JRC TECHNICAL REPORT

Marine Strategy Framework Directive

Review and analysis of EU Member States' 2018 reports

Descriptor 2: Non-Indigenous Species

Assessment (Art. 8), Good Environmental Status (Art. 9) and Targets (Art. 10)

Tsiamis K, Boschetti S, Palialexis A, Somma F, Cardoso AC

2021

Contact information
Name: Ana Cristina Cardoso
Address: Via E. Fermi 2749
Email: ana-cristina.cardoso@ec.europa.eu
Tel.: (39) 0332785702

EU Science Hub
https://ec.europa.eu/jrc

Contents

Foreword

The Marine Directors of the European Union and all EU Member States have jointly developed a common strategy for supporting the implementation of the "Marine Strategy Framework Directive" (MSFD), 2008/56/EC, amended by Commission Directive (EU) 2017/845 of 17 May 2017.

The European Commission Joint Research Centre is delivering thematic technical reports to support MSFD implementation, such as guidance documents, technical background reports and analyses related to EU Member States reporting. These thematic reports are targeted at experts who are directly or indirectly implementing the MSFD and support the further development of the Directive.

The JRC's technical report series "Marine Strategy Framework Directive – Review and analysis of EU Member States' 2018 reports", analyse, from a technical point of view, the MSFD reports submitted by EU Member States pursuant to MSFD Article 17. The analysis includes the GES Assessment (Article 8), the determination of Good Environmental Status (Article 9) and the Targets setting (Article 10). The outcome provides information for the further development of the policy implementation, supported by the EU Member States through established MSFD Technical Groups and Expert Networks.

Abstract

The current report analyses the information reported by the European Union Member States (MSs) on the Descriptor 2 (D2) – non indigenous species (NIS) – of the Marine Strategy Framework Directive (MSFD). This reporting information by the MSs followed the Article 17 requirements of MSFD for updating Articles 8, 9 and 10 of the Directive, for the last 6-year MSFD reporting cycle. By September 2020, 20 MSs reported on D2 in electronic format. Concerning Article 8, all reporting MSs assessed the the primary criterion D2C1, but only a few MSs assessed the secondary criteria D2C2 and D2C3. The assessment of the D2 criteria was not applied in a coherent manner. In addition, there were large gaps in setting threshold values for the D2 criteria, particularly for the Mediterranean and NE Atlantic countries. Moreover, new NIS introductions (D2C1) were under-reported for most MSs. Only in a few cases Good Environmental Status (GES) was reported as achieved, at specific subregions or local areas and for specific D2 criteria. As far as Article 9 is concerned, GES achievement was not assessed for the majority of MSs due to the lack of threshold values for the criteria and the lack of understanding of the GES Decision regarding achievement for D2. Regarding Article 10, large inconsistency was observed in the way the MSs have set their targets, even at national level. There was a complete lack of regional coordination for setting targets and absence of any joint target. While targets were regularly expressed as a direction towards GES achievement, they provided no quantification toward GES. The present report provides recommendations for the application of D2 criteria, GES determination and on Article 10 targets. The MSFD NIS expert network could provide technical/scientific solutions for tackling the gaps in the assessments of D2. Related work of the Regional Sea Conventions should support this effort.

1 Introduction

There are currently about 800 marine non-indigenous species (NIS) in the EU countries (Tsiamis et al. 2019), several of which exhibit invasive behavior and have negative impacts on marine ecosystem services and biodiversity (Katsanevakis et al. 2014; Ojaveer et al. 2015). To address the threats they pose the Marine Strategy Framework Directive (MSFD; EU 2008, 2010, 2017) requires EU Member States (MSs) to consider NIS in their marine management strategies, which aim to reach Good Environmental Status (GES) in European Seas.

NIS are treated as a distinct Descriptor (D2) of GES in the context of the MSFD (EU 2017): "*Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem*". The Descriptor D2 includes one primary criterion (D2C1), and two secondary criteria (D2C2 and D2C3).

1. Criterion D2C1: "*The number of non-indigenous species which are newly introduced via human activity into the wild, per assessment period (6 years), measured from the reference year as reported for the initial assessment under Article 8(1) of Directive 2008/56/EC, is minimised and where possible reduced to zero*".

2. Criterion D2C2: "*Abundance and spatial distribution of established non-indigenous species, particularly of invasive species, contributing significantly to adverse effects on particular species groups or broad habitat types*".

3. Criterion D2C3: "*Proportion of the species group or spatial extent of the broad habitat type which is adversely altered due to non-indigenous species, particularly invasive non-indigenous species*".

The environmental status of the European marine waters in the context of the MSFD was assessed by the MSs as part of the reporting obligations linked to the MSFD initial assessment, for most MSs in 2012. In that context, lists of NIS were reported in national level by each MS. Analysis of the initial reporting lists of NIS revealed important knowledge and data gaps, as well as vague definitions and significant differences on the level of detail and focus of the approach followed by each MS, pointing to the need for common standards (Palialexis et al. 2014).

Recently, Tsiamis et al. (2019) provided refined baseline inventories of NIS per MS: marine NIS reported in each EU country and MSFD marine subregion by the end of 2011. The inventories were based on the initial assessment of the MSFD and existent updated data, in collaboration with NIS experts appointed by the MSs. This work highlighted the uncertainty on the non-indigenous status of several species across EU marine waters, and the need for further harmonization and coherent implementation of MSFD D2, in relation to NIS reference points, monitoring, and thresholds. The refined baselines constitute the basis for the assessment of the primary criterion D2C1, allowing for the determination of the number of new introductions subsequent to 2012 per MS and MSFD subregion. In addition, the refined inventories of NIS can support the process towards the establishment of the threshold values for D2C1 (i.e. the number of new introductions of NIS which reveals GES at regional or subregional level), through the information related with the time trends of the listed NIS introductions and their associated pathways.

During 2019-2020, MSs have, in response to their 2018 "reporting" obligations, reported on MSFD D2 information for the last 6-year MSFD reporting cycle, following the Article 17 requirements of updating Articles 8, 9 and 10. By September 2020, 20 MSs reported on D2 in electronic format. This information is assessed in the current report.

2 MSFD Articles 8 Reports

2.1 Key results and recommendations

- In total 20 Member States (MSs) provided electronic reporting on D2. One of them (CY) did not assess any D2 criteria. EL and BG did not report in electronic format.

- All MSs that assessed D2 (19 MSs) have addressed the primary criterion D2C1; however, only eight MSs have addressed the secondary criterion D2C2 and three MSs have addressed D2C3, but not in a coherent manner.

- An explicit link between D2C2 and D2C3 should be made, to enhance the understanding of NIS impacts.

- The spatial coverage and assessment period of D2 criteria varied substantially among the MSs reports. Coherence at the subregional and regional level is needed to enable the required co-operation for setting threshold values.

- There were large gaps in setting threshold values for the D2 criteria, particularly for the Mediterranean and NE Atlantic MSs. Baltic Sea MSs reported the use of the HELCOM index for D2C1, although with slight inconsistencies in its use. A consistent approach on the methodology for setting threshold values for D2 criteria among all countries and subregions would be beneficial. Specific values of threshold could be set at regional/subregional scale. The MSFD NIS expert network works to harmonise assessment methods and threshold values at regional level.

- The majority of MSs reported that GES is expected to be achieved later than 2020 or they were not in position to estimate the timeframe for GES achievement. Only in a few cases GES was reported as achieved, at specific subregions or local areas and for specific D2 criteria.

- New NIS introductions (D2C1) were under-reported for 15 MSs. Correct reporting on those missing species could dramatically change the assessment of D2C1 and in turn the outcome of the D2 GES assessment. It is recommended to avail of existing information sources (e.g. EASIN, AquaNIS) for D2 assessment and reporting.

- For D2C2 (invasive NIS) there was scarce information provided on the parameter values. NIS included in the EU Regulation 1143/2014 (Invasive Alien Species of Union concern) must be considered in the assessments of D2C2 and D2C3. Similarly, threatened species of the IUCN Red List should be taken into consideration for the application of D2C3. MSs are deemed to establish relevant invasive NIS lists through regional or subregional collaboration. The achievement of GES for biodiversity requires explicitly addressing the pressure and impact posed by NIS, in particular invasive NIS. The D2C3 assessments in this reporting cycle cannot contribute to any biodiversity assessment for species and habitats, and guidance is needed to establish the links across state and impact/pressure criteria.

- There was a lack of common understanding of NIS terminology and related interpretation among MSs, resulting in varying information on the required fields of the reports. Collaboration among experts on taxonomies and species' status should be enhanced and streamlined.

- The MSFD NIS expert network works to provide technical/scientific solutions for the methodological gaps in the D2 assessment and threshold values. The MSFD CIS and the MSs should ensure constant support to the expert network.

2.2 Analysis of MSs Article 8 reports

2.2.1 Consistency, comparability and adequacy of reported elements

A summary of the information provided by the Member States (MSs) on the reported elements for the criteria of D2 is presented in Table 1. The quality of the information on the elements reported specifically for the primary criterion D2C1 was checked against the information provided by the MSFD baseline (Tsiamis et al., 2019), EASIN, AquaNIS and scientific literature (Table 2). Detailed information is given in Annex 1, including date of first collection, introduction pathway and related reference for each new non-indigenous species (NIS) reported.

Table 1. Number of elements (non-indigenous species-NIS; unless specified otherwise) reported for each criterion of D2, by MS at country and subregion levels. Several elements have been reported more than once in each subregion, corresponding to local scale information. ACS– Atlantic Celtic Sea; ABI– Atlantic Bay of Biscay; AMA– Macaronesia; ANS– Atlantic North Sea; BAL– Baltic Sea; BLK– Black Sea; MAD– Mediterranean Adriatic Sea; MIC-Mediterranean Ionian Sea; MWE– Mediterranean Western Basin; MAL– Mediterranean Aegean Levantine. EL and BG did not report in electronic format (N/A).

MSFD subregions	EU MSs	D2C1	D2C2	D2C3
BAL	DK[a]		1	
	EE	2	21	3
	DE	11	-	-
	LT	2	2	2
	LV	2	-	-
	PL	6	27	-
	SE	5	-	-
	FI[b]	-	-	-
ANS	BE	8	-	-
	DE	22	-	-
	DK[a]		1	
	FR	8	-	-
	NL	1	-	-
	SE	5	-	-
ACS	FR	7	-	-
	IE	3	-	-
ABI	FR	22	-	-
	PT	20	137	137
AMA	PT	32	18	-
	ES	-	-	
MWE	ES[c]	10	3	-
	FR	11	-	-
	IT[d]	6	-	-
MIC	IT[d]	7	-	-
	MT	40	-	-
	EL	N/A	N/A	N/A
MAD	HR	16	-	-
	IT[d]	14	-	-
	SI	-	-	-
MAL	EL	N/A	N/A	N/A
	CY	-	-	-
BLK	BG	N/A	N/A	N/A
	RO[e]	8	3	-

(a) DK: did not specify any elements under D2C1. During the period 2011–2015, no new NIS have been registered under the NOVANA program in Danish marine areas. Various research projects have registered a small number of new NIS in the ANS and BAL. The MSFD DK report does not indicate which are those species. DK reported 14 new NIS in the Baltic for 2011–2015, but again does not specify which are those species. D2C2 and D2C3 are treated together.

(b) FI: D2C1 is assessed at regional (Baltic Sea) scale, but not at national scale. There were no new NIS introductions in the Baltic Sea during the assessment period. 3 NIS taxa are reported as new specifically for FI during the assessment period, but these were listed under criterion D2C2, with no further information on their invasive status (if any).

(c) ES: other subregions are either not assessed or no new NIS are reported.

(d) IT: although no NIS are reported under "Elements", these are mentioned under "Description Element".

(e) RO: although no NIS are reported under "Elements", these are mentioned under "Description parameter".

Table 2. Quality check of the information provided on the elements of the primary criterion D2C1 for each EU MS. The number of elements corresponds to the number of new NIS per MS (more details are provided in Annex 1).

EU MS	Number of elements (new NIS)	Elements validated by JRC	Reason for misreporting		
			NIS detected before the 6-years assessment period of the report	NIS status wrongly attributed	Other
BE	8	7			1
DE	33	28	5		
DK	-				
EE	2	2			
ES	10	6	4		
FI	-				
FR	48	25	23		
HR	16	14	1	1	
IE	3	3			
IT	27	25	2		
LT	2	2			
LV	2	2			
MT	40	38		2	
NL	1	1			
PL	6	6			
PT	52	45	3	3	1
RO	8	8			
SE	10	9	1		
SI	-				

All 19 MSs who assessed D2 included information on the primary criterion D2C1. Eight MSs (DK, EE, ES, FI, LT, PL, PT, RO) reported information on the secondary criterion D2C2 and three MSs (EE, LT, PT) reported on the secondary criterion D2C3 (Figure 1). EE linked D2C2 NIS with D2C3 elements.

Figure 1. Number of MSs that reported each D2 criterion.
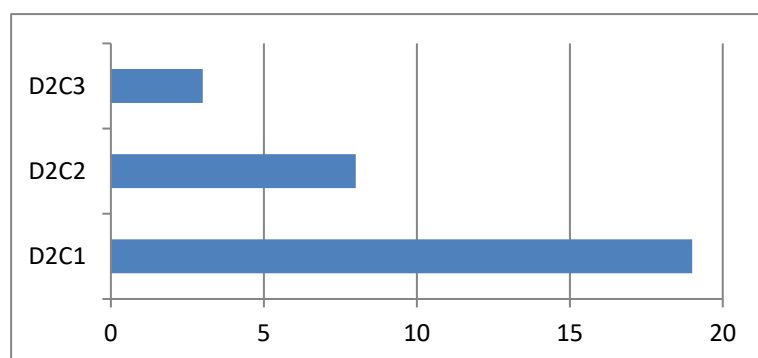
2.2.2 Existing policies related to Descriptor 2 at EU and regional levels

MSs reports did not contain any reference to the EU Regulation on Invasive Alien Species (1143/2014). The list of the Invasive Alien Species of Union concern established by this Regulation currently includes only one marine species (*Plotosus lineatus*; Commission Implementing Regulation 2019/1262), present in the Mediterranean since 2002. *P. lineatus* could until recently be purchased and kept in private aquaria in all EU countries. However, no occurrences in the wild have been reported in EU marine waters.

Aquaculture is an important pathway of intentional and unintentional introduction of NIS. The EU Regulation 708/2007, concerning the use of alien and locally absent species, establishes a framework governing aquaculture practices in relation to NIS. The goal is to assess and minimize the possible impact of NIS and any associated non-target species on aquatic habitats. Non-target species (contaminants to relevant target species) are risk assessed under this Regulation and could be a basis for checklists under D2C2.

The IUCN Red List of marine species threatened by NIS could also be a basis for reporting under D2C3.

2.3   Gaps

While all MSs reported on D2C1 (new NIS introductions), only eight countries provided information on D2C2, and only three counties on D2C3, the latter two criteria referring to abundance and spatial distribution of invasive NIS and of their impacts on natural habitats or species groups, respectively. This goes against the documented risk posed by the invasive NIS to the native species, habitats, ecosystems and their services (Katsanevakis et al. 2014). Therefore, achievement of GES for biodiversity requires to explicitly address the pressure and impact posed by NIS, in particular invasive NIS (recommendation 8 in Katsanevakis et al. 2020).

The overall spatial coverage and the assessment period of D2 reporting varied among MSs (see point 7 below) and needs to be aligned, in order to enable regional or sub-regional co-operation required for setting threshold values.

Differences in monitoring of NIS introductions among MSs introduce a significant bias, affecting the assessment of D2C1 and in turn that of GES. For example, there is high uncertainty whether unicellular planktonic species are non-indigenous in Europe's seas or they are native; they have been reported only by IT, PT, RO.

Information provided on the parameter values under D2C2 (invasive NIS) is scarce. NIS in the EU Regulation 1143/2014 must feed the D2C2 assessment and reporting. Similarly, threatened species of the Red List should be taken into consideration for the application of D2C3, to ensure coherence with the EU Biodiversity Strategy 2030 (COM(2020) 380 final). Also, MSs are deemed to establish relevant invasive NIS lists through regional or subregional collaboration. In addition, improved reporting for D2C3 should include links to assessments of particular species groups and broad habitat types considered to be particularly affected by NIS, ensuring coherence with the assessment and reporting of MSFD D1. An explicit link between D2C2 and D2C3 should be made, to enhance the understanding of NIS impacts. Guidance and collaboration across the expert networks is required to allow D2 assessments to contribute to D1 criteria assessments.

Finally, there is a different understanding of the reporting terminology among MSs, resulting in inconsistent information reported per fields. The review of the reporting guidance document and the close collaboration between MSFD competent authorities and experts can contribute to increase the common understanding of the reporting requirements.

The Joint Research Centre is working in collaboration with the MSFD NIS expert network to provide recommendations on the implementation of D2 criteria and their reporting under Article 8.

2.4   Evaluation of the MSFD assessment methodology

2.4.1   Completeness of reported MSFD methodology and 'reuse of RSC agreements'

MSs cited the NIS indices and related work of the Regional Sea Conventions: HELCOM, OSPAR and BSC. Details on their reporting can be found in Table 3.

Table 3. Regional Sea Conventions' related work on marine NIS, cited within D2 reporting. The corresponding D2 criterion and its spatial coverage are also included.

MSs	Regional Sea Convention	D2 criterion	Spatial coverage
BE	-		
DE	OSPAR & HELCOM	D2C1	subregion level
DK	OSPAR & HELCOM	D2C1	regional level (North Sea & Baltic Sea)
EE	HELCOM	D2C1	subregion level
ES	-		
FI	HELCOM	D2C1	regional level (Baltic Sea)
FR	-		
HR	-		
IE	OSPAR	D2C1	subregion level
IT	-		
LT	HELCOM	D2C1	subregion level
LV	HELCOM	D2C1	subregion level
MT	-		
NL	OSPAR	D2C1	subregion level
PL	HELCOM	D2C1	local country level
PT	-		
RO	BSC	D2C2	local country level
SE	HELCOM	D2C1	subregional level; also for the SE part of the North Sea
SI	-		

2.4.2 Evaluation of consistency, comparability and adequacy: analysis of methodological standards

2.4.2.1 Parameters

For the primary criterion D2C1 all MSs set the parameter as the number of new NIS introductions, apart from IE which reported D2C1 based on new NIS and their number of the locations recorded. For secondary criteria, the parameters reported varied among MSs (Table 4). More details can be found in Annex 2.

Table 4. Parameters of the secondary criteria of D2 based on the reporting of the MSs.

MSs	D2C2 Established NIS	D2C3 Adverse effects of NIS
DK	distribution / abundance	-
EE	biomass/ abundance	Biopollution level (BPL) and relative biomass
ES	distribution / abundance	-
FI	abundance	-
LT	species abundance and distribution in space	Biopollution level (BPL) index
PL	changes in the number of established NIS	-
PT	status of population	-
RO	average biomass/water of *Mnemiopsis leidyi*	-

2.4.2.2 Threshold values, sources and values achieved

As far as the primary criterion D2C1 is concerned, the Baltic Sea MSs reported either national sources for defining the threshold values (e.g. DE, SE) or the HELCOM threshold value, which corresponds to zero new NIS introductions (e.g. EE, DK, FI, LV, PL). Countries of the NE Atlantic referred either to national threshold values (e.g. BE, NL, DE) or to the OSPAR related work (e.g. DK). However, the latter (OSPAR) has not specified yet any

threshold value for D2C1. Black Sea and Mediterranean Sea countries did not report any threshold values for D2C1 (Table 5). More details can be found in Annex 2.

In what concerns D2C3 secondary criterion, there was scarce reporting information on its threshold values. EE reported threshold values of the Biopollution level (BPL; Olenin et al. 2007, 2010) and relative biomass of invasive NIS for D2C3. RO set the value of 4 g/m^3 as threshold value for the average concentration (biomass/water) of *Mnemiopsis leidyi*, based on the BSC information, but reported for D2C2 and not for D2C3. More details can be found in Annex 2.

Table 5. Reporting information on threshold values concerning the primary criterion D2C1 per MS.

MSs	Subregion	Threshold values	Threshold value sources	Presence of values reached (compared to the threshold values)
BE	ANS	-	National	8
DE	ANS	2	national, based on OSPAR	22
DE	BAL	1	national, based on HELCOM	11
DK	ANS	-	-	limited number of new NIS
DK	BAL	-	-	14
DK	NEA (regional)	-	OSPAR	-
DK	BAL (regional)	0	HELCOM	-
EE	BAL	0	HELCOM	2
ES	ABI	-	-	-
ES	AMA	-	-	0
ES	MWE	-	-	2 in ESAL, 8 in LEV
FI	BAL (regional)	0	HELCOM	0
FR	ABI	-	-	22
FR	ACS	-	-	7
FR	ANS	-	-	8
FR	MWE	-	-	11
HR	MAD	-	-	16
IE	ACS	-	Expert judgment	depending on new NIS and their number of locations found
IT	MAD	-		14
IT	MIC	-		7
IT	MWE	-		6
LT	BAL (regional)	0?	HELCOM?	0
LV	BAL	0?	HELCOM	2
MT	MIC	-	-	40
NL	ANS	-1	National	1
PL	BAL	0	HELCOM	depending on the local area
PT	ABI	15	-	depending on the local area
PT	AMA	-		depending on the local area
RO	BLK	-	-	depending on the local area
SE	ANS	0?	national, based on HELCOM	5
SE	BAL	0?	national, based on HELCOM	5
SI	MAD	-	-	-

2.4.2.3 Threshold values and trends

Information whether the parameter values established (threshold) were achieved was also scarce (Table 6).

Table 6. Trends and parameter achieved for each D2 criterion and subregion of MSs.

MSs	D2 Criterion	Subregion	Trends / parameter achieved
BE	D2C1	ANS	Unknown / NO
DE	D2C1	ANS	Unknown / NO
DE	D2C1	BAL	Unknown / NO
DK	D2C1	ANS	Unknown
DK	D2C1	BAL	Unknown
DK	D2C1	NEA (regional)	Unknown
DK	D2C1	BAL (regional)	Unknown
DK	D2C2	ANS	Unknown
DK	D2C2	BAL	Unknown
EE	D2C1	BAL	Not relevant / NO
EE	D2C2	BAL	Not relevant / NO
EE	D2C3	BAL	Deteriorating or stable, depending on the element
ES	D2C1	ABI	Improving in North ABI, unknown in the South ABI
ES	D2C1	AMA	Stable / Yes
ES	D2C1	MWE	Deteriorating or unknown, depending on the local region
ES	D2C2	ABI	Unknown / not assessed
ES	D2C2	AMA	Unknown / not assessed
ES	D2C2	MWE	Improving, deteriorating or unknown, depending on the local region
FI	D2C1	BAL (regional)	Improving / YES
FI	D2C2	BAL	Unknown / YES
FR	D2C1	ABI	Unknown
FR	D2C1	ACS	Unknown
FR	D2C1	ANS	Unknown
FR	D2C1	MWE	Unknown
HR	D2C1	MAD	Unknown
IE	D2C1	ACS	Unknown
IT	D2C1	MAD	Unknown / not assessed
IT	D2C1	MIC	Unknown / not assessed
IT	D2C1	MWE	Unknown / not assessed
LT	D2C1	BAL	Stable / YES
LT	D2C2	BAL	Deteriorating /NO
LT	D2C3	BAL	Deteriorating /NO
LV	D2C1	BAL	Unknown / NO
MT	D2C1	MIC	Unknown / NO
NL	D2C1	ANS	Unknown / YES
PL	D2C1	BAL	Unknown / NO or YES, depending on the local area
PL	D2C2	BAL	Unknown / not assessed
PT	D2C1	ABI	Unknown
PT	D2C1	AMA	Unknown
PT	D2C2	ABI	Unknown
PT	D2C2	AMA	Unknown
PT	D2C3	ABI	Not assessed
RO	D2C1	BLK	Unknown / NO
RO	D2C2	BLK	Unknown / YES
SE	D2C1	ANS	Not relevant / NO
SE	D2C1	BAL	Not relevant / NO
SI	D2C1	MAD	Deteriorating / NO

2.4.3 Consistency of spatial coverage and assessment period

The spatial coverage in the reporting of D2 differed among MSs and among the different D2 criteria (Table 7). For D2C1, DK reported also for the entire ANS and Baltic Sea (not only based on the Danish parts), linking to HELCOM and OSPAR work, respectively. FI reported D2C1 exclusively at regional level for the entire Baltic Sea in relation to the HELCOM index. LT reported D2C1 at subregional level of the country but assessed GES based on D2C1 at regional level for the entire Baltic Sea. Several MSs reported D2C1 and D2C2 at local level in each subregion of the country, meaning areas smaller than the MS national marine waters of each subregion.

The assessment period for D2 reported by the MSs varied (Figure 2). Two MSs (MT, PT) reported for a seven-year period (2012-2018). DK used different assessment periods: 2011-2015 for NOVANA project in relation with D2C1, and 2008-2016 in relation to D2C2. PT also used different assessment periods (2012-2017, 2012-2018, 2014-2018), according to the criterion and area investigated.

Table 7. Spatial coverage of the reporting of D2 and for each of the criteria per MS.

MSs	entire subregion	country's subregion	local level of a country's subregion
BE		D2C1	
DE		D2C1	
DK	D2C1	D2C1, D2C2	
EE		D2C1, D2C3	D2C2
ES		D2C1	D2C1, D2C2
FI	D2C1	D2C2	
FR		D2C1	D2C1
HR		D2C1	
IE		D2C1	
IT		D2C1	
LT	D2C1	D2C1	D2C2, D2C3
LV		D2C1	
MT		D2C1	
NL		D2C1	
PL			D2C1, D2C2
PT			D2C1, D2C2, D2C3
RO			D2C1, D2C2
SE		D2C1	
SI		D2C1	

Figure 2. Assessment periods of D2 reporting in relation with the number of MSs.
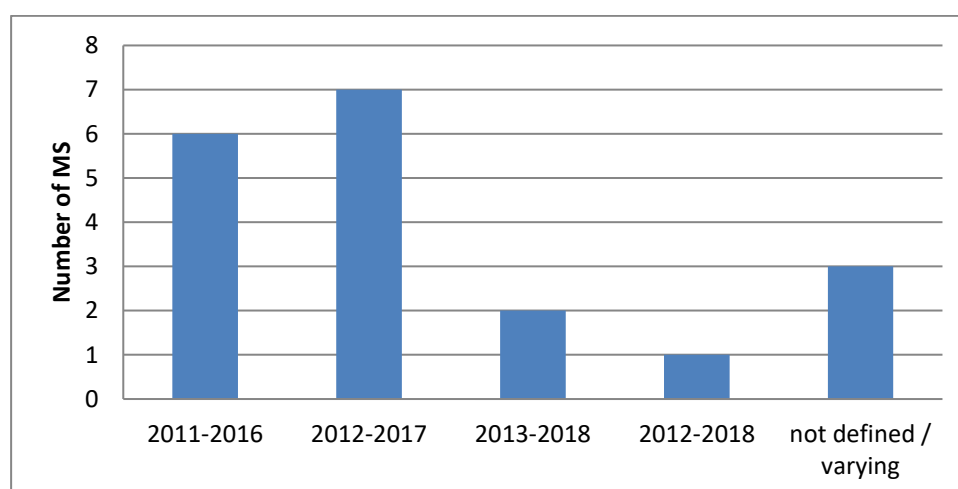
2.4.4 Extent to which GES is achieved

For the majority of the MSs, GES was reported as "*expected to be achieved later than 2020*" or as "*Unknown – Not assessed*". Only in few cases GES was reported as achieved:

- EE for D2C3 for coastal pelagic habitats;
- ES for D2C1 for North ABI and AMA;
- FI for D2C1 at the regional level of entire Baltic Sea;
- FI for D2C2;
- IE for D2C1:
- LT for D2C1;
- NL for D2C1;
- PL for D2C1 at certain local areas of the subregion;
- PL for D2C2 at certain local areas of the subregion;
- PT for D2C1 for ABI and local areas of AMA.

More details can be found in Table 8 and in Annex 2. To be noted that several MSs reported on the status of the D2C2 and whether GES was achieved or not for that criterion, although no inference on GES is required for this criterion for which no threshold values are required (see also Table 8).

Table 8. Reporting on D2 GES status (per criterion, subregion and MS).

MSs	D2 Criterion	Subregion	Criterion status	GES achieved
BE	D2C1	ANS	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
DE	D2C1	ANS	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
DE	D2C1	BAL	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
DK	D2C1	ANS	Unknown	GES expected to be achieved later than 2020, no Article 14 exception reported
DK	D2C1	BAL	Unknown	GES expected to be achieved later than 2020, no Article 14 exception reported
DK	D2C1	NEA (regional)	Unknown	GES expected to be achieved later than 2020, no Article 14 exception reported
DK	D2C1	BAL (regional)	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
DK	D2C2	ANS	Unknown	GES expected to be achieved later than 2020, no Article 14 exception reported
DK	D2C2	BAL	Unknown	GES expected to be achieved later than 2020, no Article 14 exception reported
EE	D2C1	BAL	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
EE	D2C2	BAL	Contributes to assessment of another criterion/element	Not relevant
EE	D2C3	BAL	depending on the element	depending on the element
ES	D2C1	ABI	Good in the north ABI, Unknown in the south ABI	GES achieved in north ABI, unknown in the south ABI
ES	D2C1	AMA	Good	GES achieved
ES	D2C1	MWE	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
ES	D2C2	ABI	Not assessed	unknown
ES	D2C2	AMA	Not assessed	unknown
ES	D2C2	MWE	Good, Not good or Not assessed, depending on the local region	GES expected to be achieved later than 2020, no Article 14 exception reported
FI	D2C1	BAL (regional)	Good	GES achieved

FI	D2C2	BAL	Good	GES achieved
FR	D2C1	ABI	Unknown	Unknown
FR	D2C1	ACS	Unknown	Unknown
FR	D2C1	ANS	Unknown	Unknown
FR	D2C1	MWE	Unknown	Unknown
HR	D2C1	MAD	Unknown	Unknown
IE	D2C1	ACS	Good	GES achieved
IT	D2C1	MAD	Not good	GES expected to be achieved later than 2020, Article 14 exception reported
IT	D2C1	MIC	Not good	GES expected to be achieved later than 2020, Article 14 exception reported
IT	D2C1	MWE	Not good	GES expected to be achieved later than 2020, Article 14 exception reported
LT	D2C1	BAL	Good	GES achieved
LT	D2C2	BAL	Not good	GES expected to be achieved later than 2020, Article 14 exception reported
LT	D2C3	BAL	Not good	GES expected to be achieved later than 2020, Article 14 exception reported
LV	D2C1	BAL	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
MT	D2C1	MIC	Not good	GES expected to be achieved later than 2020, Article 14 exception reported
NL	D2C1	ANS	Good	GES achieved
PL	D2C1	BAL	Good or Not good, depending on the local area	GES achieved or GES expected to be achieved by 2020, depending on the local area
PL	D2C2	BAL	Not assessed	GES achieved or GES expected to be achieved by 2020, depending on the local area
PT	D2C1	ABI	Good to all local areas	GES achieved to all local areas
PT	D2C1	AMA	Unknown / Good, based on low risk; depending on the local area	Unknown / GES achieved; depending on the local area
PT	D2C2	AMA	Not assessed	Not assessed
PT	D2C2	AMA	Unknown	Unknown
PT	D2C3	ABI	Not assessed	Not assessed
RO	D2C1	BLK	Not good	Not assessed
RO	D2C2	BLK	Good or Not good, depending on the local area	Not assessed
SE	D2C1	ANS	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
SE	D2C1	BAL	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
SI	D2C1	MAD	Not good	Not assessed

2.4.5 Analysis of the levels of integration by parameter and criteria reported

Only two MSs provided information on integration between criteria:

- EE used the information provided by D2C2 to assess D2C3
- DK treated the criteria D2C2 and D2C3 together, providing one merged criterion status.

2.4.6 Gaps

2.4.6.1 Reported information

For D2C1 there was a high number of new NIS introductions missing from the reporting. These species were found within the assessment period of the MSs based on literature sources, but they were not reported (Figure 3). The related species together with information on the date of first collection, pathway of introduction and related reference are provided in Annex 3. These missing species could have changed the assessment of the criterion status of D2C1 and subsequently defining GES. For example, NL defined GES (and assessed GES as Good) based on only one new NIS introduction in NL. However, based on the literature, there were at least 11 new NIS introductions in NL within the assessment period (Annex 3). To overcome this gap it is recommended to avail of existing information sources (e.g. EASIN, AquaNIS) for D2 assessment and reporting. Similarly, for D2C2 and D2C3 there was scarce information provided on the parameter values reported: abundance, distribution, biomass (Annex 2).

Figure 3. Number of missing new NIS from the D2C1 reporting per MS, based on published literature and online databases, which can be found in Annex 3.
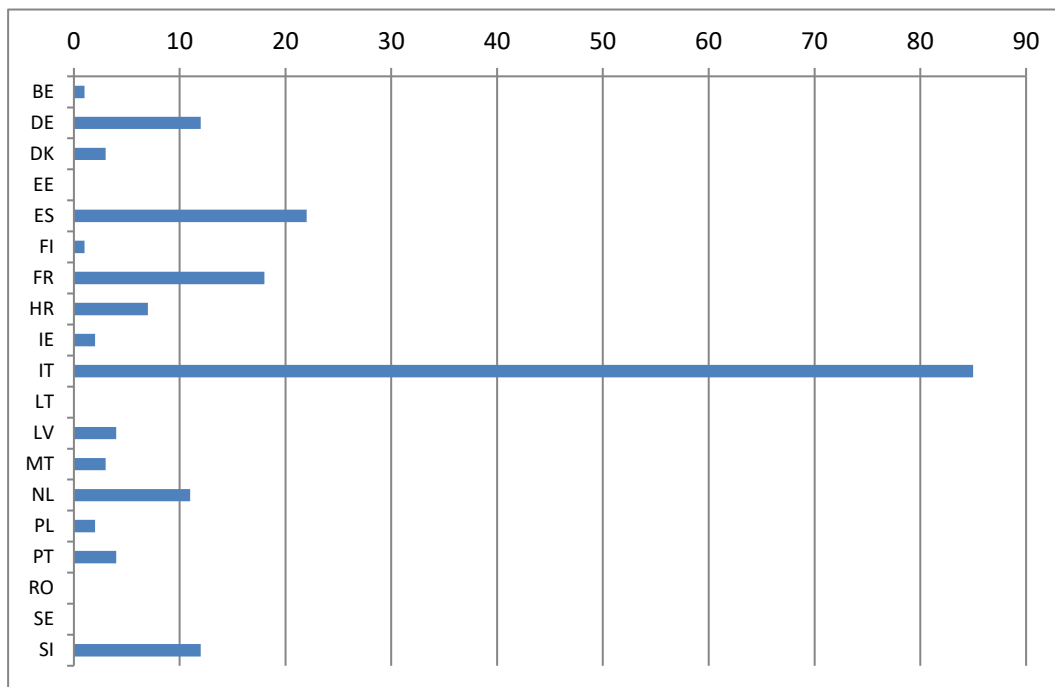
2.4.6.2 Methodology

There were large gaps on setting threshold values for D2C1, especially for the Mediterranean and NE Atlantic countries. On the other hand, Baltic Sea countries reported the use of the HELCOM index on D2C1, although there was a slight inconsistency in its use (e.g. DE: TV=1, while for FI: TV=0). GES achievement was not assessed for several countries, subregions and D2 criteria cases (Annex 2).

3 MSFD Articles 9 Reports

3.1 Key results and recommendations

- Eight MSs provided information on GES description at D2 level, while 19 MSs report at the level of criteria indicating lack of harmonization in the GES determination.

- For the majority of MSs the information provided in the GES description corresponded to the definitions of the Descriptor and its criteria and is not specified in a quantitative manner or in terms of threshold values.

- GES achievement was not assessed for the majority of MSs, especially for the Mediterranean and NE Atlantic countries, due to the lack of threshold values for the criteria and the lack of understanding of the GES Decision regarding achievement for D2.

- There were inconsistencies concerning GES determination between the information reported in Art. 8 and that of Art. 9 (see Subsection 3.4.).

- GES determination should be consistent and comparable among MSs. Whether it is applied at the level of the Descriptor or at the level of the criteria as a qualitative or a quantitative measure should be clarified from the MSFD CIS.

- GES determination at Descriptor's level requires harmonised integration rules across D2 criteria assessments.

- The secondary criteria D2C2 and D2C3, related with invasive NIS and their impact, were not assessed by the majority of the MSs, despite the risk they pose in the marine environment. Invasive NIS need to explicitly be considered in the assessment of biodiversity and ensure their consideration in management measures, without which biodiversity goals could in many cases fail.

- There is a strong need for well-defined, targeted monitoring of NIS, harmonized within and across regions. Detailed NIS monitoring guidance and exploring joint regional monitoring programmes could support the consistency and harmonization of the D2 assessments and GES determination.

3.2 Analysis of MSFD Article 9 Reports

3.2.1 Descriptor level

At the level of the Descriptor, eight Member States (MSs) provided information on GES description: BE, CY, DE, HR, LV, PL, PT, SI. However, the information provided corresponded to the MSFD definition of the Descriptor 2 and it was not specified in terms of threshold values, with the exception of:

CY: due to the high uncertainty as to the impacts of widespread invasive alien species, and the highly invasive nature of the better studied species, Cyprus waters are not in GES with respect to Descriptor 2. Article 14 exception reported.

DE: for the North Sea part, DE refered to the lack of threshold values for all the criteria of D2, highlighting the related work ongoing in collaboration with OSPAR. DE did not provide any additional information on GES determination in Art. 9 based on the specific criteria of D2 for the DE part of North Sea. When it comes to the DE part of the Baltic Sea, for D2C1 a threshold value of max. 1 species per assessment cycle was set, which differs from HELCOM, because, in line with the North Sea, a pragmatic threshold has been set at less than 25 % of the entry rate determined through constant monitoring. However, the environmental objective (Article 10 of the MSFD) aims to completely prevent new introductions.

LV: refered specifically to the primary criterion D2C1;

PT: for ABI, GES was not determined at the sub-regional level.

3.2.2 Criterion level

At the level of the criteria of the Descriptor 2, the information provided by the MSs varied based on the specific criterion:

At the level of the **primary criterion D2C1** all reporting MSs provided information on GES description with the exception of DE (but see above). However, the information provided corresponded to the definition of the criterion D2C1, and it was not specified in terms of threshold values, apart from:

CY: reported the same information as at the level of the Descriptor (see above), without specifying on D2C1.

DK: for the Baltic Sea the HELCOM threshold (set to zero new NIS) could be extended to a mid-term goal of a decline in new NIS introductions. For the North Sea, OSPAR has not set a threshold, and therefore GES cannot be evaluated.

EE: GES is achieved if new non-indigenous species (NIS) introductions are zero.

FI: no new NIS reported (zero introductions) in the Baltic Sea.

FR: GES cannot be evaluated since threshold values have not been set yet.

IE: although no threshold values associated with D2C1 have been set, Ireland has achieved GES within its maritime area for D2C1 (based on expert judgment according to information provided in Art. 8).

IT: for defining GES "the number of newly introduced NIS in areas associated with the main vectors of introduction is minimized". However, threshold values are not established yet because the data collected at the end of the first MSFD cycle through dedicated monitoring in hot spot areas for introductions, is not comparable with the data collected in 2012, mainly based on literature. Current monitoring data referring to D2 represents therefore the baseline data to be used for future GES assessment.

LT: the indicator "New non-native species for the Baltic Sea" is used, which estimates the number of new non-native species for the Baltic Sea that have appeared in the Baltic Sea waters under Lithuanian jurisdiction during the observed period.

MT: trend in number of newly introduced NIS is decreasing.

NL: GES could be established based on the decreasing trend in the number of introductions of NIS per 6-year cycle.

PT: thresholds have not yet been defined at the sub-regional level for AMA. Moreover, the list of NIS present has increased significantly, currently the list for the Azores has 85 species, a higher number than initially reported. However, this increase does not represent the real rate of new introductions during this cycle, but a greater effort for monitoring. This is why it has been chosen not to define or assess GES at Descriptor level.

At the level of **criterion D2C2** eight MSs (DK, EE, ES, LT, MT, PL, PT, RO) reported information on GES description. However, the information provided corresponded to the MSFD definition of the criterion D2C2, with the exception of the countries:

EE: under criteria D2C2, three indicators are monitored: abundance of alien pelagic invertebrate species; biomass of alien benthic invertebrate species and catch per unit effort of mobile non-indigenous species, which are contributing to the assessment of criteria D2C3.

LT: the condition is assessed according to the indicator "Species abundance and distribution in space". According to the D2C2 criterion, the condition of the marine area was assessed according to 2 invasive species. The situation in terms of the prevalence of these species deteriorated compared to the first period.

MT: the trend of the abundance and spatial distribution of established invasive alien species is stable or decreasing.

RO: information is given on the invasive species *Mnemiopsis leidyi*.

DK highlighted that "it is almost impossible to eradicate established NIS and this is why prevention or early action is considered the most cost-effective means of limiting non-resident and potentially invasive species".

At the level of **criterion D2C3** six MSs (DK, EE, ES, LT, PT, RO) reported information on GES description. However, the information provided corresponded to the definition of the criterion D2C3, and it was not specified in terms of threshold values, apart from:

EE: GES is achieved if the biopollution level (BPL) is ≤ 1; GES is achieved if the assessment period average value of contribution of NIS in macrozoobenthic community in Estonian marine area is not significantly higher than the average value from previous assessment period; GES is achieved if the assessment period average value of contribution of NIS in zooplankton community in Estonian marine area is not significantly higher than the average value from previous assessment period.

LT: the assessment of the marine area according to the D2C3 criterion was performed using the Biological Pollution Assessment Method (BPL index) for the two species included in the national list of invasive species: *Dikerogammarus villosus* and *Neogobius melanostomus*. However, the method has drawbacks that require additional targeted research. The BPL method was used in the initial assessment for the period 1990-2010. Evaluation according to the D2C3 criterion, applying the BPL method, showed that in 2012-2017 negative changes took place in the predominant type of habitats in the Lithuanian sea area. The level of biocontamination caused by the invasive species *N. melanostomus* increased from low (BPL = 1) to extreme (BPL = 4) from the initial assessment.

RO: the GES is evaluated based on the impact of *Mnemiopsis leidyi*, according to the Biopollution index.

DK highlighted that "it is almost impossible to eradicate established NIS and this is why prevention or early action is considered the most cost-effective means of limiting non-resident and potentially invasive species".

3.3   Gaps

There were large gaps on setting threshold values for D2C1, especially for the Mediterranean and NE Atlantic countries. When it comes to criteria D2C3, threshold values have not been set by any MS that reported on this criterion, with the exception of EE.

These findings are probably linked to monitoring deficiency (Tsiamis et al. 2019). There is a need for well defined, targeted monitoring of NIS, harmonized within and across regions.

Threshold values and threshold setting methods for NIS in the context of the MSFD have been discussed in an on-line workshop on the 6-7 October 2020. This workshop, organised by the JRC, was attended by national nominated NIS experts, RSCs and DG ENV. It was decided to extend the collection of NIS data in the MSFD reporting of 2018, and to use this data set to test percentage reduction on the number of new introductions as a common approach to agree on the percentage threshold value at subregional or regional scales.

3.4   Inconsistencies between Art. 8 and Art. 9

CY did not assess Art. 8, but reported on GES information based on Art. 9.

DE reported threshold values and GES determination for D2C1 in Art. 8 for the DE part of North Sea, but no relevant information was provided in Art. 9.

PL used threshold value for D2C1 based on HELCOM in order to define GES in Art. 8, but no relevant information was provided in Art. 9.

PT assessed GES based on a threshold value for D2C1 for ABI in Art. 8, but no related information was provided in Art. 9.

4 MSFD Articles 10 Reports

4.1 Key results and recommendations

- Inconsistency observed in the way the MSs have set their targets, even at national level.

- Some good practices regarding targets that are reflecting key pressures were reported (e.g. limiting the risks of introduction and spread of NIS associated with ships' ballast water and sediments). Moreover, in a few cases, targets provided a quantifiable reduction of pressure which is compatible with GES determination (e.g. the total number of introductions and movements of new NIS is close to zero). More work is needed to harmonise targets according to the above good practices and at regional level. The RSC and the MSFD D2 NIS expert network could support this task.

- As the Art. 10 targets could not directly be based on RSCs' work and especially on the reports there was a complete lack of regional coordination for setting targets and absence of any joint target.

- While targets were regularly expressed as a direction towards GES achievement (e.g. decrease of NIS, or decreasing trend), they provided no quantification toward GES.

- Targets for D2 were regularly linked with measures or other relevant policies (e.g. IMO ballast water convention) that brought actions related to NIS (ballast water control, shipping and fouling control, importing species and habitats and many more).

- Although some good practices can be identified in the reporting of the Art. 10 measures, a dedicated guidance is required to harmonise such practices and allow for joint regional target setting.

4.2 Analysis of MSFD Article 10 Reports

In total, 19 Member States reported on Art. 10.

4.2.1 Descriptor level

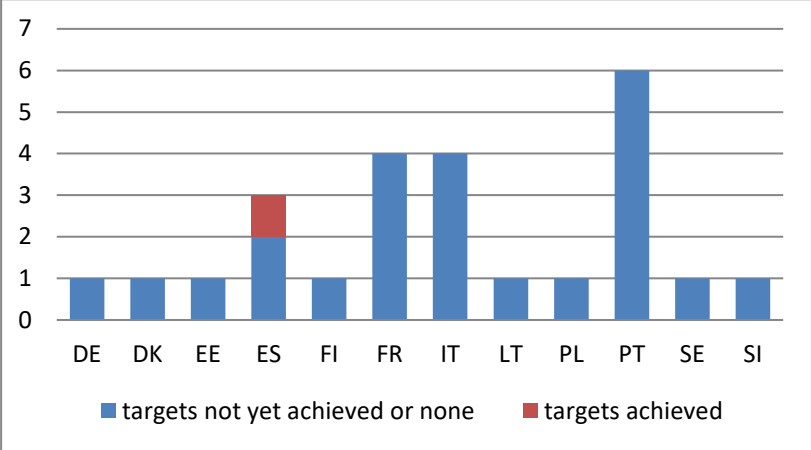At the level of the D2 Descriptor, 13 MSs reported information (Table 9). In total 26 targets were reported. All of them have not been achieved yet, with the exception of one target (ES for AMA) (Figure 4). 12 of the targets are new, 10 are same targets as in the 2012 definition, and four are modified from the 2012 definition. To be mentioned that LV targets are related with the Descriptor 1 of the MSFD.

Table 9. Description of targets, update type and target status per MS at the level of the Descriptor 2.

MSs	MSFD subregion	Description of targets	Update type	Target status
DE	ANS, BAL	The total number of introductions and movements of new species is close to zero. Prevention measures are implemented to minimise (unintentional) introduction. Emerging species will be identified in time to ensure that promising emergency measures can be implemented, if necessary. The signing and implementation of existing regulations and conventions are an important prerequisite for this.	same as 2012 definition	Target not yet achieved
DK	ANS, BAL	The Ministry of Environment and Food contributes to regional work regarding establishment of threshold values and determination of good environmental status, and works to ensure that the number of new non-indigenous species and impacts from invasive species are in accordance hereto.	new target	Target not yet achieved
EE	BAL	Ships visiting Estonian ports are fulfilling environmental requirements set by international conventions	new target	None
ES	ABI, AMA, MWE	To minimise the potential for introduction or secondary expansion of non-indigenous species, directly taking into account the anthropogenic pathways and vectors of translocation (avoid leakages in aquaculture or aquarium installations, avoid transport and release into the medium of species associated with those cultivated outside their natural range, ballast water control, control of live bait, sediment discharge control, anchoring or cleaning of hulls).	modified from 2012 definition	None
	ABI, AMA, MWE	Manage processes for invasions of alien species in an integrated manner, especially those identified in the initial evaluation of D2, including the development of early detection networks and their coordination at national level. The area covered by networks of detection and quantification of non-native species: a) existence of action protocols for screening events, b) number of marine species categorised on the list of invasive alien species, c) percentage/number of invasive species subject to management measures or actions, d) percentage/number of habitats affected by invasive species which have been subject to management measures or actions.	new target	None at ABI, AMA; not yet achieved in MWE
	AMA, MWE	Eradicate or decrease, preferably in the initial stages of the invasive processes, the abundance of invasive species to ease pressure on the habitat, in cases where the economic or biodiversity loss is significant, and provided that it is technically feasible and there is no collateral damage.	modified from 2012 definition	Target achieved in AMA; not yet achieved in MWE
FI	BAL	Maritime spatial planning is carried out in a way that it advances the achievement of good environmental status in marine environment.	same as 2012 definition	Target not yet achieved
FR	ABI, ACS, ANS, MWE	Limiting the risk of introduction of non-native species due to the import of fauna and flora.	new target	Target not yet achieved
	ABI, ACS, ANS, MWE	Limiting the transfer of non-native species (NIS) from highly impacted areas.	new target	None
	ABI, ACS, ANS, MWE	Limiting the risks of introduction and spread of non-native species (NIS) associated with ships' ballast water and sediments.	new target	Target not yet achieved
	ABI, ACS, ANS, MWE	Limiting the risk of spread of non-native species during the introduction and transfer of aquaculture species.	new target	Target not yet achieved
IT	MAD, MIC, MWE	By 2020, all ports and class 2 class 1 terminals shall be equipped with an early warning system for timely detection of the presence of invasive non-indigenous species and early warning to competent authorities.	same as 2012 definition	Target not yet achieved
	MAD, MIC, MWE	The traceability systems of all imports, translocations, and movements of non-indigenous species into aquaculture facilities, as provided for in Regulation (EC) No 708/2007, as amended, shall be implemented.	same as 2012 definition	Target not yet achieved
	MAD, MIC,	Response systems shall be implemented by the competent authorities following reports of invasive species in port areas	same as 2012	Target not yet

	MWE	and in areas intended for aquaculture.	definition	achieved
	MAD, MIC, MWE	Knowledge gaps on major introduction routes and vectors are reduced.	same as 2012 definition	Target not yet achieved
LT	BAL	Reduce the risk of the emergence of new non-indigenous species in the Baltic Sea in the maritime area of the Republic of Lithuania. The target for the indicator "New non-native species for the Baltic Sea" (criterion D2C1) has been achieved. During 2012-2017 two new non-native (alien) species entered the Lithuanian Baltic Sea waters: the bivalve mollusc *Rangia cuneata* and the crustacean *Dikerogammarus villosus*, but they have already been registered in the Baltic Sea in the sea areas of other countries. Nevertheless, the state of the marine environment according to the indicators of criteria D2C2 and D2C3: "Abundance and distribution of species in space" and "Extent of negative changes, biopollution level index - BPL" - did not reach good status. From 2011-2012, the population of *Neogobius melanostomus* established on the Lithuanian Baltic Sea coast entered the expansion phase. *N. melanostomus* is found in large numbers in many areas. The abundance of *Neogobius melanostomas* increased from 10 CPUE to 234 CPUE, i.e. more than 2000%. The black scabbardfish became the dominant abundant fish species, and the abundance of the former dominant native species declined sharply. The level of biofouling caused by *N. melanostomus* in areas BAL-LT-AA-01 and BAL-LT-AA-02 increased from the initial assessment low (BPL = 1) to extreme (BPL = 4). Therefore, the objective has been achieved, but the condition of the sea area according to the D2 descriptor is deteriorating, an exemption is requested according to Art.14.	same as 2012 definition	Target not yet achieved.
LV	BAL	Anthropogenic activities have not negatively impacted marine habitats and species.	new target	Targets related to D1
PL	BAL	Reduce the spreading of non-indigenous species introduced to the marine environment as a result of human activities, in order to ensure the presence of non-indigenous species at levels that do not affect the structure and functioning of the ecosystem, and in particular with regard to the various groups of species, areas that are particularly vulnerable to the introduction and general habitat types, by taking appropriate actions.	new target	-
PT	AMA	To promote knowledge of marine habitats and biocenesis, in particular those existing in coastal bands, to obtain quantitative and qualitative information to establish an inical state and areas of occurrence (mapped). Establish monitoring programmes to maintain and/or restore coastal habitats.	same as 2012 definition	Target not yet achieved
		Study, recast and manage monitoring networks to collect information supporting the characterisation of the marine environment, with the emphasis on situations requiring greater attention to maintain or reach Good Environmental Status and to those that may reveal the causal relationships between monitoring results and human activities.	same as 2012 definition	Target not yet achieved
		Establish monitoring programmes for species or functional groups, the proliferation of which indicates a clear change or threat of local trophic networks (ex: *Diadema antilllarum*, species outside marine aquaculture facilities, etc.).	new target	None
		Maintain effective control of the introduction of NIS into protected areas of the subdivision of Madeira.	new target	None
		Reduce the population of the *Phorcus sauciatus* species on the island of Santa Maria, promoting the exploitation of this invader resource.	new target	None
		Improve monitoring and surveillance for early detection of new NIS introductions, mainly at high-risk identified sites.	modified from 2012 definition	Target not yet achieved
SE	BAL, ANS	The marine environment shall be free of newly-released or newly-translocated non-indigenous species and strains, and non-indigenous species otherwise introduced through human activities, which may adverse effects on genetic or biological diversity or the ecosystem functioning.	modified from 2012 definition	-
SI	MAD	Establish a system to control vectors and input pathways and to act quickly where appropriate. Establishment of monitoring areas that are most exposed from the point of view of the settlement of non-native species. Establishing control over already established non-indigenous species in the region that have great invasive potential and taking action when their impacts on the environment are perceived.	same as 2012 definition	-

Figure 4. Number of targets reported at the Descriptor level of D2 per MS.

4.2.2 Criterion level

At the level of the criterion D2C1 ten MSs reported information (Table 10). In total 11 targets were reported. All of them have not been achieved yet, with the exception of two target (IE and NL) (Figure 5). 5 of the targets are new, 2 are same targets as in the 2012 definition, and 4 are modified from the 2012 definition.

Figure 5. Number of targets reported at the criterion D2C1 level per MS.
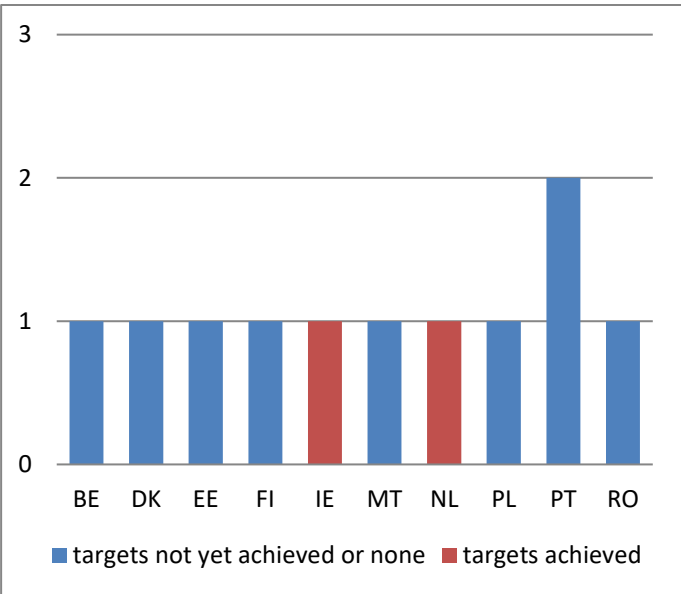
At the level of the criterion D2C2 six MSs reported information (Table 11). In total 6 targets were reported. All of them have not been achieved yet, with the exception of one target (RO for local area of the country) (Figure 6). 5 of the targets are new, and 1 is the same target as in the 2012 definition.
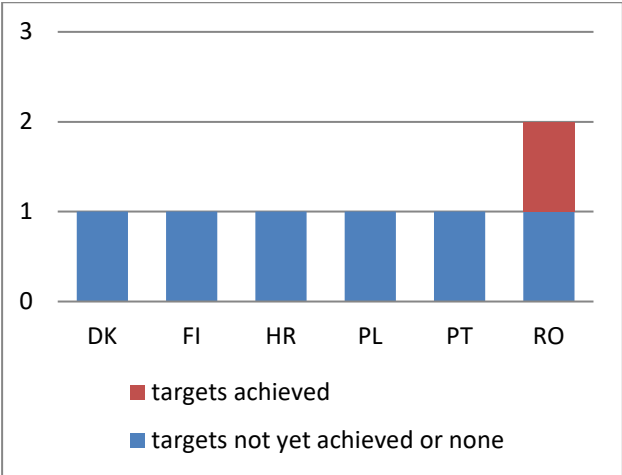
Table 10. Description of targets, update type and target status per MS at the level of the criterion D2C1.

MS	MSFD subregion	Description of targets	Update type	Target status
BE	ANS	Introduction of new human induced non-indigenous species of macrofauna and macroflora (>1 mm) in relation to the 2012 baseline is prevented. Species for which there are taxonomic disputes and for which the changes of permanent introduction, including reproduction are negligible are not taken into consideration.	same as 2012 definition	-
DK	ANS, BAL	The number of new non-indigenous species introduced through ballast water, ship fouling, and possibly other human activities is decreasing.	modified from 2012 definition	Target not yet achieved
EE	BAL	No additions of new non-indigenous species through primary invasions, including via ship ballast water.	modified from 2012 definition	Target not yet achieved
FI	BAL	Introductions of new non-indigenous species from ship ballast water/sediment and ship hulls will decrease during 2018-2024 from the current level.	new target	Target not yet achieved
IE	ACS	The number of NIS which are newly introduced via human activity into the wild per the assessment period, is minimised and where possible reduced to zero.	modified from 2012 definition	Target achieved
MT	MIC	Introduction of non-indigenous species from shipping-related activities is reduced.	modified from 2012 definition	-
NL	ANS	Minimise the risk of new introductions of non-indigenous species via shellfish transport, ballast water and hull-fouling.	same as 2012 definition	Target achieved
PL	BAL	Reduction of the pressure associated with the introduction of alien species and limiting the possibility of the spread of newly introduced alien species from the places of their original introduction.	new target	Target not yet achieved
PT	ABI	By 2021, decrease the risk of introduction of non-native species.	new target	Target not yet achieved
	AMA	The number of new introductions is minimal and if possible close to zero in the next evaluation cycle	new target	None
RO	BLK	Number of newly-introduced NIS should be zero.	new target	Target not yet achieved

Table 11. Description of targets, update type and target status per MS at the level of the criterion D2C2.

MS	MSFD subregion	Description of targets	Update type	Target status
DK	ANS, BAL	The distribution of certain invasive species is, as far as possible, at a level so that significant adverse effects are stable or decreasing.	new target	Target not yet achieved
FI	BAL	Abundance of raccoon dog and American mink decreases in waterbird breeding areas and are eradicated from selected MPAs.	new target	Target not yet achieved
HR	MAD	To establish regular monitoring in areas of particular risk (ports, harbours, farms), in order to obtain information on the occurrence of new NIS (invasive) species, and to acquire new knowledge (biology, ecology) on NIS (particularly invasive species) and not just for the Adriatic Sea and the Mediterranean, globally. To establish monitoring and evaluation of the effectiveness of existing measures in relation to the input of NIS (invasive species) as a result of anthropogenic activities in the light of increasing knowledge about these species by means of the proposed interim targets, taking such measures even further, if it is necessary.	same as 2012 definition	Target not yet achieved
PL	BAL	To minimize new introductions of non-indigenous species and the scale of their spread, in order to reduce their negative impact on the structure and functioning of the ecosystem.	new target	Target not yet achieved
PT	ABI	By 2021, establish lists of non-indigenous species, in particular IS, in the sub-region of the Iberian Coast and Bay of Biscay.	new target	Target not yet achieved
RO	BLK	Average biomass of *Mnemiopsis leidyi* does not exceed the threshold value, 4g/m3.	new target	Target achieved or not yet achieved, depending on the local area

Figure 6. Number of targets reported at the criterion D2C2 level per MS. For RO the related target was either achieved or not depending on the local area of the country.

At the level of the criterion D2C3 three MSs reported information (Table 12). In total 3 targets were reported. Only one of them has been achieved (RO) (Figure 7). All of them are new targets.

Table 12. Description of targets, update type and target status per MS at the level of the criterion D2C3.

MS	MSFD subregion	Description of targets	Update type	Target status
FI	BAL	Abundance of raccoon dog and American mink decreases in waterbird breeding areas and are eradicated from selected MPAs.	new target	Target not yet achieved
PL	BAL	Reducing the impact of invasive non-indigenous species down to a level that guarantees only a minimum level or the lack of a noticeable negative impact on the environment.	new target	-
RO	BLK	*Mnemiopsis leidyi* Biopollution index values does not exceed 2.	new target	Target achieved

Figure 7. Number of targets reported at the criterion D2C3 level per MS.
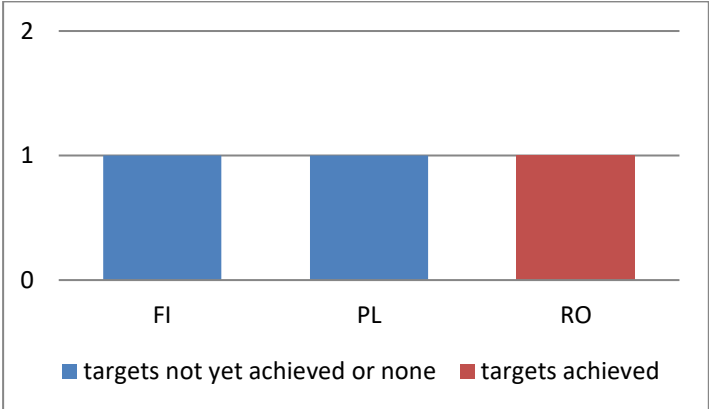
5 Conclusions and Recommendations

In total, 20 Member States (MSs) provided electronic reporting on D2.

Regarding **Article 8**, all reporting MSs assessed the the primary criterion D2C1. The secondary criteria D2C2 and D2C3, related with invasive NIS and their impact, were not assessed by the majority of the MSs, despite the risk they pose in the marine environment. In any case, the assessment of the D2 criteria was not applied in a coherent manner across the MSs. There was a lack of common understanding of NIS terminology and related interpretation among MSs, resulting in varying information on the required fields of the reports. In addition, there were large gaps in setting threshold values for the D2 criteria, particularly for the Mediterranean and NE Atlantic MSs. Baltic Sea MSs reported the use of the HELCOM index for D2C1, although with slight inconsistencies in its use. Moreover, new NIS introductions (D2C1) were under-reported for most MSs. Correct reporting on those missing species could dramatically change the assessment of D2C1 and in turn the outcome of the GES assessment. The majority of MSs reported that GES is expected to be achieved later than 2020 or they were not in position to estimate the timeframe for GES achievement. Only in a few cases GES was reported as achieved, at specific subregions or local areas and for specific D2 criteria.

As far as **Article 9** is concerned, GES achievement was not assessed for the majority of MSs, especially for the Mediterranean and NE Atlantic countries, due to the lack of threshold values for the criteria and the lack of understanding of the GES Decision regarding achievement for D2. There were inconsistencies concerning GES determination for the same MSs between the information reported in Art. 8 and that of Art. 9.

Finally, when it comes to **Article 10**, large inconsistency was observed in the way the MSs have set their targets, even at national level. Targets for D2 were regularly linked with measures or other relevant policies that brought actions related to NIS (e.g. IMO ballast water convention). However, while targets were regularly expressed as a direction towards GES achievement (e.g. decrease of NIS, or decreasing trend), they provided no quantification toward GES (e.g. the total number of introductions). As the Art. 10 targets could not directly be based on RSCs' work there was a complete lack of regional coordination for setting targets and absence of any joint target.

Recommendations:

- Coherence on the application of the D2 criteria is needed, at both subregional and regional levels.

- A consistent approach on the methodology for setting threshold values for D2 criteria among all countries and subregions would be beneficial. GES determination should be consistent and comparable among MSs.

- There is a strong need for well-defined, targeted monitoring of NIS, harmonized within and across regions, in line with the related work of the RSCs.

    - It is recommended to avail of existing information sources (e.g. EASIN, AquaNIS) for D2 assessment and reporting.

    - Collaboration among experts on taxonomies and NIS status should be enhanced and streamlined.

- More work is needed to harmonise Article 10 targets at regional level.

- The MSFD NIS expert network works to provide technical/scientific solutions for the methodological gaps in the assessments of D2. Related work of the RSCs should support this effort. The MSFD CIS and the MSs should also ensure constant support to the expert network.

6   References

EU, 'Directive 2008/ 56/EC of the European Parliament and the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)', *Official Journal of the European Union,* Volume L 164, No 19, 2008, pp: 1-22.

EU, 'Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (2010/477/EU)', *Official Journal of the European Union,* Volume L 232, No 14, 2010, pp: 1-11.

EU, 'Commission Decision (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU (Text with EEA relevance.)', *Official Journal of the European Union,* Volume L 125, No 43, 2017, pp: 1-32.

Katsanevakis, S., Coll, M., Fraschetti, S., Giakoumi, S., Goldsborough, D., Macic, V., Mackelworth, P., Rilov, G., Stelzenmüller, V., Albano, P.G., Bates, A.E., Bevilacqua, S., Gissi, E., Hermoso, V., Mazaris, A.D., Pita, C., Rossi, V., Teff-Seker, Y. and Yates, K., 'Twelve Recommendationsfor Advancing Marine Conservationin European and Contiguous Seas', *Frontiers in Marine Science*, Volume 7: 565968, 2020, doi: 10.3389/fmars.2020.565968.

Katsanevakis, S., Wallentinus, I., Zenetos, A., Leppäkoski, E., Çinar, M. E., Oztürk, B., Grabowski, M., Golani, D. and Cardoso, A. C., 'Impacts of invasive alien marine species on ecosystem services and biodiversity: a pan-European review', *Aquatic Invasions*, Volume 9, No 4, 2014, pp. 391–423.

Ojaveer, H., Galil, B.S., Campbell, M.L., Carlton, J.T., Canning-Clode, J., Cook, E.J., Davidson, A.D., Hewitt, C.L., Jelmert, A., Marchini, A., McKenzie, C.H., Minchin, D., Occhipinti-Ambrogi, A., Olenin, S., Ruiz, G., 'Classification of non-indigenous species based on their impacts: considerations for application in marine management', *Plos Biology,* Volume 13, No 4, 2015, e1002130; http://dx.doi.org/10.1371/journal.pbio.1002130.

Palialexis, A., Tornero, A.V., Barbone, E., Gonzalez, D., Hanke, G., Cardoso, A.C., Hoepffner, N., Katsanevakis, S., Somma, F., Zampoukas, N., *In-Depth Assessment of the EU Member States' Submissions for the Marine Strategy Framework Directive under articles 8, 9 and 10*. EUR 26473, Publications Office of the European Union, Luxemburg, 2014, doi: 10.2788/64014.

Tsiamis, K., Palialexis, A., Stefanova, K., Gladan, Ž.N., Skejić, S., Despalatović, M., Cvitković, I., Dragičević, B., Dulčić, J., Vidjak, O., Bojanić, N., Žuljević, A., Aplikioti, M., Argyrou, M., Josephides, M., Michailidis, N., Jakobsen, H.H., Staehr, P.A., Ojaveer, H., Lehtiniemi, M., Massé, C., Zenetos, A., Castriota, L., Livi, S., Mazziotti, C., Schembri, P.J., Evans, J., Bartolo, A.G., Kabuta, S.H., Smolders, S., Knegtering, E., Gittenberger, A., Gruszka, P., Kraśniewski, W., Bartilotti, C., Tuaty-Guerra, M., Canning-Clode, J., Costa, A.C., Parente, M.I., Botelho, A.Z., Micael, J., Miodonski, J.V., Carreira, G.P., Lopes, V., Chainho, P., Barberá, C., Naddafi, R., Florin, A.B., Barry, P., Stebbing, P.D., Cardoso, A.C., 'Non-indigenous species refined national baseline inventories: A synthesis in the context of the European Union's Marine Strategy Framework Directive', *Marine Pollution Bulletin,* Volume 145, 2019, pp: 429-435.

List of abbreviations

ABI	Atlantic Bay of Biscay
ACS	Atlantic Celtic Sea
AMA	Macaronesia
ANS	Atlantic North Sea
BAL	Baltic Sea
BLK	Black Sea
EASIN	European Alien Species Information Network
EU	European Union
GES	Good Environmental Status
IAS	Invasive Alien Species
MAD	Mediterranean Adriatic Sea
MIC	Mediterranean Ionian Sea
MS	Member State
MSFD	Marine Strategy Framework Directive
MWE	Mediterranean Western Basin
NIS	Non-indigenous species
RSC	Regional Sea Convention

List of figures

List of tables

Annexes

Annex 1. Elements (new non indigenous species) reported by Member States per MSFD subregion and country, based on criterion D2C1. Cheking by JRC, date of first observation, pathway of introduction and related sources are also provided (when relevant information was available). TS=transport-stowaway; RN=release in nature; COR=corridor; EC=escape from confinement; TC=transport-contaminant. More information is provided on request on **JRC-EASIN@ec.europa.eu**

MSs	Sub region	Element	JRC check	Date	Pathway	Sources
BE	ANS	*Ammothea hilgendorfi*	OK	2013	TS: hull fouling	WGITMO, 2014
BE	ANS	*Balanus glandula*	OK	2015	TS: hull fouling	Kerckhof et al., 2018
BE	ANS	*Boccardia proboscidea*	OK	2011	TS: hull fouling// TC: on animals // TS: ballast water	Kerckof & Faase, 2014; Tsiamis et al. 2019 baseline
BE	ANS	*Boccardiella hamata*	?			the species has not been found in Belgium but in NL // Kerckhof & Faasse 2014
BE	ANS	*Caulacanthus ustulatus*	OK	2011	TC: on animals	Kerckhof et al. 2012
BE	ANS	*Dasysiphonia japonica*	OK	2015	TS: hull fouling	ICES 2016
BE	ANS	*Gracilaria vermiculophylla*	OK	2011	TC: on animals // TS: hull fouling	Kerckhof et al. 2012
BE	ANS	*Ruditapes philippinarum*	OK	2014	RN: fishery // Unaided	Kerckhof 2014
DE	ANS	*Antithamnionella spirographidis*	OK	2012	TC: on animals // TS: ballast water // Unaided	Lackschewitz et al. 2015
DE	ANS	*Arachnidium lacourti*	OK	2014	Unknown	Aquanis // Rohde et al. 2015
DE	ANS	*Boccardia proboscidea*	OK	2016	Unknown	Aquanis
DE	ANS	*Botrylloides violaceus*	OK	2011	TS: hull fouling	Lackschewitz et al. 2015
DE	ANS	*Corella eumyota*	OK	2016	Unknown	Aquanis // Nestler 2017
DE	ANS	*Dasya baillouviana*	?	1960S		Aquanis
DE	ANS	*Dasysiphonia japonica*	OK	2015	Unknown	Aquanis
DE	ANS	*Didemnum vexillum*	OK	2016	TS: hull fouling	Aquanis // Lackschewitz & Buschbaum 2017
DE	ANS	*Dikerogammarus villosus*	?	1995		Already in DE North Sea since 1995, but maybe inland – see Aquanis
DE	ANS	*Fenestrulina delicia*	OK	2011	TC: on animals	Aquanis // Kuhlenkamp & Kind 2012
DE	ANS	*Melita nitida*	?	2008	TS: ballast water// TS: hull fouling	Reichert & Beermann 2011
DE	ANS	*Monocorophium uenoi*	OK	2016	Unknown	Aquanis // Nestler 2017
DE	ANS	*Neodexiospira brasiliensis*	OK	2014	Unknown	Aquanis
DE	ANS	*Pileolaria berkeleyana*	OK	2013	Unknown	Aquanis // Lackschewitz et al. 2015
DE	ANS	*Polydora websteri*	OK	2014	Unknown	Aquanis

DE	ANS	*Pseudodiaptomus marinus*	OK	2011	TS: ballast water// Unaided	Aquanis // Jha et al. 2013
DE	ANS	*Rangia cuneata*	OK	2013	Unknown	Aquanis // Lackschewitz et al. 2015
DE	ANS	*Schizobrachiella verrilli*	OK	2011	Unknown	Aquanis // Kuhlenkamp & Kind 2012
DE	ANS	*Smittoidea prolifica*	OK	2011	TC: on animals	Aquanis // Kuhlenkamp & Kind 2012
DE	ANS	*Streblospio benedicti*	?	2006		Aquanis
DE	ANS	*Synidotea laticauda*	OK	2011	TS: ballast water// Unaided	Aquanis
DE	ANS	*Undaria pinnatifida*	OK	2016	TC: on animals // TS: hull fouling	Aquanis // Lackschewitz & Buschbaum 2017
DE	BAL	*Antithamnionella ternifolia*	OK	2014	Unknown	Aquanis // HELCOM 2017)
DE	BAL	*Diadumene lineata*	OK	2011	TS: hull fouling	Aquanis
DE	BAL	*Dreissena bugensis*	OK	2014	TS: ballast water// Unaided	Aquanis
DE	BAL	*Echinogammarus trichiatus*	OK	2014	Unaided	Aquanis // Zettler 2015
DE	BAL	*Ficopomatus enigmaticus*	OK	2014	TS: ballast water// Unaided // TS: hull fouling	Aquanis // WGITMO 2016.
DE	BAL	*Grandidierella japonica*	OK	2015	Unaided	Aquanis // HELCOM 2017
DE	BAL	*Hemigrapsus takanoi*	OK	2014	Unaided	Geburzi et al. 2015
DE	BAL	*Hypania invalida*	?	2010	TS: ballast water	Aquanis
DE	BAL	*Paramysis lacustris*	OK	2013	Unaided	Aquanis // Zettler 2015
DE	BAL	*Proasellus coxalis*	OK	2011	TS: ballast water	Aquanis // Lackschewitz et al. 2015
DE	BAL	*Sinelobus vanhaareni*	OK	2012	Unknown	Aquanis
EE	BAL	*Laonome sp.*	OK	2012	TS: ballast water	Kotta et al. 2015
EE	BAL	*Rangia cuneata*	OK	2016	TS: ballast water// TS: hull fouling	Möller & Kotta, 2017
ES	MWE	*Callinectes sapidus*	OK	2012	Unknown	Castejon & Guerao 2013
ES	MWE	*Rugulopteryx okamurae*	OK			Altamirano et al. 2017
ES	MWE	*Aplidium accarense*	OK	2012	TS: hull fouling	Lopez-Legentil et al. 2015
ES	MWE	*Biuve fulvipunctata*	OK	2015	Unknown	Malaquias et al. in Karachle et al. 2016
ES	MWE	*Callinectes sapidus*	OK	2015	Unknown	Izquierdo-Gómez & Izquierdo-Muñoz in Karachle et al. 2016
ES	MWE	*Caprella scaura*	?	2005	TS: ballast water// TS: hull fouling	Martinez & Adarraga 2008

ES	MWE	*Halimeda incrassata*	?	2011	EC: aquarium // TS: hull fouling	Alos et al. 2016
ES	MWE	*Paracaprella pusilla*	?	2011	TS: hull fouling	Ros et al. 2013
ES	MWE	*Perinereis linea*	OK	2012	TS: ballast water// TS: hull fouling	Arias et al. 2013
ES	MWE	*Plocamium secundatum*	?	1976?		Algaebase
FR	MWE	*Amathia verticillata*	?	1888		Joliet 1888
FR	MWE	*Ampithoe valida*	?	2000		Faasse 2015
FR	MWE	*Aoroides longimerus*	OK	2015	TS: hull fouling	Ulman et al. 2017
FR	MWE	*Celleporaria brunnea*	OK	2015	Unknown	Ulman et al. 2017
FR	MWE	*Chaetozone corona*	OK	2012	Unknown	Le Garrec, comm. pers.
FR	MWE	*Haminoea japonica*	?	Unknown	Unknown	Hanson et al. 2013
FR	MWE	*Ianiropsis serricaudis*	OK	2015	Unknown	Ulman et al. 2017
FR	MWE	*Oulastrea crispata*	OK	2012	TS: hull fouling	Hoeksema & Oceaña Vicente 2014
FR	MWE	*Paranthura japonica*	OK	2014	TS: hull fouling	Marchini et al. 2015
FR	MWE	*Penaeus aztecus*	OK	2015	TC: on animals	Galil et al. 2017
FR	MWE	*Stenothoe georgiana*	OK	2015	Unknown	Ulman et al. 2017
FR	ANS	*Boccardia proboscidea*	OK	2014	TS: ballast water	Spilmont et al. 2016
FR	ANS	*Ciona robusta*	OK	2012	Unknown	Bishop et al. 2015
FR	ANS	*Euchone limnicola*	OK	2015	TS: ballast water// TS: hull fouling	Guyonnet & Borg 2015
FR	ANS	*Lovenella assimilis*	?	2007	TS: ballast water// TS: hull fouling	Brylinski et al. 2016
FR	ANS	*Penaeus semisulcatus*	OK	2016	TS: ballast water	Pezy et al. 2017
FR	ANS	*Perisesarma alberti*	OK	2016	EC: aquarium	Pezy et al. 2017
FR	ANS	*Pseudodiaptomus marinus*	?	2010	TS: ballast water	Brylinski et al. 2012
FR	ANS	*Ptilohyale littoralis*	OK	2014	Unaided	Spilmont et al. 2016
FR	ACS	*Aoroides longimerus*	OK	2014	TS: hull fouling	Gouillieux et al. 2015
FR	ACS	*Asterocarpa humilis*	?	2005		Bishop et al. 2013
FR	ACS	*Botrylloides diegensis*	?	2004	TS: hull fouling	Bishop et al. 2015
FR	ACS	*Chaetozone corona*	?	1996	TS: hull fouling// TS: ballast water	Le Garrec et al. 2016
FR	ACS	*Haminoea japonica*	?	2003	TC: on animals	Hanson et al. 2013
FR	ACS	*Polysiphonia morrowii*	?	1970s	TS: hull fouling// TC: on animals	Geoffroy et al. 2012

FR	ACS	*Tritia corniculum*	OK	2013	TC: on animals	Gully et al. 2013
FR	ABI	*Asterocarpa humilis*	?	2011	Unknown	Bishop et al. 2013 // ICES 2013
FR	ABI	*Chaetozone corona*	?	1996	TS: hull fouling// TS: ballast water	Garrec et al. 2016
FR	ABI	*Ciona robusta*	OK	2013	Unknown	Nydam et al. 2017
FR	ABI	*Eurytemora pacifica*	OK	2014	TS: ballast water	Brylinski et al. 2016
FR	ABI	*Gracilariopsis chorda*	?	2010	Unknown	Mineur et al. 2012
FR	ABI	*Grandidierella japonica*	OK	2015	TC: on animals	Droual et al. 2017
FR	ABI	*Polysiphonia morrowii*	?	2011	Unknown	Geoffroy et al. 2012
FR	ABI	*Ampithoe valida*	OK	2014	TC: on animals	Gouillieux 2017
FR	ABI	*Aoroides curvipes*	?	2009	TC: on animals	Gouillieux et al. 2015
FR	ABI	*Aoroides longimerus*	OK	2013	TC: on animals	Gouillieux et al. 2015
FR	ABI	*Aoroides semicurvatus*	?	2009	TC: on animals	Gouillieux et al. 2015
FR	ABI	*Celleporaria brunnea*	?	2007	Unknown	André et al. 2014
FR	ABI	*Dyspanopeus sayi*	?	2007	TC: on animals	Aubert & Sauriau 2015
FR	ABI	*Grandidierella japonica*	?	2010	TC: on animals // TS: ballast water	Jourde et al. 2013
FR	ABI	*Ianiropsis serricaudis*	OK	2013	TC: on animals	Gouillieux 2018
FR	ABI	*Incisocalliope aestuarius*	?	1975-1976	Unknown	Aquanis
FR	ABI	*Maeotias marginata*	OK	2013		Nowaczyk et al. 2016
FR	ABI	*Melita nitida*	OK	2013	TC: on animals	Gouillieux et al. 2016
FR	ABI	*Mnemiopsis leidyi*	?	2005	Unknown	Aquanis
FR	ABI	*Monocorophium uenoi*	?	2007	TC: on animals	Gouillieux & Massé 2019
FR	ABI	*Paranthura japonica*	?	2007	TS: hull fouling// EC: live food	Lavesque et al. 2013
FR	ABI	*Pseudodiaptomus marinus*	?	2011	TS: ballast water	Brylinski et al. 2012
HR	MAD	*Abudefduf vaigiensis*	OK			
HR	MAD	*Aglaothamnion feldmanniae*	OK			
HR	MAD	*Antithamnion amphigeneum*	OK			
HR	MAD	*Antithamnionella elegans*	?	1983		Span & Antolic 1983 (in Verlaque CIESM Atlas)
HR	MAD	*Celleporaria brunnea*	OK	2014	TS: hull fouling	Marić et al. 2016

HR	MAD	*Colaconema codicola*	OK			
HR	MAD	*Homarus americanus*	OK	2018	EC: live food	Pavičić et al. 2020
HR	MAD	*Lamprohaminoea cyanomarginata*	OK	2016	Unaided // TS: ballast water	Dragicevic et al. in Chartosia et al. 2018
HR	MAD	*Mnemiopsis leidyi*	OK	2016	TS: ballast water	Malej et al. 2017
HR	MAD	*Oplegnathus fasciatus*	OK	2015	Unaided // TS: ballast water	Dulcic et al. 2016
HR	MAD	*Parvocalanus crassirostris*	OK	2014	TS: ballast water	Vidjak et al. 2016
HR	MAD	*Percnon gibbesi*	OK	2014	Unaided // TS: ballast water	Dulčić & Dragičević 2015
HR	MAD	*Pseudodiaptomus marinus*	OK	2016	Unaided // TS: ballast water	Vidjak et al. 2018
HR	MAD	*Pseudo-nitzschia multistriata*	OK			
HR	MAD	*Skeletonema grevillei*	?	2014	TS: ballast water	Pfannkuchen et al. 2018
HR	MAD	*Watersipora subtorquata*	OK			
IE	ACS	*Perophora japonica*	OK	2012	TS: hull fouling	Aquanis
IE	ACS	*Schizoporella japonica*	OK	2015	TS: hull fouling	Aquanis
IE	ACS	*Undaria pinnatifida*	OK	2012	TS: hull fouling	Aquanis
LT	BAL	*Dikerogammarus villosus*	OK	2015	TS: hitchhikers // TS: ballast water// TS: hull fouling	Aquanis
LT	BAL	*Rangia cuneata*	OK	2013	Unaided	Aquanis
LV	BAL	*Laonome sp.*	OK	2012-2014	Unknown	WGITMO 2018
LV	BAL	*Sinelobus vanhaareni*	OK	2015	TS: ballast water	WGITMO 2018
MT	MIC	*Abudefduf hoefleri*	OK	2014	TS: ballast water	Vella et al. 2016
MT	MIC	*Abudefduf saxatilis*	?			
MT	MIC	*Acanthurus chirurgus*	OK	2016	EC: aquarium // TS: ballast water	Evans et al. 2017
MT	MIC	*Acanthurus coeruleus*	OK	2013	EC: aquarium // TS: ballast water	Evans et al. 2015
MT	MIC	*Acanthurus monroviae*	?			Natural range expansion (Zenetos et al. 2012)
MT	MIC	*Achelia sawayai*	OK	2016	Unknown	Ulman et al. 2017
MT	MIC	*Acrothamnion preissii*	OK	2014	Unaided // TS: hull fouling	Evans et al. 2015
MT	MIC	*Botryllus schlosseri*	OK			
MT	MIC	*Branchiomma bairdi*	OK	2012		Arias et al. 2013
MT	MIC	*Bugula neritina*	OK			

MT	MIC	Caprella scaura	OK	2012		Ros et al. 2014
MT	MIC	Caulerpa taxifolia var. distichophylla	OK	2013	TS: hitchhikers	Schembri et al. 2015
MT	MIC	Celleporaria brunnea	OK	2016	TS: hull fouling	Ulman et al. 2017
MT	MIC	Celleporaria vermiformis	OK			
MT	MIC	Cephalopholis nigri	OK	2016	EC: aquarium // TS: ballast water	Vella et al. 2016c
MT	MIC	Chrysiptera hemicyanea	OK	2017	EC: aquarium	Deidun et al. 2018
MT	MIC	Codium fragile	OK			
MT	MIC	Dendostrea folium	OK	2016	TS: hull fouling	Ulman et al. 2017
MT	MIC	Didemnum sp.	OK			
MT	MIC	Dispio uncinata	OK			
MT	MIC	Heniochus intermedius	OK	2014	EC: aquarium // TS: ballast water	Evans et al. 2015
MT	MIC	Herdmania momus	OK	2013	TS: ballast water// TS: hull fouling// TS: hitchhikers	Evans et al. 2013
MT	MIC	Hippopodina sp.	OK			
MT	MIC	Hydroides dirampha	OK	2016	TS: hull fouling	Ulman et al. 2017
MT	MIC	Kirkegaardia dorsobranchialis	OK			
MT	MIC	Lagocephalus sceleratus	OK	2014	Unaided	Deidun et al. 2015
MT	MIC	Lumbrinerides neogesae	OK			
MT	MIC	Lutjanus fulviflamma	OK	2013	EC: aquarium // TS: ballast water// COR	Vella et al. 2015
MT	MIC	Maritigrella fuscopunctata	OK	2014	TS: ballast water	Portelli et al. in Crocetta et al. 2015
MT	MIC	Mesanthura sp.	OK	2016	Unknown	Ulman et al. 2017
MT	MIC	Notomastus aberans	OK	2017		Katsanevakis et al. 2020
MT	MIC	Oculina patagonica	OK	2017		Chartosia et al. 2018
MT	MIC	Paracerceis sculpta	OK	2016	TS: hull fouling	Ulman et al. 2017
MT	MIC	Paranthura japonica	OK	2016	TS: hull fouling	Ulman et al. 2017
MT	MIC	Pomacanthus maculosus	OK	2012	EC: aquarium // TS: ballast water	Evans et al. 2016
MT	MIC	Prionospio depauperata	OK	2018		Katsanevakis et al. 2020
MT	MIC	Sargocentron sp.	OK	2017	Unaided	Deidun et al. 2016
MT	MIC	Stegastes variabilis	OK	2014	TS: ballast water	UoM 2014
MT	MIC	Stenothoe georgiana	OK	2016	TS: hull fouling	Ulman et al. 2017

MT	MIC	*Watersipora arcuata*	OK	2016	TS: hull fouling	Ulman, et al. 2017
NL	ANS	*Monocorophium uenoi*	OK	2013	TC: on animals	Faasse 2014
PL	BAL	*Limnodrilus profundicola*	OK	2014		Marszewska et al. 2017
PL	BAL	*Melita nitida*	OK	2014	TS: ballast water// TS: hull fouling	Normant-Saremba et al. 2017
PL	BAL	*Palaemon macrodactylus*	OK	2014	TS: ballast water	Janas &Tutak 2014
PL	BAL	*Rangia cuneata*	OK	2011	TS: ballast water// TS: hull fouling // Unaided	Warzocha & Drgas 2013
PL	BAL	*Dreissena bugensis*	OK	2011	TS: ballast water// TS: hull fouling // Unaided	Woźniczka et al. 2016
PL	BAL	*Rangia cuneata*	OK	2011	TS: ballast water// TS: hull fouling	Warzocha & Drgas 2013
PT	ABI	*Crepidula fornicata*	?	1999		Aquanis
PT	ABI	*Cynoscion regalis*	OK	2016	TS: ballast water	Morais & Teodósio 2016
PT	ABI	*Reptadeonella violacea*	OK	2012	Unknown	Aquanis; Souto 2016
PT	ABI	*Arcuatula senhousia*	OK	2015	TC: on animals	
PT	ABI	*Balanus trigonus*	OK	2013	TS: hull fouling	Aquanis
PT	ABI	*Celleporaria brunnea*	OK	2012	TS: hull fouling	Canning-Clode et al. 2013
PT	ABI	*Cynoscion regalis*	OK	2016	TS: ballast water	Morais & Teodósio 2016
PT	ABI	*Distaplia corolla*	OK	2016	TS: hull fouling	Ramos 2016
PT	ABI	*Megabalanus tintinnabulum*	OK	2016		Aquanis
PT	ABI	*Reptadeonella violacea*	OK	2012	Unknown	Aquanis; Souto 2016
PT	ABI	*Schizoporella errata*	OK	2016	TS: hull fouling / TC: on animals	Aquanis; Souto 2016
PT	ABI	*Scytosiphon dotyi*	OK	2016	TS: hull fouling / TC: on animals	Aquanis; Berecibar 2016
PT	ABI	*Amphibalanus eburneus*	OK			
PT	ABI	*Celleporaria brunnea*	OK	2012	TS: hull fouling	Chainho et al. 2015
PT	ABI	*Cynoscion regalis*	OK	2016	TS: ballast water	Morais & Teodósio 2016
PT	ABI	*Didemnum vexillum*	OK			
PT	ABI	*Hesperibalanus fallax*	OK	2015	TS: hull fouling	Tristancho Ruiz 2015
PT	ABI	*Molgula occidentalis*	native	2015		Tristancho Ruiz 2015
PT	ABI	*Schizoporella errata*	OK	2016	TS: hull fouling / TC: on animals	Aquanis; Souto 2016
PT	ABI	*Styela canopus*	OK	2015	TS: hull fouling	Tristancho Ruiz 2015
PT	AMA	*Alexandrium minutum*	OK	2013	TC: on animals	

PT	AMA	Amathia gracilis	OK		TS: hull fouling	Micael et al. 2017
PT	AMA	Aoroides longimerus	OK	2013	TS: hull fouling	
PT	AMA	Branchiomma luctuosum	OK	2017	TS: hull fouling	
PT	AMA	Caprella scaura	OK	2015	TS: hull fouling	Aquanis
PT	AMA	Caulerpa prolifera	OK	2013	Unkown	Cardigos et al., 2013
PT	AMA	Ciona intestinalis	OK	2014	TS: hull fouling	ICES 2016
PT	AMA	Ficopomatus enigmaticus	OK	2016	Unaided	
PT	AMA	Halimeda incrassata	OK	2016	TS: people	
PT	AMA	Lophocladia trichoclados	?	2016	TS: people	
PT	AMA	Mycale (carmia)	OK		TS: hull fouling	
PT	AMA	Ostrea edulis	OK	2013	TS: hull fouling	
PT	AMA	Paracerceis sculpta	OK	2014	TS: hull fouling	Marchini et al. 2018
PT	AMA	Phorcus sauciatus	?	2013	Unaided/range expansion?	Ávila et al. 2015).
PT	AMA	Schizoporella errata	OK	2013	TS: hull fouling	Micael et al. 2014
PT	AMA	Styela clava	OK	2014	TS: hull fouling	ICES 2018
PT	AMA	Tricellaria inopinata	OK	2014	TS: hull fouling	Micael et al. 2016
PT	AMA	Aplidium glabrum	OK		TS: hull fouling	Ramalhosa et al. 2019
PT	AMA	Austrominius modestus	?	2005	TS: ballast water/ TS: hull fouling	Aquanis
PT	AMA	Botrylloides niger	OK		TS: hull fouling	Gestoso et al. 2017 ; Ramalhosa et al. 2019
PT	AMA	Bugula neritina	OK	2012	TS: hull fouling	Ramalhosa et al. 2017; Gestoso et al. 2018; Ramalhosa et al. 2019; Aquanis
PT	AMA	Celleporaria inaudita	?	2007		Canning-Clode et al. 2013
PT	AMA	Cronius ruber	?	2018	Unaided	Schaefer et al. 2019
PT	AMA	Distaplia magnilarva	OK		TS: hull fouling	Ramalhosa et al. 2019
PT	AMA	Paracerceis sculpta	OK	2015	TS: hull fouling	Ramalhosa et al. 2017
PT	AMA	Parasmittina alba	OK	2013	TS: hull fouling	Souto et al. 2018
PT	AMA	Parasmittina multiaviculata	OK	2013	TS: hull fouling	Souto et al. 2018

PT	AMA	*Polyandrocarpa zorritensis*	OK		TS: hull fouling	Ramalhosa et al. 2019
PT	AMA	*Prosuberites longispinus*	OK		TS: hull fouling	Ramalhosa et al. 2019
PT	AMA	*Sphaeroma walkeri*	OK	2015	TS: hull fouling	Ramalhosa et al. 2017
PT	AMA	*Symplegma brakenhielmi*	OK	2015	TS: hull fouling	Gestoso et al. 2018; Riera et al. 2018; Aquanis
PT	AMA	*Tricellaria inopinata*	OK		TS: hull fouling	Ramalhosa et al. 2019
RO	BLK	*Eutintinnus tubulosus*	OK		TS: ballast water	
RO	BLK	*Eutintinnus apertus*	OK		TS: ballast water	
RO	BLK	*Amphorellopsis acuta*	OK		TS: ballast water	
RO	BLK	*Rhizodomus tagatzi*	OK		TS: ballast water	
RO	BLK	*Salpingella decurtata*	OK	2012	TS: ballast water	Aquanis
RO	BLK	*Tintinnopsis tocantinensis*	OK		TS: ballast water	
RO	BLK	*Eutintinnus pectinis*	OK		TS: ballast water	
RO	BLK	*Codonellopsis morchella*	OK		TS: ballast water	
SE	ANS	*Caprella mutica*	OK	2011	TS: ballast water// TS: hull fouling// TS: hitchhikers // Unaided	Aquanis // ICES WGITMO 2012; Appelqvist C. & Kilströmer A. 2011
SE	ANS	*Euplokamis dunlapae*	OK	2011	TS: ballast water	Aquanis // ICES WGITMO 2011 // Granhag et al. 2012
SE	ANS	*Ficopomatus enigmaticus*	?	1939		Aquanis
SE	ANS	*Hemigrapsus sanguineus*	OK	2012	TS: ballast water	Berggren 2013
SE	ANS	*Hemigrapsus takanoi*	OK	2016	Unknown	http://www.havsmiljoinstitutet.se/digitalAssets/1579/1579170_vasterhavet_2016.pdf
SE	BAL	*Boccardiella ligerica*	OK	2013	TS: ballast water	Aquanis // Adill et al. 2015
SE	BAL	*Laonome sp.*	OK	2014	Unknown	Kotta et al. 2015
SE	BAL	*Mytilopsis leucophaeata*	OK	2011	TS: ballast water// TS: hull fouling	Aquanis // Florin et al. 2013
SE	BAL	*Rangia cuneata*	OK	2016	TS: ballast water// TS: hull fouling	Von Proschewitzs 2017
SE	BAL	*Rhithropanopeus harrisii*	OK	2014	TS: ballast water// Unaided	Berggren 2015
SI	MAD	–				

Annex 2. Parameters, threshold values (TV), TV sources, values achieved, trends, criterion status and GES status per D2 criteria, for each Member State and MSFD subregion, as reported by the Member States.

MSs	Criterion	Subregion	Parameter	TV	TV sources	Presence of values achieved	Trends and parameter achieved	Criteria status	GES achieved
BE	D2C1	ANS	number of new NIS	-	National	8	Unknown / NO	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
DE	D2C1	ANS	number of new NIS	2	national, based on OSPAR	22	Unknown / NO	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
DE	D2C1	BAL	number of new NIS	1	national, based on HELCOM	11	Unknown / NO	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
DK	D2C1	ANS	number of new NIS	-	-	limited number of new NIS in the North Sea and Baltic Sea of DK, but not specified	Unknown	Unknown	GES expected to be achieved later than 2020, no Article 14 exception reported
DK	D2C1	BAL	number of new NIS	-	-	14 new NIS are reported for the Baltic part of DK for 2011-2015, but not specified	Unknown	Unknown	GES expected to be achieved later than 2020, no Article 14 exception reported
DK	D2C1	NEA (regional)	number of new NIS	-	OSPAR	-	Unknown	Unknown	GES expected to be achieved later than 2020, no Article 14 exception reported
DK	D2C1	BAL (regional)	number of new NIS	0	HELCOM	-	Unknown	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
DK	D2C2	ANS	distribution / abundance	N/A	N/A	-	Unknown	Unknown	GES expected to be achieved later than 2020, no Article 14 exception reported
DK	D2C2	BAL	distribution / abundance	N/A	N/A	-	Unknown	Unknown	GES expected to be achieved later than 2020, no Article 14 exception reported
EE	D2C1	BAL	number of new NIS	0?	HELCOM	2	Not relevant / NO	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
EE	D2C2	BAL	biomass/Abundance	N/A	N/A	depending on species and local area	Not relevant / NO	Contributes to assessment of another criterion/ele	Not relevant
EE	D2C3	BAL	Biopollution level (BPL) and relative biomass	depending on the element	Olenin et al. 2007, 2010 for BPL	depending on the element	Deteriorating or stable, depending on the element	depending on the element	depending on the element

41

ES	D2C1	ABI	number of new NIS	-	-	-	improving in north ABI, unknown in the South ABI	Good in the north ABI, unknown in the south ABI	achieved in north ABI, unknown in the south ABI
ES	D2C1	AMA	number of new NIS	-	-	0	Stable / Yes	Good	GES achieved
ES	D2C1	MWE	number of new NIS	-	-	2 in ESAL, 8 in LEV	deteriorating or unknow, depending on the local region	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
ES	D2C2	ABI	distribution / abundance	N/A	N/A	-	Unknown / not assessed	Not assessed	unknown
ES	D2C2	AMA	distribution / abundance	N/A	N/A	-	Unknown / not assessed	Not assessed	unknown
ES	D2C2	MWE	distribution / abundance	N/A	N/A	-	improving, deteriorating or unknown, depending on the local region	Good, not good or not assessed, depending on the local region	GES expected to be achieved later than 2020, no Article 14 exception reported
FI	D2C1	BAL (regional)	number of new NIS	0	HELCOM	0	improving / YES	Good	GES achieved
FI	D2C2	BAL	abundance	N/A	N/A	-	Unknown / YES	Good	GES achieved
FR	D2C1	ABI	number of new NIS	-	-	22	Unknown	Unknown	Unknown
FR	D2C1	ACS	number of new NIS	-	-	7	Unknown	Unknown	Unknown
FR	D2C1	ANS	number of new NIS	-	-	8	Unknown	Unknown	Unknown
FR	D2C1	MWE	number of new NIS	-	-	11	Unknown	Unknown	Unknown
HR	D2C1	MAD	number of new NIS	-	-	16	Unknown	Unknown	Unknown
IE	D2C1	ACS	new NIS and the number of locations found	-	-	depending on species and number of locations found	Unknown / Unknown	Good	GES achieved
IT	D2C1	MAD	number of new NIS	-	-	14.0	Unknown / not assessed	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
IT	D2C1	MIC	number of new NIS	-	-	7.0	Unknown / not assessed	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
IT	D2C1	MWE	number of new NIS	-	-	6.0	Unknown / not assessed	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
LT	D2C1	BAL (regional)	number of new NIS	0?		0	Stable / YES	Good	GES achieved

LT	D2C2	BAL	Species abundance and distribution in space	N/A	N/A	2000.0	Deteriorating /NO	Not good	GES expected to be achieved later than 2020, Article 14 exception reported
LT	D2C3	BAL	BPL index		National	4.0	Deteriorating /NO	Not good	GES expected to be achieved later than 2020, Article 14 exception reported
LV	D2C1	BAL	number of new NIS	0?	HELCOM	2	Unknown / NO	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
MT	D2C1	MIC	number of new NIS	-	-	40	Unknown / NO	Not good	GES expected to be achieved later than 2020, Article 14 exception reported
NL	D2C1	ANS	number of new NIS	8	National; ANSNL-OSPAR-D2C1-exoten2017	1	Unknown / YES	Good	GES achieved
PL	D2C1	BAL	number of new NIS	0	HELCOM	depending on the local area	Unknown / NO or YES depending on the local area	Good or Not good, depending on the local area	GES achieved or GES expected to be achieved by 2020, depending on the local area
PL	D2C2	BAL	changes in the number of established NIS	N/A	N/A	-	Unknown / not assessed	Not assessed	GES achieved or GES expected to be achieved by 2020, depending on the local area
PT	D2C1	ABI	number of new NIS	15.00	-	depending on the local area	Unknown / Unknown	Good to all local areas	GES achieved to all local areas
PT	D2C1	AMA	number of new NIS	-	-	None / 20.00; depending on the local area	Unknown / Unknown	Unknown / Good, based on low risk; depending on the local area	Unknown / GES achieved; depending on the local area
PT	D2C2	ABI	status of population	N/A	N/A	None	Unknown / Unknown	Not assessed	Not assessed
PT	D2C2	AMA	status of population	N/A	N/A	None	Unknown / Unknown	Unknown	Unknown
PT	D2C3	ABI		-	-	None	None / None	Not assessed	Not assessed
RO	D2C1	BLK	number of new NIS	-	-	depending on the local area	Unknown / NO	Not good	Not assessed
RO	D2C2	BLK	average biomass/water of Mnemiopsis leidyi	N/A	N/A	depending on the local area	Unknown / YES	Good or Not good, depending on the local area	Not assessed
SE	D2C1	ANS	number of new NIS	0?	national, based on HELCOM	5	Not relevant / NO	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported
SE	D2C1	BAL	number of new NIS	0?	national, based on HELCOM	5	Not relevant / NO	Not good	GES expected to be achieved later than 2020, no Article 14 exception reported

SI	D2C1	MAD	-	-	-	-	Deteriorating / NO	Not good	Not assessed

Annex 3. Missing elements (new non indigenous species) from the reporting information of the Member States per MSFD subregion and country, for criterion D2C1. Date of first observation, pathway of introduction and related sources are also provided. TS=transport-stowaway; RN=release in nature; COR=corridor; EC=escape from confinement; TC=transport-contaminant. More information is provided on request on JRC-EASIN@ec.europa.eu.

MSs	Sub-region	Element	Date	Pathway	Sources
BE	ANS	*Pseudodiaptomus marinus*	2015	TS: ballast water	Deschutter et al., 2018
DE	ANS	*Ceramium circinatum*	2015	Unknown	Aquanis // Nestler 2017.
DE	BAL	*Evadne anonyx*	2014	TS: ballast water// Unaided	Aquanis // Wasmund et al. 2015
DE	BAL	*Haminoea solitaria*	2016	Unknown	HELCOM 2017 Wranik & Malaquias 2018
DE	BAL	*Homarus americanus*	2014	RN: fishery	Aquanis // Rabitsch, et al. submitted
DE	ANS	*Obesogammarus crassus*	2016	COR	Aquanis
DE	ANS	*Pileolaria militaris*	2012	Unaided	Aquanis // Kuhlenkamp & Kind pers. comm. Rabitsch & Nehring 2017
DE	BAL	*Potamothrix bavaricus*	2015	Unknown	Aquanis
DE	BAL	*Rangia cuneata*	2014	Unaided	Aquanis // Wiese et al. 2016
DE	ANS	*Ruditapes philippinarum*	2016	Unaided	Aquanis
DE	ANS	*Watersipora subatra ex W.subtorquata*	2012	Unaided	Aquanis // Kuhlenkamp & Kind 2013
DE	BAL	*Blackfordia virginica*	2014	TS: hull fouling	Aquanis // Jaspers et al. 2018
DE	BAL	*Garveia franciscana*	2014	Unknown	Aquanis // Bock & Lieberum 2016 // HELCOM 2017
DK	BAL	*Acipenser gueldenstaedtii*	2013	EC: aquaculture	ICES 2014
DK	ANS	*Beroe ovata*	2013	not menioned	ICES 2015
DK	ANS	*Bonamia ostreae*	2014	TC: parasites on animals	ICES 2016
ES	MWE	*Aplus assimilis*	2014	not menioned	López Soriano & Quiñonero Salgado 2014
ES	MWE	*Arcuatula senhousia*	2014	not menioned	López Soriano & Quiñonero Salgado 2014
ES	MWE	*Ascidiella aspersa*	2015	not menioned	Gonzalez Carrión 2015

ES	MWE	*Balistoides conspicillum*	2012	EC: aquarium// TS: ballast water	Weitzmann et al. 2015
ES	ABI	*Callinectes exasperatus*	2013	TS: ballast water	Cuesta et al. 2015
ES	MWE	*Celleporaria brunnea*	2016	TS: hull fouling	Ulman et al. 2017
ES	AMA	*Chiton cumingsii*	2012	TS: hull fouling	ARIAS & ANADÓN 2013
ES	MWE	*Crepidula fornicata*	2014	not menioned	López Soriano & Quiñonero Salgado 2014
ES	MWE	*Crepipatella dilatata*	2014	not menioned	López Soriano & Quiñonero Salgado 2014
ES	MWE	*Didemnum vexillum*	2012	not menioned	Ordonez et al. 2015
ES	MWE	*Haplosporidium pinnae*	2016	Unknown	Catanese et al. 2018
ES	MWE	*Hydroides brachyacantha*	2016	TS: hull fouling	Ulman et al. 2017
ES	MWE	*Mesanthura romulea*	2016	TS: hull fouling	Ulman et al. 2017
ES	ABI	*Mytilaster minimus*	2015	Unknown	Pejovic et al. 2015
ES	ABI	*Pachygrapsus gracilis*	2013	TS: ballast water// TS: hull fouling	Cuesta et al. 2015
ES	MWE	*Paranthura japonica*	2016	TS: hull fouling	Ulman et al. 2017
ES	ABI	*Pilumnopeus africanus*	2013	TC: on animals	Cuesta et al. 2015
ES	AMA	*Platyscelus armatus*	2012	Unknown	Mingorance et al. 2014
ES	MWE	*Tricellaria inopinata*	2016	TS: hull fouling	Ulman et al. 2017
ES	AMA	*Branchiomma bairdi*	2012	Unknown	Aquanis // ICES 2014
ES	ABI	*Caprella mutica*	2012	Unaided // TS: hull fouling// TS: fishing equip	Aquanis // Almón et al. 2014
ES	MWE	*Lagocephalus sceleratus*	2014	Unaided	Izquierdo-Muñoz & Izquierdo-Gomez 2014
FI	BAL	*Sinelobus stanfordi/Sinelobus vanhaareni*	2016	TS: ballast water	WGITMO 2018
FR	MWE	*Caprella scaura*	2014	Unknown	Marchini et al. 2015
FR	MWE	*Chelidonura fulvipunctata*	2014	not menioned	Horst 2015
FR	MWE	*Paracerceis sculpta*	2014	Unknown	Marchini et al. 2015
FR	MWE	*Amphibalanus improvisus*	2015	not menioned	Ulman et al. 2017
FR	MWE	*Sacostrea glomerata*	2015	not menioned	Ulman et al. 2017
FR	MWE	*Tricellaria inopinata*	2015	not menioned	Ulman et al. 2017
FR	MWE	*Diplosoma listerianum*	2016	not menioned	Ulman 2016

FR	MWE	*Watersipora arcuata*	2016	Unknown	Ulman et al. 2017
FR	MWE	*Godiva quadricolor*	2017	Unknown	Crocetta & Malegue in Gerovasileiou et al. 2017
FR	MWE	*Percnon gibbesi*	2014	Unknown	Aquanis
FR	ABI	*Stephos marsalensis*	2014	TS: ballast water	Brylinski & Courcot 2019
FR	ABI	*Boccardia proboscidea*	2013	Unknown	Spilmont et al. 2016
FR		*Chrysymenia wrightii*	2013	Unknown	Aquanis
FR	MWE	*Lyrodus pedicellatus*	2014	Unknown	Aquanis
FR	ABI	*Neomysis americana*	2017	TS: ballast water	Massé et al. 2018
FR	ABI	*Pachymeniopsis lanceolata*	2016	TS: hull fouling	Le Roux 2018
FR	ABI	*Rangia cuneata*	2017	Unknown	Kerckhof et al. 2018
FR	MWE	*Rapana venosa*	2015	Unknown	Aquanis
HR	MAD	*Chaetoceros pseudosymmetricus*	2015	COR	Čalić et al. 2017
HR	MAD	*Echinolittorina punctata*	2014	Unaided	Milat et al. 2016
HR	MAD	*Neanthes agulhana*	2014	Unknown	Spagnolo et al. 2017
HR	MAD	*Pileolaria berkeleyana*	2014	TS: hull fouling	Spagnolo et al. 2017
HR	MAD	*Ruditapes philippinarum*	2013	Unaided // TS: ballast water	Nerlovic et al. 2016
HR	MAD	*Spirorbis marioni*	2014	Unknown	Spagnolo et al. 2017
HR	MAD	*Styela plicata*	2014	TS: hull fouling	Marić et al. 2016
IE	ACS	*Botryllus schlosseri*	>2012?	TS: hull fouling	GBIF
IE	ACS	*Bugulina fulva*	2012	TS: hull fouling	Aquanis
IT	MAD	*Aglaothamnion halliae*	2016	TC: on animals	Servello et al. 2019
IT	MAD	*Aurelia solida*	2015	TS: ballast water// Unaided	Scorrano et al. 2016
IT	MAD	*Bispira polyomma*	2014	Unknown	Aquanis
IT	MAD	*Botrylloides diegensis*	2015	TC: on animals	Aquanis
IT	MAD	*Branchiomma bairdi*	2012	TS: ballast water// TS: hull fouling	Arias et al. 2013
IT	MAD	*Branchiomma boholense*	2012	Unaided	Servello et al. 2019
IT	MAD	*Didemnum vexillum*	2012	TS: hull fouling// TC: on animals	Servello et al. 2019

IT	MAD	*Euthymonacha polita*	2013	Unaided // TS: ballast water	Servello et al. 2019
IT	MAD	*Grandidierella japonica*	2015	TS: hull fouling// TC: on animals	Munari et al. 2016
IT	MAD	*Lagocephalus sceleratus*	2013	Unaided	Aquanis
IT	MAD	*Loxostomina costulata*	2013	Unaided // TS: ballast water	Servello et al. 2019
IT	MAD	*Mawia benovici*	2013	TS: ballast water	Piraino et al. 2014
IT	MAD	*Melanothamnus japonicus*	2016	TC: on animals	Servello et al. 2019
IT	MAD	*Mnemiopsis leidyi*	2016	Unaided	Servello et al. 2019
IT	MAD	*Nereis jacksoni*	2015	Unknown	Servello et al. 2019
IT	MAD	*Oithona davisae*	2014	TS: ballast water	Servello et al. 2019
IT	MAD	*Oplegnathus fasciatus*	2015	EC: aquarium// TS: ballast water	Ciriaco & Lipej 2015
IT	MAD	*Palaemon macrodactylus*	2012-13	TS: ballast water	Aquanis
IT	MAD	*Parametopella cypris*	2014	TS: hull fouling// TS: ballast water	Aquanis
IT	MAD	*Paramphitrite birulai*	2013	Unknown	Loia et al. 2017
IT	MAD	*Penaeus aztecus*	2016	Unaided // TS: ballast water	Servello et al. 2019
IT	MAD	*Pinctada imbricata radiata*	2012	Unaided	Servello et al. 2019
IT	MAD	*Polysiphonia schneideri*	2016	TS: hull fouling	Servello et al. 2019
IT	MAD	*Pyropia suborbiculata*	2014	TS: hull fouling// TC: on animals	Servello et al. 2019
IT	MAD	*Spiroloculina antillarum*	2013	Unaided // TS: ballast water	Servello et al. 2019
IT	MIC	*Achelia sawayai*	2016	Unknown	Ulman et al. 2017
IT	MIC	*Aurelia solida*	2015	TS: ballast water// Unaided	Servello et al. 2019
IT	MIC	*Biuve fulvipunctata*	2015	Unaided // TS: ballast water	Malaquias et al. 2016
IT	MIC	*Branchiomma bairdi*	2016	TS: hull fouling	Aquanis
IT	MIC	*Cassiopea andromeda*	2014	TS: hull fouling// TS: ballast water// Unaided	Servello et al. 2019
IT	MIC	*Chlorurus rhakoura*	2017	TS: ballast water// TS: hull fouling	Insacco & Zava 2017
IT	MIC	*Chondria curvilineata*	2015	TS: hull fouling	Servello et al. 2019
IT	MIC	*Dasysiphonia japonica*	2014	TC: on animals	Aquanis
IT	MIC	*Dermatobranchus rubidus*	2014	TS: ballast water// TS: hull fouling	Colucci et al. 2015

IT	MIC	*Erugosquilla massavensis*	2017	Unaided // TS: ballast water	Servello et al. 2019
IT	MIC	*Godiva quadricolor*	2016	TS: hull fouling// TS: ballast water	Servello et al. 2019
IT	MIC	*Hemiramphus far*	2013	Unaided	Falautano et al. 2014
IT	MIC	*Lagocephalus sceleratus*	2013	Unaided	aquanis // Azzurro et al. 2014
IT	MIC	*Lottia sp.*	2015	TS: hull fouling// TS: ballast water	Scuderi & Eernisse 2016
IT	MIC	*Oithona davisae*	2014	TS: ballast water// TC: on animals	Servello et al. 2019
IT	MIC	*Ophioblennius atlanticus*	2017	TS: hull fouling// TS: ballast water	Azzurro et al. 2018
IT	MIC	*Paradella dianae*	2016	TS: hull fouling	Aquanis
IT	MIC	*Paranthura japonica*	2013	TC: on animals	Lorenti et al. 2016
IT	MIC	*Parasmittina egyptiaca*	2016	TS: hull fouling	Servello et al. 2019
IT	MIC	*Penaeus aztecus*	2014	TC: on animals // TS: ballast water// Unaided	Arnesano et al. 2015 // Scannella et al. 2016
IT	MIC	*Peneroplis arietinus*	2017	Unknown	Aquanis
IT	MIC	*Perophora multiclathrata*	2013	TS: hull fouling	Servello et al. 2019
IT	MIC	*Polycera hedgpethi*	2012	TS: hull fouling// TS: ballast water	Servello et al. 2019
IT	MIC	*Polysiphonia morrowii*	2012	TC: on animals	Servello et al. 2019
IT	MIC	*Pseudonereis anomala*	2013	Unaided // TS: ballast water	D'Alessandro et al. 2016
IT	MIC	*Pterois miles*	2015	Unaided	Azzurro et al. 2017
IT	MIC	*Rhopilema nomadica*	2015	Unaided	Balistreri & Ghelia 2015
IT	MIC	*Sciaenops ocellatus*	2016	Unknown	Servello et al. 2019
IT	MIC	*Siganus rivulatus*	2015	Unaided	Karachle et al. 2016
IT	MIC	*Smittina nitidissima*	2014	Unaided	Servello et al. 2019
IT	MIC	*Spirobranchus tetraceros*	2016	TS: hull fouling// TC: on animals// TS: ballast water	Servello et al. 2019
IT	MIC	*Stenothoe georgiana*	2016	TS: hull fouling// TC: on animals	Servello et al. 2019
IT	MIC	*Symplegma brakenhielmi*	2016	TC: on animals // TS: hull fouling// TS: ballast water	Aquanis
IT	MIC	*Trachysalambria palaestinensis*	2016	Unaided // TS: ballast water	Servello et al. 2019
IT	MIC	*Upeneus pori*	2017	Unaided	Servello et al. 2019
IT	MIC	*Watersipora arcuata*	2013	TS: hull fouling	Servello et al. 2019

IT	MWE	*Acanthurus chirurgus*	2012	EC: aquarium// TS: ballast water	Langeneck et al. 2015
IT	MWE	*Amphistegina cf. papillosa*	2017	Unaided // TS: ballast water	Servello et al. 2019
IT	MWE	*Amphistegina lessonii*	2017	Unaided // TS: ballast water// TC: on animals	Servello et al. 2019
IT	MWE	*Amphistegina lobifera*	2017	Unaided // TS: ballast water// TC: on animals	Servello et al. 2019
IT	MWE	*Branchiomma bairdi*	2015	TS: hull fouling	Aquanis
IT	MWE	*Cassiopea andromeda*	2014	TS: hull fouling// TS: ballast water// Unaided	Servello et al. 2019
IT	MWE	*Caulerpa taxifolia var. distichophylla*	2012	EC: aquarium// TS: hull fouling	Musco et al. 2014
IT	MWE	*Chaetodon auriga*	2015	EC: aquarium	Servello et al. 2019
IT	MWE	*Chaetozone corona*	2016	TS: ballast water	Servello et al. 2019
IT	MWE	*Charybdis (Charybdis) feriata*	2015	TS: hull fouling// TS: ballast water// TS: Hitchhikers on ship/boat	Karachle et al. 2016
IT	MWE	*Coscinospira arietina*	2017	Unaided // TS: ballast water	Servello et al. 2019
IT	MWE	*Grandidierella japonica*	2013	TS: hull fouling// TC: on animals	Marchini et al. 2016
IT	MWE	*Lagocephalus sceleratus*	2016	Unaided	Aquanis
IT	MWE	*Lutjanus sebae*	2016	Unknown	Servello et al. 2019
IT	MWE	*Mitrella psilla*	2016	TS: hull fouling// TS: ballast water	Aquanis
IT	MWE	*Oithona davisae*	2014	TC: on animals	Aquanis
IT	MWE	*Penaeus aztecus*	2014	TC: on animals // TS: ballast water	Cruscanti et al. 2015
IT	MWE	*Rhithropanopeus harrisii*	2013	TS: hull fouling// TS: ballast water// TS: Hitchhikers on ship/boat	Servello et al. 2019
IT	MWE	*Rhopilema nomadica*	2015	Unaided	Aquanis
IT	MWE	*Stenothoe georgiana*	2013	TS: hull fouling// TC: on animals	Servello et al. 2019
IT	MWE	*Syllis pectinans*	2013	Unknown	Servello et al. 2019
IT	MWE	*Symplegma brakenhielmi*	2014	TS: hull fouling	Aquanis
IT	MWE	*Watersipora arcuata*	2013	TS: hull fouling	Ferrario et al. 2015
IT	MWE	*Zebrasoma xanthurum*	2015	EC: aquarium// TS: ballast water	Guidetti et al. 2016
LV	BAL	*Rhithropanopeus harrisii*	2013	TS: ballast water// Unaided	WGITMO 2018, AQUANIS
LV	BAL	*Dikerogammarus villosus*	2015	Unknown	Aquanis
LV	BAL	*Boccardiella ligerica*	2014	Unknown	Aquanis

LV	BAL	*Mytilopsis leucophaeata*	2015	Unknown	Aquanis
MT	MIC	*Holacanthus africanus*	2017	TS: Other means of transport // EC: aquarium	Deidun et al. 2017
MT	MIC	*Holocentrus adscensionis*	2016	TS: ballast water	Vella et al. 2016
MT	MIC	*Phyllorhiza punctata*	2016	Unaided // TS: ballast water// TS: hull fouling	Deidun et al. 2017
NL	ANS	*Eusarsiella zostericola*	2012	TC: on animals // Unaided	Faasse et al. 2013
NL	ANS	*Ammothea hilgendorfi*	2013	TS: hull fouling// TS: ballast water	Faasse et al. 2013
NL	ANS	*Boccardia proboscidea*	2013	TC: on animals // TS: hull fouling// TS: ballast water	Kerckof & Faase 2014
NL	ANS	*Boccardiella hamata*	2013	TC: on animals // TS: hull fouling// TS: ballast water	Kerckhof & Faasse 2014
NL	ANS	*Ampithoe valida*	2014	TS: hull fouling	Faase 2015
NL	ANS	*Blackfordia virginica*	2014	TS: ballast water	Faasse & Melchers 2014
NL	ANS	*Cephalothrix simula*	2012	Unknown	Faasse & Turbeville 2015
NL	ANS	*Mulinia lateralis*	2017	TS: ballast water	Craeymeersch et al. 2019
NL	ANS	*Biflustra grandicella*	2016	Unknown	De Blauwe 2017
NL	ANS	*Gobiosoma bosc*	2017	Unknown	Aquanis // Gittenberger et al. 2017
NL	ANS	*Tridentiger barbatus*	2016	Unknown	Aquanis // Gittenberger et al. 2017
PL	BAL	*Laonome sp.*	2015	Unknown	Bick et al. 2017
PL	BAL	*Sinelobus vanhaareni*	2014	Unknown	Brzana et al. 2019 // Bamber 2014
PT	AMA	*Branchiomma bairdi*	2013	TS: ballast water/ TS: hull fouling/ TS: Hitchhikers on ship/boat	Aquanis
PT	AMA	*Bugulina simplex*	2013	TS: hull fouling	Aquanis
PT	ABI	*Mnemiopsis leidyi*	2017	?	WGITMO 2018
PT	ABI	*Tenellia adspersa*	2016	Unknown	Aquanis // ICES 2017
SI	MAD	*Amathia verticillata*	2013-2016	TS: hull fouling	Trkov et al. 2017
SI	MAD	*Amphibalanus amphitrite*	2012-2015?	TS: ballast water	Flander-Putrle et al. 2016
SI	MAD	*Brachidontes pharaonis*	2012	TS: ballast water/ TS: hull fouling	Crocettta et al in Lipej et al. 2018
SI	MAD	*Chrysiptera cyanea*	2013	EC: aquarium	Lipej et al. 2014
SI	MAD	*Haminoea japonica*	2013-2016	TS: hull fouling	Trkov et al. 2017

SI	MAD	*Melibe viridis*	2016	TS: ballast water// Unaided	Lipej & Mavric 2017
SI	MAD	*Monocorophium sextonae*	2012-2015?	TS: ballast water	Flander-Putrle et al. 2016
SI	MAD	*Polycera hedgpethi*	2015	TS: hull fouling / TC: on animals	Lipej & Trkov 2016 in DAILIANIS et al. 2016
SI	MAD	*Polycerella emertoni*	2013-2016	TS: hull fouling	Trkov et al. 2017
SI	MAD	*Pseudodiaptomus marinus*	2015	TS: ballast water	Lučić et al. 2015
SI	MAD	*Stephanolepis diaspros*	2013	Unaided	Lipej et al. 2014 in Kapiris et al. 2014
SI	MAD	*Styela plicata*	2014	TS: hull fouling	Spagnolo et al. 2017

The European Commission's science and knowledge service
Joint Research Centre

JRC Mission
As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.

EU Science Hub
ec.europa.eu/jrc

@EU_ScienceHub

EU Science Hub - Joint Research Centre

EU Science, Research and Innovation

EU Science Hub

Publications Office
of the European Union