OSPAR CEMP Guidelines

Common Indicator: Changes to non-indigenous species communities (NIS3)

(OSPAR Agreement 2018-04)[1] [2]

This OSPAR biodiversity indicator is still in the early stages of implementation and as a result of iteration and learning, it is anticipated that there will be evolution of the methods and approaches documented in the CEMP guidelines. Version updates will be clearly indicated and be managed in a phased approach via ICG-COBAM through its expert groups and with the oversight and steer of BDC.

Contents

[1] This document exists in English only

[2] Update 2022

1 Introduction

Non-Indigenous Species (NIS) are organisms that have been introduced outside of their natural range as a result of human-mediated activities (e.g., shipping, aquaculture, recreational boating). Invasive NIS are a subset of established NIS which have spread, are spreading or have demonstrated their potential to spread elsewhere, and have an adverse effect on biological diversity, ecosystem functioning, socio-economic values and/or human health in invaded regions. Marine NIS had been overlooked for decades but, during the 20th century, their broad ecological, economical and societal impacts had started to be well documented (Ojaveer et al. 2018). NIS can threaten the balance of a local or regional ecosystem, and can reduce abundance or even displace indigenous species (Galil 2007). This can occur through competition for food, space and resources (Stæhr et al. 2000), by predation or the introduction of disease, although the direct causality is often uncertain (Didham et al. 2005). On a global scale, human-mediated introductions are responsible for biotic homogenization. Consequently, NIS are one of the five drivers of biodiversity changes at a worldwide scale (Diaz et al. 2019), including in marine European Seas (IPBES 2019). Globally, invasive NIS are considered one of the most important threats to biodiversity after habitat loss. In recognition of this NIS are one of the pressures on the marine environment being addressed under the Marine Strategy Framework Directive (MSFD), where descriptor 2 states that 'NIS introduced as a result of human activities are at levels that do not adversely alter the ecosystem'.

Preventing the introduction of NIS is currently considered the only feasible management option in the marine environment (Lehtiniemi et al 2015). This is a result of limited practical and cost-effective means of eradicating or controlling NIS in the marine environment, as shown by the very limited number of successful eradication attempts (Ojaveer et al. 2015). Efforts under the MSFD are therefore focused on limiting the environmental pressure of NIS by reducing the rate of their introduction and spread by managing pathways through which NIS move. A similar approach is also the main driver behind the alien species regulations (EC regulations 1143/2014).

2 Assessment criteria

2.1 indicators and parameters

The indicator presented within this document takes a pragmatic approach to assessing changes to the community of NIS within the OSPAR marine region. The EU MSFD aims to link a programme of measures to reduce human pressures on the marine environment, in this case, the introduction and spread of NIS, and a monitoring programme implemented with the view of determining the effectiveness of the programme of measures. The indicator examines one parameter (P1) described below:

The "New Introductions" parameter (P1): Quantifies new NIS records in the assessment area during the assessment period. It is a measure of the number of NIS identified and reported for the first time in the assessment area (i.e. not previously present) during the assessment period. Relative change in this parameter, over subsequent assessment periods, facilitates assessment of this pressure on the marine environment and may be used to evaluate the effectiveness of measures aimed at preventing or reducing the introduction of NIS and their spread across areas. The first criterion (D2C1) of the EU Commission Decision on Good Environmental Status (GES; 2017/848/UE) with respect to NIS, basically concerns an assessment of changes in the total number of new NIS between 6-year reporting periods. This OSPAR NIS common indicator has been developed to be aligned to that approach, to allow Contracting Parties that are also EU Member States to use the results for EU MSFD reporting if they choose to do so. Given that a quantitative threshold for the NIS indicator has not yet been agreed upon, the indicator assessment is made through analysis of trends in New NIS arrivals using the P1 – New introductions formulation. In

addition to a simple comparison of the sum of new NIS arrivals between periods, the mean annual rate of introductions is calculated (i.e. # NIS/year), by dividing NIS sum with 6 years (length of the reporting periods). For comparison, the annual rate of introductions was also determined as the slope of accumulated NIS for each 6-year period, calculated by simple linear regression analysis.

OSPAR Regions are used as the assessment area units for the indicator for OSPAR purposes. To ensure those Contracting Parties that are also EU Member States which would like to use the regional indicator results for EU MSFD Article 8 reporting, the indicator also calculated results for assessment area units using the national Exclusive Economic Zones as the boundaries to align with EU MSFD assessment guidance (GES; 2017/848/UE).

With the further development of monitoring programmes and the gathering of more robust data, assessments, using the other parameters (P2-P4) will hopefully be made feasible. Contracting Parties are currently using a variety of monitoring approaches, with many observations provided through academic surveys and from citizen science. While such information is definitely useful, data currently only fulfills the minimum requirement for information with regard to new NIS introductions, while still enabling comparable assessment of EU MSFD D2C1.

For future development, additional parameters for assessing the NIS need to be developed such as populations parameters (spatial distribution, abundances and demography), and its effects on the ecosystem. These are also requested in the EU MSFD context as secondary NIS criteria D2C2 (Spread of NIS) and D2C3 (NIS impact) where and when the first criterion is not met. The following parameters could be considered and developed as candidate indicators in OSPAR in the future;

The "Total NIS abundance" parameter (P2): Quantifies for each assessment area, the change in the total observed number of NIS (not the number of individuals) between assessment periods. This parameter provides insight into the persistence and stability of NIS assemblages in each assessment area. In addition, it facilitates the evaluation of eradication measures, undertaken where appropriate. Ecosystems that are colonized by NIS often suffer from other human pressures and activities that can cause decline in native species. Ideally P2 should therefore be standardized by the number of total species present or should be established based on a ratio of NIS/native species to express the overall contribution of NIS to the local community

The "Dispersal range" parameter (P3): Quantifies the relative change in the number of discrete locations a species is found within the assessment area between assessment periods. Comparison of P3 scores between assessment periods can facilitate the assessment of speed of spread and the potential effectiveness of management including attempts of local eradication. Calculation of a mean P3 score, in addition to the assessment of P3 scores for individual species, provides an overall indication of how species distributions are changing. To reduce the effect of sampling effort, P3 should optimally be standardized with uncertainties on the number, location and dates of stations sampled for each assessment period. This parameter makes sense if the same area is always monitored, and that both presence and absence of the NIS is reported.

The "Dispersal rate" parameter (P4): Based on geo-referenced observations of first NIS observations in each country, it is possible to track the spread of individual species, and calculate their rate of dispersal (whatever the means, natural or human-mediated, from which this dispersal originates)

The parameters P2-P4 require regular standardized monitoring, and for the assessment of NIS impact - intimate knowledge of their interactions with the local ecosystems. Such knowledge is generally unavailable, is very sparse or very difficult to demonstrate without significant investment, furthermore at wide regional

sea scales. In addition, the likelihood of reducing the impact of NIS once there are established through a programme of measures is considered low (Ojaveer et al. 2015, Simberloff et al. 2013).

Given availability of suitable data, the set of P1-P4 parameters would provide a means of determining the effectiveness of a programme of measures aimed at reducing the number of NIS being introduced, becoming established and spreading. Table 1 provides a summary of the parameters.

Table 1. Parameter summary, where t refers to the assessment period, M refers to total monitoring locations, M_s refers to monitoring locations where species is present, ΔD is the distance (km) between two locations where species had been observed during the time span (Δt; years) between these observations. If more than two observations for a NIS are recorded, then the average dispersal rate is reported.

Parameter	Description	Formula
P1 - New Introductions	Number of new introductions within assessment area and assessment period	$\sum new\ NIS\ introductions$
P2 - Total NIS	Change in total number of observed NIS between assessment periods	$\sum NIS_{t-1} - \sum NIS_t$
P3 - Dispersal range	Relative change in the proportion of monitoring locations within which the species is found	$\left(\frac{M_s}{M}\right)_{t-1} - \left(\frac{M_s}{M}\right)_t$
P4 - Dispersal rate	Rate of dispersal (km per year) for specific NIS	$\frac{\Delta D}{\Delta t}$

2.2 Assessment outputs / results

The following outputs were included in the NIS trend assessment:

- A map showing the location of observations provided by each country
- A histogram of the number of new NIS records per Contracting Parties (CP) for each reporting period
- A histogram of the total number of new records of NIS per OSPAR region for three successive periods
- A Venn diagram to visualize the overlap in NIS between three regions during the 2003-2020 period
- Maps of the number of new NIS records (2015-2020) per CP and OSPAR region
- Changes in the annual new NIS records and trends in cumulative NIS number analysed with linear regression analysis
- The annual rate of NIS introduction for each of the three reporting periods for each OSPAR region, visualized using Box plots and supported by an analysis of variance (two-way ANOVA with pairwise comparison)

3 Monitoring requirements

3.1 Purpose

The assessment of new introductions of NIS is conducted from a baseline of those NIS present at the reference year, within the assessment area. In order to implement this indicator, three minimum requirements need to be met:

1. Species taxonomic categories to be considered
2. NIS baseline (and reference year)
3. Monitoring programmes able to detect established and introduced NIS

In order to implement the new introductions indicator, a list of NIS already present within the marine waters of Contracting Parties needs to be drawn. MSFD European Union Member States reports, published and grey literature, historical database entries and data from baseline monitoring for NIS, prior to the first assessment period, contributed to this list. With each new assessment period, introductions from the previous assessment period are added in order to create a 'live' baseline. In this context, it is important to note the important time lag between observations made in the field and their publication, which in addition varies across taxonomic groups (e.g., Zenetos et al., 2019).

Monitoring capable of detecting newly introduced NIS, as well as those already present, is required to quantify the number of new NIS introductions, assess NIS community abundance and determine the spread. The indicator does not specify methods to be used for monitoring. However, it is worth noting that monitoring in high-risk locations such as ports, marinas or aquaculture facilities will enhance detection of new NIS introductions, and facilitate early-detection, and therefore may provide more accurate data on which to base the assessment of an indicator. The minimum requirement for monitoring is the identification, recording and collation of data on new NIS introductions (date, lat & long data (or name of a place), type of habitat, species).

Quantification of monitoring effort is valuable for the interpretation of indicator assessment outcomes. For example, a relative increase in new NIS introductions may be an artifact of increased total monitoring effort or increased monitoring effort in high-risk locations, rather than an increase in NIS introductions. Considering that biodiversity changes are a response not only to NIS but also other drivers (e.g., pollution, climate change, natural resources uses, marine urbanization etc.), to properly interpreting P2 would require to standardize the number of NIS by the total number of species, to determine the relative contribution of NIS to the community. Similarly, for P3, ideally the same area should be monitored over time and presence-absence of the NIS reported, so that NIS expansion can be reliably assessed. Synergy and transparency between Contracting Parties with respect to monitoring effort, collection of data and reporting of data is recommended to aid quantification of effort and interpretation of indicator assessments.

Though, not an explicit requirement of the new introductions indicator, the use of a species priority list may aid monitoring for new NIS introductions. A priority species list would comprise high-risk species associated with key introduction pathways i.e., shipping, recreational boating, aquaculture. An additional criterion might be the likelihood to accurately identify the NIS (and/or to set-up adequate method for identifying it). It should also include species already reported in neighboring regions, seas or states but not yet in the targeted area. Rather than attempting to identify and report on all NIS, focusing on a specific set of species by region or division, may facilitate the acquisition of more accurate data on those species. Therefore, a species list may provide a balanced approach to NIS monitoring in a climate with limited resources.

While currently there is limited monitoring for NIS in the marine environment, this is under development in many of the Contracting Parties, allowing for a more robust and in-depth assessments to be conducted in the near future. Furthermore, with increased regional co-ordination of monitoring and data management, assessments will become more standardised with less need for interpretation of results.

3.2 Quantitative Objectives

Overall, the new introductions indicator depends on a baseline survey of NIS in the assessment area which aims to detect the presence of NIS. By comparing the change in numbers of new NIS introductions recorded over the assessment period a rate of introduction can be calculated. In addition to assessing the rate of introduction, the total NIS composition is determined to assess monitoring, control and eradication effectiveness. This will provide a more detailed assessment of the data highlighting possible pathways of concern or monitoring anomalies. Also, by comparing several monitoring stations within the assessment area, information about the secondary spread of NIS will be collected, which is a very valuable information regarding the connectivity of the different marine areas within and across OSPAR Regions.

Specific values are needed to assess whether a new introductions threshold is met or not. For some indicators, explicit quantitative thresholds can be easily set. However, in the absence of detailed information regarding the current status of NIS, determination of a quantitative threshold in relation to NIS is problematic. This again relates to the rather preliminary stage of NIS monitoring applied within OSPAR. Thus, setting regional threshold values for NIS on new introductions is challenging and complex and was discussed through NIS-EG (BDC 19/6/Info05) and is currently a topic of debate and investigation within the RSCs.

The threshold for this OSPAR common indicator on new introductions of NIS is described as a 'reduction in the rate of introduction and spread of NIS', which should be standardized by the monitoring effort as pointed in the previous section. Given that a NIS new introductions quantitative threshold value is currently not defined at the OSPAR regional sea level, Contracting Parties may choose to adopt their own quantitative threshold. D2C1 thresholds based on analysis of trends in new NIS arrivals are currently being investigated. The thresholds under investigation is a percent reduction in new NIS arrivals (e.g. 50%) either compared to the previous 6-year cycle, or an average of the three cycles (2003-2020).

3.3 Monitoring Strategy

A baseline assessment of the number of new NIS listed within the assessment area, will provide a reference point against which the success of a programme of measures can be estimated. Data from a range of sources (e.g., research and development projects, implementation of the Ballast Water Management Convention Risk Assessments, other risk assessment processes) and from dedicated monitoring should be used to develop a distribution list of NIS for use as a baseline. From this baseline, any further introductions, changes in community and spread of NIS will be considered.

It is impossible at this point in time to specify exact monitoring requirements for this indicator, but rather this indicator provides a framework of common ground on which to build more detailed requirements, while recognising and accommodating the range of monitoring efforts that are likely to be applied by Contracting Parties. There are several methods that can therefore be adopted and be applicable to this indicator, such as, a dedicated NIS monitoring programme, a risk-based approach (focusing on high-risk locations only), or the use of existing monitoring programmes that have been modified to facilitate detection of NIS. It is, however, imperative that locations at high-risk from the introduction of NIS (i.e., the so-called introduction hotspots concentrating introduction vectors and pathways) are monitored.

Certain elements of the indicator are deliberately open to interpretation to allow Contracting Parties to adapt them to their needs and current situation (e.g., monitoring methods and species to be monitored). The

indicator provides a framework to ensure that there is a common basis for a regional approach to assessing descriptor 2 of the MSFD, ensuring a degree of comparability between Contracting Parties and Regions.

3.4 Sampling strategies/protocols

As with the monitoring strategy, it is not possible to specify the sampling strategy for this indicator at this point in time. Currently, all sampling strategies suitable for the detection of marine NIS should be utilised.

Ideally monitoring should focus on points at high-risk of introduction where are the main introduction and spreading vectors (i.e., in harbours, marinas and aquaculture sites). Focusing monitoring at these locations will optimise the potential for timely detection of new introductions allowing for a rapid response to their introduction. Also, at this time, any tools and methods used to report accurately NIS presence should be utilized (including for instance Rapid Assessment Surveys, full inventories, use of DNA-based approach such as environmental DNA/metabarcoding or barcoding). Moving forwards, we should attempt to standardise the monitoring strategies used across the region or at least, for determining trends more accurately, within region or Contracting Parties across assessment periods.

Monitoring programmes with the aim of providing the necessary information to assess the NIS pressure through a coherent and comprehensive overview, must integrate methodological criteria of good environmental status, as well as establish thresholds and targets for each region, which have to be defined and addressed in agreement with coordinated common monitoring programmes among CP.

A unique GES with different or similar threshold values according to the characteristics of each region is broadly plausible. Given increasing trans-boundary pressures, there is a need to harmonise both the monitoring methods, the list of species, through a set of testing monitoring hot-spots and protocols following the lead of the working groups of experts that will increase the interoperability of regions.

3.5 Quality assurance/Quality control (QA/QC)

Currently, there is no specific QA/QC process. In addition to the internal quality assurance/control provided by the Contracting Parties (CPs) we performed the following controls for the QSR2023 assessment:

1. Check format of date of first observation
2. Check format of lat long data
3. Merge data from all countries into a table with common column headings
4. Check taxonomic identification against WORMS
5. Assign information on higher taxonomic grouping
6. Check cryptogenic status. For NIS where CP's provided different information, relevant data bases (EASIN and AquaNIS) were consulted
7. Remove NIS species recommended not to be included in the NIS assessment. To align the assessment with criteria for NIS assessments decided under the MSFD NIS descriptor (D2), we adopted the following criteria for data selection (Table 1):

For taxonomic referential and coherence we acknowledge that several records have an approximate geographical reference, or an inexact period of time for the first record, e.g. before a specific year, or in a set of years. These records were accordingly assigned to a central geographical point in the referenced area, or to the most approximate period of time in accordance with the periods established for the assessment.

Table 1. Species groups to include or exclude in setting the percentage of reduction for newly introduced NIS (Tsiamis et al., 2021).

Species group	Exclude from threshold (yes/no/why)
Cryptogenic	yes (high uncertainty)
Cryptogenic expanding	yes (high uncertainty)
Range-expanding	yes (cannot be considered alien)
Partly native	Case-by-case at subregional level
NIS introduced through natural dispersal	Case-by-case
Debatable/questionable	yes (status may change in the future)
Unicellular marine algae	yes (significant data gaps regarding their origin)
Parasites	Case-by-case at subregional level if sufficient information is available
Extinct species	Case-by-case (based on taxon, research effort, regional data, etc.)
Freshwater/Oligohaline species	no (provided they are found in coastal systems of a country)

Based on these criteria (Table 1), we excluded cryptogenic species, phytoplankton species and parasitic species from the NIS assessment.

3.6 Data reporting, handling, and management

Reporting should be done every 6 years, in coherence with MSFD timeline, but assessments can be conducted between years at any point during this period. Reports will be submitted to OSPAR by Contracting Parties every reporting period. Data handling and management will need to be agreed as the indicator is developed further. Data management and handling will be further developed over time. Several databases exist at an EU level which may be of use, but this needs to be examined further. A process whereby baselines for the region and/or Contracting Party are maintained and up-dated needs to be agreed. This is a key point to decrease time lag between reports and data availability. Data bases and data management should accordingly be standardized and centralized.

4 Assessment

4.1 Data acquisition

Data was provided on formal request from OSPAR to its Contracting Parties and supplied to the indicator lead. Data requirements for this indicator were simple- date, geo-reference and species detected supplemented with supporting information. To assess the indicator Contracting Parties were only required to provide information on NIS presence. Lack of absence data, however, put some limitations to the later analysis of spread.

A data call with a guidance document was distributed in April 2021 to all contracting parties (Appendix 1 – NIS data call document) with a deadline for submission on May 31st 2021. Along with this an excel template file was distributed with preselected dropdown menus for several optional parameters. The data flow including quality assurance process within each Contracting Party was organised internally. Subsequent data handling and reporting at the OSPAR level was later decided within the OSPAR NIS EG (see section 3.5). For future work, this it is recommended that process is aligned with similar processes within the other RSCs.

All types of NIS detection data were encouraged to be sent from the Contracting Parties, as long as the data had been quality controlled and the compulsory data fields were filled out. Accordingly, a range of available data, including existing statutory monitoring, information from research projects, data from neighbouring countries and other sources were provided.

4.2 Assessment criteria

The new introductions parameter (P1) identifies how many new NIS are introduced into the assessment area during and between assessment periods. By quantifying the number of NIS species present in the monitoring location throughout the indicator assessment period this parameter can be used to measure the effectiveness of measures aimed at stopping or reducing the introduction of NIS, both in the short term (i.e., 1 year) and over longer periods of time (i.e., over multiple reporting periods). For example, use of the species parameter to show a reduced trend in the annual numbers of introductions after the implementation of ballast water management measures would enable us to conclude that ballast water management is an effective management option. This is the only parameter that has been used in recent assessments such as IA2017 and will also be the only parameter applied in the QSR2023 assessment. Considerations for future possible parameters on persistence and dispersal of NIS (P2-P4) is described in appendix 2.

4.3 Presentation of assessment results

Results are presented as self-explanatory graphs and maps combined with supporting statistical test results.

Specifically, the assessment will include a graph of the number of new NIS introductions per assessment period over all OSPAR Region, for each OSPAR region and each Contracting Party. In addition, the assessment will include a plot of the cumulative number of introductions per year and assessment period over all OSPAR Regions, for each OSPAR region and number of new NIS per year. From the number of new NIS introduced per year, the annual rate of NIS introduction (#NIS per year) was calculated and from this a mean introduction rate for each of the three assessment periods and each of the three OSPAR regions established. Differences in rates between assessment periods and OSPAR regions were be analysed with a statistical test (two-way ANOVA with pairwise comparison. A Venn diagram is used to present the number of NIS species in common among regions. Data analysis was performed using the R-Core software R-Core-Team. (2019), MS-Excel and the SigmaPlot statistical software.

5 Change Management

Responsibility for delivery and follow up of this assessment is through the ICG-COBAM expert group on non-indigenous species (NIS-EG), which provides input to ICG-COBAM under the Biodiversity Committee, the work is undertaken by the NIS expert group which provides input into ICG-COBAM.

6 References

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7 Appendix

7.1 Appendix 1 - NIS data call

OSPAR Common Indicators: Instructions for filling in the OSPAR Non-Indigenous Species data call

Do not remove, add, or adjust any columns or calculations included in the associated MS Excel reporting sheets

- **Always use the latest version of the reporting sheets, which will be delivered as part of the OSPAR data call. Do not use old versions;**
- **Do not remove, add or adjust any columns or calculations included in the associated MS Excel reporting sheet;**
- **All coordinates are to be calculated using WGS84 (EPSG: 4326) and to be presented as decimal degrees;**
- **All blank values to be left as blank (i.e. don't use filler comments or symbols);**
- **Please do not use any thousand separators (commas, apostrophies, or spaces) in number fields.**

CONTACTS

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Please contact the indicator lead if you have any queries about what data to include in your submission.

Technical contact: data@ospar.org

Please contact data@ospar.org if you encounter problems submitting your data.

Submission instructions

Please submit the data in the attached template by **31 May 2021**.

Please note that the document is split between 1) **compulsory** information for QSR23 and 2) additional **optional** datafields where information is requested where available.

Compulsory information is considered necessary for QSR23 assessments whereas additional **optional** information is considered supplementary to reporting requirements, but nevertheless useful to inform understanding of NIS in the OSPAR region.

Data Requirement

For the QSR2023 Non-Indigenous Species Common Indicator "Trends in the first recorded introductions of novel non-indigenous species" assessment data are required on first reports of NIS within OSPAR Regions II, II or IV covering a minimum of two 6-year periods. The intermediate assessment covered the period 2003 to 2014 (both inclusive). To expand on this we request that each Contracting Party provide data on first reports of NIS within their waters for each Region, made between 1 January 2003 and 31 December 2020 to the extent that these data exist.

The data-arrangements for NIS are not fully developed. The data call for IA2017 was ad hoc, and data were received in formats that did not allow for clear comparison and storage, partially because of incomplete data sets. Therefore, this data call asks for a resubmission of data from the previously assessed period in the specified data format.

Given the recent discussion in JRC on whether to include oligohaline, cryptogenic and partly native species in the definition of NIS, we request data on all NIS including these, to the extent that this information is available. The final decision on whether or not to include these NIS in the QSR2023 assessment will be taken later.

1. Geographic Scope

Data are required for OSPAR Regions II, III or IV (see Figure 1). For Contracting Parties which span more than one OSPAR Region we will need data on first reports of species into each OSPAR Region (if they have been reported in each region). For example, UK will need to provide data on first reports of NIS into both regions II and III.

If a new introduction has been detected in an estuary, or lagoon and the Contracting Party is considering whether to report the observation as having been made in an OSPAR Region, then the shapefile of the OSPAR Regions to be used for assessment purposes can be used to determine whether the introduction falls within the assessment area and therefore is to be reported. Figure 1 below provides an image of the Regions and the legend includes a hyperlink to ODIMS where the shapefile to be used for assessment purposes can be found.

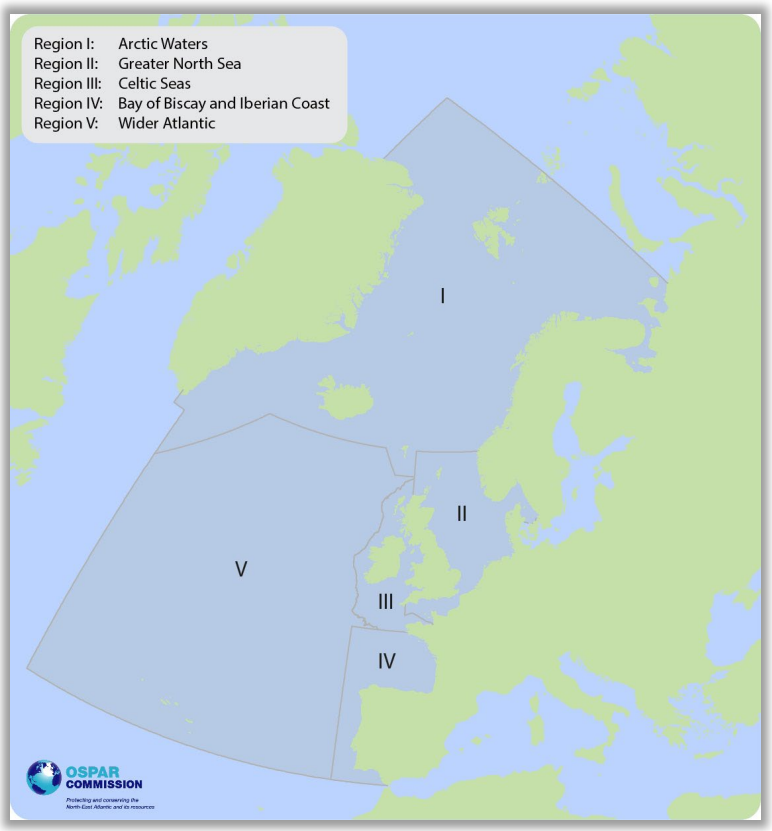

Figure 1. OSPAR Regions. https://odims.ospar.org/layers/geonode:ospar_regions_2017_01_002

2. Data Submission Format

Please fill in the worksheet in the Excel Workbook OSPAR_NIS-reporting_format_210312.xlsx according to the guidance in the table below. Please ensure that each species report is entered on a new row. If there are no data to report, please add "No data". Please consider the optional "Supporting Information" table at the bottom of this doc that requests other information in the format that they are available:

Field	Data type	Description	Compulsory/Optional
Contracting Party	Text	Two letter country code for the Contracting Party reporting the data. e.g. "DK"	Compulsory
Species common name	Text	Please provide the species common name. In the event that the species has multiple common names please provide the most commonly used in this column and provide	Compulsory

		further information in the 'Comment' column if necessary. e.g. "Carpet sea squirt"	
Species latin name	Text	Please provide the species latin name. If there are synonyms provide only one in this column and provide further information in the 'Comment' column if necessary. e.g. *"Didemnum vexillum"*	Compulsory
Species authority	Text	Please provide the authority of this species *e.g. "Kott, 2002"*	Compulsory
Taxonomic group	Text	Please provide information on the taxonomic group the species belongs to. Select from: Fishes and lampreys, Invertebrates, Lancelets, Tunicates, Plantae, Fungi, Bacteria, Protista, Mammals, Amphibians, Reptiles e.g. "Mammals"	Compulsory
Oligohaline	Boolean	Please provide information whether the species is considered to be oligohaline or not (very low salinity, specifically in the range 0 to 5 psu (~ brackish) "Yes", "No" , "unknown"	Compulsory
Partly native in OSPAR Region	Boolean	Please provide information on whether the species is assumed to be native in other OSPAR regions	Compulsory

		"Yes", "No", "unknown"	
Cryptogenic	Boolean	Please provide information on whether its a species of uncertain (Yes) or certain origin (No) "Yes", "No", "unknown"	Compulsory
Date of first report	Date	Please provide the date on which the NIS was first reported in the waters of the stated OSPAR region. For many contracting parties there will be only one date per species. However, for UK and France, there may be more than one date as these contracting parties span more than one OSPAR region. Date in the form of DD/MM/YYYY e.g. "01/05/2008"	Compulsory
Date of status update	Date	Please provide the date on which information on the status of each NIS was updated. Date in the form of DD/MM/YYYY e.g. "01/03/2020"	Compulsory
Location of first report	Text	Please provide the name of the location in which the NIS was first reported e.g. "Poole Harbour"	Compulsory
Location of first report GR 1 (latitude)	Number	Latitude of report, as decimal degrees, calculated using WGS84 e.g. "50,20"	Compulsory
Location of first report GR 2 (longitude)	Number	Longitude of report, as comma separated, decimal degrees, calculated using WGS84	Compulsory

		e.g. "-5,01"	
OSPAR Region	Text	Please provide the OSPAR region within which the species was reported. Choose from: II, III or IV e.g."II"	Compulsory
Any documentation of geographical spread?	Text	Has it spread? "Yes", "No", "Unknown" If "Yes" please see supporting information data section at the end of this document	Optional
Pathway of introduction	Text	To the extent possible, please provide information on the known pathway of introduction. **Choose from* (listed at the bottom of this table) in Excel drop down.** e.g. "UNKNOWN"	Optional
Evidence of breeding in the wild?	Boolean	Please provide information if possible on the ability of the species to successfully breed in the wild of your region "Yes", "No"	Optional
Is taxonomic status certain?	Boolean	Please provide information if possible on whether the taxonomic status of the species is certain or not. "Yes", "No"	Optional
Data gathering method and sources	Text	Methods for data gathering, and sources used **Choose from Excel drop down** "Government monitoring"	Optional

		"Academic survey" "Citizen science" "Other"	
Data quality assurance	Boolean	Have data been quality checked? "Yes", "No", "unknown"	
Comment	Text	Additional information related to the report e.g. "synonyms: *Didemnum vestum*, *Didemnum vestitum*. Report by citizen scientist."	Optional

***Pathway of introduction options:**

RELEASE IN NATURE: Fishery in the wild (including game fishing)

RELEASE IN NATURE: Other intentional release

ESCAPE FROM CONFINEMENT: Farmed animals (including animals left under limited control)

ESCAPE FROM CONFINEMENT: Aquaculture/ mariculture

ESCAPE FROM CONFINEMENT: Botanical garden/zoo/aquaria (excluding domestic aquaria)

ESCAPE FROM CONFINEMENT: Pet/aquarium/ terrarium species (including live food for such species)

ESCAPE FROM CONFINEMENT: Live food and live bait

TRANSPORT- CONTAMINANT: Contaminant nursery material

TRANSPORT- CONTAMINANT: Contaminant on animals (except parasites, species transported by host/vector)

TRANSPORT- CONTAMINANT: Parasites on animals (including species transported by host and vector)

TRANSPORT- CONTAMINANT: Contaminant on plants (except parasites, species transported by host/vector)

TRANSPORT- STOWAWAY: Angling/fishing equipment

TRANSPORT- STOWAWAY: Hitchhikers on ship/boat (excluding ballast water and hull fouling)

TRANSPORT- STOWAWAY: Ship/boat ballast water

TRANSPORT- STOWAWAY: Ship/boat hull fouling

TRANSPORT- STOWAWAY:Organic packing material, in particular wood packaging

Addition TRANSPORT - STOWAWAY: On towed equipment

TRANSPORT- STOWAWAY: Other means of transport

Addition TRANSPORT - UNINTENTIONAL : On marine litter

CORRIDOR: Interconnected waterways/basins/ seas

UNAIDED:Natural dispersal across borders of invasive alien species that have been introduced through pathways 1 to 5

UNKNOWN

Supporting Information

Contracting Parties are further requested to submit any of the following, additional, supporting information they may have as this will be useful for future assessments of NIS spread (D2C2):

Type of supporting information	**Data format**
Spatial distribution data	This could be spatial data in the form of Shapefiles, on extent and distribution, either as abundance data or presence / absence data. Also other data which may support the work of the indicator, including observed or modelled data of spread or distribution over the assessed time period. It is anticipated this could be available for invasive species.
Impact the species have had and evidence to support this	Reference to reports or scientific studies
National target species list on NIS	Is there a national target species list? If so is it regularly updated based on dedicated monitoring?

7.2 Appendix 2 - Recommendations for future NIS indicators

The total NIS parameter (P2) quantifies whether the total number of NIS changes over time. This is important to assess whether recently introduced species persist over a longer period or vanish after, for example, the following winter, or if more ancient established NIS finally disappeared as a consequence of interactions with resident species and environment. For instance the highly invasive macroalgae, *Caulerpa taxifolia*, almost disappeared from coast of France (new introduced *Caulperpa* species came afterwards). Another example is the highly invasive slipper limpet, which declined in the whole Bay of Brest (Manche) after decades. The Inventory-Parameter, therefore, concentrates on the community of NIS and changes therein. The inventory is negative if the number of disappearing NIS is higher than the number of newly introduced NIS. Should there be measures to eradicate unwanted species or NIS in general (e.g., cleaning pontoons in marinas); the Inventory Parameter can monitor their effectiveness. This can provide additional information on management effectiveness at the regional and/or local level e.g., individual marinas or OSPAR region level. This NIS parameter can only be assessed when NIS records derive from an annually repeated monitoring survey. Academic reports typically only provides evidence of the first observation, occasionally trends over a period of time. Accordingly we did not investigate P2, but it is recommended for future assessments.

The dispersal spread parameter (P3) quantifies if an established NIS is expanding or decreasing in range within a specific geographical area. This is a crucial parameter to follow secondary spread often very fast in marine environment due to the combination of high natural dispersal of many marine species and regional transports by human activities (e.g. effects of leisure boating; Clarke Murray et al. 2011; Ulman et al. 2019). A positive dispersal parameter value indicates that the species is increasing in range coverage within the assessment area and a negative dispersal parameter value indicates that the species is decreasing in range. NIS range may vary over time with natural fluctuation of the species distribution, but also as the species spreads, or in response to management measures. As assessment of P3 requires NIS records from a standardized annually repeated monitoring program, this parameter was not investigated further.

The dispersal rate parameter (P4) quantifies the rate of dispersal as $\Delta D / \Delta T$ where ΔD is the distance between two target points (a point and the closest earlier occurrence of a given species) and ΔT is the number of years between the two observations. In case of several observations, the dispersal rate is calculated as the average of the individual rates. To enable the calculation of distances, the coastline should be simplified to a resolution of eg. 10km x 10 km, where all cells containing water are defined as water cells. The distance can then calculated as a cost distance in ArcMap. We performed a preliminary analysis for a few species with P4, which indicated its usefulness. However, without consistent temporal and spatial coverage in monitoring there is very low confidence in the calculated dispersal rates and it was therefore decided not to include an assessment of P4.