3	High	9	3	Medium	8	1	High	3
Varidentella neostriatula (Thalmann, 1950)	4	Medium	11	3	High	9	3	Medium	8	1	High	3
Choromytilus chorus (Molina, 1782)	4	High	12	1	High	3	3	Medium	8	3	Medium	8
Polyopes lancifolius (Harvey) Kawaguchi & Wang	4	High	12	3	Medium	8	2	Medium	5	2	Medium	5
Ophryotrocha diadema Åkesson, 1976	4	High	12	4	High	12	2	Medium	5	1	Low	1
Ophryotrocha japonica Paxton & Åkesson, 2010	4	High	12	4	High	12	2	Medium	5	1	Low	1
Perinereis aibuhitensis (Grube, 1878)	4	Medium	11	3	High	9	3	High	9	1	Low	1
Aoroides curvipes Ariyama, 2004	4	High	12	4	Medium	11	2	Medium	5	1	Medium	2
Microcosmus anchylodeirus Traustedt, 1883	4	High	12	3	Medium	8	3	High	9	1	Low	1
Synidotea laticauda Benedict, 1897	4	High	12	4	High	12	2	Medium	5	1	Low	1
Cotylorhiza erythraea Stiasny, 1920	3	High	9	4	High	12	3	Medium	8	1	Low	1
Parasmittina egyptiaca (Waters, 1909)	4	High	12	4	High	12	2	Medium	5	1	Low	1
Champsodon spp.	4	High	12	4	High	12	2	Medium	5	1	Low	1

(Continues)

Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Cheilodipterus novemstriatus (Rüppell, 1838)	4	High	12	3	Low	7	3	Low	7	2	Low	4
Acanthophora spicifera (M.Vahl) Børgesen	2	High	6	2	High	6	4	High	12	2	Medium	5
Codium dwarkense Børgesen	2	Medium	5	2	Medium	5	4	Medium	11	3	Medium	8
Botrylloides nigrum Herdman, 1886	4	Medium	11	4	High	12	1	High	3	1	High	3
Ciona savignyi Herdman, 1882	3	Medium	8	3	Low	7	3	Medium	8	2	High	6
Molgula ficus (Macdonald, 1859)	3	High	9	3	High	9	3	Medium	8	1	High	3
Sphaeroma quoianum H. Milne Edwards, 1840	3	High	9	3	High	9	3	Low	7	2	Low	4
Celleporaria vermiformis (Waters, 1909)	4	High	12	4	High	12	2	Low	4	1	Low	1
Licornia jolloisii (Audouin, 1826)	4	High	12	4	Medium	11	2	Medium	5	1	Low	1
Microporella coronata (Audouin, 1826)	4	High	12	4	High	12	2	Low	4	1	Low	1
Mucropetraliella thenardii (Audouin, 1826)	4	High	12	4	High	12	2	Low	4	1	Low	1
Parasmittina protecta (Thornely, 1905)	4	High	12	4	High	12	2	Low	4	1	Low	1
Parasmittina serruloides Harmelin, Bitar & Zibrowius, 2009	4	High	12	4	High	12	2	Low	4	1	Low	1
Torquatella longiuscula (Harmer, 1957)	4	High	12	4	High	12	2	Low	4	1	Low	1
Goniadella gracilis (Verrill, 1873)	4	High	12	4	High	12	1	Medium	2	1	Medium	2
Charybdis (Charybdis) japonica (A. Milne-Edwards, 1861)	4	High	12	2	Medium	5	3	Medium	8	1	High	3
Rhynchozoon larreyi (Audouin, 1826)	4	High	12	4	Medium	11	2	Low	4	1	Low	1
Smittina nitidissima (Hincks, 1880)	4	High	12	4	Medium	11	2	Low	4	1	Low	1
Alepes djedaba (Forsskål, 1775)	4	High	12	4	High	12	1	Medium	2	1	Medium	2
Apogonichthyoides pharaonis (Bellotti, 1874)	4	High	12	4	High	12	1	Medium	2	1	Medium	2

(Continues)

Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Nereis (Nereis) gilchristi Day, 1967	4	Medium	11	3	Low	7	3	Medium	8	1	Low	1
Amphiodia (Amphispina) obtecta Mortensen, 1940	4	High	12	3	Low	7	2	Low	4	2	Low	4
Microporella genisii (Audouin, 1826)	4	Medium	11	4	Medium	11	2	Low	4	1	Low	1
Tritia obsoleta (Say, 1822)	2	High	6	3	Medium	8	3	Medium	8	2	Medium	5
Prosphaerosyllis longipapillata (Hartmann-Schröder, 1979)	4	High	12	4	High	12	1	Low	1	1	Low	1
Laticorophium baconi (Shoemaker, 1934)	3	Medium	8	3	Medium	8	3	Medium	8	1	Medium	2
Perophora multiclathrata (Sluiter, 1904)	4	High	12	2	High	6	2	High	6	1	Medium	2
Akatopora leucocypha (Marcus, 1937)	4	High	12	3	High	9	2	Low	4	1	Low	1
Cephalopholis taeniops (Valenciennes, 1828)	4	High	12	3	Medium	8	2	Medium	5	1	Low	1
Equulites klunzingeri (Steindachner, 1898)	4	Medium	11	3	Medium	8	2	Medium	5	1	Medium	2
Paraehlersia weissmannioides (Augener, 1913)	4	High	12	3	Medium	8	2	Low	4	1	Low	1
Perkinsyllis augeneri (Hartmann-Schröder, 1979)	4	High	12	3	Medium	8	2	Low	4	1	Low	1
Stylarioides grubei Salazar-Vallejo, 2011	4	High	12	4	Medium	11	1	Low	1	1	Low	1
Tridentiger trigonocephalus (Gill, 1859)	2	Medium	5	3	Medium	8	3	Medium	8	2	Low	4
Dipolydora tentaculata (Blake & Kudenov, 1978)	4	Low	10	4	Low	10	1	Low	1	1	High	3
Polydora websteri Hartman in Loosanoff & Engle, 1943	2	High	6	3	Medium	8	2	Medium	5	2	Medium	5
Nuttallia obscurata (Reeve, 1857)	2	High	6	3	Medium	8	3	Medium	8	1	Medium	2
Boccardia knoxi (Rainer, 1973)	2	High	6	3	Medium	8	2	Medium	5	2	Low	4
Boccardia pseudonatrix Day, 1961	2	High	6	3	Medium	8	2	Medium	5	2	Low	4
Hydroides albiceps (Grube, 1870)	1	Medium	2	3	Medium	8	4	High	12	1	Low	1
Iphione muricata (Lamarck, 1818)	4	High	12	3	Medium	8	1	Medium	2	1	Low	1

(Continues)

Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Polydora rickettsi Woodwick, 1961	2	High	6	3	Medium	8	2	Medium	5	2	Low	4
Terebrasabella heterouncinata Fitzhugh & Rouse, 1999	2	High	6	3	Medium	8	2	Medium	5	2	Low	4
Celleporaria labelligera Harmer, 1957	3	High	9	3	High	9	2	Low	4	1	Low	1
Celleporina bitari Harmelin, 2014	3	High	9	3	High	9	2	Low	4	1	Low	1
Drepanophora birbira Powell, 1967	3	High	9	2	Medium	5	3	Medium	8	1	Low	1
Equulites elongatus (Günther, 1874)	4	High	12	2	Medium	5	2	Medium	5	1	Low	1
Pomadasys stridens (Forsskål, 1775)	4	High	12	3	Medium	8	1	Medium	2	1	Low	1
Boonea bisuturalis (Say, 1822)	3	Medium	8	2	Medium	5	3	Medium	8	1	Medium	2
Dictyosphaeria cavernosa (Forsskål) Børgesen	1	High	3	2	Medium	5	2	Medium	5	3	Medium	8
Neomeris annulata Dickie	3	High	9	3	Medium	8	1	Medium	2	1	Medium	2
Sabellastarte spectabilis (Grube, 1878)	2	High	6	3	Medium	8	2	Medium	5	1	Medium	2
Syllis bella Chamberlin, 1919	4	High	12	3	Low	7	1	Low	1	1	Low	1
Charybdis (Charybdis) lucifera (Fabricius, 1798)	4	High	12	2	Low	4	2	Low	4	1	Low	1
Corella inflata Huntsman, 1912	2	Medium	5	3	Low	7	2	High	6	1	High	3
Sillago suezensis Golani, Fricke & Tikochinski, 2013	4	High	12	1	High	3	2	Medium	5	1	Low	1
Caprella simia Mayer, 1903	2	Medium	5	2	Medium	5	3	High	9	1	Low	1
Batillaria attramentaria (G. B. Sowerby I, 1855)	2	Medium	5	3	Medium	8	1	Low	1	2	Medium	5
Gemma gemma (Totten, 1834)	2	High	6	3	Medium	8	1	Medium	2	1	High	3
Archaias angulatus (Fichtel & Moll, 1798)	3	High	9	1	Medium	2	2	Medium	5	1	Medium	2
Aulacomya atra (Molina, 1782)	1	Medium	2	1	High	3	3	High	9	2	Low	4
Glycera dibranchiata Ehlers, 1868	1	High	3	3	Medium	8	2	Medium	5	1	Low	1

(Continues)

Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
Alatina alata (Reynaud, 1830)	2	Medium	5	2	Low	4	2	Low	4	2	Low	4
Tetrapygus niger (Molina, 1782)	2	Low	4	2	Low	4	1	Low	1	3	Medium	8
Stoechospermum polypodioides (J.V.Lamouroux) J.Agardh	1	Medium	2	1	Medium	2	1	Medium	2	1	High	3

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Codium parvulum (Bory de Saint Vincent ex Audouin) P.C. Silva	MED	48	YES	NO	Seaweed	Primary producer	Western Indo-Pacific	Interconnected waterways/ basins/seas
Halimeda incrassata (J.Ellis) J.V. Lamouroux	MED	48	YES	YES	Seaweed	Primary producer	Tropical Atlantic	Ship/boat hull fouling, Pet/ aquarium/terrarium species (including live food for such species)
Erugosquilla massavensis (Kossmann, 1880)	MED	48	YES	YES	Arthropod	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas
Hemigrapsus sanguineus (De Haan, 1835)	NE Atlantic, MED, Black Sea	48	YES	YES	Arthropod	Predator	Temperate Northern Pacific	Ship/boat ballast water
Penaeus pulchricaudatus Stebbing, 1914	MED	48	YES	YES	Arthropod	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas
Portunus segnis (Forskål, 1775)	MED	48	YES	YES	Arthropod	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas
Pterois miles (Bennett, 1828)	MED (possibly Black Sea, NE Atlantic)	48	YES	YES	Fish	Predator	Western Indo-Pacific, Temperate Southern Africa	Interconnected waterways/ basins/seas , Pet/aquarium/ terrarium species (including live food for such species)
Amphistegina lobifera Larsen, 1976	East and Central Med, and Adriatic	48	YES	YES	Foraminiferan	Primary producer, omnivore	Circumtropical	Ship/boat ballast water, Interconnected waterways/ basins/seas , Parasites on animals (including species transported by host and vector)
Xenostrobus securis (Lamarck, 1819)	MED, NE Atlantic, Black Sea	48	YES	YES	Mollusc	Filter Feeder	Central Indo-Pacific	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
Rhopilema nomadica Galil, 1990	MED	47	YES	YES	Cnidarian	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Lagocephalus sceleratus (Gmelin, 1789)	MED	47	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas
Chama pacifica Broderip, 1835	MED	47	YES	YES	Mollusc	Filter Feeder	Western Indo-Pacific, Central Indo-Pacific, Temperate Northern Pacific, Eastern Indo-Pacific	Interconnected waterways/ basins/seas
Spirobranchus kraussii (Baird, 1865)	MED	47	YES	NO	Polychaete	Filter Feeder	Western Indo-Pacific, Temperate Southern Africa	Interconnected waterways/ basins/seas , Ship/boat hull fouling
Microcosmus exasperatus Heller, 1878	MED	45	YES	YES	Ascidian	Filter Feeder	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas , Ship/boat hull fouling
Charybdis (Goniohellenus) longicollis Leene, 1938	MED	45	YES	YES	Arthropod	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas
Herdmania momus (Savigny, 1816)	MED	45	YES	YES	Ascidian	Filter Feeder	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas , Ship/boat hull fouling
Matuta victor (Fabricius, 1781)	MED	45	YES	YES	Arthropod	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas
Pseudodiaptomus marinus Sato, 1913	NE Atlantic, MED, Baltic, Black Sea	45	YES	YES	Arthropod	Omnivore	Temperate Northern Pacific	Ship/boat ballast water
Siganus luridus (Rüppell, 1829)	MED	45	YES	YES	Fish	Herbivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Siganus rivulatus Forsskål & Niebuhr, 1775	MED	45	YES	YES	Fish	Herbivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Dictyota acutiloba J.Agardh	MED	44	YES	NO	Seaweed	Primary producer	Central Indo-Pacific; Eastern Indo-Pacific; Temperate South America	Ship/boat hull fouling
Boccardia proboscidea Hartman, 1940	NE Atlantic	44	YES	YES	Polychaete	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water, ?Ship/boat hull fouling, Aquaculture / mariculture
Balanus glandula Darwin, 1854	NE Atlantic, Baltic Sea	44	YES	YES	Arthropod	Filter Feeder	Temperate Northern Pacific	Ship/boat hull fouling?
Didemnum perlucidum Monniot F., 1983	NE Atlantic, MED	44	NO	NO	Ascidian	Filter Feeder	Uknown	Ship/boat hull fouling, Ship/boat ballast water
Penaeus semisulcatus De Haan, 1844 [in De Haan, 1833-1850]	MED	44	YES	YES	Arthropod	Omnivore	Western Indo-Pacific	Interconnected waterways/ basins/seas, Ship/boat ballast water

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Styela plicata (Lesueur, 1823)	MED, NE Atlantic	44	YES	YES	Ascidian	Filter Feeder	Temperate Northern Pacific	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
Trachysalambria palaestinensis (Steinitz, 1932)	MED	44	YES	YES	Arthropod	Omnivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Macrorhynchia philippina Kirchenpauer, 1872	MED	44	YES	YES	Cnidarian	Filter Feeder	Circumtropical	Ship/boat hull fouling, Ship/boat ballast water, Interconnected waterways/basins/seas
Phyllorhiza punctata Lendenfeld, 1884	MED	44	YES	YES	Cnidarian	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas
Dendostrea folium (Linnaeus, 1758)	MED	44	YES	YES	Mollusc	Filter Feeder	Western Indo-Pacific, Central Indo-Pacific, Temperate Australasia	Ship/boat hull fouling
Megabalanus coccopoma (Darwin, 1854)	NE Atlantic, Baltic Sea	43	YES	YES	Arthropod	Filter Feeder	Tropical Eastern Pacific	Ship/boat hull fouling
Phallusia nigra Savigny, 1816	MED	43	YES	YES	Ascidian	Filter Feeder	Western Indo-Pacific; Tropical Atlantic	Ship/boat hull fouling
Schizoporella japonica Ortmann, 1890	Baltic Sea, NE Atlantic	43	YES	YES	Bryozoan	Filter Feeder	Temperate Northern Pacific	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
Torquigener flavimaculosus Hardy & Randall, 1983	MED	43	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas
Hydroides sanctaecrucis Krøyer in Mörch, 1863	MED	42	YES	YES	Polychaete	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling
Microcosmus squamiger Michaelsen, 1927	MED, NE Atlantic	42	YES	YES	Ascidian	Filter Feeder	Circumtropical	Ship/boat hull fouling, Ship/boat ballast water
Galaxaura rugosa (J.Ellis & Solander) J.V. Lamouroux	MED	42	YES	NO	Seaweed	Primary producer	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Interconnected waterways/ basins/seas
Chrysonephos lewisii (W.R. Taylor) W.R.Taylor	MED	42	YES	YES	Seaweed	Primary producer	Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water
Codium pulvinatum M.J.Wynne & R.Hoffman	MED	42	YES	NO	Seaweed	Primary producer	Western Indo-Pacific	Interconnected waterways/ basins/seas
Rugulopteryx okamurae (E.Y. Dawson) I.K.Hwang, W.J.Lee & H.S.Kim	MED	42	YES	YES	Seaweed	Primary producer	Temperate Northern Pacific	Unknown
Zostera japonica Ascherson & Graebner	all	42	NO	NO	Seagrass	Primary producer	Temperate Northern Pacific, Central Indo-Pacific	Contaminant on animals (except parasites, species transported by host/vector)
Hydroides ezoensis Okuda, 1934	MED, NE Atlantic	42	YES	YES	Polychaete	Filter Feeder	Temperate Northern Pacific	Ship/boat ballast water, Ship/ boat hull fouling, Aquaculture / mariculture

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Hydroides operculata (Treadwell, 1929)	MED	42	YES	NO	Polychaete	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water
Charybdis (Charybdis) hellerii (A. Milne-Edwards, 1867)	MED	42	YES	YES	Arthropod	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water
Polyandrocarpa zorritensis (Van Name, 1931)	MED	42	YES	YES	Ascidian	Filter Feeder	Temperate South America	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
Watersipora arcuata Banta, 1969	MED	42	YES	YES	Bryozoan	Filter Feeder	Tropical Eastern Pacific	Ship/boat hull fouling
Amphisorus hemprichii Ehrenberg, 1839	MED	42	YES	YES	Foraminiferan	Primary producer, omnivore	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Interconnected waterways/basins/seas, Ship/boat ballast water
Amphistegina lessonii d'Orbigny in Guérin-Méneville, 1832	East and Central Med, and Adriatic	42	YES	YES	Foraminiferan	Primary producer, omnivore	Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water
Spirolina acicularis (Batsch, 1791)	MED	42	YES	NO	Foraminiferan	Primary producer, omnivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water
Heterostegina depressa d'Orbigny, 1826	MED	42	YES	YES	Foraminiferan	Primary producer, omnivore	Circumtropical	Interconnected waterways/basins/seas, Ship/boat ballast water
Spondylus spinosus Schreibers, 1793	MED	42	YES	YES	Mollusc	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Caulerpa serrulata (Forsskål) J. Agardh	MED	41	NO	NO	Seaweed	Primary producer	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Pet/aquarium/terrarium species (including live food for such species)
Branchiomma bairdi (McIntosh, 1885)	MED, NE Atlantic	41	YES	YES	Polychaete	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water
Hydroides brachyacanthus Rioja, 1941	MED	41	YES	yes	Polychaete	Filter Feeder	Tropical Eastern Pacific	Ship/boat hull fouling, ?Ship/boat ballast water
Hydroides heterocerus (Grube, 1868)	MED	41	YES	NO	Polychaete	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Hydroides homoceros Pixell, 1913	MED	41	YES	NO	Polychaete	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Hydroides minax (Grube, 1878)	MED	41	YES	NO	Polychaete	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Ecteinascidia thurstoni Herdman, 1890	MED	41	YES	NO	Ascidian	Filter Feeder	Western Indo-Pacific	Interconnected waterways/basins/seas , Ship/boat hull fouling
Penaeus hathor (Burkenroad, 1959)	MED	41	YES	NO	Arthropod	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Styela canopus (Savigny, 1816)	MED, NE Atlantic	41	YES	YES	Ascidian	Filter Feeder	Western Indo-Pacific; Central Indo-Pacific	Ship/boat hull fouling
Aurelia coerulea von Lendenfeld, 1884	MED	41	YES	YES	Cnidarian	Predator	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
Aurelia solida Browne, 1905	MED	41	YES	YES	Cnidarian	Predator	Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water, Interconnected waterways/basins/seas
Celtodoryx ciocalyptoides (Burton, 1935)	NE Atlantic, Baltic Sea	41	YES	YES	Porifera	Filter Feeder	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
Callionymus filamentosus Valenciennes, 1837	MED	41	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
Fistularia commersonii Rüppell, 1838	MED	41	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
Lagocephalus guentheri Miranda Ribeiro, 1915	MED	41	YES	YES	Fish	Predator	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Interconnected waterways/basins/seas
Stephanolepis diaspros Fraser-Brunner, 1940	MED	41	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
Upeneus pori Ben-Tuvia & Golani, 1989	MED	41	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
Coscinospira hemprichii Ehrenberg, 1839	East Med	41	YES	YES	Foraminiferan	Primary producer, omnivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water
Parasorites sp.	Western Med	41	YES	YES	Foraminiferan	Primary producer, omnivore	Central Indo-Pacific	Ship/boat ballast water, Parasites on animals (including species transported by host and vector)?, Contaminant on plants (except parasites, species transported by host/vector)
Haminoea japonica Pilsbry, 1895	MED, NE Atlantic	41	YES	YES	Mollusc	Herbivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
Rapana venosa (Valenciennes, 1846)	NE Atlantic: MED	41	YES	YES	Mollusc	Filter Feeder	Temperate Northwest Atlantic	Ship/boat hull fouling, Ship/boat ballast water, Contaminant on animals (except parasites, species transported by host/vector)
Symplegma reptans (Oka, 1927)	MED	41	YES	NO	Ascidian	Filter Feeder	Temperate Northern Pacific, Western Indo-Pacific	Ship/boat hull fouling

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Boccardiella hamata (Webster, 1879)	NE Atlantic	40	YES	YES	Polychaete	Detritivore	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water, ? Ship/boat hull fouling, Aquaculture / mariculture
Actaea savignii (H. Milne Edwards, 1834)	MED	40	YES	NO	Arthropod	Herbivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Atergatis roseus (Rüppell, 1830)	MED	40	YES	YES	Arthropod	Omnivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas
Corella eumyota Traustedt, 1882	NE Atlantic	40	YES	YES	Ascidian	Filter Feeder	Southern Ocean, Temperate Australasia	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
Paranthura japonica Richardson, 1909	NE Atlantic, MED	40	YES	YES	Arthropod	Predator	Temperate Northern Pacific	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
Textularia agglutinans d'Orbigny, 1839	MED; Temp. N.-Atlantic	40	YES	NO	Foraminiferan	Detritivore	Circumtropical	Interconnected waterways/ basins/seas, Ship/boat ballast water
Rangia cuneata (G. B. Sowerby I, 1832)	NE Atlantic, Baltic Sea	40	YES	YES	Mollusc	Filter Feeder	Temperate Northwest Atlantic	Ship/boat ballast water
Streblospio gynobranchiata Rice & Levin, 1998	MED	39	YES	NO	Polychaete	Detritivore	Tropical Atlantic, Temperate Northern Pacific	Ship/boat ballast water
Ascidia cannelata Oken, 1820	MED	39	YES	YES	Ascidian	Filter Feeder	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas , Ship/boat hull fouling
Carupa tenuipes Dana, 1852	MED	39	YES	YES	Arthropod	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas, Ship/boat ballast water
Macrophthalmus (Macrophthalmus) indicus Davie, 2012	MED	39	YES	YES	Arthropod	Omnivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Rhodosoma turcicum (Savigny, 1816)	MED	39	YES	NO	Ascidian	Filter Feeder	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Ship/boat hull fouling
Symplegma bahraini Monniot C. & Monniot F., 1997	MED	39	YES	YES	Ascidian	Filter Feeder	Tropical Eastern Pacific, Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water
Pempheris rhomboidea Kossmann & Räuber, 1877	MED	39	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Sargocentron rubrum (Forsskål, 1775)	MED	39	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/ basins/seas

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Perna viridis (Linnaeus, 1758)	MED, NE Atlantic	39	NO	NO	Mollusc	Filter Feeder	Western Indo-Pacific; Central Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water
Kappaphycus alvarezii (Doty) Doty ex P.C.Silva	MED	38	NO	NO	Seaweed	Primary producer	Temperate Northern Pacific, Central Indo-Pacific	Other intentional release
Palola valida (Gravier, 1900)	MED	38	YES	YES	Polychaete	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
Saurida lessepsianus Russell, Golani & Tikochinski, 2015	MED	38	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
Upeneus moluccensis (Bleeker, 1855)	MED	38	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
Ocinebrellus inornatus (Récluz, 1851)	MED, NE Atlantic	38	YES	YES	Mollusc	Predator	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
Urosalpinx cinerea (Say, 1822)	NE Atlantic	38	YES	YES	Mollusc	Predator	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector)
Avrainvillea amadelpha (Montagne) A.Gepp & E.S. Gepp	MED	37	YES	NO	Seaweed	Primary producer	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Other means of transport
Neodexiospira brasiliensis (Grube, 1872)	NE Atlantic	37	YES	YES	Polychaete	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling
Neodexiospira steueri (Sterzinger, 1909)	MED	37	YES	NO	Polychaete	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Polydora colonia Moore, 1907	MED	37	YES	YES	Polychaete	Detritivore	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
Spirobranchus tetraceros (Schmarda, 1861)	MED	37	YES	YES	Polychaete	Filter Feeder	Western Indo-Pacific, Central Indo-Pacific, Temperate Australasia	Interconnected waterways/basins/seas , Ship/boat hull fouling
Ampithoe valida Smith, 1873	NE Atlantic, MED	37	YES	YES	Arthropod	Herbivore	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector)
Anilocra pilchardi Bariche & Trilles, 2006	MED	37	YES	NO	Arthropod	Predator	Western Indo-Pacific	Parasites on animals (including species transported by host and vector), Interconnected waterways/basins/seas
Aoroides longimerus Ren & Zheng, 1996	NE Atlantic, MED	37	YES	YES	Arthropod	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Cymothoa indica Schioedte & Meinert, 1884	*MED*	37	YES	NO	Arthropod	Predator	Western Indo-Pacific	Parasites on animals (including species transported by host and vector), Interconnected waterways/basins/seas
Grandidierella japonica Stephensen, 1938	NE Atlantic, MED, Baltic Sea	37	YES	YES	Arthropod	Detritivore	Temperate Northern Pacific	Ship/boat hull fouling, Ship/boat ballast water, Contaminant on animals (except parasites, species transported by host/vector)
Ianiropsis serricaudis Gurjanova, 1936	NE Atlantic, MED	37	YES	YES	Arthropod	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
Melita nitida Smith, 1873	NE Atlantic, Baltic Sea	37	YES	YES	Arthropod	Detritivore	Temperate Northwest Atlantic	Ship/boat hull fouling
Stenothoe georgiana Bynum & Fox, 1977	MED	37	YES	YES	Arthropod	Omnivore	Temperate Northwest Atlantic	Ship/boat hull fouling
Atherinomorus forskalii (Rüppell, 1838)	MED	37	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
Parupeneus forsskali (Fourmanoir & Guézé, 1976)	MED	37	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
Sorites marginalis (Lamarck, 1816)	MED; Temp. N.-Atlantic	37	YES	NO	Foraminiferan	Primary producer, omnivore	Circumtropical	Interconnected waterways/basins/seas, Ship/boat ballast water
Gracilaria salicornia (C.Agardh) E.Y.Dawson	MED	36	NO	NO	Seaweed	Primary producer	Western Indo-Pacific; Central Indo-Pacific	Release in nature for use (other than above, e.g., fur, transport, medical use), Ship/boat hull fouling
Bispira polyomma Giangrande & Faasse, 2012	NE Atlantic, Baltic Sea	36	YES	YES	Polychaete	Filter Feeder	Uknown	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water, ?Ship/boat hull fouling
Eurythoe complanata (Pallas, 1766)	MED	36	YES	YES	Polychaete	Omnivore	Western Indo-Pacific; Central Indo-Pacific; Eastern Indo-Pacific	Interconnected waterways/basins/seas
Leodice antennata Savigny in Lamarck, 1818	MED	36	YES	YES	Polychaete	Omnivore	Western Indo-Pacific; Tropical Atlantic	Interconnected waterways/basins/seas, Ship/boat ballast water
Naineris setosa (Verrill, 1900)	MED	36	YES	YES	Polychaete	Detritivore	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector)
Prionospio sexoculata Augener, 1918	MED	36	YES	NO	Polychaete	Omnivore	Temperate Southern Africa	Ship/boat hull fouling

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Ascidia sydneiensis Stimpson, 1855	*MED, NE Atlantic	36	NO	NO	Ascidian	Filter Feeder	Central Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water
Ericthonius pugnax (Dana, 1852)	NE Atlantic, MED	36	YES	YES	Arthropod	Detritivore	Temperate Northern Pacific	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
Polyclinum constellatum Savigny, 1816	MED	36	YES	NO	Ascidian	Filter Feeder	Circumtropical	Ship/boat hull fouling
Diadema setosum (Leske, 1778)	MED	36	YES	YES	Echinoderm	Omnivore	Western Indo-Pacific; Central Indo-Pacific	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
Pararotalia calcariformata McCulloch, 1977	MED	36	YES	NO	Foraminiferan	Primary producer, omnivore	Western Indo-Pacific, Central Indo-Pacific, Temperate Southern Africa	Interconnected waterways/basins/seas, Ship/boat ballast water
Mytilopsis sallei (Récluz, 1849)	MED, NE Atlantic, Black Sea	36	YES	NO	Mollusc	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water, Pet/aquarium/terrarium species (including live food for such species)
Lithophyllum yessoense Foslie	MED	35	YES	YES	Seaweed	Primary producer	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
Ceratonereis mirabilis Kinberg, 1865	MED	35	YES	YES	Polychaete	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
Laonome calida Capa, 2007	Baltic Sea, NE Atlantic, Black Sea	35	YES	YES	Polychaete	Filter Feeder	Temperate Australasia	Ship/boat hull fouling, Ship/boat ballast water
Laonome triangularis Hutchings & Murray, 1984	MED	35	YES	NO	Polychaete	Filter Feeder	Temperate Australasia	Ship/boat ballast water
Leonnates persicus Wesenberg-Lund, 1949	MED	35	YES	NO	Polychaete	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
Linopherus canariensis Langerhans, 1881	MED	35	YES	YES	Polychaete	Omnivore	Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water
Callinectes exasperatus (Gerstaecker, 1856)	*NE Atlantic, MED	35	YES	YES	Arthropod	Predator	Tropical Atlantic	Ship/boat ballast water
Clavelina oblonga Herdman, 1880	MED	35	YES	YES	Ascidian	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling
Pyura praeputialis (Heller, 1878)	NE Atlantic, MED	35	NO	NO	Ascidian	Filter Feeder	Temperate Australasia	Ship/boat hull fouling, Ship/boat ballast water
Marivagia stellata Galil & Gershwin, 2010	MED	35	YES	NO	Cnidarian	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
Scarus ghobban Forsskål, 1775	MED	35	YES	YES	Fish	Herbivore	Western Indo-Pacific	Interconnected waterways/basins/seas

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Potamocorbula amurensis (Schrenck, 1861)	all seas	35	NO	NO	Mollusc	Filter Feeder	Temperate Northern Pacific	Ship/boat ballast water
Pseudocodium okinawense E.J. Faye, M.Uchimura & S. Smimada	MED	34	YES	NO	Seaweed	Primary producer	Temperate Northern Pacific, Central Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water
Dipolydora socialis (Schmarda, 1861)	NE Atlantic	34	YES	YES	Polychaete	Detritivore	Temperate South America	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
Dorvillea similis (Crossland, 1924)	MED	34	YES	YES	Polychaete	Detritivore	Western Indo-Pacific	Interconnected waterways/basins/seas
Leonnates decipiens Fauvel, 1929	MED	34	YES	NO	Polychaete	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
Leonnates indicus Kinberg, 1866	MED	34	YES	NO	Polychaete	Omnivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
Lepidonotus tenuisetosus (Gravier, 1902)	MED	34	YES	YES	Polychaete	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
Notomastus mossambicus (Thomassin, 1970)	MED	34	YES	YES	Polychaete	Detritivore	Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water
Perinereis linea (Treadwell, 1936)	MED, NE Atlantic	34	YES	YES	Polychaete	Omnivore	Temperate Northern Pacific, Central Indo-Pacific	Live food and live bait, Contaminated bait
Prionospio depauperata Imajima, 1990	MED	34	YES	NO	Polychaete	Detritivore	Temperate Northern Pacific	Ship/boat ballast water
Prionospio pulchra Imajima, 1990	MED, NE Atlantic	34	YES	YES	Polychaete	Detritivore	Temperate Northern Pacific	Ship/boat hull fouling, Ship/boat ballast water, Contaminant on animals (except parasites, species transported by host/vector)
Botrylloides anceps (Herdman, 1891)	MED	34	YES	NO	Ascidian	Filter Feeder	Central Indo-Pacific; Temperate Northern Pacific; Temperate Australasia	Ship/boat hull fouling
Charybdis (Charybdis) feriata (Linnaeus, 1758)	MED	34	YES	YES	Arthropod	Predator	Western Indo-Pacific	Ship/boat ballast water
Incisocalliope aestuarius (Watling & Maurer, 1973)	NE Atlantic	34	YES	YES	Arthropod	Predator	Temperate Northwest Atlantic	Ship/boat hull fouling
Paracaprella pusilla Mayer, 1890	MED	34	YES	YES	Arthropod	Omnivore	Uknown	Ship/boat hull fouling
Conopeum tenuissimum (Canu, 1908)	NE Atlantic	34	NO	NO	Bryozoan	Filter Feeder	Temperate Northwest Atlantic, Tropical Atlantic	Ship/boat hull fouling
Corymorpha bigelowi (Maas, 1905)	MED	34	NO	NO	Cnidarian	Predator	Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water, Interconnected waterways/basins/seas

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Synaptula reciprocans (Forsskål, 1775)	MED	34	YES	YES	Echinoderm	Detritivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Hemiramphus far (Forsskål, 1775)	MED	34	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas
Planiliza haematocheila (Temminck & Schlegel, 1845)	MED and Black sea	34	YES	YES	Fish	Omnivore	Central Indo-Pacific	Angling/fishing equipment
Crepidula onyx G. B. Sowerby I, 1824	NE Atlantic, MED	34	NO	NO	Mollusc	Filter Feeder	Tropical Eastern Pacific, Temperate South America	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
Sargassum horneri (Turner) C. Agardh	all	33	NO	NO	Seaweed	Primary producer	Temperate Northern Pacific, Central Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water
Glycinde bonhourei Gravier, 1904	MED	33	YES	YES	Polychaete	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas
Nereis persica Fauvel, 1911	MED	33	YES	YES	Polychaete	Omnivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Polycirrus twisti Potts, 1928	MED	33	YES	YES	Polychaete	Detritivore	Central Indo-Pacific	Interconnected waterways/ basins/seas
Prionospio krusadensis Fauvel, 1929	MED	33	YES	NO	Polychaete	Detritivore	Western Indo-Pacific, central Indo-Pacific, Temperate Northern Pacific	Ship/boat ballast water
Prionospio paucipinnulata Blake & Kudenov, 1978	MED	33	YES	NO	Polychaete	Detritivore	Temperate Australasia	Ship/boat hull fouling, Ship/boat ballast water
Prionospio saccifera Mackie & Hartley, 1990	MED	33	YES	NO	Polychaete	Detritivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas
Syllis ergeni Çinar, 2005	MED	33	YES	NO	Polychaete	Omnivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Syllis pectinans Haswell, 1920	MED	33	YES	YES	Polychaete	Omnivore	Central Indo-Pacific; Temperate Australasia	Unknown
Timarete punctata (Grube, 1859)	MED	33	YES	NO	Polychaete	Detritivore	Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water, Interconnected waterways/basins/seas
Ampithoe bizseli Özaydinli & Coleman, 2012	MED	33	YES	YES	Arthropod	Herbivore	Western Indo-Pacific	Ship/boat hull fouling
Ptilohyale littoralis (Stimpson, 1853)	NE Atlantic	33	YES	YES	Arthropod	Herbivore	Uknown	Ship/boat ballast water
Cephea cephea (Forskål, 1775)	MED	33	YES	NO	Cnidarian	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Etrumeus golanii DiBattista, Randall & Bowen, 2012	MED	33	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Nemipterus randalli Russell, 1986	MED	33	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Pteragogus trispilus Randall, 2013	MED	33	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas
Sphyraena chrysotaenia Klunzinger, 1884	MED, Black Sea	33	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas
Sphyraena flavicauda Rüppell, 1838	MED	33	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas
Geukensia demissa (Dillwyn, 1817)	MED, NE Atlantic	33	NO	NO	Mollusc	Filter Feeder	Temperate Northwest Atlantic, Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water
Phyllodoce longifrons Ben-Eliahu, 1972	MED	32	YES	NO	Polychaete	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas
Timarete caribous (Grube, 1859)	MED	32	YES	NO	Polychaete	Detritivore	Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water
Achelia sawayai Marcus, 1940	MED, NE Atlantic	32	YES	YES	Arthropod	Predator	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Ship/boat hull fouling
Distaplia bermudensis Van Name, 1902	MED	32	YES	YES	Ascidian	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
Monocorophium uenoi (Stephensen, 1932)	NE Atlantic	32	YES	YES	Arthropod	Detritivore	Temperate Northern Pacific	Ship/boat hull fouling
Nematostella vectensis Stephenson, 1935	NE Atlantic	32	YES	YES	Cnidarian	Filter Feeder	Temperate Northwest Atlantic, Tropical Atlantic	Contaminant on animals (except parasites, species transported by host/vector)
Parexocoetus mento (Valenciennes, 1847)	MED	32	YES	YES	Fish	Omnivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas
Scomberomorus commerson (Lacepède, 1800)	MED	32	YES	YES	Fish	Predator	Western Indo-Pacific, Central Indo-Pacific, Temperate Australasia	Interconnected waterways/ basins/seas
Borelis schlumbergeri (Reichel, 1937)	MED	32	YES	NO	Foraminiferan	Primary producer, omnivore	Circumtropical	Interconnected waterways/ basins/seas, Ship/boat ballast water
Siphonaperta pittensis (Albani, 1974)	MED	32	YES	NO	Foraminiferan	Detritivore, Herbivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas, Ship/boat ballast water
Branchiomma coheni Tovar-Hernandez & Knight-Jones, 2006	MED, NE Atlantic	31	NO	NO	Polychaete	Filter Feeder	Tropical Eastern Pacific	Ship/boat hull fouling, Ship/boat ballast water

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Aoroides semicurvatus Ariyama, 2004	NE Atlantic	31	YES	YES	Arthropod	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
Aplidium accarense (Millar, 1953)	MED, NE Atlantic	31	YES	YES	Ascidian	Filter Feeder	Uknown	Ship/boat hull fouling
Ascidia curvata (Traustedt, 1882)	MED	31	YES	NO	Ascidian	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling
Asterias amurensis Lutken, 1871	NE Atlantic	31	NO	NO	Echinoderm	Predator	Temperate Northern Pacific	Ship/boat hull fouling, Ship/boat ballast water, Machinery/ equipment, Live food and live bait
Miliolinella fichteliana (d'Orbigny, 1839)	MED	31	YES	YES	Foraminiferan	Omnivore	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Interconnected waterways/ basins/seas, Ship/boat ballast water
Varidentella neostriatula (Thalmann, 1950)	MED	31	YES	NO	Foraminiferan	Detritivore, Herbivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas, Ship/boat ballast water
Choromytilus chorus (Molina, 1782)	NE Atlantic	31	YES	YES	Mollusc	Filter Feeder	Temperate South America	Ship/boat hull fouling, Ship/boat ballast water, Contaminant on animals (except parasites, species transported by host/ vector)
Polyopes lancifolius (Harvey) Kawaguchi & Wang	Atl	30	YES	YES	Seaweed	Primary producer	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
Ophryotrocha diadema Åkesson, 1976	MED	30	YES	YES	Polychaete	Omnivore	Temperate Northern Pacific	Ship/boat ballast water
Ophryotrocha japonica Paxton & Åkesson, 2010	MED Sea, NE Atlantic	30	YES	YES	Polychaete	Omnivore	Temperate Northern Pacific	Ship/boat ballast water
Perinereis aibuhitensis (Grube, 1878)	MED, NE Atlantic	30	YES	YES	Polychaete	Omnivore	Central Indo-Pacific	Live food and live bait
Aoroides curvipes Ariyama, 2004	NE Atlantic	30	YES	YES	Arthropod	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
Microcosmus anchylodeirus Traustedt, 1883	MED	30	YES	YES	Ascidian	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling
Synidotea laticauda Benedict, 1897	NE Atlantic	30	YES	YES	Arthropod	Herbivore	Temperate Northern Pacific	Ship/boat hull fouling, Ship/boat ballast water
Cotylorhiza erythraea Stiasny, 1920	MED	30	YES	NO	Cnidarian	Predator	Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water, Interconnected waterways/basins/seas
Parasmittina egyptiaca (Waters, 1909)	MED	30	YES	YES	Bryozoan	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Champsodon spp.	MED	30	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas
Cheilodipterus novemstriatus (Rüppell, 1838)	MED	30	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Acanthophora spicifera (M.Vahl) Børgesen	MED	29	NO	NO	Seaweed	Primary producer	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water, Interconnected waterways/basins/seas
Codium dwarkense Børgesen	MED	29	NO	NO	Seaweed	Primary producer	Western Indo-Pacific; Central Indo-Pacific	Ship/boat hull fouling
Botrylloides nigrum Herdman, 1886	MED	29	YES	NO	Ascidian	Filter Feeder	circumtropical	Ship/boat hull fouling
Ciona savignyi Herdman, 1882	NE Atlantic	29	NO	NO	Ascidian	Filter Feeder	Temperate Northern Pacific	Ship/boat hull fouling
Molgula ficus (Macdonald, 1859)	NE Atlantic, MED	29	NO	NO	Ascidian	Filter Feeder	Central Indo-Pacific; Temperate Australasia	Ship/boat hull fouling
Sphaeroma quoianum H. Milne Edwards, 1840	all seas	29	NO	NO	Arthropod	Filter Feeder	Temperate Australasia	Ship/boat hull fouling
Celleporaria vermiformis (Waters, 1909)	MED	29	YES	YES	Bryozoan	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Licornia jolloisii (Audouin, 1826)	MED	29	YES	NO	Bryozoan	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Microporella coronata (Audouin, 1826)	MED	29	YES	YES	Bryozoan	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Mucropetraliella thenardii (Audouin, 1826)	MED	29	YES	NO	Bryozoan	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Parasmittina protecta (Thornely, 1905)	MED	29	YES	NO	Bryozoan	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Parasmittina serruloides Harmelin, Bitar & Zibrowius, 2009	MED	29	YES	NO	Bryozoan	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Torquatella longiuscula (Harmer, 1957)	MED	29	YES	NO	Bryozoan	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Goniadella gracilis (Verrill, 1873)	NE Atlantic, Baltic Sea	28	YES	YES	Polychaete	Predator	Temperate Northwest Atlantic	Ship/boat ballast water
Charybdis (Charybdis) japonica (A. Milne-Edwards, 1861)	MED	28	YES	YES	Arthropod	Predator	Temperate Northern Pacific, Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water
Rhynchozoon larreyi (Audouin, 1826)	MED	28	YES	NO	Bryozoan	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Smittina nitidissima (Hincks, 1880)	MED	28	YES	YES	Bryozoan	Filter Feeder	Western Indo-Pacific; Tropical Atlantic	Ship/boat hull fouling
Alepes djedaba (Forsskål, 1775)	MED	28	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Apogonichthyoides pharaonis (Bellotti, 1874)	MED	28	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Nereis (Nereis) gilchristi Day, 1967	MED	27	YES	NO	Polychaete	Omnivore	Temperate Southern Africa	Interconnected waterways/ basins/seas , Ship/boat hull fouling
Amphiodia (Amphispina) obtecta Mortensen, 1940	MED	27	YES	NO	Echinoderm	Predator	Western Indo-Pacific	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
Microporella genisii (Audouin, 1826)	MED	27	YES	NO	Bryozoan	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Tritia obsoleta (Say, 1822)	NE Atlantic	27	NO	NO	Mollusc	Predator	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector)
Prosphaerosyllis longipapillata (Hartmann-Schröder, 1979)	MED	26	YES	YES	Polychaete	Predator	Central Indo-Pacific	Interconnected waterways/ basins/seas
Laticorophium baconi (Shoemaker, 1934)	all seas	26	NO	NO	Arthropod	Detritivore	Temperate Northern Pacific, Tropical Eastern Pacific	Ship/boat hull fouling
Perophora multiclathrata (Sluiter, 1904)	MED	26	YES	YES	Ascidian	Filter Feeder	Central Indo-Pacific, Eastern Indo-Pacific, Tropical Atlantic	Ship/boat hull fouling
Akatopora leucocypha (Marcus, 1937)	MED	26	YES	NO	Bryozoan	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling
Cephalopholis taeniops (Valenciennes, 1828)	MED	26	YES	YES	Fish	Predator	Tropical Atlantic	Ship/boat hull fouling
Equulites klunzingeri (Steindachner, 1898)	MED	26	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas
Paraehlersia weissmannioides (Augener, 1913)	MED	25	YES	NO	Polychaete	Omnivore	Central Indo-Pacific	Interconnected waterways/ basins/seas
Perkinsyllis augeneri (Hartmann-Schröder, 1979)	MED	25	YES	NO	Polychaete	Omnivore	Central Indo-Pacific	Interconnected waterways/ basins/seas
Stylarioides grubei Salazar-Vallejo, 2011	MED	25	YES	YES	Polychaete	Detritivore	Western Indo-Pacific	Interconnected waterways/ basins/seas
Tridentiger trigonocephalus (Gill, 1859)	MED (possibly Black Sea, NE Atlantic)	25	NO	NO	Fish	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas, Ship/boat ballast water
Dipolydora tentaculata (Blake & Kudenov, 1978)	NE Atlantic	24	YES	YES	Polychaete	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
Polydora websteri Hartman in Loosanoff & Engle, 1943	NE Atlantic, MED	24	NO	NO	Polychaete	Detritivore	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Nuttallia obscurata (Reeve, 1857)	NE Atlantic, Baltic Sea	24	NO	NO	Mollusc	Filter Feeder	Temperate Northern Pacific, Central Indo-Pacific	Ship/boat ballast water
Boccardia knoxi (Rainer, 1973)	NE Atlantic, MED	23	NO	NO	Polychaete	Detritivore	Temperate Australasia	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
Boccardia pseudonatrix Day, 1961	NE Atlantic, MED	23	NO	NO	Polychaete	Detritivore	Temperate Southern Africa	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
Hydroides albiceps (Grube, 1870)	MED, NE Atlantic	23	NO	NO	Polychaete	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Iphione muricata (Lamarck, 1818)	MED	23	YES	NO	Polychaete	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas
Polydora rickettsi Woodwick, 1961	NE Atlantic, MED	23	NO	NO	Polychaete	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
Terebrasabella heterouncinata Fitzhugh & Rouse, 1999	NE Atlantic, MED	23	NO	NO	Polychaete	Filter Feeder	Temperate Southern Africa	Ship/boat hull fouling, Ship/boat ballast water, Contaminant on animals (except parasites, species transported by host/ vector)
Celleporaria labelligera Harmer, 1957	MED	23	YES	NO	Bryozoan	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Celleporina bitari Harmelin, 2014	MED	23	YES	NO	Bryozoan	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Drepanophora birbira Powell, 1967	MED	23	YES	NO	Bryozoan	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
Equulites elongatus (Günther, 1874)	MED	23	YES	NO	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/ basins/seas
Pomadasys stridens (Forsskål, 1775)	MED	23	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/ basins/seas
Boonea bisuturalis (Say, 1822)	MED, NE Atlantic	23	NO	NO	Mollusc	Predator	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
Dictyosphaeria cavernosa (Forsskål) Børgesen	MED	21	NO	NO	Seaweed	Primary producer	Circumtropical	Interconnected waterways/ basins/seas
Neomeris annulata Dickie	MED	21	YES	NO	Seaweed	Primary producer	Circumtropical	Interconnected waterways/ basins/seas , Pet/aquarium/ terrarium species (including live food for such species)

(Continues)

Horizon Scanning Species	European Sea(s)	Sum of weighted final scores	Already present in European seas	Already present in EU countries	Taxonomic group	Functional group	Native distribution range	Primary pathway(s)
Sabellastarte spectabilis (Grube, 1878)	MED	21	NO	NO	Polychaete	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water, Pet/aquarium/terrarium species (including live food for such species)
Syllis bella Chamberlin, 1919	MED	21	YES	NO	Polychaete	Omnivore	Temperate Northern Pacific, Tropical Eastern Pacific	Unknown
Charybdis (Charybdis) lucifera (Fabricius, 1798)	MED	21	YES	YES	Arthropod	Predator	Western Indo-Pacific; Central Indo-Pacific	Ship/boat ballast water
Corella inflata Huntsman, 1912	NE Atlantic	21	NO	NO	Ascidian	Filter Feeder	Temperate Northern Pacific	Ship/boat hull fouling
Sillago suezensis Golani, Fricke & Tikochinski, 2013	MED	21	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
Caprella simia Mayer, 1903	NE Atlantic	20	NO	NO	Arthropod	Omnivore	Temperate Northern Pacific	Ship/boat hull fouling, Ship/boat ballast water
Batillaria attramentaria (G. B. Sowerby I, 1855)	NE Atlantic	19	NO	NO	Mollusc	Herbivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
Gemma gemma (Totten, 1834)	NE Atlantic, Black Sea	19	NO	NO	Mollusc	Filter Feeder	Temperate Northwest Atlantic, Tropical Atlantic	Contaminant on animals (except parasites, species transported by host/vector)
Archaias angulatus (Fichtel & Moll, 1798)	MED	18	NO	NO	Foraminiferan	Primary producer	Tropical Atlantic	Ship/boat ballast water
Aulacomya atra (Molina, 1782)	MED (Adriatic), NE Atlantic	18	YES	YES	Mollusc	Filter Feeder	Temperate South America	Ship/boat hull fouling, Ship/boat ballast water
Glycera dibranchiata Ehlers, 1868	MED, NE Atlantic	17	NO	NO	Polychaete	Predator	Temperate Northwest Atlantic	Live food and live bait
Alatina alata (Reynaud, 1830)	MED,	17	NO	NO	Cnidarian	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
Tetrapygus niger (Molina, 1782)	NE Atlantic	17	NO	NO	Echinoderm	Herbivore	Temperate South America	Contaminant on animals (except parasites, species transported by host/vector)
Stoechospermum polypodioides (J.V.Lamouroux) J.Agardh	MED	9	NO	NO	Seaweed	Primary producer	Western Indo-Pacific; Central Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water

APPENDIX C

List of species initially considered for horizon scanning but eventually excluded during the exercise and consensus workshop. The reason of exclusion and the taxonomic group for each species are also given

Species excluded from the Horizon Scanning	Reason of exclusion	Taxonomic Group
Biddulphia sinensis Greville	cryptogenic	Diatom
Chaetoceros bacteriastroides G.H.H. Karsten	cryptogenic	Diatom
Coscinodiscus wailesii Gran & Angst	cryptogenic	Diatom
Ethmodiscus punctiger Castracane	cryptogenic	Diatom
Pseudo-nitzschia multistriata (Takano) Takano	cryptogenic	Diatom
Skeletonema tropicum Cleve	cryptogenic	Diatom
Thalassiosira tealata Takano	cryptogenic	Diatom
Alexandrium monilatum (J.F.Howell) Balech	cryptogenic	Dinoflagellate
Coolia malayensis Leaw, P.-T.Lim & Usup	cryptogenic	Dinoflagellate
Gymnodinium catenatum H.W.Graham	cryptogenic	Dinoflagellate
Karenia brevis (C.C.Davis) Gert Hansen & Ø. Moestrup	cryptogenic	Dinoflagellate
Ostreopsis lenticularis Y.Fukuyo	cryptogenic	Dinoflagellate
Ostreopsis ovata Fukuyo	cryptogenic	Dinoflagellate
Pyrodinium bahamense Plate	cryptogenic	Dinoflagellate
Thecadinium yashimaense S.Yoshimatsu, S. Toriumi & J.D.Dodge	cryptogenic	Dinoflagellate
Agglutinella compressa El-Nakhal, 1983	would not predict a potential impact	Foraminiferan
Agglutinella robusta El-Nakhal, 1983	would not predict a potential impact	Foraminiferan
Articulina pacifica Cushman, 1944	would not predict a potential impact	Foraminiferan
Cibicides mabahethi Said, 1949	would not predict a potential impact	Foraminiferan
Entosigmomorphina sp.	exclude (not in species level)	Foraminiferan
Epistomaroides punctulata (d'Orbigny, 1826)	would not predict a potential impact	Foraminiferan
Hauerina diversa Cushman, 1946	would not predict a potential impact	Foraminiferan
Mimosina affinis Millett, 1900	would not predict a potential impact	Foraminiferan
Pegidia lacunata McCulloch, 1977	would not predict a potential impact	Foraminiferan
Planogypsina acervalis (Brady, 1884)	cryptogenic	Foraminiferan
Pseudohauerinella dissidens (McCulloch, 1977)	would not predict a potential impact	Foraminiferan
Pseudomassilina australis (Cushman, 1932)	would not predict a potential impact	Foraminiferan
Pseudotriloculina subgranulata (Cushman, 1918)	would not predict a potential impact	Foraminiferan
Sorites orbiculus (Forsskål in Niebuhr, 1775)	cryptogenic	Foraminiferan
Actinotrichia fragilis (Forsskål) Børgesen	would not predict a potential impact	Seaweed
Dasya flocculosa Zanardini	would not predict a potential impact	Seaweed
Gelidiella acerosa (Forsskål) Feldmann & G. Hamel	would not predict a potential impact	Seaweed
Gracilaria vermiculophylla (Ohmi) Papenfuss	already widespread in EU	Seaweed

(Continues)

Species excluded from the Horizon Scanning	Reason of exclusion	Taxonomic Group
Halimeda opuntia (Linnaeus) J.V. Lamouroux	would not predict a potential impact	Seaweed
Halophila stipulacea (Forsskål) Ascherson	too widespread in the Eastern MED	Seagrass
Polycladia myrica (S.G.Gmelin) Draima, Ballesteros, F.Rousseau & T.Thibaut	would not predict a potential impact	Seaweed
Polysiphonia subtilissima Montagne	cryptogenic and widely present in MED	Seaweed
Rosenvingea intricata (J.Agardh) Børgesen	Tethyan relict, it could be native in the MED	Seaweed
Sargassum dentifolium (Turner) C.Agardh	would not predict a potential impact	Seaweed
Sargassum natans (Linnaeus) Gaillon	would not predict an environmental potential impact; only touristic implications	Seaweed
Undaria pinnatifida (Harvey) Suringar	already widespread in EU; localised in MED (Thau and Venice), more common in Atlantic	Seaweed
Arcuatula senhousia (Benson, 1842)	already widespread in EU	Mollusc
Crassostrea virginica (Gmelin, 1791)	confused with *Magallana* spp; complex taxonomy may result in impediments on its real ecology and status	Mollusc
Crepidula fornicata (Linnaeus, 1758)	already widespread in EU	Mollusc
Dendostrea frons (Linnaeus, 1758)	would not predict a potential impact	Mollusc
Finella pupoides A. Adams, 1860	would not predict a potential impact	Mollusc
Magallana sikamea (Amemiya, 1928)	confused with Magallana spp	Mollusc
Pteria colymbus (Röding, 1798)	questionable; maybe misidentification of Pinctada radiata	Mollusc
Daylithos parmatus (Grube, 1877)	the report of this species in the Mediterranean Sea turned into a new species: *Semiodera cinari* Salazar-Vallejo, 2012	Polychaete
Dodecaceria capensis Day, 1961	questionable	Polychaete
Leiocapitellides analis Hartmann-Schröder, 1960	questionable	Polychaete
Leiochrides australis Augener, 1914	questionable	Polychaete
Leonnates aylaoberi Çinar & Dagli, 2013	cryptogenic, maybe native	Polychaete
Lepidonotus carinulatus (Grube, 1870)	questionable, possibly a misidentification of a native species	Polychaete
Lumbrineris perkinsi Carrera-Parra, 2001	cryptogenic and questionable (identification uncertain)	Polychaete
Novafabricia infratorquata (Fitzhugh, 1973)	questionable, possibly a misidentification of a native species	Polychaete
Polydora cornuta Bosc, 1802	already widespread in EU	Polychaete
Pseudonereis anomala Gravier, 1899	already widespread in EU	Polychaete
Pseudopolydora paucibranchiata (Okuda, 1937)	already widespread in EU; until recently it has been misidentified as the native *P. antennata*. The re-examination of historical collections in Naples showed that this species occurs in the MED at least since 1977 (Gambi, pers. comm.).	Polychaete
Gobius cruentatus Gmelin, 1789	native in Mediterranean	Fish
Gobius xanthocephalus Heymer & Zander, 1992	native in Mediterranean	Fish

(Continues)

Species excluded from the Horizon Scanning	Reason of exclusion	Taxonomic Group
Iniistius pavo (Valenciennes, 1840)	native in Europe	Fish
Istiompax indica (Cuvier, 1832)	native in Europe	Fish
Kyphosus incisor (Cuvier, 1831)	arrival in EU due to climate change only	Fish
Neogobius melanostomus (Pallas, 1814)	already widespread in EU	Fish
Parablennius incognitus (Bath, 1968)	native in Mediterranean	Fish
Plectorhinchus gaterinus (Forsskål, 1775)	native in Europe	Fish
Plotosus lineatus (Thunberg, 1787)	recently risk assessed for the IAS Regulation	Fish
Pomatoschistus bathi Miller, 1982	native in Mediterranean	Fish
Sarpa salpa (Linnaeus, 1758)	native in Mediterranean	Fish
Sparus aurata Linnaeus, 1758	native in Mediterranean	Fish
Synagrops japonicus (Döderlein, 1883)	cryptogenic	Fish
Afropinnotheres monodi Manning, 1993	cryptogenic	Arthropod
Callinectes bocourti A. Milne-Edwards, 1879	already widespread in EU	Arthropod
Homarus americanus H. Milne Edwards, 1837	recently risk assessed for the IAS Regulation	Arthropod
Penaeus aztecus Ives, 1891	already widespread in EU	Arthropod
Sphaeroma walkeri Stebbing, 1905	already widespread in EU	Arthropod
Ascidiella aspersa (Müller, 1776)	native in Europe	Ascidian
Botrylloides giganteum (Pérès, 1949)	questionable; maybe a missidentification; probably conspecific with *B. pizoni* reported from Taranto, Ionian Sea	Ascidian
Ciona intestinalis (Linnaeus, 1767)	native in Europe	Ascidian
Ciona robusta Hoshino & Tokioka, 1967	already widespread in EU	Ascidian
Didemnum vexillum Kott, 2002	already widespread in EU	Ascidian
Diplosoma listerianum (Milne Edwards, 1841)	cryptogenic	Ascidian
Styela clava Herdman, 1881	already widespread in EU	Ascidian
Symplegma viride Herdman, 1886	double entry under the name *S. baharani*	Ascidian
Beania maxilladentata Ramalho, Muricy & Taylor, 2010	recorded only in Madeira; impact uknown	Bryozoan
Calyptotheca alexandriensis Abdel-Salam, Taylor & Dorgham, 2017	cryptogenic	Bryozoan
Celleporaria brunnea (Hincks, 1884)	already widespread in EU	Bryozoan
Celleporaria inaudita Tilbrook, Hayward & Gordon, 2001	recorded only in Madeira; impact uknown	Bryozoan
Conopeum ponticum Hayward, 2001	only on artificial substrates; would not predict a potential impact	Bryozoan
Favosipora purpurea Souto, Kaufmann & Canning-Clode, 2015	cryptogenic	Bryozoan
Parasmittina alba Ramalho, Muricy & Taylor, 2011	cryptogenic	Bryozoan
Parasmittina multiaviculata Souto, Ramalhosa & Canning-Clode, 2016	cryptogenic	Bryozoan
Diadumene leucolena (Verrill, 1866)	would not predict a potential impact	Cnidarian
Mawia benovici (Piraino, Aglieri, Scorrano & Boero, 2014)	cryptogenic	Cnidarian
Taxella gracilicaulis (Jäderholm, 1903)	would not predict a potential impact	Cnidarian