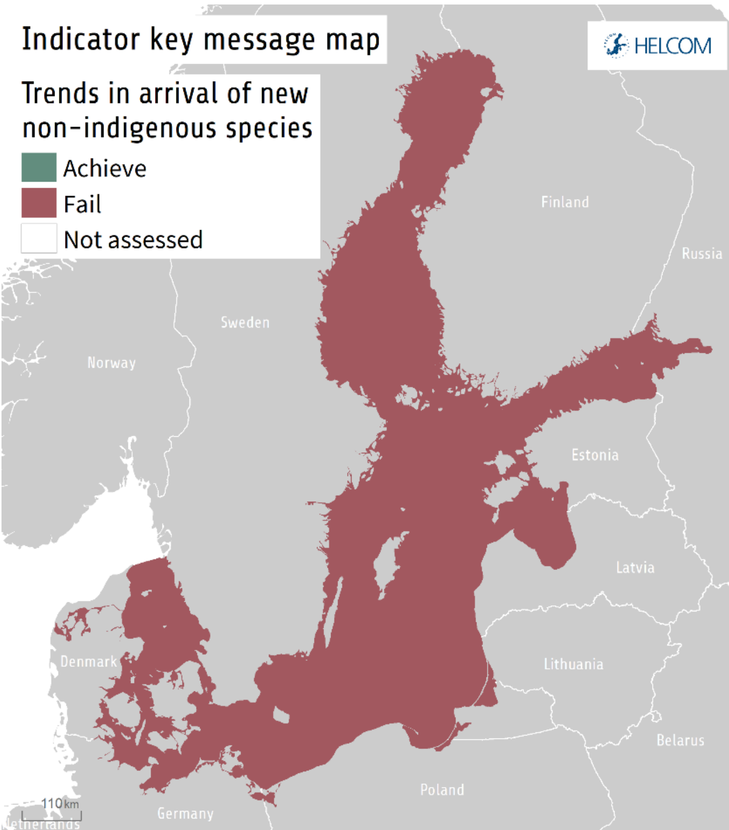
HELCOM core indicator report
July 2018

Trends in arrival of new non-indigenous species

Key Message

Twelve new non-indigenous species (NIS) or cryptogenic species (CS) have appeared for the first time in the Baltic Sea during the assessment period 2011-2016.

The Baltic Sea assessment units in which these new NIS/CS have been detected are the Kattegat, Great Belt, Kiel Bay, Bay of Mecklenburg, Arkona Basin, Bornholm Basin and Gulf of Riga. The new NIS have been detected both through regular environmental monitoring activities, and in many cases based on incidental sightings. The data have been verified by national experts. Monitoring is not considered to sufficiently cover all areas of the Baltic Sea and hot spot areas for new introductions (e.g. ports) to allow for the conclusion that in areas where no new NIS have been observed there have not been any new introductions.



Key message figure 1. Status assessment results based evaluation of the indicator 'Trends in arrival of new non-indigenous species'. The assessment is carried out using Scale 1 HELCOM assessment units (defined in the HELCOM Monitoring and Assessment Strategy Annex 4). **Click here to access interactive maps at the HELCOM Map and Data Service: Trends in arrival of new non-indigenous species**.

The trend in arrival of new NIS has been increasing since the beginning of the 1900s, indicating a degraded status in the entire Baltic Sea during the period leading up to 2016. However, there has been a slight decrease in the number of new NIS detected in recent years (HELCOM, 2014a). The heavy maritime activity in the Baltic Sea is linked to the number of NIS detected in the region.

Monitoring data does not cover all habitats, taxonomical groups or port areas in most of the countries surrounding the Baltic Sea. The confidence in the assessment for areas where detections of new NIS have been made is **high**. In assessment units where no detections have been made, the confidence may be **low** if no regular monitoring is conducted. This however varies between assessment units.

The indicator is applicable in the waters of all countries bordering the Baltic Sea and operational only in the assessed areas due to availability of monitoring data.

Relevance of the core indicator

NIS are one of the major external stressors and can drive changes in marine ecosystems, the impacts of which are often unpredictable. Over 170 NIS and CS have been observed in the Baltic Sea (AquaNIS 2018). The pathways responsible for the currently established species (59% of all introduced species) are shipping and natural spread from neighbouring areas. Substantial uncertainty in the information on introduction pathways (except for deliberate releases) hampers detailed analyses and makes it very difficult to assess new human-mediated introductions both into and within the Baltic Sea. Thus the indicator assesses only the new introductions for the whole Baltic Sea, but reports these new sightings at a sub-basin scale.

NIS and CS comprise not only the established organisms but all new species even if they will not establish as species that do not establish self-sustaining populations are also regarded as failed management. Thus, the number of NIS and CS evaluates the successfulness of preventive management as well as the status of the ecosystem by indicating the areas where the level of unpredictable risk is high.

Policy relevance of the core indicator

	BSAP Segment and Objectives	MSFD Descriptors and Criteria
Primary link	• No introductions of alien species from ships	D2 Non-indigenous species 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
Secondary link		
Other relevant legislation: IMO Ballast Water Management Convention, 2004		

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Trends in arrival of new non-indigenous species HELCOM core indicator 2018 (pdf)

Results and Confidence

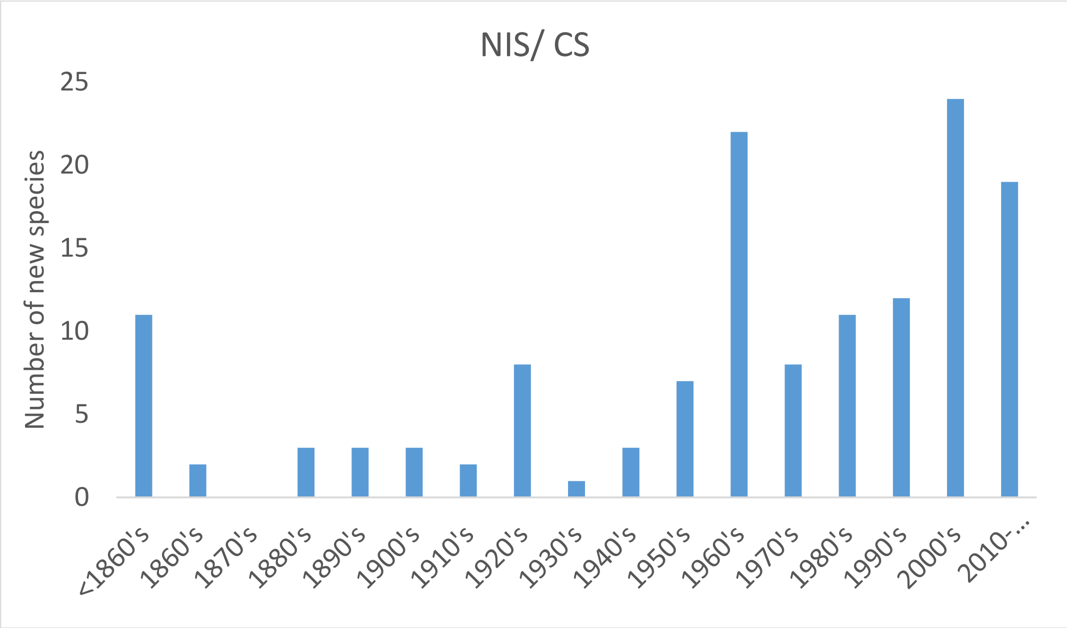
New arrivals of non-indigenous species to the Baltic Sea

Twelve new human-mediated introductions to the Baltic Sea were observed from 2011 to 2016. These species are: *Antithamnionella ternifolia, Beroe ovata, Tharyx killariensis, Chaetoceros concavicornis, Diadumene lineata, Echinogammarus trichiatus, Grandidierella japonica, Haminoea solitaria, Hemigrapsus takanoi, Laonome* sp., *Proasellus coxalis* and *Sinelobus c.f.vanhaareni.* In three sub-basins only one new NIS was observed (Kattegat, Arkona Basin, Gulf of Riga), in three areas two new NIS were observed (Great Belt, Bay of Mecklenburg, Bornholm Basin) and in one area (Kiel bay) three new NIS were observed for the first time in the Baltic Sea. These areas are considered to fail the established threshold value. As the uncertainty related to vectors and pathways concerning many new introductions inside the Baltic Sea is high we cannot say the other sub-basins are in good status although there are no known new Baltic Sea-first observations recorded in them. There are however several human-mediated introductions (e.g. for bivalve species) from one Baltic country or sub-basin to another during the assessment period, indicating failed threshold value conditions elsewhere. Therefore we are not assessing the sub-basins without Baltic Sea-first observations with the present level of knowledge.

The current results are based on AquaNIS data that has been verified by national experts. The indicator results could be significantly improved if dedicated monitoring program for NIS would be launched in all HELCOM countries. Current evaluations are strongly biased towards better investigated groups (molluscs, crustaceans, fish), whereas almost no information on micro/meio taxa and pathogens is available for consideration.

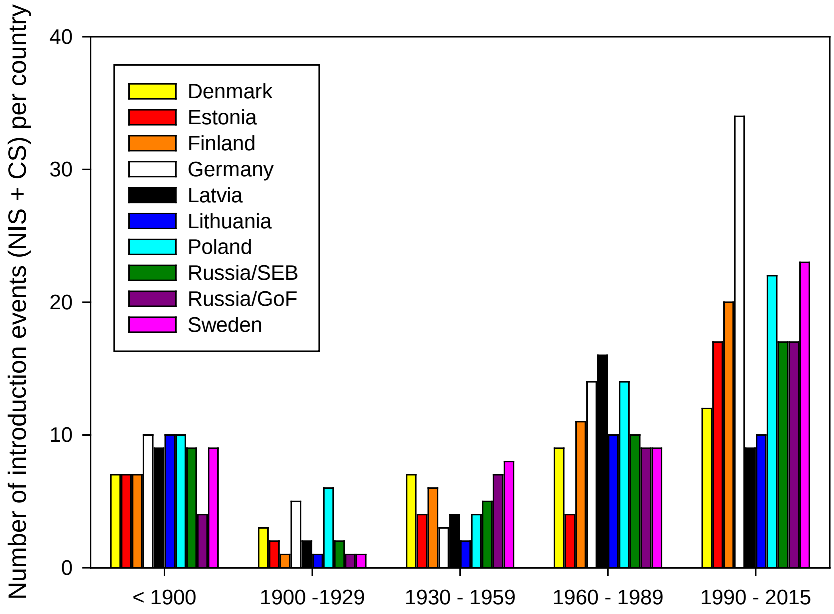
Trends in the arrival of non-indigenous species

The number of new NIS increased steadily until the mid-20th century (Results figure 1). Results figure 1 illustrates the temporal development of numbers of new NIS and CS observed in the Baltic Sea until 2016. The number of arrivals has increased over time and there seems to be a shift in the time series in the 1960s.



Results figure 1. Number of new NIS in Baltic Sea until 2016. The bars indicate the number of invasions per time period.

The trend of new NIS has increased sharply and has not shown signs of decline in 1990s and 2000s (Results figure 2). Shipping and cultural activities (includes crustaceans, bivalves, fish and other taxa, which have been intentionally stocked) have been responsible for the majority of the introductions (Zaiko et al. 2011).



Results figure 2. Non-indigenous species and cryptogenic species introductions per 5 time periods and countries or country regions based on Ojaveer et al. 2016.

Confidence of the indicator status evaluation

The confidence for areas where detections of new NIS have been made is **high**. The detections have been verified by regional experts, and the observations are considered to be correct.

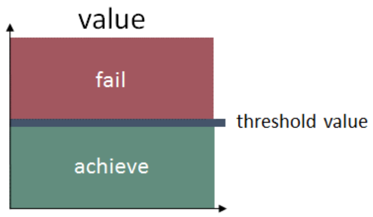
In assessment units where no detections have been made, the confidence may be **low** if no regular monitoring is conducted. This however varies between assessment units.

Regular monitoring dedicated to NIS is not available in most countries and areas and thus data is not considered to sufficiently cover all areas of the Baltic Sea to ensure that all new introductions are detected, thus a zero result for an assessment unit may be a false negative.

Thresholds and Status evaluation

The ultimate goal is to minimize anthropogenic introductions of NIS to zero. The threshold value between good status and not good status is **’no new introductions of NIS per assessment unit through human activities during a six year assessment period**’ (Thresholds figure 1). As a mid-term goal a decrease in the rate of new introductions should be considered. The evaluation against the baseline species list is carried out and all new species introduced to the Baltic Sea per assessment unit over a six year period are listed and counted.

The focus in the indicator is on human-mediated introductions and not secondary spread by natural means (migration, water currents etc.). There are large regional inconsistencies in the assessment of introductions to vectors/pathways due to different knowledge level and information availability in different sub-basins. Therefore the indicator considers only new introductions into the Baltic Sea where we have a better level of confidence for the vector/pathway and not the spread inside the Baltic although part of this spread is for sure due to human actions (certainly for some bivalve species e.g. *Mytilopsis leucophaeata* and *Rangia cuneata*).



Thresholds figure 1. Schematic representation of the threshold value, where the threshold is achieved if no new species appear in the Baltic Sea due to human activities during the six year assessment period.

The confidence in the applicability of the threshold value is moderate as the concept is broadly considered to be valid and the deleterious effects of NIS are in general well known. As monitoring data is not readily available, the applicability has not been sufficiently tested. Furthermore the 6-year evaluation period has been selected based on management cycles and may not be the most ecologically relevant assessment period. However, a recent study conducted by ICES on the temporal adequacy of a three year period assessment states that this is likely to be a too short period and considers a six-year assessment period to be more appropriate (ICES, 2013).

Eradication of already introduced NIS species has proved not to be feasible in aquatic environments (Sambrook et al. 2014) after establishment and spread. No knowledge of eradication of alien invertebrates or marine organisms has been recorded in Europe. This proves the difficulty from the operative and economic perspective of implementing such measures (Genovesi, 2005). Thus, reaching a pristine status cannot be used as a relevant threshold value.

To enable an evaluation of status, the indicator requires a baseline in the form of a list that specifies which NIS/CS were already present in each assessment unit at a certain point in time. The baseline list has been made for the year 2010. Altogether 160 NIS and cryptogenic species have been observed in the Baltic Sea by

2010 (based AquaNIS 2018) (see Metadata for details). The number of species present in 2010 varies between assessment units. Some flexibility in the indicator evaluation against the baseline list should be ensured if a NIS is later found to have invaded an area during a previous assessment period.

Assessment Protocol

The majority of the relevant data is in point format. The processing required for making an evaluation against the baseline species list for an assessment unit only requires summing the number of new species introduced to the Baltic Sea per assessment unit. The 17 sub-basin assessment units (HELCOM Scale 2) are used for the assessment but due to differing monitoring efforts the indicator evaluation (against the threshold) is done on the whole Baltic scale (scale 1).

The borders of the sub-basins reflect the large scale environmental gradients typical of the Baltic Sea, with salinity often being the most relevant gradient in relation to the introduction and potential large-scale spreading of NIS. The relevance of evaluating the number of new introductions on the scale of sub-basins is also due to the relatively low current detection rate of new arrivals. Monitoring programmes do not currently cover coastal areas adequately, however some monitoring activities are carried out in the coastal areas. Also, future wider implementation of port surveys and other monitoring programmes may warrant evaluations based on the coastal assessment units. Thus, existing programmes should be used for the indicator and be adapted, if possible. A further opportunity is the implementation of a cost-efficient rapid-assessment program on NIS, which already exists in some countries.

Indicator calculation

The main parameters used to evaluate whether the threshold value is achieved in this core indicator are the new species introduced by human actions to the Baltic Sea per assessment unit after the year used to determine the baseline. However, in order to increase regional coherence and comparability between the HELCOM and OSPAR environmental assessments, the same indicator parameter processing is proposed. Therefore, the parameters 'inventory' and 'dispersal' are also considered in this core indicator. These two parameters are to be considered as supporting parameters that provide important information and their use in providing information of the spread of NIS might become more strongly incorporated in the indicator concept at a later stage of development.

Indicators evaluating the negative effects of NIS are not currently being developed in HELCOM. Advantages with the approach of the current indicator is considered to be that the indicator:

- is based on quantitative and qualitative data, not on expert judgement,
- works on a short time scale (in contrast to assessing environmental impact),
- can reflect the effectiveness of measures,
- evaluation is not dependent on earlier evaluations
- can be applied to a range of monitoring types and efforts,
- pragmatic, simple and considered to be effective,
- takes into account the current levels of uncertainty in relation to requirements for monitoring for NIS in the marine environment, and
- incorporates the same parameters as the comparable OSPAR indicator promoting regional coherence.

1. Species-Parameter

This main parameter describes how many new NIS/CS have been recorded in the Baltic Sea per assessment unit due to human actions during the assessment period. Only this parameter is used in the trend evaluation at this point in time.

SP (assessment period) = number of new introduced non-indigenous and cryptogenic species in the Baltic Sea per assessment unit

Regular monitoring of species has to be conducted to identify new human-mediated arrivals. The parameter depends on the 2010 baseline list of NIS, and only documents new species detected after 2010 per assessment unit. This parameter can be used to measure the effectiveness of measures aimed at stopping or reducing the human-mediated introductions of NIS.

The parameter can also be used to evaluate the provisional threshold value, i.e. the rate of introduction. This could provide the most accurate indication of the effectiveness of implemented management measures. For example the species parameter could be used to show the trend in the annual numbers of introductions after the implementation of ballast water management measures to enable conclusions on the ballast water management effectiveness as a management option.

2. Inventory-Parameter

The calculation of the Inventory-Parameter is not applied to the trend assessment, but contains additional information for the state of the NIS community:

IP (assessment period) = number of NIS and CS in the assessment unit - number of NIS in the same assessment unit from the previous assessment period.

The parameter focuses on changes in the number of NIS detected in a specific assessment unit irrespective of regional species-baseline lists. The 'inventory' parameter quantifies whether the NIS species composition changes over time and focuses on changes in the total number of NIS individuals independent of the species list.

This supporting parameter enables an evaluation of whether recently introduced species persist over a longer period of time or vanishes after, for example, the following winter. The inventory parameter 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, i.e. reflecting a good status. Should there be measures to eradicate unwanted species or NIS in general (e.g. cleaning pontoons in marinas); the Inventory Parameter can monitor the effectiveness of these measures and can provide additional information on management effectiveness at the regional and/or local level.

3. Dispersal-Parameter

The supporting parameter 'dispersal' enables an evaluation of the spreading of the NIS. New species will first appear at a certain or possibly a few locations within an assessment unit after which, depending on the degree of invasiveness, these NIS will spread to other nearby locations. The dispersal parameter is calculated for each NIS separately:

$$\frac{\textbf{number of monitoring locations where NIS X was located with the assessment unit}}{\textbf{total number of monitoring locations in assessment unit}}(\boldsymbol{assessment\ period-1})-$$
$$\frac{\boldsymbol{number\ of\ monitoring\ locations\ where\ NIS\ X\ was\ located\ with\ the\ assessment\ unit}}{\boldsymbol{total\ number\ of\ monitoring\ locations\ in\ assessment\ unit}}(\boldsymbol{assessment\ period})$$

A positive dispersal parameter value indicates that the species or its range is reducing within the assessment unit, while a negative dispersal parameter value indicates that the species is present at more locations than previously recorded and is therefore spreading. The dispersal parameter is therefore able to indicate the speed at which the NIS is spreading and the effectiveness of counter-measures. It is widely accepted, that large scale eradication measures are unlikely to succeed in the marine environment. However, there are exceptions where eradication may be feasible, especially in the first phase of a new introduction. Also, there are methods aimed at reducing the local spread of NIS (i.e. the cleaning of ship and boat hulls).

Assessment units

The indicator is assessed for the scale 2 assessment units, making up 17 sub-basins in the HELCOM area. The assessment units are defined in the HELCOM Monitoring and Assessment Strategy Annex 4.

The large uncertainty related to new introductions, especially concerning their vectors/pathways, prevents the use any more detailed scale in the assessment with this current indicator. At present the indicator only considers new introduction to the Baltic Sea but the indicator results show these introductions per assessment units. This approach however underestimates the NIS introductions in many areas as we cannot obtain reliable data for intra-Baltic spread (for vectors/pathways) and thus we cannot assess the status of new arrivals per assessment unit, which would give a better view of the status.

Relevance of the Indicator

Policy relevance

The introduction of NIS and their subsequent establishment into aquatic environments, especially in coastal waters, can cause severe environmental, economic and public health impacts. Since the early 1990s when the Marine Environmental Protection Committee (MEPC) of the International Maritime Organisation (IMO) put the NIS issue on the agenda, the issue has gathered an ever increasing weight in marine environmental protection. In 2004, the International Convention for the Control and Management of Ship's Ballast Water and Sediments (BWM Convention) was adopted by the IMO. The Convention requires ships in international traffic to manage their ballast water and sediments (Regulation B-3) to certain standards specified in the Convention (Regulation D-2), as well as keeping a ballast water record books and an international ballast water management certificate. There is a phase-in period for ships to implement their ballast water and sediment management plan, during which they are allowed to exchange ballast water (Regulation B-1) in the open sea under certain premises of depth and distance from the shore (Regulation D-1).

The Convention entered into force 8 September 2017.

In the BSAP (in the Roadmap towards harmonised implementation and ratification of the 2004 International Convention for Control and Management of Ships' Ballast Water and Sediments), Contracting Parties agreed to adjust/extend by 2010 the HELCOM monitoring programmes to obtain reliable data on non-indigenous species in the Baltic Sea, including port areas, in order to gather the necessary data to conduct and/or evaluate and consult risk assessments according to the relevant IMO guidelines. As a first step, species that pose the major ecological harm and those that can be easily identified and monitored should be covered. The evaluation of any adverse ecological impacts caused by non-indigenous species should form an inherent and mandatory part of the HELCOM monitoring system.

Good Environmental Status (GES) according to the EU MSFD is to be determined on the basis of eleven qualitative descriptors. One of the qualitative descriptors concerns non-indigenous species and describes the GES for this descriptor as 'Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem'.

In order to minimize adverse effects of introductions and transfers of marine organisms for aquaculture ICES drafted the 'ICES Code of Practice on the Introductions and Transfers of Marine Organisms' (ICES, 2005). The Code of Practice summarizes measures and procedures to be taken into account when planning the introduction of NIS for aquaculture purposes. On the European level, the EC Council Regulation No 708/2007 concerning the use of NIS and locally absent species in aquaculture (EC, 2007) is based on the ICES Code of Practice. With a wider scope the recently adopted EU Regulation on the prevention and management of the introduction and spread of invasive alien species, entering into force on 1 January 2015, aims to protect native biodiversity and ecosystem services, as well as to minimize and mitigate the human health or economic impacts that these species can have (EU, 2014).

Role of non-indigenous species in the ecosystem

The introduction of invasive non-indigenous species (NIS) is a severe threat to marine environments. NIS have caused ecological, economic and public health impacts globally (Ruiz et al., 1997; Mack et al., 2000; Lockwood et al., 2007; Ojaveer & Kotta, 2014). NIS can induce considerable changes in the structure and dynamics of marine ecosystems and may also hamper the economic use of the sea or even represent a risk for human health. Ecological impacts include changes in habitats and communities and alterations in food web functioning, in extreme cases even losses of native species can occur (Galil, 2007). Economic impacts range from financial losses in fisheries to expenses for industries for cleaning intake or outflow pipes and structures from fouling (Black, 2001; Williams et al., 2010). Public health impacts may arise from the introduction of pathogens or toxic algae.

Only a minority of all NIS become invasive i.e. have a potential to cause negative impacts. Those NIS which cause the most harm on the environment and/or humans are the most important to assess, not only in terms of assessing the current and changing status of the ecosystems (requirements from the WFD and MSFD), but also in terms of the marine management perspective in order to facilitate strong move towards implementation of the ecosystem based approach.

Documented ecological impact is known only for 43 NIS in the Baltic Sea (Zaiko et al. 2011), which is less than 50 % of the species registered in the sea. According to the biopollution index (e.g. Zaiko et al. 2011), the highest biopollution (BPL = 3, strong impact) occurs in coastal lagoons, inlets and gulfs, and the moderate biopollution (BPL = 2) in the open sea areas. None of the Baltic sub-regions got classified as 'low impact' (BPL = 0 or 1) indicating that invasive species with recognized impacts are established in all areas.

General information about NIS can be found in the Baltic Sea Environment Fact Sheet (BSEFS) 'Biopollution index' that gives more information of the impacts and the BSEFS 'Observed non-indigenous and cryptogenic species in the Baltic Sea' that gives more information on how the baseline was derived. For more species specific NIS information the BSEFS 'Abundance and distribution of Marenzelleria species', 'Abundance and distribution of Round goby' and 'Abundance and distribution of the Zebra mussel' can be referred to.

Human pressures linked to the indicator

	General	MSFD Annex III, Table 2a
Strong link	Maritime traffic, especially ballast water management and biofouling, aquaculture	Biological - Input or spread of non-indigenous species
Weak link		

The indicator evaluates the status of the marine environment affected by anthropogenic pressures. It is important to distinguish between naturally spreading and anthropogenically introduced species. If it is not possible to distinguish between a human mediated introduction and natural spread the species is called cryptogenic. For the indicator all new observed species are therefore first to be treated as NIS or cryptogenic and only species which can be shown to have spread naturally will be removed from the indicator.

According to Minchin et al. (2008), nine main categories of pathways for all aquatic environments through which species may spread can be defined. These are: shipping, canals, wild fisheries, culture activities, ornamental and life food trade, leisure activities, research and education, biological control and alteration to natural waterflow. In the Baltic Sea, the increasing shipping activities and development of the new navigable waterways during the last 60 years has resulted in the increasing number of unintentional introduction of NIS species, transported in ballast tanks or on ship hulls (Olenin et al., 2009). Besides shipping, especially aquaculture has been identified as a very important vector in some parts of the Baltic Sea (Wolff and Reise 2002).

Monitoring Requirements

Monitoring methodology

Common HELCOM monitoring of relevance to the indicator is described in the **HELCOM Monitoring Manual in the programme topic: Non-indigenous species**.

Non-indigenous species are occasionally detected in regular biological monitoring programmes, previously described e.g. in the COMBINE manual. Some national differences in the sampling strategies exist, thus causing some discrepancy in the predicted detection rate of new NIS arrivals. Despite differences between the countries a homogenized strategy for NIS detection should be pursued including also port monitoring.

Guidelines for monitoring of non-indigenous species by extended Rapid Assessment Survey are adopted and published.

Current monitoring

The monitoring activities relevant to the indicator that are currently carried out by HELCOM Contracting Parties are described in the **HELCOM Monitoring Manual** monitoring concepts table.

Prior to 2012 and the HELCOM ALIENS 2 (HELCOM 2013a) and BALSAM projects, only Estonia had monitoring of NIS in the vicinity of the port and there was no monitoring inside the actual port area. Since 2012 Estonia has carried out annual port surveys. Sampling was conducted in ports during the ALIENS projects, but there are no guarantees of the continuation at any interval due to lack of resources. Latvia and Poland have also conducted port surveys since 2013, although not regularly. In addition, some individual port surveys and long-term projects have been conducted in Poland (e.g. Norman-Saremba et al. 2017), Lithuania and Finland (Paavola et al. 2008). As part of these projects, data on the presence of NIS in ports in Estonia (Muuga), Finland (Turku, Naantali, Kotka, Hamina, Sköldvik and Kokkola), Poland (Gdynia) and Sweden (Gothenburg) are currently available on line. In 2009 Germany established an annual “Rapid Assessment Survey” (RAS) to improve monitoring on non-indigenous species in ports in 2009 and extended the sampling referring to the HELCOM/OSPAR protocol in 2016 (eRAS). This method still needs further development since important organism groups such as phytoplankton, jellyfish, and fish are not included in the eRAS method.

Description of optimal monitoring

Shipping and boating are considered to be primary vectors for the introductions of new NIS into the Baltic Sea. Implementing port surveys regularly in the whole Baltic Sea would greatly increase the confidence of the indicator. One conceivable option for a regular and regionally harmonized monitoring of NIS may be the HELCOM/OSPAR protocol for the execution of port surveys (HELCOM, 2013b). The protocol has been tested in certain Contracting Parties and proposed for inclusion in several national monitoring programmes.

According to the protocol, sampling should be conducted at least twice annually (spring bloom and summer maximum) in minimum every five years to monitor the port areas and also for the purpose of granting ballast water management convention (BWMC) exemptions. During the intermediate period, reviews should take place (not more frequent than annually) based on any new information on the basis of the exemption granted including but not limited to: presence of non-indigenous species, introduction pathways for NIS, changes in physical conditions in the port.

To ensure a good detection rate of new NIS the shallow water habitats should be added to ongoing biological monitoring programmes. In these littoral areas a higher monitoring effort is needed for fish, crustaceans, mussels, snails, macroalgae and plants. Currently NIS data from monitoring is backed up with opportunistic studies and research.

Data and updating

Access and use

The data and resulting data products (tables, figures and maps) available on the indicator web page can be used freely given that the source is cited. The indicator should be cited as following:

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Metadata

[Result: Trends in arrival of new non-indigenous species]

[Data: Trends in arrival of new non-indigenous species]

There is a strong scientific community in the Baltic region studying NIS and a shared database (AquaNIS) compiling information from scientific papers and national studies. The approach has good prospects to give an indication of the success of management measures to minimize the introduction of non-indigenous species. It has harmonized targets in the Baltic Sea.

Data used in the indicator originates from the AquaNIS database, NOBANIS database, scientific publications, and national experts.

Geographical coverage

The indicator covers the entire Baltic Sea: national coastal and offshore waters divided to sub-basins. There are however wide gaps in the spatial coverage of the current biodiversity monitoring especially in the coastal areas. Currently, the monitoring of coastal and estuarine biodiversity is not conducted to reliably show the distribution and abundance of several NIS.

Temporal coverage

The time series data may overemphasize the recent decades and show too steep increase in the rate of introductions due to improved monitoring of NIS.

Contributors and references

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Archive

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Earlier versions of this indicator are available at:

HOLAS II component- Core indicator report – web-based version July 2017 (pdf)

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