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RESEARCH ARTICLE

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

Konstantinos Tsiamis¹  | Ernesto Azzurro² | Michel Bariche³ | Melih E. Çinar⁴  | Fabio Crocetta⁵ | Olivier De Clerck⁶ | Bella Galil⁷ | Fernando Gómez⁸ | Razy Hoffman⁷ | Kathe Jensen⁹ | Lyudmila Kamburska¹⁰ | Joachim Langeneck¹¹ | Martin R. Langer¹² | Ya'arit Levitt-Barmats^{7,13} | Marco Lezzi¹⁴ | Agnese Marchini¹⁵ | Anna Occhipinti-Ambrogi¹⁵ | Henn Ojaveer^{16,17} | Stefano Piraino¹⁸ | Noa Shenkar^{7,13} | Maria Yankova¹⁹ | Argyro Zenetos²⁰ | Ante Žuljević²¹ | Ana Cristina Cardoso¹

¹European Commission, Joint Research Centre (JRC), Ispra, Italy

²ISPRA, Livorno, Italy

³Department of Biology, American University of Beirut, Beirut, Lebanon

⁴Faculty of Fisheries, Department of Hydrobiology, Ege University, Izmir, Turkey

⁵Department of Integrative Marine Ecology, Stazione Zoologica Anton Dohrn, Naples, Italy

⁶Phycology Research Group and Centre for Molecular Phylogenetics and Evolution, Ghent University, Ghent, Belgium

⁷The Steinhardt Museum of Natural History, Israel National Center for Biodiversity Studies, Tel-Aviv University, Tel Aviv, Israel

⁸Carmen Campos 3, Puerto Santa Maria, Spain

⁹Zoological Museum (Natural History Museum of Denmark), Copenhagen, Denmark

¹⁰Water Research Institute- IRSA-CNR, Verbania-Pallanza, Italy

¹¹Department of Biology, University of Pisa, Pisa, Italy

¹²Institut für Geowissenschaften, Abteilung Paläontologie, Universität Bonn, Bonn, Germany

¹³School of Zoology, George S. Wise Faculty of Life Science, Tel-Aviv University, Tel Aviv, Israel

¹⁴ARPAT, Regional Agency for Environmental Protection of Tuscany, Pisa, Italy

¹⁵Department of Earth and Environmental Sciences, University of Pavia, Pavia, Italy

¹⁶Pärnu College, University of Tartu, Pärnu, Estonia

¹⁷National Institute of Aquatic Resources, Technical University of Denmark, Kgs. Lyngby, Denmark

¹⁸Department of Biological and Environmental Sciences and Technologies, Università del Salento, Lecce, Italy

¹⁹Department of Marine Biology and Ecology, Institute of Oceanology, Varna, Bulgaria

²⁰Hellenic Centre for Marine Research, Institute of Marine Biological Resources and Inland Waters, Anavyssos, Greece

²¹Institute of Oceanography and Fisheries, Split, Croatia

Correspondence

Konstantinos Tsiamis, European Commission, Joint Research Centre (JRC), Ispra, Italy.
Email: konstantinos.tsiamis@ec.europa.eu

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 1143/2014 does not fully acknowledge the threat they pose to the EU marine environment.

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2. In this study, the first EU-scale horizon scanning 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), 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 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 1). 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 1), 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 2): 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, 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

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).

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 consultation among the experts within each thematic group was

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%).

performed. Experts had the opportunity to revise their scores and exclude species (Appendix 3) 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 2).

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

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

ecosystem services, following the scheme by Liqueste et al. (2013) and Katsanevakis, Wallentinus, et al. (2014).

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); (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 1). 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 1, 3). 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 1, 2). 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 2).

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 2).

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 corresponding to 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

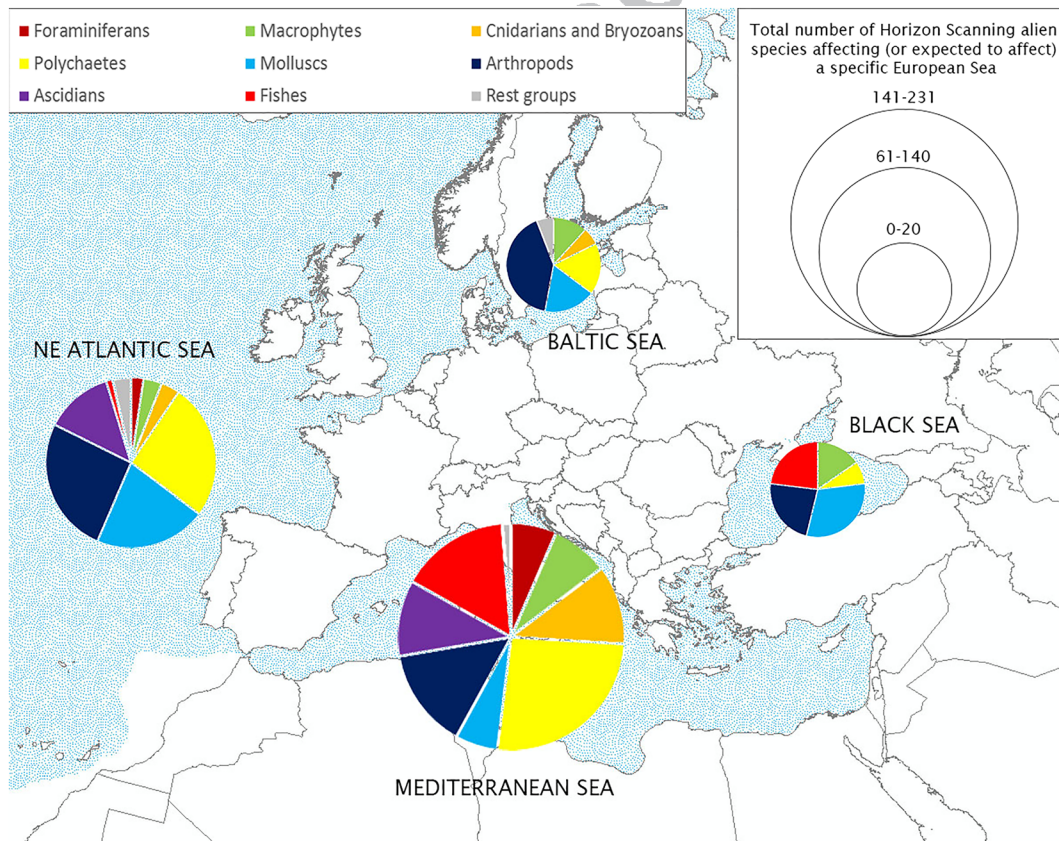


FIGURE 1 Threatened European seas likely to be affected by the arrival, establishment, spread and impact of the marine alien species, listed through the current horizon scanning, within the next 10 years. The size of each pie chart represents the total number of the horizon scanning species expected 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

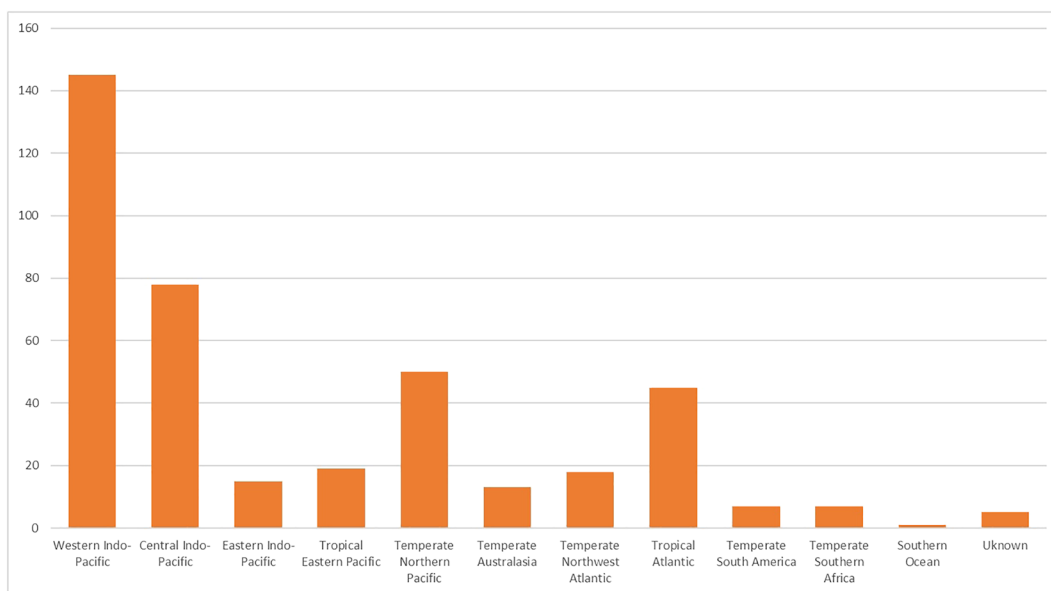


FIGURE 2 Native distribution range of marine alien species listed through the current horizon scanning expected to (further) affect EU marine waters. Each species can have a native distribution range extending to one or more marine realms

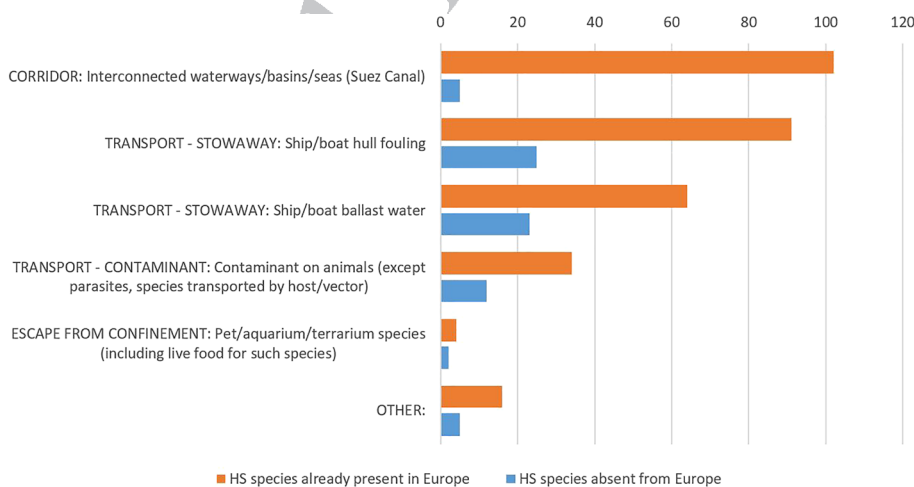


FIGURE 3 Number of marine alien species listed through the current horizon scanning, which are already introduced or expected to arrive in Europe's seas through primary introduction pathways. Several species are linked to more than one pathway

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

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

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TABLE 5 Top-priority marine invasive 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:						
<i>Codium parvulum</i>	-	Macrophyte	Western Indo-Pacific	Suez Canal	Natural	No: established in Israel, Lebanon, Syria and Turkey, difficult taxonomy, prevention of dispersal to EU impossible
<i>Halimeda incrassata</i>	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
<i>Ergosquilla massavensis</i>	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
<i>Hemigrapsus sanguineus</i>	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)
<i>Penaeus pulchricaudatus</i>	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
<i>Portunus segnis</i>	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
<i>Pterois miles</i>	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
<i>Amphistegina lobifera</i>	CY, EL, IT, MT	Foraminifera	Western-Central Indo-Pacific	Ballast, Suez Canal,	Natural, ballast	No:

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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
<i>Xenostrobus securis</i>	IT, ES, FR	Mollusc	Central Indo-Pacific	Hull, aquaculture parasites on animals	Natural	microscopic, effective prevention of secondary dispersal to other EU countries and mitigation of established populations are impossible Partially: prevention of secondary dispersal to other EU countries is rather impossible; mitigation of established populations could be attempted through targeted collections
<i>Rhopilema nomadica</i>	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
<i>Lagocephalus sceleratus</i>	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 tetratoxin poisoning can be reduced through public awareness initiatives
<i>Chama pacifica</i>	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
<i>Spirobranchus kraussii</i>	-	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
<i>Microcosmus exasperatus</i>	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
<i>Charybdis longicollis</i>	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

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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
<i>Herdmania momus</i>	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
<i>Matuta victor</i>	EL	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
<i>Pseudodiaptomus marinus</i>	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
<i>Siganus luridus</i>	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
<i>Siganus rivulatus</i>	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. H5 species absent from European seas that attained the highest scoring:						
<i>Didemnum perlucidum</i>	-	Ascidian	Unknown	Hull, ballast	Not applicable	Partially: difficult identification, effective prevention could be achieved by managing shipping and applying early-warning eradication
<i>Hydroides sanctaerucis</i>	-	Polychaete	Tropical Atlantic	Hull	Not applicable	Partially: effective prevention could be achieved by managing shipping and applying early-warning eradication
<i>Zostera japonica</i>	-	Macrophyte	Temperate northern Pacific, central Indo-Pacific	Aquaculture	Not applicable	Yes: effective prevention can be achieved by managing oyster imports into Europe
<i>Caulerpa serrulata</i>	-	Macrophyte	Western-central Indo-Pacific, Tropical Atlantic	Aquarium	Not applicable	Yes: effective prevention can be achieved by managing aquarium trade

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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
<i>Perma viridis</i>	-	Mollusc	Western-central Indo-Pacific	Hull, ballast	Not applicable	Partially: effective prevention could be achieved by managing shipping and applying early-warning eradication
<i>Kappaphycus alvarezii</i>	-	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

1 Seas. However, these marine areas are vulnerable to secondary intro- 54
2 ductions of IAS from infested neighbouring areas (e.g. many species 55
3 introduced in the North Sea spread secondarily into the Baltic Sea, 56
4 either by natural or human intervention – Ojaveer et al., 2017). 57

5 The majority of the HS species considered in the current study 58
6 have been already introduced, even if generally not widespread, in at 59
7 least one European sea. Consequently, these species were over- 60
8 represented in the final ranking list, especially at higher ranking since 61
9 they were given the score of '4' for the parameters of the likelihood 62
10 of arrival and establishment. In order to overcome this bias, we chose 63
11 to highlight also the top scoring species that are not present yet in 64
12 Europe, such as *D. perlucidum* and *Z. japonica*, despite their lower 65
13 ranking position (lower overall score) compared to other IAS that 66
14 already exist in Europe. The assessment ultimately resulted in a top- 67
15 priority list of HS species, including species both present and absent 68
16 from Europe. 69

17 Roy et al. (2019) identified eight marine HS species of very high 70
18 or high risk of arrival, establishment, spread, and potential impact; our 71
19 investigation, by contrast, resulted in identification of 26 top-priority 72
20 marine HS species. Only two species – *C. parvulum* and *P. viridis* – are 73
21 in common for these two lists. Although Roy et al. (2019) considered 74
22 *Crepidula onyx*, *Mytilopsis sallei*, *Acanthophora spicifera*, *Potamocorbula* 75
23 *amurensis*, and *Symplegma reptans* as very high- or high-risk HS spe- 76
24 cies, these species scored lower in our ranking and were not included 77
25 in the top-priority HS group. *Plotosus lineatus*, ranked as a very high- 78
26 risk species by Roy et al. (2019), was excluded from our analysis since 79
27 it is already included in the list of IAS of Union concern of the IAS 80
28 Regulation (EC, 2019). Finally, several species included in our top- 81
29 priority HS list either scored low (*D. perlucidum*, *Z. japonica*) or were 82
30 not considered at all (e.g. *K. alvarezii*, *H. sanguineus*, *L. sceleratus*, 83
31 *S. kraussii*, *M. exasperatus*, *M. victor*, *S. luridus*, *S. rivulatus*) by Roy et al. 84
32 (2019). The above discrepancies on the lists of species between the 85
33 two studies could be attributed to methodological differences, such as 86
34 the consideration of the confidence level in weighting the scores 87
35 given by the experts in our study, which was absent in Roy et al. 88
36 (2019) study. In addition, the latter authors excluded from their analy- 89
37 sis species with distribution wider than three European countries, 90
38 instead of five countries as was followed by our work. This can explain 91
39 the exclusion/not consideration in Roy et al. (2019) assessment of 92
40 species such as *Siganus* spp. and *L. sceleratus*, which have distribution 93
41 wider than three European countries. Finally, the wider geographic 94
42 coverage of the expertise involved in the current exercise and the 95
43 engagement of a much higher number of marine experts specialized in 96
44 specific taxonomic groups in this study – allowing for a more accurate 97
45 scoring of species – could also explain the differences on the out- 98
46 comes between the two lists of species. 99

47 Carboneras et al. (2018) performed a pan-European prioritiza- 100
48 tion exercise for alien species to be risk assessed and possibly listed 101
49 in the list of IAS of Union concern of the IAS Regulation. This work 102
50 investigated 1,323 alien species from diverse environments (terres- 103
51 trial, fresh water, marine) focusing on their spread and impact, 104
52 including species both absent and already widespread across 105
53 Europe. In their top priority list (urgent need for a risk assessment

by 2018) marine species were poorly represented, with only eight 54
marine species listed from a total of 59. Among them, *Crepidula* 55
fornicata, *Didemnum vexillum*, *Gammarus tigrinus*, *Lophocladia* 56
lallemandi, and *Mnemiopsis leidyi* are species already widespread 57
across Europe, which was the reason for their exclusion from our 58
HS list. The remaining three species by Carboneras et al. (2018) 59
were *H. americanus*, *P. miles*, and *Rapana venosa*. *Homarus* 60
americanus was excluded from our study since it has been already 61
risk assessed and submitted to the IAS Regulation, while the other 62
two species have been included in our HS list. 63

64 Based on Article 4 of the IAS Regulation, one of the criteria 65
set for inclusion of species in the list of IAS of Union concern is 66
that “it is likely that the inclusion on the Union list will effectively pre- 67
vent, minimize or mitigate their adverse impact” (EU, 2014). There- 68
fore, an HS species can be more suitable for performing a risk 69
assessment for the IAS Regulation if its associated management can 70
offer effective prevention and/or mitigation of its population. Wide- 71
spread species place an unrealistic challenge to management 72
(Lehtiniemi et al., 2015; Ojaveer et al., 2018). Managing species that 73
are as yet absent or have a limited distribution across the EU 74
marine waters should be more realistic. Under that concept, the HS 75
species taken into consideration in the current study are all in prin- 76
ciple suitable for performing a risk assessment and possibly to be 77
listed in the Union list. 78

79 The ranking and prioritization of the HS species examined in our 80
study resulted in 26 top-priority marine HS species. Considering 81
those, a further screening based on the feasibility of their manage- 82
ment resulted in a list of 18 species. The management of these 18 spe- 83
cies seems at least partially feasible, and we believe that they are the 84
most suitable species for performing risk assessments for the IAS Reg- 85
ulation. Among the 18 species, six of them are not present yet in any 86
European sea: the macrophytes *C. serrulata*, *K. alvarezii*, *Z. japonica*, 87
the mollusc *P. viridis*, the polychaete *H. sanctaerucis*, and the ascidian 88
D. perlucidum, which can all have serious impacts on the marine native 89
communities (Baker, Fajans, & Bergquist, 2003; Chandrasekaran, Arun 90
Nagendran, Pandiaraja, Krishnankutty, & Kamalakannan, 2008; Posey, 91
1988; Simpson, Wernberg, & McDonald, 2016; Vranken et al., 2018). 92
Thus, an effective control of their possible primary introduction path- 93
ways into Europe (ship fouling, ballast, aquaculture, aquarium trade) 94
should be applied. 95

96 Among the 18 species proposed as suitable for performing risk 97
assessments, 12 of them are already introduced into Europe. The 98
fishes *P. miles*, *L. sceleratus*, *S. luridus*, and *S. rivulatus*, already quite 99
widespread in Cyprus and Greece and reaching the Italian coasts, pose 100
a severe threat to native marine ecosystems (Azzurro, Fanelli, 101
Mostarda, Catra, & Andaloro, 2007; Bariche, Letourneur, & Harmelin- 102
Vivien, 2004; Kalogirou, 2011; Morris, 2012; Sala, Kizilkaya, Yildirim, & 103
Ballesteros, 2011; Salomidi et al., 2016; Vergés et al., 2014), highlight- 104
ing the need for management action. Their conspicuous size and easily 105
identifiable morphology could facilitate efficient removal, helping 106
actions for controlling established populations through targeted fish-
eries or by the involvement of motivated citizens (such a recreational
divers and spear-fishers). The arthropods *M. victor*, *H. sanguineus*, and

1 *P. segnis* can have negative effects on native benthic invertebrates
 2 through predation (Galil & Mendelson, 2013; Gerard, Cerrator, &
 3 Larson, 1999; Rabaoui, Arculeo, Mansour, & Tlig-Zouari, 2015); their
 4 dispersal to other EU countries could be prevented through vessel-
 5 ballast management and early-warning eradication at the local level.
 6 The molluscs *X. securis* and *C. pacifica* can smother native fauna
 7 (Mienis, 2003; Russo, 2001), while the former can be a key host
 8 favouring the spread of parasites (*Marteilia refringens*) to native bivalve
 9 populations (Pascual et al., 2010). Mitigation of established
 10 populations of *X. securis* could be achieved through targeted popula-
 11 tion control, while prevention of secondary dispersal of *C. pacifica* to
 12 other EU countries could be prevented through hull management and
 13 early-warning alert and local eradication. Finally, biofouling species
 14 such as the polychaete *S. kraussii* and the ascidians *M. exasperatus* and
 15 *H. momus* may outcompete native species and overgrow on cultured
 16 bivalves, as well as on man-made structures, such as ropes, floating
 17 pontoons, pipes, buoys, mooring blocks, and fish cages, hence
 18 compromising their functioning (Eno, Clark, & Sanderson, 1997;
 19 Lambert, 2007; Mineur et al., 2012). Their dispersal to other EU coun-
 20 tries could be prevented through vessel-fouling management (MEPC,
 21 2011) and early-warning alert and local eradication.

22 It has to be noted, however, that most of above species (see also
 23 Table 5) entered the Mediterranean Sea through the Suez Canal
 24 (a pathway of introduction unmanaged, and unlikely to be managed in
 25 the foreseeable future). The large populations established in the
 26 Levantine Sea by species such as *L. sceleratus*, *S. luridus*, *S. rivulatus*,
 27 *M. victor*, *P. segnis*, *C. pacifica*, *S. kraussii*, *M. exasperatus*, and
 28 *H. momus*, and the presence of their planktonic larval stages, argue to
 29 the difficulty of control/mitigation attempts – as propagules pressure
 30 will continue, and perhaps increase with the continued warming of
 31 the water. In addition, localized mitigation efforts have proven imprac-
 32 tical for the lionfish (*Pterois volitans*) in the west Atlantic Ocean (Dahl,
 33 Patterson, & Snyder, 2016; Johnston & Purkis, 2015). These concerns
 34 should be addressed in depth in the upcoming listing process of IAS of
 35 Union concern. Horizon scanning assessments usually include high
 36 levels of uncertainty (Roy et al., 2015), and this definitely applies
 37 when assessing marine invasions in EU waters. The relevant details of
 38 life-history characteristics, invasion history and associated pathways
 39 of marine IAS, useful for assessing the likelihood of arrival, establish-
 40 ment and spread, are not always available (Minchin, Gollasch, Cohen,
 41 Hewitt, & Olenin, 2009; Ojaveer et al., 2018). Similarly, the worldwide
 42 information on the impacts of marine invasive species is often very
 43 limited (Ojaveer et al., 2015; Ojaveer & Kotta, 2015). Therefore,
 44 expert judgement was applied in many cases, which often resulted in
 45 variation among the experts scoring of the species parameters. This
 46 problem was addressed by the use of the confidence level on the
 47 scoring and the consensus among the experts of the same thematic
 48 group. However, bias was also observed among the different thematic
 49 groups of evaluators. The overall consensus workshop mitigated this
 50 bias, although we do acknowledge that the complete elimination of
 51 the experts' bias is rather difficult.

52 Expert bias was even more evident in the evaluation of the man-
 53 agement feasibility of the top-priority marine HS species, due to the

limited number of applied management efforts against marine IAS 54
 worldwide (Bax et al., 2001; Thresher & Kuris, 2004). Therefore, the 55
 attributed feasibility of management for the current top-priority HS 56
 species must be considered with caution and should be further inves- 57
 tigated under the listing process of IAS of Union concern. For the 58
 same reason, we would encourage, ideally, the performance of risk 59
 assessments for all the 26 top-priority HS species of our study. The 60
 HS participants concur that region-wide, multi-vector pathways-based 61
 management is most effective in preventing the introduction of 62
 marine IAS. 63

64 5 | CONCLUSIONS 65

66 Almost 4 years after the publication of the IAS Regulation, the list of 67
 IAS of Union concern includes only one fully marine species. This 68
 under-representation of marine species from the Union list does not 69
 acknowledge the magnitude of their threat to the EU marine environ- 70
 ment. The current HS exercise provides 26 top-priority marine HS 71
 species, 18 of which are considered as most suitable to perform risk 72
 assessments in the frame of the IAS Regulation: *C. serrulata*, 73
C. pacifica, *D. perlucidum*, *H. sanguineus*, *H. momus*, *H. sanctaecrucis*, 74
K. alvarezii, *L. sceleratus*, *M. victor*, *Microcosmus exasperates*, *P. viridis*, 75
P. segnis, *P. miles*, *S. luridus*, *S. rivulatus*, *S. kraussii*, *X. securis*, and 76
Z. japonica. 77

78 In depth-assessment should consider the feasibility of manage- 79
 ment of the species, since the subjectivity of the issue on certain spe- 80
 cies is quite evident. Indeed, although the panel of experts of the 81
 current HS exercise had a consensus in the final list of the top-priority 82
 HS species, there was a strong debate among them on the feasibility 83
 of management of certain species already established in Europe. How- 84
 ever, all experts agreed that preventive measures aiming at holistic 85
 management of the introduction pathways of the species are to be 86
 privileged. 87

88 Biological invasions are dynamic, and the HS should be performed 89
 periodically, in order to review listed species and assess new ones. To 90
 this end, knowledge on marine biological invasions as well as on the 91
 taxonomy and biogeography across the wide range of marine phyla 92
 are crucial for successfully assessing HS assessments on marine spe- 93
 cies, and this kind of expertise should be encouraged. 94

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1 ORCID

2 Konstantinos Tsiamis  <https://orcid.org/0000-0003-1192-3516>3 Melih E. Çinar  <https://orcid.org/0000-0002-1802-2801>

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Uncorrected Proof

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 Foraminifera	44	29	15	Martin Langer Fernando Gómez Ana Cristina Cardoso Konstantinos Tsiamis
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
Annelida	79	11	68	Melih Ertan Çınar Marco Lezzi Joachim Langeneck
Fish	49	13	36	Michel Bariche Maria Yankova Ernesto Azzurro
Arthropods & Tunicates	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

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
<i>Codium parvulum</i> (Bory de Saint-Vincent ex Audouin) P. C. Silva	4	High	12	4	High	12	4	High	12	4	High	12
<i>Halimeda incrassata</i> (J.Ellis) J.V. Lamouroux	4	High	12	4	High	12	4	High	12	4	High	12
<i>Erugosquilla massavensis</i> (Kossmann, 1880)	4	High	12	4	High	12	4	High	12	4	High	12
<i>Hemigrapsus sanguineus</i> (De Haan, 1835)	4	High	12	4	High	12	4	High	12	4	High	12
<i>Penaeus pulchricaudatus</i> Stebbing, 1914	4	High	12	4	High	12	4	High	12	4	High	12
<i>Portunus segnis</i> (Forskål, 1775)	4	High	12	4	High	12	4	High	12	4	High	12
<i>Pterois milés</i> (Bennett, 1828)	4	High	12	4	High	12	4	High	12	4	High	12
<i>Amphistegina lobifera</i> Larsen, 1976	4	High	12	4	High	12	4	High	12	4	High	12
<i>Xenostrobus securis</i> (Lamarck, 1819)	4	High	12	4	High	12	4	High	12	4	High	12
<i>Rhopilema nomadica</i> Gall, 1990	4	High	12	4	High	12	4	High	12	4	Medium	11
<i>Lagocephalus sceleratus</i> (Gmelin, 1789)	4	High	12	4	High	12	4	High	12	4	Medium	11
<i>Chama pacifica</i> Broderip, 1835	4	High	12	4	High	12	4	High	12	4	Medium	11
<i>Spirobranchus kraussii</i> (Baird, 1865)	4	High	12	4	High	12	4	High	12	4	Medium	11
<i>Microcosmus exasperatus</i> Heller, 1878	4	High	12	4	High	12	4	High	12	3	High	9
<i>Charybdis (ContoHELLenus) longicollis</i> Leene, 1938	4	High	12	4	High	12	3	High	9	4	High	12
<i>Herdmania momus</i> (Savigny, 1816)	4	High	12	4	High	12	4	High	12	3	High	9

(Continues)

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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
<i>Matuta victor</i> (Fabricius, 1781)	4	High	12	4	High	12	3	High	9	4	High	12
<i>Pseudodiaptomus marinus</i> Sato, 1913	4	High	12	4	High	12	4	High	12	3	High	9
<i>Siganus luridus</i> (Rüppell, 1829)	4	High	12	4	High	12	3	High	9	4	High	12
<i>Siganus rivulatus</i> Försskål & Niebuhr, 1775	4	High	12	4	High	12	3	High	9	4	High	12
<i>Dictyota acutiloba</i> J. Agardh	4	High	12	4	High	12	4	High	12	3	Medium	8
<i>Boccardia proboscidea</i> Hartman, 1940	4	High	12	4	High	12	4	Medium	11	3	High	9
<i>Balanus glandula</i> Darwin, 1854	4	High	12	4	High	12	4	High	12	3	Medium	8
<i>Didemnum perlucidum</i> Monniot F., 1983	3	Medium	8	4	High	12	4	High	12	4	High	12
<i>Penaeus semiscalatus</i> De Haan, 1844 [in De Haan, 1833-1850]	4	High	12	4	Medium	11	4	High	12	3	High	9
<i>Styela plicata</i> (Lesueur, 1823)	4	High	12	4	High	12	4	High	12	3	Medium	8
<i>Trachysalambria palaestinensis</i> (Steinitz, 1932)	4	High	12	4	High	12	4	High	12	3	Medium	8
<i>Macrorhynchia philippina</i> Kirchenpauer, 1872	4	High	12	4	High	12	3	Medium	8	4	High	12
<i>Phyllorhiza punctata</i> Lendenfeld, 1884	4	High	12	4	High	12	4	High	12	3	Medium	8
<i>Dendostrea folium</i> (Linnaeus, 1758)	4	High	12	4	High	12	4	High	12	3	Medium	8
<i>Megabalanus coccopoma</i> (Darwin, 1854)	4	High	12	4	High	12	4	High	12	3	Low	7
<i>Phallusia nigra</i> Savigny, 1816	4	Medium	11	4	High	12	4	High	12	3	Medium	8
<i>Schizoporella japonica</i> Ortman, 1890	4	High	12	4	High	12	4	Medium	11	3	Medium	8
<i>Torquigener flavimaculosus</i> Hardy & Randall, 1983	4	High	12	4	High	12	3	Medium	8	4	Medium	11
<i>Hydroides sanctaerucis</i> Krøyer in Mörch, 1863	3	High	9	4	High	12	4	High	12	3	High	9
<i>Microcosmus squamiger</i> Michaelsen, 1927	4	High	12	4	High	12	4	High	12	2	High	6
<i>Galaxaura rugosa</i> (J. Ellis & Solander) J.V. Lamouroux	4	High	12	4	High	12	3	High	9	3	High	9

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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
<i>Chrysonophos lewisii</i> (W.R. Taylor) W.R.Taylor	4	High	12	4	High	12	3	High	9	3	High	9
<i>Codium pulvinatum</i> M.J.Wynne & R.Hoffman	4	High	12	4	High	12	4	High	12	2	High	6
<i>Rugulopteryx okamurae</i> (E.Y. Dawson) I.K.Hwang, W.J.Lee & H.S.Kim	4	High	12	4	High	12	3	High	9	3	High	9
<i>Zostera japonica</i> Ascherson & Graebner	2	High	6	4	High	12	4	High	12	4	High	12
<i>Hydroides ezoensis</i> Okuda, 1934	4	High	12	4	High	12	4	High	12	2	High	6
<i>Hydroides operculata</i> (Treadwell, 1929)	4	High	12	4	High	12	3	High	9	3	High	9
<i>Charybdis (Charybdis) hellerii</i> (A. Milne-Edwards, 1867)	4	High	12	4	High	12	3	High	9	3	High	9
<i>Polyandrocarpa zorritensis</i> (Van Name, 1931)	4	High	12	4	High	12	4	High	12	2	High	6
<i>Watersipora arcuata</i> Banta, 1969	4	High	12	4	High	12	4	High	11	3	Low	7
<i>Amphisorus hemprichii</i> Ehrenberg, 1839	4	High	12	4	High	12	4	High	12	2	High	6
<i>Amphistegina lessonii</i> d'Orbigny in Guérin-Méneville, 1832	4	High	12	4	High	12	4	High	12	2	High	6
<i>Spirolina acicularis</i> (Batsch, 1791)	4	High	12	4	High	12	3	High	9	3	High	9
<i>Heterostegina depressa</i> d'Orbigny, 1826	4	High	12	4	High	12	4	High	12	2	High	6
<i>Spondylus spinosus</i> Schreibers, 1793	4	High	12	4	High	12	3	High	9	3	High	9
<i>Caulerpa serrulata</i> (Forskål) J. Agardh	3	High	9	4	High	12	4	High	12	3	Medium	8
<i>Branchioma bairdi</i> (McIntosh, 1885)	4	High	12	4	High	12	4	High	12	2	Medium	5
<i>Hydroides brachyacantha</i> Rioja, 1941	4	High	12	4	High	12	4	High	12	2	Medium	5
<i>Hydroides heterocera</i> (Grube, 1868)	4	High	12	4	High	12	4	High	12	2	Medium	5
<i>Hydroides homoceros</i> Pixell, 1913	4	High	12	4	High	12	4	High	12	2	Medium	5

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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
<i>Hydroides minax</i> (Grube, 1878)	4	High	12	4	High	12	4	High	12	2	Medium	5
<i>Ecteinascidia thurstoni</i> Herdman, 1890	4	High	12	4	Medium	11	4	High	12	2	High	6
<i>Penaeus hathor</i> (Burkenroad, 1959)	4	High	12	4	High	12	4	High	12	2	Medium	5
<i>Styela canopus</i> (Savigny, 1816)	4	High	12	4	High	12	4	High	12	2	Medium	5
<i>Aurelia coerulea</i> von Lendenfeld, 1884	4	High	12	4	High	12	4	Medium	11	2	High	6
<i>Aurelia solida</i> Browne, 1905	4	High	12	4	High	12	4	Medium	11	2	High	6
<i>Celtodoryx ciocalyptoides</i> (Burton, 1935)	4	High	12	4	Medium	11	3	Low	7	4	Medium	11
<i>Callionymus filamentosus</i> Valenciennes, 1837	4	Medium	11	4	High	12	3	Medium	8	4	Low	10
<i>Fistularia commersonii</i> Rüppell, 1838	4	High	12	4	Medium	11	4	Medium	11	3	Low	7
<i>Lagocephalus guentheri</i> Miranda Ribeiro, 1915	4	High	12	4	High	12	3	High	9	3	Medium	8
<i>Stephanolepis diaspros</i> Fraser-Brunner, 1940	4	High	12	4	High	12	3	Medium	8	3	High	9
<i>Upeneus pori</i> Ben-Tuvia & Golani, 1989	4	High	12	4	High	12	3	Medium	8	3	High	9
<i>Coscinospira hemprichii</i> Ehrenberg, 1839	4	High	12	4	High	12	4	High	12	2	Medium	5
<i>Parasorites Seigle & Rivera</i> , 1977	4	High	12	4	High	12	4	High	12	2	Medium	5
<i>Haminoea japonica</i> Pilsbry, 1895	4	High	12	4	High	12	3	High	9	3	Medium	8
<i>Rapana venosa</i> (Valenciennes, 1846)	4	Medium	11	4	High	12	3	High	9	3	High	9
<i>Symplegma reptans</i> (Oka, 1927)	4	High	12	4	High	12	4	High	12	2	Medium	5
<i>Boccardiella hamata</i> (Webster, 1879)	4	High	12	4	High	12	4	Medium	11	2	Medium	5
<i>Actaea savignii</i> (H. Milne Edwards, 1834)	4	High	12	4	Medium	11	3	High	9	3	Medium	8
<i>Atergatis roseus</i> (Rüppell, 1830)	4	High	12	4	High	12	3	Medium	8	3	Medium	8
<i>Corella eumyota</i> Traustedt, 1882	4	High	12	4	High	12	4	High	12	2	Low	4

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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
<i>Paranthura japonica</i> Richardson, 1909	4	High	12	4	High	12	4	High	12	2	Low	4
<i>Textularia agglutinans</i> d'Orbigny, 1839	4	High	12	4	High	12	4	High	12	2	Low	4
<i>Rangia cuneata</i> (G. B. Sowerby I, 1832)	4	High	12	4	High	12	3	Medium	8	3	Medium	8
<i>Streblospio gynobranchiata</i> Rice & Levin, 1998	4	High	12	4	High	12	4	High	12	1	High	3
<i>Ascidia cannellata</i> Oken, 1820	4	High	12	4	High	12	4	High	12	1	High	3
<i>Carupa tenuipes</i> Dana, 1852	4	High	12	4	High	12	4	High	12	1	High	3
<i>Macrophthalmus</i> (<i>Macrophthalmus</i>) <i>indicus</i> Davie, 2012	4	High	12	4	High	12	3	High	9	2	High	6
<i>Rhodosoma turcicum</i> (Savigny, 1816)	4	High	12	4	High	12	4	High	12	1	High	3
<i>Symplegma bahraini</i> Monniot C. & Monniot F., 1997	4	High	12	4	High	12	4	High	12	1	High	3
<i>Pempheris rhomboidea</i> Kossmann & Rüber, 1877	4	High	12	4	High	12	3	High	9	2	High	6
<i>Sargocentron rubrum</i> (Forsskal, 1775)	4	High	12	4	High	12	3	High	9	2	High	6
<i>Penna viridis</i> (Linnaeus, 1758)	3	High	9	3	High	9	4	High	12	3	High	9
<i>Kappaphycus alvarezii</i> (Doty) Doty ex P.C.Silva	2	High	6	4	High	12	4	High	12	3	Medium	8
<i>Palola valida</i> (Gravier, 1900)	4	High	12	4	High	12	3	High	9	2	Medium	5
<i>Saurida lessepsianus</i> Russell, Golani & Tikochinski, 2015	4	High	12	4	High	12	2	Medium	5	3	High	9
<i>Upeneus moluccensis</i> (Bleeker, 1855)	4	High	12	4	High	12	2	Medium	5	3	High	9
<i>Ocinebrellus inomatus</i> (Récluz, 1851)	4	High	12	4	High	12	2	High	6	3	Medium	8
<i>Urosalpinx cinerea</i> (Say, 1822)	4	High	12	4	High	12	2	High	6	3	Medium	8
<i>Avrainvillea amadelpa</i> (Montagne) A.Gepp & E.S. Gepp	4	High	12	4	High	12	2	Medium	5	3	Medium	8
<i>Neodexiospira brasiliensis</i> (Grube, 1872)	4	High	12	4	High	12	4	High	12	1	Low	1
<i>Neodexiospira steueri</i> (Sterzinger, 1909)	4	High	12	4	High	12	4	High	12	1	Low	1

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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
<i>Polydora colonia</i> Moore, 1907	4	High	12	4	High	12	4	High	12	1	Low	1
<i>Spirobranchus tetraceros</i> (Schmarda, 1861)	4	High	12	4	High	12	4	High	12	1	Low	1
<i>Amphitoe valida</i> Smith, 1873	4	High	12	4	High	12	4	High	12	1	Low	1
<i>Anilocra pilchardi</i> Bariche & Trilles, 2006	4	High	12	4	High	12	3	Medium	8	2	Medium	5
<i>Aoroides longimerus</i> Ren & Zheng, 1996	4	High	12	4	High	12	4	High	11	1	Medium	2
<i>Cynothoa indica</i> Schioedte & Meinert, 1884	4	High	12	4	High	12	3	Medium	8	2	Medium	5
<i>Grandierella japonica</i> Stephensen, 1938	4	High	12	4	High	12	4	High	12	1	Low	1
<i>Ianropsis serricaudis</i> Gurjanova, 1936	4	High	12	4	High	12	4	High	12	1	Low	1
<i>Melita nitida</i> Smith, 1873	4	High	12	4	High	12	4	High	12	1	Low	1
<i>Stenothoe georgiana</i> Bynum & Fox, 1977	4	High	12	4	High	12	4	High	12	1	Low	1
<i>Atherinomor</i> <i>forskali</i> (Ruppell, 1838)	4	High	12	4	High	12	3	Medium	8	2	Medium	5
<i>Parupeneus forskali</i> (Fourmanoir & Guézé, 1976)	4	High	12	4	High	12	3	High	9	2	Low	4
<i>Sorites marginalis</i> (Lamarck, 1816)	4	High	12	4	High	12	3	Medium	8	2	Medium	5
<i>Gracilaria salicornia</i> (C.Agardh) E.Y.Dawson	3	High	9	3	Medium	8	3	Medium	8	4	Medium	11
<i>Bispira polyomma</i> Giangrande & Faasse, 2012	4	High	12	4	High	12	3	Medium	8	2	Low	4
<i>Eurythoe complanata</i> (Pallas, 1766)	4	High	12	4	High	12	3	High	9	1	High	3
<i>Leodice antennata</i> Savigny in Lamarck, 1818	4	High	12	4	High	12	3	High	9	1	High	3
<i>Naineris setosa</i> (Verrill, 1900)	4	High	12	4	High	12	4	Medium	11	1	Low	1
<i>Prionospio sexoculata</i> Augener, 1918	4	High	12	4	High	12	3	High	9	1	High	3
<i>Ascidia sydneiensis</i> Stimpson, 1855	3	High	9	4	High	12	4	High	12	1	High	3
<i>Erichthonius pugnax</i> (Dana, 1852)	4	High	12	4	High	12	4	Medium	11	1	Low	1

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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
<i>Polycilium constellatum</i> Savigny, 1816	4	High	12	4	High	12	3	Medium	8	2	Low	4
<i>Diadema setosum</i> (Leske, 1778)	4	High	12	4	High	12	3	Medium	8	2	Low	4
<i>Pararotalia calcariformata</i> McCulloch, 1977	4	High	12	3	High	9	3	High	9	2	High	6
<i>Mytilopsis sallei</i> (Récluz, 1849)	3	Medium	8	3	Medium	8	4	High	12	3	Medium	8
<i>Lithophyllum yessoense</i> Foslie	4	High	12	4	High	12	3	High	9	1	Medium	2
<i>Ceratonereis mirabilis</i> Kinberg, 1865	4	High	12	4	High	12	3	Medium	8	1	High	3
<i>Laonome calida</i> Capa, 2007	4	High	12	4	High	12	3	High	9	1	Medium	2
<i>Laonome triangularis</i> Hutchings & Murray, 1984	4	High	12	4	High	12	3	High	9	1	Medium	2
<i>Leonnates persicus</i> Wesenberg-Lund, 1949	4	High	12	4	High	12	3	High	9	1	Medium	2
<i>Linopherus canariensis</i> Langerhans, 1881	4	High	12	4	High	12	3	High	9	1	Medium	2
<i>Callinectes exasperatus</i> (Gerstaecker, 1856)	4	High	12	3	Medium	8	4	High	12	1	High	3
<i>Clavelina oblonga</i> Herdman, 1880	4	High	12	4	High	12	3	High	9	1	Medium	2
<i>Pyura praeputialis</i> (Heller, 1878)	2	High	6	3	Medium	8	3	High	9	4	High	12
<i>Marivagia stellata</i> Gall & Gershwin, 2010	4	High	12	4	Medium	11	4	Medium	11	1	Low	1
<i>Scarus ghobban</i> Forsskål, 1775	4	High	12	4	Medium	11	3	Medium	8	2	Low	4
<i>Potamocorbula amurensis</i> (Schrenck, 1861)	2	Medium	5	3	High	9	4	High	12	3	High	9
<i>Pseudocodium okinawense</i> E.J. Faye, M. Uchimura & S. Smimada	4	High	12	4	High	12	3	Medium	8	1	Medium	2
<i>Dipolydora socialis</i> (Schmarda, 1861)	4	Low	10	4	Low	10	4	Low	10	2	Low	4
<i>Dorvillea similis</i> (Crossland, 1924)	4	High	12	4	High	12	3	High	9	1	Low	1
<i>Leonnates decipiens</i> Fauvel, 1929	4	High	12	4	Medium	11	3	High	9	1	Medium	2
<i>Leonnates indicus</i> Kinberg, 1866	4	High	12	4	Medium	11	3	High	9	1	Medium	2

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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
<i>Lepidonotus tenuisetosus</i> (Gravier, 1902)	4	High	12	4	High	12	3	High	9	1	Low	1
<i>Notomastus mossambicus</i> (Thomassin, 1970)	4	High	12	4	High	12	3	High	9	1	Low	1
<i>Peritreis linea</i> (Treadwell, 1936)	4	High	12	4	High	12	3	High	9	1	Low	1
<i>Prionospio depauperata</i> Imajima, 1990	4	High	12	4	High	12	3	High	9	1	Low	1
<i>Prionospio pulchra</i> Imajima, 1990	4	High	12	4	High	12	3	High	9	1	Low	1
<i>Botrylioides anceps</i> (Herdman, 1891)	4	High	12	4	High	12	2	Medium	5	2	Medium	5
<i>Charybdis</i> (<i>Charybdis</i>) <i>feriata</i> (Linnaeus, 1758)	4	High	12	4	High	12	3	Low	7	1	High	3
<i>Incisocallope aestuarius</i> (Watling & Maurer, 1973)	4	High	12	4	High	12	3	High	9	1	Low	1
<i>Paracaprella pusilla</i> Mayer, 1890	4	High	12	4	High	12	3	High	9	1	Low	1
<i>Conopeum tenuissimum</i> (Canu, 1908)	3	High	9	4	High	12	4	High	12	1	Low	1
<i>Corynorhpa bigelowi</i> (Maas, 1905)	3	High	9	4	High	12	4	High	12	1	Low	1
<i>Synaptula reciprocans</i> (Forskål, 1775)	4	High	12	4	High	12	3	High	9	1	Low	1
<i>Hemiramphus far</i> (Forskål, 1775)	4	High	12	4	High	12	3	High	9	1	Low	1
<i>Planiliza haematocheila</i> (Temminck & Schlegel, 1845)	4	High	12	4	High	12	1	Medium	2	3	Medium	8
<i>Crepidula onyx</i> G. B. Sowerby I, 1824	3	High	9	3	Medium	8	4	High	12	2	Medium	5
<i>Sargassum horneri</i> (Turner) C. Agardh	2	High	6	3	Medium	8	4	Medium	11	3	Medium	8
<i>Glycinde bonhourei</i> Gravier, 1904	4	High	12	4	High	12	3	Medium	8	1	Low	1
<i>Nereis persica</i> Fauvel, 1911	4	High	12	4	High	12	3	Medium	8	1	Low	1
<i>Polycirrus twisti</i> Potts, 1928	4	High	12	4	High	12	3	Medium	8	1	Low	1
<i>Prionospio krusadensis</i> Fauvel, 1929	4	High	12	4	High	12	3	Medium	8	1	Low	1
<i>Prionospio paucipinnulata</i> Blake & Kudenov, 1978	4	High	12	4	High	12	3	Medium	8	1	Low	1

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

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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
<i>Borelis schlumbergeri</i> (Reichel, 1937)	4	High	12	3	High	9	3	Low	7	2	Low	4
<i>Siphonaptera pittensis</i> (Albani, 1974)	4	Medium	11	3	High	9	3	Medium	8	2	Low	4
<i>Branchiomma coheni</i> Tovar-Hernandez & Knight-Jones, 2006	2	High	6	3	Medium	8	4	High	12	2	Medium	5
<i>Aoroides semicurvatus</i> Ariyama, 2004	4	High	12	4	High	12	2	Medium	5	1	Medium	2
<i>Aplidium accarensis</i> (Millar, 1953)	4	High	12	4	High	12	2	Medium	5	1	Medium	2
<i>Ascidia curvata</i> (Traustedt, 1882)	4	High	12	4	High	12	2	Medium	5	1	Medium	2
<i>Asterias amurensis</i> Lutken, 1871	3	Medium	8	3	Medium	8	3	Low	7	3	Medium	8
<i>Miliolinella fichteliana</i> (d'Orbigny, 1839)	4	Medium	11	3	High	9	3	Medium	8	1	High	3
<i>Varidantella neostriatula</i> (Thalman, 1950)	4	Medium	11	3	High	9	3	Medium	8	1	High	3
<i>Choromytilus chorus</i> (Molina, 1782)	4	High	12	1	High	3	3	Medium	8	3	Medium	8
<i>Polydora lancifolius</i> (Harvey) Kawaguchi & Wang	4	High	12	3	Medium	8	2	Medium	5	2	Medium	5
<i>Ophytrocha diadema</i> Åkesson, 1976	4	High	12	4	High	12	2	Medium	5	1	Low	1
<i>Ophytrocha japonica</i> Paxton & Åkesson, 2010	4	High	12	4	High	12	2	Medium	5	1	Low	1
<i>Perinereis aibuhitensis</i> (Grube, 1878)	4	Medium	11	3	High	9	3	High	9	1	Low	1
<i>Aoroides curvipes</i> Ariyama, 2004	4	High	12	4	Medium	11	2	Medium	5	1	Medium	2
<i>Microcosmus anchylodeirus</i> Traustedt, 1883	4	High	12	3	Medium	8	3	High	9	1	Low	1
<i>Synidotea laticauda</i> Benedict, 1897	4	High	12	4	High	12	2	Medium	5	1	Low	1
<i>Cotylorhiza erythraea</i> Stiasny, 1920	3	High	9	4	High	12	3	Medium	8	1	Low	1
<i>Parasmittina egyptiaca</i> (Waters, 1909)	4	High	12	4	High	12	2	Medium	5	1	Low	1
<i>Champsodon</i> spp.	4	High	12	4	High	12	2	Medium	5	1	Low	1

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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
<i>Cheilodipterus novemstriatus</i> (Rüppell, 1838)	4	High	12	3	Low	7	3	Low	7	2	Low	4
<i>Acanthophora spicifera</i> (M. Vahl) Børgesen	2	High	6	2	High	6	4	High	12	2	Medium	5
<i>Codium dwarkense</i> Børgesen	2	Medium	5	2	Medium	5	4	Medium	11	3	Medium	8
<i>Botryliodes nigrum</i> Herdman, 1886	4	Medium	11	4	High	12	1	High	3	1	High	3
<i>Ciona savignyi</i> Herdman, 1882	3	Medium	8	3	Low	7	3	Medium	8	2	High	6
<i>Molgula ficus</i> (Macdonald, 1859)	3	High	9	3	High	9	3	Medium	8	1	High	3
<i>Sphaeroma quojianum</i> H. Milne Edwards, 1840	3	High	9	3	High	9	3	Low	7	2	Low	4
<i>Celleporaria vermiformis</i> (Waters, 1909)	4	High	12	4	High	12	2	Low	4	1	Low	1
<i>Licomia jolloisii</i> (Audouin, 1826)	4	High	12	4	Medium	11	2	Medium	5	1	Low	1
<i>Microporella coronata</i> (Audouin, 1826)	4	High	12	4	High	12	2	Low	4	1	Low	1
<i>Mucropetraliella thenardii</i> (Audouin, 1826)	4	High	12	4	High	12	2	Low	4	1	Low	1
<i>Parasmittina protecta</i> (Thornely, 1905)	4	High	12	4	High	12	2	Low	4	1	Low	1
<i>Parasmittina serruloides</i> Harmelin, Bitar & Zibrowius, 2009	4	High	12	4	High	12	2	Low	4	1	Low	1
<i>Torquatella longiuscula</i> (Harmer, 1957)	4	High	12	4	High	12	2	Low	4	1	Low	1
<i>Goniadella gracilis</i> (Verrill, 1873)	4	High	12	4	High	12	1	Medium	2	1	Medium	2
<i>Charybdis</i> (<i>Charybdis</i>) <i>japonica</i> (A. Milne-Edwards, 1861)	4	High	12	2	Medium	5	3	Medium	8	1	High	3
<i>Rhynchozoon larreyi</i> (Audouin, 1826)	4	High	12	4	Medium	11	2	Low	4	1	Low	1
<i>Smittina nitidissima</i> (Hincks, 1880)	4	High	12	4	Medium	11	2	Low	4	1	Low	1
<i>Alepes djedaba</i> (Forsskål, 1775)	4	High	12	4	High	12	1	Medium	2	1	Medium	2
<i>Apogonichthyoides pharaonis</i> (Bellotti, 1874)	4	High	12	4	High	12	1	Medium	2	1	Medium	2

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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
<i>Nereis (Nereis) gilchristi</i> Day, 1967	4	Medium	11	3	Low	7	3	Medium	8	1	Low	1
<i>Amphiodia (Amphispina) oblecta</i> Mortensen, 1940	4	High	12	3	Low	7	2	Low	4	2	Low	4
<i>Microporella genisii</i> (Audouin, 1826)	4	Medium	11	4	Medium	11	2	Low	4	1	Low	1
<i>Tritia obsoleta</i> (Say, 1822)	2	High	6	3	Medium	8	3	Medium	8	2	Medium	5
<i>Prophaerosyllis longipapillata</i> (Hartmann-Schröder, 1979)	4	High	12	4	High	12	1	Low	1	1	Low	1
<i>Laticorophium baconi</i> (Shoemaker, 1934)	3	Medium	8	3	Medium	8	3	Medium	8	1	Medium	2
<i>Perophora multiclathrata</i> (Sluiter, 1904)	4	High	12	2	High	6	2	High	6	1	Medium	2
<i>Akatopora leucocypha</i> (Marcus, 1937)	4	High	12	3	High	9	2	Low	4	1	Low	1
<i>Cephalopholis taeniops</i> (Valenciennes, 1828)	4	High	12	3	Medium	8	2	Medium	5	1	Low	1
<i>Equilites klunzingeri</i> (Steindachner, 1898)	4	Medium	11	3	Medium	8	2	Medium	5	1	Medium	2
<i>Paraehlersia weissmannioides</i> (Augener, 1913)	4	High	12	3	Medium	8	2	Low	4	1	Low	1
<i>Perkinsyllis augeneri</i> (Hartmann-Schröder, 1979)	4	High	12	3	Medium	8	2	Low	4	1	Low	1
<i>Stylarianoides grubei</i> Salazar-Vallejo, 2011	4	High	12	4	Medium	11	1	Low	1	1	Low	1
<i>Tridentiger trigonocephalus</i> (Gill, 1859)	2	Medium	5	3	Medium	8	3	Medium	8	2	Low	4
<i>Dipolydora tentaculata</i> (Blake & Kudenov, 1978)	4	Low	10	4	Low	10	1	Low	1	1	High	3
<i>Polydora websteri</i> Hartman in Loosanoff & Engle, 1943	2	High	6	3	Medium	8	2	Medium	5	2	Medium	5
<i>Nuttallia obscurata</i> (Reeve, 1857)	2	High	6	3	Medium	8	3	Medium	8	1	Medium	2
<i>Boccardia knoxi</i> (Rainer, 1973)	2	High	6	3	Medium	8	2	Medium	5	2	Low	4
<i>Boccardia pseudonatrix</i> Day, 1961	2	High	6	3	Medium	8	2	Medium	5	2	Low	4
<i>Hydroides albiceps</i> (Grube, 1870)	1	Medium	2	3	Medium	8	4	High	12	1	Low	1
<i>Iphione muricata</i> (Lamarck, 1818)	4	High	12	3	Medium	8	1	Medium	2	1	Low	1

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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
<i>Polydora rickettsi</i> Woodwick, 1961	2	High	6	3	Medium	8	2	Medium	5	2	Low	4
<i>Terebrasabella heterouncinata</i> Fitzhugh & Rouse, 1999	2	High	6	3	Medium	8	2	Medium	5	2	Low	4
<i>Cepleporaria labelligera</i> Harmer, 1957	3	High	9	3	High	9	2	Low	4	1	Low	1
<i>Cepleporina bitari</i> Harmelin, 2014	3	High	9	3	High	9	2	Low	4	1	Low	1
<i>Drepanophora birbira</i> Powell, 1967	3	High	9	2	Medium	5	3	Medium	8	1	Low	1
<i>Equilites elongatus</i> (Günther, 1874)	4	High	12	2	Medium	5	2	Medium	5	1	Low	1
<i>Pomadysys stridens</i> (Forskål, 1775)	4	High	12	3	Medium	8	1	Medium	2	1	Low	1
<i>Boonea bisuturalis</i> (Say, 1822)	3	Medium	8	2	Medium	5	3	Medium	8	1	Medium	2
<i>Dictyosphaeria cavernosa</i> (Forskål) Børgesen	1	High	3	2	Medium	5	2	Medium	5	3	Medium	8
<i>Neomeris annulata</i> Dickie	3	High	9	3	Medium	8	1	Medium	2	1	Medium	2
<i>Sabellastarte spectabilis</i> (Grube, 1878)	2	High	6	3	Medium	8	2	Medium	5	1	Medium	2
<i>Syllis bella</i> Chamberlin, 1919	4	High	12	3	Low	7	1	Low	1	1	Low	1
<i>Charybdis</i> (<i>Charybdis</i>) <i>lucifera</i> (Fabricius, 1798)	4	High	12	2	Low	4	2	Low	4	1	Low	1
<i>Corella inflata</i> Huntsman, 1912	2	Medium	5	3	Low	7	2	High	6	1	High	3
<i>Sillago suezensis</i> Golani, Fricke & Tikochinski, 2013	4	High	12	1	High	3	2	Medium	5	1	Low	1
<i>Caprella simia</i> Mayer, 1903	2	Medium	5	2	Medium	5	3	High	9	1	Low	1
<i>Batillaria atramentaria</i> (G. B. Sowerby I, 1855)	2	Medium	5	3	Medium	8	1	Low	1	2	Medium	5
<i>Gemma gemma</i> (Totten, 1834)	2	High	6	3	Medium	8	1	Medium	2	1	High	3
<i>Archaias angulatus</i> (Fichtel & Moll, 1798)	3	High	9	1	Medium	2	2	Medium	5	1	Medium	2
<i>Aulacomya atra</i> (Molina, 1782)	1	Medium	2	1	High	3	3	High	9	2	Low	4
<i>Glycera dibranchiata</i> Ehlers, 1868	1	High	3	3	Medium	8	2	Medium	5	1	Low	1

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Horizon Scanning Species	Likelihood of arrival			Likelihood of establishment			Likelihood of spread			Potential Impact		
	Consensus score	Consensus confidence level	Weighted final score	Already present in European seas	Already present in EU countries	Taxonomic group	Consensus score	Consensus confidence level	Weighted final score	Consensus score	Consensus confidence level	Weighted final score
<i>Alatina alata</i> (Reynaud, 1830)	2	Medium	5	YES	NO	Algae	2	Low	4	2	Low	4
<i>Tetrapygus niger</i> (Molina, 1782)	2	Low	4	YES	YES	Algae	2	Low	4	1	Low	8
<i>Stochoospermum polypteroideus</i> (J.V. Lamouroux) J. Agardh	1	Medium	2	YES	Medium	Algae	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)				
<i>Codium parvulum</i> (Bory de Saint-Vincent ex Audouin) P. C. Silva	MED	48	YES	NO	Algae	Primary producer	Western Indo-Pacific	Interconnected waterways/basins/seas				
<i>Halimeda incrassata</i> (J. Ellis) J. V. Lamouroux	MED	48	YES	YES	Algae	Primary producer	Tropical Atlantic	Ship/boat hull fouling, Pet/aquarium/terrarium species (including live food for such species)				
<i>Erugosquilla massavensis</i> (Kossmann, 1880)	MED	48	YES	YES	Arthropods	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas				
<i>Hemigrapsus sanguineus</i> (De Haan, 1835)	NE Atlantic, MED, Black Sea	48	YES	YES	Arthropods	Predator	Temperate Northern Pacific	Ship/boat ballast water				
<i>Penaeus pulchricaudatus</i> Stebbing, 1914	MED	48	YES	YES	Arthropods	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas				
<i>Portunus segnis</i> (Forskål, 1775)	MED	48	YES	YES	Arthropods	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas				
<i>Pterois milés</i> (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)				
<i>Amphistegina lobifera</i> Larsen, 1976	East and Central Med, and Adriatic	48	YES	YES	Foraminifera	Primary producer, omnivore	Circumtropical	Ship/boat ballast water, Interconnected waterways/basins/seas, Parasites on animals (including species transported by host and vector)				
<i>Xenostrobus securis</i> (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)				
<i>Rhopilema nomadica</i> Gailli, 1990	MED	47	YES	YES	Cnidarians	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas				

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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)
<i>Lagocephalus sceleratus</i> (Gmelin, 1789)	MED	47	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Chama pacifica</i> 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
<i>Spirobranchus kraussii</i> (Baird, 1865)	MED	47	YES	NO	Annelida	Filter Feeder	Western Indo-Pacific, Temperate Southern Africa	Interconnected waterways/basins/seas, Ship/boat hull fouling
<i>Microcosmus exasperatus</i> Heller, 1878	MED	45	YES	YES	Tunicate	Filter Feeder	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat hull fouling
<i>Charybdis</i> (<i>Goniobellinus</i>) <i>longicollis</i> Leene, 1938	MED	45	YES	YES	Arthropods	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Herdmania momus</i> (Savigny, 1816)	MED	45	YES	YES	Tunicate	Filter Feeder	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat hull fouling
<i>Mututa victor</i> (Fabricius, 1781)	MED	45	YES	YES	Arthropods	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Pseudodiaptomus marinus</i> Sato, 1913	NE Atlantic, MED, Baltic, Black Sea	45	YES	YES	Arthropods	Omnivore	Temperate Northern Pacific	Ship/boat ballast water
<i>Siganus luridus</i> (Rüppell, 1829)	MED	45	YES	YES	Fish	Herbivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Siganus rivulatus</i> Forsskål & Niebuhr, 1775	MED	45	YES	YES	Fish	Herbivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Dictyota acutiloba</i> J. Agardh	MED	44	YES	NO	Algae	Primary producer	Central Indo-Pacific; Eastern Indo-Pacific; Temperate South America	Ship/boat hull fouling
<i>Boccardia proboscidea</i> Hartman, 1940	NE Atlantic	44	YES	YES	Annelida	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water, ?Ship/boat hull fouling, Aquaculture / mariculture
<i>Balanus glandula</i> Darwin, 1854	NE Atlantic, Baltic Sea	44	YES	YES	Arthropods	Filter Feeder	Temperate Northern Pacific	Ship/boat hull fouling?
<i>Didemnum perlucidum</i> Monniot F., 1983	NE Atlantic, MED	44	NO	NO	Tunicate	Filter Feeder	Unknown	Ship/boat hull fouling, Ship/boat ballast water
<i>Penaeus semisulcatus</i> De Haan, 1844 [In De Haan, 1833-1850]	MED	44	YES	YES	Arthropods	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water

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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)
<i>Styela plicata</i> (Lesueur, 1823)	MED, NE Atlantic	44	YES	YES	Tunicate	Filter Feeder	Temperate Northern Pacific	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
<i>Trachysalambria palaestinensis</i> (Steinitz, 1932)	MED	44	YES	YES	Arthropods	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Macrophythia philippina</i> Kirchenpauer, 1872	MED	44	YES	YES	Cnidarians	Filter Feeder	Circumtropical	Ship/boat hull fouling, Ship/boat ballast water, Interconnected waterways/basins/seas
<i>Phyllorhiza punctata</i> Lendenfeld, 1884	MED	44	YES	YES	Cnidarians	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Dendostrea folium</i> (Linnaeus, 1758)	MED	44	YES	YES	Mollusc	Filter Feeder	Western Indo-Pacific, Central Indo-Pacific, Temperate Australasia	Ship/boat hull fouling
<i>Megalalanus coccopoma</i> (Darwin, 1854)	NE Atlantic, Baltic Sea	43	YES	YES	Arthropods	Filter Feeder	Tropical Eastern Pacific	Ship/boat hull fouling
<i>Phallusia nigra</i> Savigny, 1816	MED	43	YES	YES	Tunicate	Filter Feeder	Western Indo-Pacific; Tropical Atlantic	Ship/boat hull fouling
<i>Schizoporella japonica</i> Ortman, 1890	Baltic Sea, NE Atlantic	43	YES	YES	Bryozoans	Filter Feeder	Temperate Northern Pacific	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
<i>Torquigener flavimaculosus</i> Hardy & Randall, 1983	MED	43	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Hydroides sanctaerucis</i> Krøyer in Mörch, 1863	MED	42	YES	YES	Annelida	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling
<i>Microcosmus squamiger</i> Michaelsen, 1927	MED, NE Atlantic	42	YES	YES	Tunicate	Filter Feeder	Circumtropical	Ship/boat hull fouling, Ship/boat ballast water
<i>Galaxaura rugosa</i> (J.Ellis & Solander) J.V. Lamouroux	MED	42	YES	NO	Algae	Primary producer	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Interconnected waterways/basins/seas
<i>Chrysonophos lewisii</i> (W.R. Taylor) W.R. Taylor	MED	42	YES	YES	Algae	Primary producer	Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water
<i>Codium pulvinatum</i> M.J. Wynne & R. Hoffman	MED	42	YES	NO	Algae	Primary producer	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Rugulopteryx okamurae</i> (E.Y. Dawson) I.K.Hwang, W.J.Lee & H.S.Kim	MED	42	YES	YES	Algae	Primary producer	Temperate Northern Pacific	Unknown
<i>Zostera japonica</i> 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)
<i>Hydroides ezoensis</i> Okuda, 1934	MED, NE Atlantic	42	YES	YES	Annelida	Filter Feeder	Temperate Northern Pacific	Ship/boat ballast water, Ship/boat hull fouling, Aquaculture / mariculture

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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)
<i>Hydroides operculata</i> (Treadwell, 1929)	MED	42	YES	NO	Annelida	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water
<i>Charybdis</i> (<i>Charybdis</i>) <i>hellerii</i> (A. Milne-Edwards, 1867)	MED	42	YES	YES	Arthropods	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Polyandrocarpa zorriventris</i> (Van Name, 1931)	MED	42	YES	YES	Tunicate	Filter Feeder	Temperate South America	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
<i>Watersipora arcuata</i> Banta, 1969	MED	42	YES	YES	Bryozoans	Filter Feeder	Tropical Eastern Pacific	Ship/boat hull fouling
<i>Amphisorus hemprichii</i> Ehrenberg, 1839	MED	42	YES	YES	Foraminifera	Primary producer, omnivore	Western Indo-Pacific, Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Amphistegina lessonii</i> d'Orbigny in Guérin-Méneville, 1832	East and Central Med, and Adriatic	42	YES	YES	Foraminifera	Primary producer, omnivore	Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Spirolina acicularis</i> (Batsch, 1791)	MED	42	YES	NO	Foraminifera	Primary producer, omnivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Heterostegina depressa</i> d'Orbigny, 1826	MED	42	YES	YES	Foraminifera	Primary producer, omnivore	Circumtropical	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Spondylus spinosus</i> Schreibers, 1793	MED	42	YES	YES	Mollusc	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Caulerpa serrulata</i> (Forskäll) J. Agardh	MED	41	NO	NO	Algae	Primary producer	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Pet/aquarium/terrarium species (including live food for such species)
<i>Branchiommata bairdi</i> (McIntosh, 1885)	MED, NE Atlantic	41	YES	YES	Annelida	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water
<i>Hydroides brachyacantha</i> Rioja, 1941	MED	41	YES	yes	Annelida	Filter Feeder	Tropical Eastern Pacific	Ship/boat hull fouling, Ship/boat ballast water
<i>Hydroides heterocera</i> (Grube, 1868)	MED	41	YES	NO	Annelida	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Hydroides homoceros</i> Pixell, 1913	MED	41	YES	NO	Annelida	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Hydroides minax</i> (Grube, 1878)	MED	41	YES	NO	Annelida	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Ecteinascidia thurstoni</i> Herdman, 1890	MED	41	YES	NO	Tunicate	Filter Feeder	Western Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat hull fouling
<i>Penaeus hathor</i> (Burkenroad, 1959)	MED	41	YES	NO	Arthropods	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas

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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)
<i>Styela canopus</i> (Savigny, 1816)	MED, NE Atlantic	41	YES	YES	Tunicate	Filter Feeder	Western Indo-Pacific; Central Indo-Pacific	Ship/boat hull fouling
<i>Aurelia coerulea</i> von Lendenfeld, 1884	MED	41	YES	YES	Cnidarians	Predator	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
<i>Aurelia solida</i> Browne, 1905	MED	41	YES	YES	Cnidarians	Predator	Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water, Interconnected waterways/basins/seas
<i>Celtodoryx ciocalyptoides</i> (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)
<i>Callionymus filamentosus</i> Valenciennes, 1837	MED	41	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Fistularia commersonii</i> Ruppell, 1838	MED	41	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Lagocephalus guentheri</i> Miranda Ribeiro, 1915	MED	41	YES	YES	Fish	Predator	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Interconnected waterways/basins/seas
<i>Stephanolepis diaspros</i> Fraser-Brunner, 1940	MED	41	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Upeneus pori</i> Ben-Tuvia & Golani, 1989	MED	41	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Coscinospira hemprichii</i> Ehrenberg, 1839	East Med	41	YES	YES	Foraminifera	Primary producer, omnivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Parasorites</i> Seiglie & Rivera, 1977	Western Med	41	YES	YES	Foraminifera	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)
<i>Haminioea japonica</i> Pilsbry, 1895	MED, NE Atlantic	41	YES	YES	Mollusc	Herbivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
<i>Rapana venosa</i> (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)
<i>Symplegma reptans</i> (Oka, 1927)	MED	41	YES	NO	Tunicate	Filter Feeder	Temperate Northern Pacific, Western Indo-Pacific	Ship/boat hull fouling

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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)
<i>Boccardiella hamata</i> (Webster, 1879)	NE Atlantic	40	YES	YES	Annelida	Detritivore	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water, ? Ship/boat hull fouling, Aquaculture / mariculture
<i>Actaea savignii</i> (H. Milne Edwards, 1834)	MED	40	YES	NO	Arthropods	Herbivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Atergatis roseus</i> (Rüppell, 1830)	MED	40	YES	YES	Arthropods	Omnivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Corella eumyota</i> Traustedt, 1882	NE Atlantic	40	YES	YES	Tunicate	Filter Feeder	Southern Ocean, Temperate Australasia	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
<i>Paranthura japonica</i> Richardson, 1909	NE Atlantic, MED	40	YES	YES	Arthropods	Predator	Temperate Northern Pacific	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
<i>Textularia agglutinans</i> d'Orbigny, 1839	MED; Temp. N.-Atlantic	40	YES	NO	Foraminifera	Detritivore	Circumtropical	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Rangia cuneata</i> (G. B. Sowerby I, 1832)	NE Atlantic, Baltic Sea	40	YES	YES	Mollusc	Filter Feeder	Temperate Northwest Atlantic	Ship/boat ballast water
<i>Sireblospio gynobranchiata</i> Rice & Levin, 1998	MED	39	YES	NO	Annelida	Detritivore	Tropical Atlantic, Temperate Northern Pacific	Ship/boat ballast water
<i>Ascidia cannellata</i> Oken, 1820	MED	39	YES	YES	Tunicate	Filter Feeder	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat hull fouling
<i>Carupa tenuipes</i> Dana, 1852	MED	39	YES	YES	Arthropods	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Macrophthalmus</i> (<i>Macrophthalmus</i>) <i>indicus</i> Davie, 2012	MED	39	YES	YES	Arthropods	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Rhodosoma turcicum</i> (Savigny, 1816)	MED	39	YES	NO	Tunicate	Filter Feeder	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Ship/boat hull fouling
<i>Symplegma bahraini</i> Monniot C. & Monniot F., 1997	MED	39	YES	YES	Tunicate	Filter Feeder	Tropical Eastern Pacific, Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water
<i>Pempheris rhomboidea</i> Kossmann & Rüber, 1877	MED	39	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Sargocentron rubrum</i> (Forsskal, 1775)	MED	39	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas

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Horizon Scanning Species	European Seas(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)
<i>Perna viridis</i> (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
<i>Kappaphycus alvarezii</i> (Doty) Doty ex P.C.Silva	MED	38	NO	NO	Algae	Primary producer	Temperate Northern Pacific, Central Indo-Pacific	Other intentional release
<i>Palola valida</i> (Gravier, 1900)	MED	38	YES	YES	Annelida	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Saurida lessepsianus</i> Russell, Golani & Tikochinski, 2015	MED	38	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Upeneus moluccensis</i> (Bleeker, 1855)	MED	38	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Ocinobrellus inornatus</i> (Récluz, 1851)	MED, NE Atlantic	38	YES	YES	Mollusc	Predator	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
<i>Urosalpinx cinerea</i> (Say, 1822)	NE Atlantic	38	YES	YES	Mollusc	Predator	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector)
<i>Avrainvillea amadelpha</i> (Montagne) A.Gepp & E.S. Gepp	MED	37	YES	NO	Algae	Primary producer	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Other means of transport
<i>Neodioxispira brasiliensis</i> (Grube, 1872)	NE Atlantic	37	YES	YES	Annelida	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling
<i>Neodioxispira steueri</i> (Sterzinger, 1909)	MED	37	YES	NO	Annelida	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Polydora colonia</i> Moore, 1907	MED	37	YES	YES	Annelida	Detritivore	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
<i>Spirobranchus tetraceros</i> (Schmarda, 1861)	MED	37	YES	YES	Annelida	Filter Feeder	Western Indo-Pacific, Central Indo-Pacific, Temperate Australasia	Interconnected waterways/basins/seas, Ship/boat hull fouling
<i>Ampithoe valida</i> Smith, 1873	NE Atlantic, MED	37	YES	YES	Arthropods	Herbivore	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector)
<i>Anilocra pilchardi</i> Bariche & Trilles, 2006	MED	37	YES	NO	Arthropods	Predator	Western Indo-Pacific	Parasites on animals (including species transported by host and vector), Interconnected waterways/basins/seas
<i>Aoroides longimerus</i> Ren & Zheng, 1996	NE Atlantic, MED	37	YES	YES	Arthropods	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)

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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)
<i>Cymothoa indica</i> Schioedte & Meinert, 1884	MED	37	YES	NO	Arthropods	Predator	Western Indo-Pacific	Parasites on animals (including species transported by host and vector), Interconnected waterways/basins/seas
<i>Grandidierella japonica</i> Stephensen, 1938	NE Atlantic, MED, Baltic Sea	37	YES	YES	Arthropods	Detritivore	Temperate Northern Pacific	Ship/boat hull fouling, Ship/boat ballast water, Contaminant on animals (except parasites, species transported by host/vector)
<i>Ianropsis serricaudis</i> Gurjanova, 1936	NE Atlantic, MED	37	YES	YES	Arthropods	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
<i>Melita nitida</i> Smith, 1873	NE Atlantic, Baltic Sea	37	YES	YES	Arthropods	Detritivore	Temperate Northwest Atlantic	Ship/boat hull fouling
<i>Stenothoe georgiana</i> Bynum & Fox, 1977	MED	37	YES	YES	Arthropods	Omnivore	Temperate Northwest Atlantic	Ship/boat hull fouling
<i>Atherinomorur forskalii</i> (Rüppell, 1838)	MED	37	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Parupeneus forskalii</i> (Fourmanoir & Guézé, 1976)	MED	37	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Sorites marginalis</i> (Lamarck, 1816)	MED; Temp. N.-Atlantic	37	YES	NO	Foraminifera	Primary producer, omnivore	Circumtropical	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Gracilaria salicornia</i> (C.-Agardh) E.Y.Dawson	MED	36	NO	NO	Algae	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
<i>Bispira polyomma</i> Giangrande & Faasse, 2012	NE Atlantic, Baltic Sea	36	YES	YES	Annelida	Filter Feeder	Unknown	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water, ?Ship/boat hull fouling
<i>Eurythoe complanata</i> (Pallas, 1766)	MED	36	YES	YES	Annelida	Omnivore	Western Indo-Pacific; Central Indo-Pacific; Eastern Indo-Pacific	Interconnected waterways/basins/seas
<i>Leodice antennata</i> Savigny in Lamarck, 1818	MED	36	YES	YES	Annelida	Omnivore	Western Indo-Pacific; Tropical Atlantic	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Naineris setosa</i> (Verrill, 1900)	MED	36	YES	YES	Annelida	Detritivore	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector)
<i>Prionospio sexoculata</i> Augener, 1918	MED	36	YES	NO	Annelida	Omnivore	Temperate Southern Africa	Ship/boat hull fouling

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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)
<i>Ascidia sydneiensis</i> Stimpson, 1855	*MED, NE Atlantic	36	NO	NO	Tunicate	Filter Feeder	Central Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water
<i>Erichthonius pugnax</i> (Dana, 1852)	NE Atlantic, MED	36	YES	YES	Arthropods	Detritivore	Temperate Northern Pacific	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
<i>Polychinum constellatum</i> Savigny, 1816	MED	36	YES	NO	Tunicate	Filter Feeder	Circumtropical	Ship/boat hull fouling
<i>Diadema setosum</i> (Leske, 1778)	MED	36	YES	YES	Echinodermata	Omnivore	Western Indo-Pacific; Central Indo-Pacific	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
<i>Pararotalia calcariformata</i> McCulloch, 1977	MED	36	YES	NO	Foraminifera	Primary producer, omnivore	Western Indo-Pacific, Central Indo-Pacific, Temperate Southern Africa	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Mytilopsis sallei</i> (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)
<i>Lithophyllum yessoense</i> Foslie	MED	35	YES	YES	Algae	Primary producer	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
<i>Ceratonereis mirabilis</i> Kinberg, 1865	MED	35	YES	YES	Annelida	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Laonome calida</i> Capa, 2007	Baltic Sea, NE Atlantic, Black Sea	35	YES	YES	Annelida	Filter Feeder	Temperate Australasia	Ship/boat hull fouling, Ship/boat ballast water
<i>Laonome triangularis</i> Hutchings & Murray, 1984	MED	35	YES	NO	Annelida	Filter Feeder	Temperate Australasia	Ship/boat ballast water
<i>Leonnates persicus</i> Wesenberg-Lund, 1949	MED	35	YES	NO	Annelida	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Linopherus canariensis</i> Langerhans, 1881	MED	35	YES	YES	Annelida	Omnivore	Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water
<i>Callinectes exasperatus</i> (Gerstaecker, 1856)	*NE Atlantic, MED	35	YES	YES	Arthropods	Predator	Tropical Atlantic	Ship/boat ballast water
<i>Clavelina oblonga</i> Herdman, 1880	MED	35	YES	YES	Tunicate	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling
<i>Pyura praeputialis</i> (Heller, 1878)	NE Atlantic, MED	35	NO	NO	Tunicate	Filter Feeder	Temperate Australasia	Ship/boat hull fouling, Ship/boat ballast water
<i>Marivagia stellata</i> Gallil & Gershwin, 2010	MED	35	YES	NO	Cnidarians	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Scarus ghobban</i> Forsskal, 1775	MED	35	YES	YES	Fish	Herbivore	Western Indo-Pacific	Interconnected waterways/basins/seas

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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)
<i>Potamocorbula amurensis</i> (Schrenck, 1861)	all seas	35	NO	NO	Mollusc	Filter Feeder	Temperate Northern Pacific	Ship/boat ballast water
<i>Pseudocodium okinawense</i> E.J. Faye, M.Uchimura & S. Srimada	MED	34	YES	NO	Algae	Primary producer	Temperate Northern Pacific, Central Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water
<i>Dipolydora socialis</i> (Schmarda, 1861)	NE Atlantic	34	YES	YES	Annelida	Detritivore	Temperate South America	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
<i>Donvillea similis</i> (Crossland, 1924)	MED	34	YES	YES	Annelida	Detritivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Leonattes decipiens</i> Fauvel, 1929	MED	34	YES	NO	Annelida	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Leonattes indicus</i> Kinberg, 1866	MED	34	YES	NO	Annelida	Omnivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Lepidonotus tenuisetosus</i> (Gravier, 1902)	MED	34	YES	YES	Annelida	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Notomastus mossambicus</i> (Thomassin, 1970)	MED	34	YES	YES	Annelida	Detritivore	Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water
<i>Perinereis lineata</i> (Treadwell, 1936)	MED, NE Atlantic	34	YES	YES	Annelida	Omnivore	Temperate Northern Pacific, Central Indo-Pacific	Live food and live bait, Contaminated bait
<i>Prionospio depauperata</i> Imajima, 1990	MED	34	YES	NO	Annelida	Detritivore	Temperate Northern Pacific	Ship/boat ballast water
<i>Prionospio pulchra</i> Imajima, 1990	MED, NE Atlantic	34	YES	YES	Annelida	Detritivore	Temperate Northern Pacific	Ship/boat hull fouling, Ship/boat ballast water, Contaminant on animals (except parasites, species transported by host/vector)
<i>Botrylloides anceps</i> (Herdman, 1891)	MED	34	YES	NO	Tunicate	Filter Feeder	Central Indo-Pacific; Temperate Northern Pacific; Temperate Australasia	Ship/boat hull fouling
<i>Charybdis (Charybdis) feriata</i> (Linnaeus, 1758)	MED	34	YES	YES	Arthropods	Predator	Western Indo-Pacific	Ship/boat ballast water
<i>Incisocalloipe aestuarius</i> (Watling & Maurer, 1973)	NE Atlantic	34	YES	YES	Arthropods	Predator	Temperate Northwest Atlantic	Ship/boat hull fouling
<i>Paracaprella pusilla</i> Mayer, 1890	MED	34	YES	YES	Arthropods	Omnivore	Unknown	Ship/boat hull fouling
<i>Conopeum tenuissimum</i> (Canu, 1908)	NE Atlantic	34	NO	NO	Bryozoans	Filter Feeder	Temperate Northwest Atlantic, Tropical Atlantic	Ship/boat hull fouling
<i>Corymorpha bigelowi</i> (Maas, 1905)	MED	34	NO	NO	Cnidarians	Predator	Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water, Interconnected waterways/basins/seas

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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)
<i>Synaptula reciprocans</i> (Forskål, 1775)	MED	34	YES	YES	Echinodermata	Detritivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Hemiramphus far</i> (Forskål, 1775)	MED	34	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Planiliza haematocheila</i> (Temminck & Schlegel, 1845)	MED and Black sea	34	YES	YES	Fish	Omnivore	Central Indo-Pacific	Angling/fishing equipment
<i>Crepidula onyx</i> 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)
<i>Sargassum homeri</i> (Turner) C. Agardh	all	33	NO	NO	Algae	Primary producer	Temperate Northern Pacific, Central Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water
<i>Glycinde bonhourei</i> Gravier, 1904	MED	33	YES	YES	Annelida	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Nereis persica</i> Fauvel, 1911	MED	33	YES	YES	Annelida	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Polycirrus twisti</i> Potts, 1928	MED	33	YES	YES	Annelida	Detritivore	Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Prionospio krusadensis</i> Fauvel, 1929	MED	33	YES	NO	Annelida	Detritivore	Western Indo-Pacific, central Indo-Pacific, Temperate Northern Pacific	Ship/boat ballast water
<i>Prionospio paucipinnulata</i> Blake & Kudenov, 1978	MED	33	YES	NO	Annelida	Detritivore	Temperate Australasia	Ship/boat hull fouling, Ship/boat ballast water
<i>Prionospio saccifera</i> Mackie & Hartley, 1990	MED	33	YES	NO	Annelida	Detritivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Syllis ergeni</i> Çinar, 2005	MED	33	YES	NO	Annelida	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Syllis pectinans</i> Haswell, 1920	MED	33	YES	YES	Annelida	Omnivore	Central Indo-Pacific; Temperate Australasia	Unknown
<i>Timarete punctata</i> (Grube, 1859)	MED	33	YES	NO	Annelida	Detritivore	Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water, Interconnected waterways/basins/seas
<i>Amphithoe bizseli</i> Özaydinli & Coleman, 2012	MED	33	YES	YES	Arthropods	Herbivore	Western Indo-Pacific	Ship/boat hull fouling
<i>Ptilohyale littoralis</i> (Stimpson, 1853)	NE Atlantic	33	YES	YES	Arthropods	Herbivore	Unknown	Ship/boat ballast water
<i>Cephea cephea</i> (Forskål, 1775)	MED	33	YES	NO	Cnidarians	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas

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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)
<i>Etrumeus golanii</i> DiBattista, Randall & Bowen, 2012	MED	33	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Nemipterus randalli</i> Russell, 1986	MED	33	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Pteragogus trispilus</i> Randall, 2013	MED	33	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Sphyræna chrysoaenia</i> Klunzinger, 1884	MED, Black Sea	33	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Sphyræna flavicauda</i> Rüppell, 1838	MED	33	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Geukensia demissa</i> (Dillwyn, 1817)	MED, NE Atlantic	33	NO	NO	Mollusc	Filter Feeder	Temperate Northwest Atlantic, Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water
<i>Phylodoce longifrons</i> Ben-Eliahu, 1972	MED	32	YES	NO	Annelida	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Timarete caribous</i> (Grube, 1859)	MED	32	YES	NO	Annelida	Detritivore	Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water
<i>Achelia sawayai</i> Marcus, 1940	MED, NE Atlantic	32	YES	YES	Arthropods	Predator	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Ship/boat hull fouling
<i>Distaplia bermudensis</i> Van Name, 1902	MED	32	YES	YES	Tunicate	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling, Contaminant on animals (except parasites, species transported by host/vector)
<i>Monocorophium uenoi</i> (Stephensen, 1932)	NE Atlantic	32	YES	YES	Arthropods	Detritivore	Temperate Northern Pacific	Ship/boat hull fouling
<i>Nematostella vectensis</i> Stephenson, 1935	NE Atlantic	32	YES	YES	Cnidarians	Filter Feeder	Temperate Northwest Atlantic, Tropical Atlantic	Contaminant on animals (except parasites, species transported by host/vector)
<i>Parexocoetus mento</i> (Valenciennes, 1847)	MED	32	YES	YES	Fish	Omnivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Scomberomorus commerson</i> (Lacepède, 1800)	MED	32	YES	YES	Fish	Predator	Western Indo-Pacific, Central Indo-Pacific, Temperate Australasia	Interconnected waterways/basins/seas
<i>Borelis schlumbergeri</i> (Reichel, 1937)	MED	32	YES	NO	Foraminifera	Primary producer, omnivore	Circumtropical	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Siphonaperta pittensis</i> (Albani, 1974)	MED	32	YES	NO	Foraminifera	Detritivore, Herbivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Branchioma coheni</i> Tovar-Hernandez & Knight-Jones, 2006	MED, NE Atlantic	31	NO	NO	Annelida	Filter Feeder	Tropical Eastern Pacific	Ship/boat hull fouling, Ship/boat ballast water

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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)
<i>Aoroides semicurvatus</i> Ariyama, 2004	NE Atlantic	31	YES	YES	Arthropods	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
<i>Aplidium accarense</i> (Millar, 1953)	MED, NE Atlantic	31	YES	YES	Tunicate	Filter Feeder	Unknown	Ship/boat hull fouling
<i>Ascidia curvata</i> (Traustedt, 1882)	MED	31	YES	NO	Tunicate	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling
<i>Asterias amurensis</i> Lutken, 1871	NE Atlantic	31	NO	NO	Echinodermata	Predator	Temperate Northern Pacific	Ship/boat hull fouling, Ship/boat ballast water, Machinery/equipment, Live food and live bait
<i>Mililolinella fichteliana</i> (d'Orbigny, 1839)	MED	31	YES	YES	Foraminifera	Omnivore	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Varidentella neostriatula</i> (Thalman, 1950)	MED	31	YES	NO	Foraminifera	Detritivore, Herbivore	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Choromytilus chorus</i> (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)
<i>Polyopes lancifolius</i> (Harvey) Kawaguchi & Wang	Atl	30	YES	YES	Algae	Primary producer	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
<i>Ophytrocha diadema</i> Åkesson, 1976	MED	30	YES	YES	Annelida	Omnivore	Temperate Northern Pacific	Ship/boat ballast water
<i>Ophytrocha japonica</i> Paxton & Åkesson, 2010	MED Sea, NE Atlantic	30	YES	YES	Annelida	Omnivore	Temperate Northern Pacific	Ship/boat ballast water
<i>Perinereis ibuhitensis</i> (Grube, 1878)	MED, NE Atlantic	30	YES	YES	Annelida	Omnivore	Central Indo-Pacific	Live food and live bait
<i>Aoroides curvipes</i> Ariyama, 2004	NE Atlantic	30	YES	YES	Arthropods	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
<i>Microcosmus anchylodeirus</i> Traustedt, 1883	MED	30	YES	YES	Tunicate	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling
<i>Synidotea laticauda</i> Benedict, 1897	NE Atlantic	30	YES	YES	Arthropods	Herbivore	Temperate Northern Pacific	Ship/boat hull fouling, Ship/boat ballast water
<i>Cobylorhiza erythraea</i> Stiasny, 1920	MED	30	YES	NO	Cnidarians	Predator	Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water, Interconnected waterways/basins/seas
<i>Parasmittina egyptiaca</i> (Waters, 1909)	MED	30	YES	YES	Bryozoans	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling

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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)
<i>Champsodon</i> spp.	MED	30	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Cheilodipterus novemstriatus</i> (Rüppell, 1838)	MED	30	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Acanthophora spicifera</i> (M. Vahl) Børgesen	MED	29	NO	NO	Algae	Primary producer	Western Indo-Pacific, Central Indo-Pacific, Tropical Atlantic	Ship/boat hull fouling, Ship/boat ballast water, Interconnected waterways/basins/seas
<i>Codium dwarkense</i> Børgesen	MED	29	NO	NO	Algae	Primary producer	Western Indo-Pacific; Central Indo-Pacific	Ship/boat hull fouling
<i>Botrylloides nigrum</i> Herdman, 1886	MED	29	YES	NO	Tunicate	Filter Feeder	circumtropical	Ship/boat hull fouling
<i>Ciona savignyi</i> Herdman, 1882	NE Atlantic	29	NO	NO	Tunicate	Filter Feeder	Temperate Northern Pacific	Ship/boat hull fouling
<i>Molgula ficus</i> (Macdonald, 1859)	NE Atlantic, MED	29	NO	NO	Tunicate	Filter Feeder	Central Indo-Pacific; Temperate Australasia	Ship/boat hull fouling
<i>Sphaeroma quonianum</i> H. Milne Edwards, 1840	all seas	29	NO	NO	Arthropods	Filter Feeder	Temperate Australasia	Ship/boat hull fouling
<i>Celeporaria vermiformis</i> (Waters, 1909)	MED	29	YES	YES	Bryozoans	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Licornia jolloisii</i> (Audouin, 1826)	MED	29	YES	NO	Bryozoans	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Microporella coronata</i> (Audouin, 1826)	MED	29	YES	YES	Bryozoans	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Mucropetraliella thenardii</i> (Audouin, 1826)	MED	29	YES	NO	Bryozoans	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Parasmittina protecta</i> (Thomely, 1905)	MED	29	YES	NO	Bryozoans	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Parasmittina serruloides</i> Harmelin, Bitar & Zibrowius, 2009	MED	29	YES	NO	Bryozoans	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Torquatella longiuscula</i> (Harmer, 1957)	MED	29	YES	NO	Bryozoans	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Goniadella gracilis</i> (Verrill, 1873)	NE Atlantic, Baltic Sea	28	YES	YES	Annelida	Predator	Temperate Northwest Atlantic	Ship/boat ballast water
<i>Charybdis</i> (<i>Charybdis</i>) <i>japonica</i> (A. Milne-Edwards, 1861)	MED	28	YES	YES	Arthropods	Predator	Temperate Northern Pacific, Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water
<i>Rhynchozoon larreyi</i> (Audouin, 1826)	MED	28	YES	NO	Bryozoans	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Smittina nitidissima</i> (Hincks, 1880)	MED	28	YES	YES	Bryozoans	Filter Feeder	Western Indo-Pacific; Tropical Atlantic	Ship/boat hull fouling
<i>Alepes djedaba</i> (Forsskål, 1775)	MED	28	YES	YES	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas

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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)
<i>Apogonichthyoides pharaonis</i> (Bellotti, 1874)	MED	28	YES	YES	Fish	Omnivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Nereis (Nereis) gilchristi</i> Day, 1967	MED	27	YES	NO	Annelida	Omnivore	Temperate Southern Africa	Interconnected waterways/basins/seas, Ship/boat hull fouling
<i>Amphiodia (Amphispina) oblecta</i> Mortensen, 1940	MED	27	YES	NO	Echinodermata	Predator	Western Indo-Pacific	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
<i>Microporella genisii</i> (Audouin, 1826)	MED	27	YES	NO	Bryozoans	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Tritia obsoleta</i> (Say, 1822)	NE Atlantic	27	NO	NO	Mollusc	Predator	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector)
<i>Prosphaerosyllis longipapillata</i> (Hartmann-Schröder, 1979)	MED	26	YES	YES	Annelida	Predator	Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Laticorophium baconi</i> (Shoemaker, 1934)	all seas	26	NO	NO	Arthropods	Detritivore	Temperate Northern Pacific, Tropical Eastern Pacific	Ship/boat hull fouling
<i>Perophora multidiathrata</i> (Sluiter, 1904)	MED	26	YES	YES	Tunicate	Filter Feeder	Central Indo-Pacific, Eastern Indo-Pacific, Tropical Atlantic	Ship/boat hull fouling
<i>Akatopora leucocypha</i> (Marcus, 1937)	MED	26	YES	NO	Bryozoans	Filter Feeder	Tropical Atlantic	Ship/boat hull fouling
<i>Cephalopholis taeniops</i> (Valenciennes, 1828)	MED	26	YES	YES	Fish	Predator	Tropical Atlantic	Ship/boat hull fouling
<i>Equulites klunzingeri</i> (Steindachner, 1898)	MED	26	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Paraehlersia weissmannioides</i> (Augener, 1913)	MED	25	YES	NO	Annelida	Omnivore	Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Perkinsyllis augeneri</i> (Hartmann-Schröder, 1979)	MED	25	YES	NO	Annelida	Omnivore	Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Stylarioides grubei</i> Salazar-Vallejo, 2011	MED	25	YES	YES	Annelida	Detritivore	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Tridentiger trigonocephalus</i> (Gill, 1859)	MED (possibly Black Sea, NE Atlantic)	25	NO	NO	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas, Ship/boat ballast water
<i>Dipolydora tentaculata</i> (Blake & Kudenov, 1978)	NE Atlantic	24	YES	YES	Annelida	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
<i>Polydora websteri</i> Hartman in Loosanoff & Engle, 1943	NE Atlantic, MED	24	NO	NO	Annelida	Detritivore	Temperate Northwest Atlantic	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water

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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)
<i>Nuttallia obscurata</i> (Reeve, 1857)	NE Atlantic, Baltic Sea	24	NO	NO	Mollusc	Filter Feeder	Temperate Northern Pacific, Central Indo-Pacific	Ship/boat ballast water
<i>Boccardia knoxi</i> (Rainer, 1973)	NE Atlantic, MED	23	NO	NO	Annelida	Detritivore	Temperate Australasia	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
<i>Boccardia pseudonatrix</i> Day, 1961	NE Atlantic, MED	23	NO	NO	Annelida	Detritivore	Temperate Southern Africa	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
<i>Hydroides albiceps</i> (Grube, 1870)	MED, NE Atlantic	23	NO	NO	Annelida	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Iphione muricata</i> (Lamarck, 1818)	MED	23	YES	NO	Annelida	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Polydora rickettsi</i> Woodwick, 1961	NE Atlantic, MED	23	NO	NO	Annelida	Detritivore	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector), Ship/boat ballast water
<i>Terebrasabella heterouncinata</i> Fitzhugh & Rouse, 1999	NE Atlantic, MED	23	NO	NO	Annelida	Filter Feeder	Temperate Southern Africa	Ship/boat hull fouling, Ship/boat ballast water, Contaminant on animals (except parasites, species transported by host/vector)
<i>Celleporaria labelligera</i> Harmer, 1957	MED	23	YES	NO	Bryozoans	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Celleporina bitari</i> Harmelin, 2014	MED	23	YES	NO	Bryozoans	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Drepanophora bibira</i> Powell, 1967	MED	23	YES	NO	Bryozoans	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling
<i>Equilites elongatus</i> (Günther, 1874)	MED	23	YES	NO	Fish	Predator	Western Indo-Pacific; Central Indo-Pacific	Interconnected waterways/basins/seas
<i>Pomadasystris stridens</i> (Forsskål, 1775)	MED	23	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Boonea bisuturalis</i> (Say, 1822)	MED, NE Atlantic	23	NO	NO	Mollusc	Predator	Temperate Northern Pacific	Contaminant on animals (except parasites, species transported by host/vector)
<i>Dictyosphaeria cavernosa</i> (Forsskål) Børgesen	MED	21	NO	NO	Algae	Primary producer	Circumtropical	Interconnected waterways/basins/seas
<i>Neomeris annulata</i> Dickie	MED	21	YES	NO	Algae	Primary producer	Circumtropical	Interconnected waterways/basins/seas, Pet/aquarium/terrarium species (including live food for such species)

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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)
<i>Sabellastarte spectabilis</i> (Grube, 1878)	MED	21	NO	NO	Annelida	Filter Feeder	Western Indo-Pacific	Ship/boat hull fouling, Ship/boat ballast water, Pet/aquarium/terrarium species (including live food for such species)
<i>Syllis bella</i> Chamberlin, 1919	MED	21	YES	NO	Annelida	Omnivore	Temperate Northern Pacific, Tropical Eastern Pacific	Unknown
<i>Charybdis (Charybdis) lucifera</i> (Fabricius, 1798)	MED	21	YES	YES	Arthropods	Predator	Western Indo-Pacific; Central Indo-Pacific	Ship/boat ballast water
<i>Corella inflata</i> Huntsman, 1912	NE Atlantic	21	NO	NO	Tunicate	Filter Feeder	Temperate Northern Pacific	Ship/boat hull fouling
<i>Siligo suzensis</i> Golani, Fricke & Tikochinski, 2013	MED	21	YES	YES	Fish	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Caprella simia</i> Mayer, 1903	NE Atlantic	20	NO	NO	Arthropods	Omnivore	Temperate Northern Pacific	Ship/boat hull fouling, Ship/boat ballast water
<i>Batillaria atramentaria</i> (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)
<i>Gemma gemma</i> (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)
<i>Archaias angulatus</i> (Fichtel & Moll, 1798)	MED	18	NO	NO	Foraminifera	Primary producer	Tropical Atlantic	Ship/boat ballast water
<i>Aulacomya atra</i> (Molina, 1782)	MED (Adriatic), NE Atlantic	18	YES	YES	Mollusc	Filter Feeder	Temperate South America	Ship/boat hull fouling, Ship/boat ballast water
<i>Glycera dibranchiata</i> Ehlers, 1868	MED, NE Atlantic	17	NO	NO	Annelida	Predator	Temperate Northwest Atlantic	Live food and live bait
<i>Alatina alata</i> (Reynaud, 1830)	MED,	17	NO	NO	Cnidarians	Predator	Western Indo-Pacific	Interconnected waterways/basins/seas
<i>Tetrapygus niger</i> (Molina, 1782)	NE Atlantic	17	NO	NO	Echinodermata	Herbivore	Temperate South America	Contaminant on animals (except parasites, species transported by host/vector)
<i>Stoechospermum polydoides</i> (J.V. Lamouroux) J.Agardh	MED	9	NO	NO	Algae	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
<i>Biddulphia sinensis</i> Greville	cryptogenic	Diatom
<i>Chaetoceros bacteriastroides</i> G.H.H.Karsten	cryptogenic	Diatom
<i>Coscinodiscus wailesii</i> Gran & Angst	cryptogenic	Diatom
<i>Ethmodiscus punctiger</i> Castracane	cryptogenic	Diatom
<i>Pseudo-nitzschia multistriata</i> (Takano) Takano	cryptogenic	Diatom
<i>Skeletonema tropicum</i> Cleve	cryptogenic	Diatom
<i>Thalassiosira tealata</i> Takano	cryptogenic	Diatom
<i>Alexandrium monilatum</i> (J.F.Howell) Balech	cryptogenic	Dinoflagellate
<i>Coolia malayensis</i> Leaw, P.-T.Lim & Usup	cryptogenic	Dinoflagellate
<i>Gymnodinium catenatum</i> H.W.Graham	cryptogenic	Dinoflagellate
<i>Karenia brevis</i> (C.C.Davis) Gert Hansen & Ø. Moestrup	cryptogenic	Dinoflagellate
<i>Ostreopsis lenticularis</i> Y.Fukuyo	cryptogenic	Dinoflagellate
<i>Ostreopsis ovata</i> Fukuyo	cryptogenic	Dinoflagellate
<i>Pyrodinium bahamense</i> Plate	cryptogenic	Dinoflagellate
<i>Thecadinium yashimaense</i> S.Yoshimatsu, S. Toriumi & J.D.Dodge	cryptogenic	Dinoflagellate
<i>Agglutinella compressa</i> El-Nakhal, 1983	would not predict a potential impact	Foraminifera
<i>Agglutinella robusta</i> El-Nakhal, 1983	would not predict a potential impact	Foraminifera
<i>Articulina pacifica</i> Cushman, 1944	would not predict a potential impact	Foraminifera
<i>Cibicides mabahethi</i> Said, 1949	would not predict a potential impact	Foraminifera
<i>Entosigmomorphina</i> sp.	exclude (not in species level)	Foraminifera
<i>Epistomaroides punctulata</i> (d'Orbigny, 1826)	would not predict a potential impact	Foraminifera
<i>Hauerina diversa</i> Cushman, 1946	would not predict a potential impact	Foraminifera
<i>Mimosina affinis</i> Millett, 1900	would not predict a potential impact	Foraminifera
<i>Pegidia lacunata</i> McCulloch, 1977	would not predict a potential impact	Foraminifera
<i>Planogypsina acervalis</i> (Brady, 1884)	cryptogenic	Foraminifera
<i>Pseudohauerinella dissidens</i> (McCulloch, 1977)	would not predict a potential impact	Foraminifera
<i>Pseudomassilina australis</i> (Cushman, 1932)	would not predict a potential impact	Foraminifera
<i>Pseudotriloculina subgranulata</i> (Cushman, 1918)	would not predict a potential impact	Foraminifera
<i>Sorites orbiculus</i> (Forsskål in Niebuhr, 1775)	cryptogenic	Foraminifera
<i>Actinotrichia fragilis</i> (Forsskål) Børgesen	would not predict a potential impact	Seaweed
<i>Dasya flocculosa</i> Zanardini	would not predict a potential impact	Seaweed
<i>Gelidiella acerosa</i> (Forsskål) Feldmann & G. Hamel	would not predict a potential impact	Seaweed
<i>Gracilaria vermiculophylla</i> (Ohmi) Papenfuss	already widespread in EU	Seaweed
<i>Halimeda opuntia</i> (Linnaeus) J.V.Lamouroux	would not predict a potential impact	Seaweed
<i>Halophila stipulacea</i> (Forsskål) Ascherson	too widespread in the Eastern MED	Seagrass
<i>Polycladia myrica</i> (S.G.Gmelin) Draima, Ballesteros, F.Rousseau & T.Thibaut	would not predict a potential impact	Seaweed
<i>Polysiphonia subtilissima</i> Montagne	cryptogenic and widely present in MED	Seaweed
<i>Roseningea intricata</i> (J.Agardh) Børgesen	Tethyan relict, it could be native in the MED	Seaweed

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Species excluded from the Horizon Scanning	Reason of exclusion	Taxonomic Group	
<i>Sargassum dentifolium</i> (Turner) C.Agardh	would not predict a potential impact	Seaweed	54
<i>Sargassum natans</i> (Linnaeus) Gaillon	would not predict an environmental potential impact; only touristic implications	Seaweed	55
<i>Undaria pinnatifida</i> (Harvey) Suringar	already widespread in EU; localised in MED (Thau and Venice), more common in Atlantic	Seaweed	56
<i>Arcuatula senhousia</i> (Benson, 1842)	already widespread in EU	Mollusc	57
<i>Crassostrea virginica</i> (Gmelin, 1791)	confused with <i>Magallana</i> spp; complex taxonomy may result in impediments on its real ecology and status	Mollusc	58
<i>Crepidula fornicata</i> (Linnaeus, 1758)	already widespread in EU	Mollusc	59
<i>Dendostrea frons</i> (Linnaeus, 1758)	would not predict a potential impact	Mollusc	60
<i>Finella pupoides</i> A. Adams, 1860	would not predict a potential impact	Mollusc	61
<i>Magallana sikamea</i> (Amemiya, 1928)	confused with <i>Magallana</i> spp	Mollusc	62
<i>Pteria colymbus</i> (Röding, 1798)	questionable; maybe misidentification of <i>Pinctada radiata</i>	Mollusc	63
<i>Daylithos parmatius</i> (Grube, 1877)	the report of this species in the Mediterranean Sea turned into a new species: <i>Semiodera cinari</i> Salazar-Vallejo, 2012	Annelida	64
<i>Dodecaceria capensis</i> Day, 1961	questionable	Annelida	65
<i>Leiocapitellides analis</i> Hartmann-Schröder, 1960	questionable	Annelida	66
<i>Leiochrides australis</i> Augener, 1914	questionable	Annelida	67
<i>Leonnates aylaoberi</i> Çinar & Dagli, 2013	cryptogenic, maybe native	Annelida	68
<i>Lepidonotus carinulatus</i> (Grube, 1870)	questionable, possibly a misidentification of a native species	Annelida	69
<i>Lumbrineris perkinsi</i> Carrera-Parra, 2001	cryptogenic and questionable (identification uncertain)	Annelida	70
<i>Novafabricia infratorquata</i> (Fitzhugh, 1973)	questionable, possibly a misidentification of a native species	Annelida	71
<i>Polydora cornuta</i> Bosc, 1802	already widespread in EU	Annelida	72
<i>Pseudonereis anomala</i> Gravier, 1899	already widespread in EU	Annelida	73
<i>Pseudopolydora paucibranchiata</i> (Okuda, 1937)	already widespread in EU; until recently it has been misidentified as the native <i>P. antennata</i> . The re-examination of historical collections in Naples showed that this species occurs in the MED at least since 1977 (Gambi, pers. comm.).	Annelida	74
<i>Gobius cruentatus</i> Gmelin, 1789	native in Mediterranean	Fish	75
<i>Gobius xanthocephalus</i> Heymer & Zander, 1992	native in Mediterranean	Fish	76
<i>Iniistius pavo</i> (Valenciennes, 1840)	native in Europe	Fish	77
<i>Istiompax indica</i> (Cuvier, 1832)	native in Europe	Fish	78
<i>Kyphosus incisor</i> (Cuvier, 1831)	arrival in EU due to climate change only	Fish	79
<i>Neogobius melanostomus</i> (Pallas, 1814)	already widespread in EU	Fish	80
<i>Parablennius incognitus</i> (Bath, 1968)	native in Mediterranean	Fish	81
<i>Plectorhinchus gaterinus</i> (Forsskål, 1775)	native in Europe	Fish	82
<i>Plotosus lineatus</i> (Thunberg, 1787)	recently risk assessed for the IAS Regulation	Fish	83
<i>Pomatoschistus bathi</i> Miller, 1982	native in Mediterranean	Fish	84
<i>Sarpa salpa</i> (Linnaeus, 1758)	native in Mediterranean	Fish	85
<i>Sparus aurata</i> Linnaeus, 1758	native in Mediterranean	Fish	86
<i>Synagrops japonicus</i> (Döderlein, 1883)	cryptogenic	Fish	87
<i>Afropinnotheres monodi</i> Manning, 1993	cryptogenic	Arthropod	88

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Species excluded from the Horizon Scanning	Reason of exclusion	Taxonomic Group	
Callinectes bocourti A. Milne-Edwards, 1879	already widespread in EU	Arthropod	54
Homarus americanus H. Milne Edwards, 1837	recently risk assessed for the IAS Regulation	Arthropod	55
Penaeus aztecus Ives, 1891	already widespread in EU	Arthropod	56
Sphaeroma walkeri Stebbing, 1905	already widespread in EU	Arthropod	57
Ascidella aspersa (Müller, 1776)	native in Europe	Tunicate	58
Botrylloides giganteum (Pérès, 1949)	questionable; maybe a missidentification; probably conspecific with B. pizoni reported from Taranto, Ionian Sea	Tunicate	59
Ciona intestinalis (Linnaeus, 1767)	native in Europe	Tunicate	60
Ciona robusta Hoshino & Tokioka, 1967	already widespread in EU	Tunicate	61
Didemnum vexillum Kott, 2002	already widespread in EU	Tunicate	62
Diplosoma listerianum (Milne Edwards, 1841)	cryptogenic	Tunicate	63
Styela clava Herdman, 1881	already widespread in EU	Tunicate	64
Symplegma viride Herdman, 1886	double entry under the name <i>S. baharani</i>	Tunicate	65
Beania maxilladentata Ramalho, Muricy & Taylor, 2010	recorded only in Madeira; impact unknown	Bryozoan	66
Calyptotheca alexandriensis Abdel-Salam, Taylor & Dorgham, 2017	cryptogenic	Bryozoan	67
Celleporaria brunnea (Hincks, 1884)	already widespread in EU	Bryozoan	68
Celleporaria inaudita Tilbrook, Hayward & Gordon, 2001	recorded only in Madeira; impact unknown	Bryozoan	69
Conopeum ponticum Hayward, 2001	only on artificial substrates; would not predict a potential impact	Bryozoan	70
Favosipora purpurea Souto, Kaufmann & Canning-Clode, 2015	cryptogenic	Bryozoan	71
Parasmittina alba Ramalho, Muricy & Taylor, 2011	cryptogenic	Bryozoan	72
Parasmittina multiaviculata Souto, Ramalhosa & Canning-Clode, 2016	cryptogenic	Bryozoan	73
Diadumene leucolena (Verrill, 1866)	would not predict a potential impact	Cnidarian	74
Mawia benovici (Piraino, Aglieri, Scorrano & Boero, 2014)	cryptogenic	Cnidarian	75
Taxella gracilicaulis (Jäderholm, 1903)	would not predict a potential impact	Cnidarian	76
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