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Background

This document contains the assessment methodology for how the spatial pressure and impact assessment (SPIA) will be conducted in HOLAS III. For some work strands the development work is still ongoing and for those topics the direction of the development work and a timeline when the work will be finished, is given.

The SPIA in HOLAS III will be based on the same principle Halpern methodology as in HOLAS II, including the possibility estimate the cumulative burden to the environment using an additive model. Beyond the cumulative aspects the method enables the spatial presentation and use of individual, or a subset, of spatial data layers, representing activities, pressures and ecosystem components, with the impact adjusted through the use of sensitivity scores. Based on the feedback from HOLAS II, CIA Scoping meeting (CIA SCOPING 1-2020) and the technical workshop (Technical CIA WS 1-2020), the MetDev project Work Package 1, has been working to improve certain aspects of the assessment methodology, according to the priorities listed in the project application.

This document describes the methodology for those aspects that are to be done differently in HOLAS III, compared to HOLAS II, as developed within the MetDev work package 1. A full description of the cumulative impact assessment methodology can be found in thematic assessment of cumulative impacts, published for HOLAS II.

Action requested

The Meeting is invited to endorse the proposed approach for the spatial pressure and impact assessment in HOLAS, III to be submitted to HOD 61-2021 for approval.

The Meeting is invited to endorse the plan for the development work that is still ongoing and agree on its submission to HOD 61-2021 for approval.

Assessment methodology for the spatial and impact assessment in HOLAS III

The cumulative impact assessment in HOLAS III will be carried out by using the HELCOM SPIA tool (BSII in HOLAS I and II). The tool follows the methodology developed by Halpern et al. in 2008, as in HOLAS I and II. The methods assesses the cumulative burden to the environment is calculated with an additive model, including pressure layers, ecosystem components and sensitivity scores.

The pressure and ecosystem component layers are based on the work in HOLAS II, however, including 6 new benthic habitat layers and the fish layers created in Pan Baltic Scope which will replace the ones used in HOLAS II. The full list of layers that will be included in the assessment can be found in Annex1. Data for the assessment will represent the assessment period 2016-2021.

The development aspects of HELCOM SPIA for HOLAS III

In the approved plan for HOLAS III, in line with the wishes expressed by the Contracting Parties, all technical development work and improving of infrastructure needed to support the State of the Baltic Sea report takes place prior to the start of the actual HOLAS assessment process. This development work is clustered under a HOLAS III preparatory phase. The preparatory phase runs from the beginning of 2020 to the first quarter of 2022, in a staggered structure.

The MetDev project is targeting the third and final step of the preparatory phase, for the WP 1 on cumulative impacts, the aim is to develop the tools and methods for the cumulative impact assessment in HOLAS III. GEAR 21-2019 discussed how to tackle spatial pressure and impact assessment in the Baltic Sea region in future assessments, as well as the role of the Baltic Sea Pressure and Impact Indices (BSPI/BSII) in HOLAS III. The Meeting concluded on a three-step process to reach a shared view on these questions and by extension the development needs for HOLAS III. The process included a survey for national contacts, a Scoping Meeting and a technical workshop.

Based on the outcome of the scoping and technical workshop, the MetDev project Work Package 1, has been working to improve certain aspects of the assessment methodology. The output of this work is presented in the next sections, divided to chapters according to the different aspects of the assessment.

The development of the SPIA online tool

The HELCOM SPIA online tool (currently unavailable due to development work) is an open-source tool developed at HELCOM and free for everyone to use. The tool includes 3 sections: Information, layers and calculation. The first sections introduces the tool, gives background information and provides links for the further reading. In the layers section the user can use the map viewer to explore the pressure and ecosystem layers available for the calculation. In the calculation section to user can make the selection of the calculation method (pressure or impact index) and the layers that will be included in the calculation. Based on the selection, the tool produces a pre-defined sensitivity score matrix, that the user can use directly or edit the sensitivities in the tool. The results of the calculation will appear on the map pane on the right side of the section. In the interactive map the user can explore the results and e.g. download the outputs of the calculation.

One of the most important development points that were discussed and outlined in the CIA Scoping meeting (CIA SCOPING 1-2020) and the technical workshop (Technical CIA WS 1-2020), was to enable doing subset analysis by including only desired pressure and ecosystem layers and to improve the ways to explore the results of the assessment. This will increase diversity of the outputs of the assessment results and improve the usability of the results to e.g. management purposes.

One key aspect to explore the result, and also to improve the transparency of the assessment, is to enable linking the impact back to the underlying human activity, pressure and ecosystem component data. In HOLAS III this will be implemented in the updated tool to run the spatial impact assessment. In the tool the user can run the impact assessment on any desired layer combination and explore the result map in the tools' map viewer.

In the tools' result map viewer it will be possible to explore the contribution of pressure and ecosystem layers to the total impact for each pixel of the result raster. In practice this means, that if the user of the tool is interested of certain hotspot in the map, by clicking the cell the user can see, as a graph and a table, the contribution of each pressure and ecosystem component layer to the total impact, to this particular hot spot. For those pressure layers that are aggregated from various human activities layers (e.g. physical loss), one can also access the information of the contribution of those activities for the pressure layer, for that particular spot.

In addition to being able to explore the result per pixel, the user can also choose a larger area by selecting the cell of interest or choosing from a predefined list of areas, such as HELCOM sub-basins (assessment units). As previously, the user can also see the contribution of pressure and ecosystem components to the total impact, for the whole assessment area, in this case the HELCOM Marine area.

Sensitivity score review process

Separate sensitivity score questionnaires were carried out for both HOLAS I and HOLAS II, where completely new sensitivity scores were created for the assessment. The development of the indices between these two assessments were substantial, justifying the creation of completely new scores. Also the number of ecosystem components clearly increased and the aggregation of pressures from human activities were introduced, resulting in a need for new sensitivity scores. The method to do the cumulative impact assessment and number of pressures and ecosystem components in HOLAS III, are rather close to the ones in HOLAS II, justifying that only a revision of the scores used in HOLAS II was needed.

The review was done in order ensure the usage of most up to date knowledge, but also to create the sensitivity scores for 11 new ecosystems components introduced in HOLAS III. In addition there was strong support to improve the sensitivity scores from the CIA Scoping meeting (CIA SCOPING 1-2020) and the technical workshop (Technical CIA WS 1-2020).

The review process was launched in connection with launching the invitation for the HELCOM MetDev Workshop on Spatial Pressure and Impact Assessment (HELCOM MetDev SPIA WS 1-2021). National experts were asked to suggest new sensitivity scores for each combination of pressure and ecosystem component layers or indicate if any combination requires further discussion. More detailed description of the review can be found here.

The results of the review process were discussed at the workshop. The workshop went through all combinations that were suggested to be reviewed and decided on the new scores for those combinations. New sensitivity scores were based on the average of the old sensitivity score value and the suggested new values. If some other approach was used, the rationale for this was documented. The results of this exercise are documented in the outcome of the workshop and in annex 1 were the new scores are listed.

The expertise of the workshop didn't cover all pressures and ecosystem components, and in order to get the best available information, the workshop agreed to ask guidance from the corresponding HELCOM expert groups for the extraction of fish (Cod, Herring and Sprat) and introduction of NIS pressure layers. This work will be finalized this autumn and final sensitivity scores will be presented at HOD 61-2021 for approval.

Improvements to data and methodology to create layers

The data layers that will be used for the assessment are based mainly on the ones in HOLAS II, but 6 new ecosystem components will be added to the assessment, as described in the section "benthic habitats" further down the document. However almost all layers will have updated data for the HOLAS III assessment period 2016-2021. As in HOLAS II, the data is stemming from the national data call, HELCOM reporting, open sources and data request to other organizations.

The methodology how to create the pressure and ecosystem layers will also be based mainly on the previous assessment. There are, however, some changes and improvements to how certain layers are made and what data they will be constructed from.

Eutrophication

Eutrophication is one of the main threats to the biodiversity of the Baltic Sea and the nutrient pressure layers had the biggest contribution to the total impact in HOLAS II cumulative impact assessment. The concentration of nutrients (total nitrogen and phosphorus) were used to produce the pressure layers in HOLAS II. Based on the feedback from HOLAS II process, the CIA Scoping meeting (CIA SCOPING 1-2020) and the technical workshop (Technical CIA WS 1-2020), better ways to depict the spatial distribution and the pressure caused by nutrients are needed. This issue was discussed at the Workshop on Spatial impact and pressure assessment (HELCOM MetDev SPIA WS 1-2021) and a task group was established to develop the methodology further.

In the first gathering of the task group, different approaches to develop the layers were discussed. Potential solution included to use the data and methodologies used in the HELCOM indicator work for eutrophication or finding better ways to interpolate the concentration of nutrients by using the DIVA software, or other sophisticated methods. Using the established methodologies from the HELCOM indicator work (eutrophication ratios per assessment unit) would offer an agreed and well documented methodology that is already used in other eutrophication work. However, the spatial scale in these two assessments are somewhat different and the usage of this methodology in the cumulative impact assessment context, requires further development.

Given the importance of the layers and the short time to develop the methodology after the MetDev workshop, the task group suggests that this work will continue during the fall 2021, and the final methodology will be submitted to HOD 61-2021, for approval. Desirable option would be to use the eutrophication ratio based HELCOM indicator methodology and efforts to transfer this method to fit the cumulative impact assessment will continue. However, the concentration-based interpolation approach as used in HOLAS II but with more advanced interpolation methods is also kept on the table at this stage, to ensure the best available methodology can be found.

Introduction of NIS

This section provides background info and a method summary of the suggestion to develop the pressure layer on Introduction of non-indigenous species and translocations. A full description of methodology can be found in annex 2.

Background

HELCOM HOLAS III will include spatial assessments of anthropogenic pressures and their potential effects on the Baltic marine environment. This will require spatial data or models of pressure distributions. Already

HOLAS II included spatial layers of anthropogenic pressures which were used separately in pressure assessments and together in the cumulative effect assessment (CEA) called Baltic Sea Impact Index (BSII).

Spatial representation of the distribution of non-indigenous species (NIS) is not a simple task for at least three reasons: (i) many NIS do not establish stable populations but are found occasionally in marine surveys, (ii) marine monitoring programmes do not focus to assess distributions of NIS, and (iii) it is not obvious which NIS should be included in maps. The HOLAS II approach to indicate this pressure was based on the number of observed NIS per assessment unit. In HOLAS III, this pressure layer could be improved to indicate the threat more realistically in marine environment.

Method summary

The suggested approach will use the most up-to-date input data from the available NIS portals agreed in HELCOM level and reviewed by HELCOM experts. The list of NIS will be filtered to include only established species which are suspected (or known) to cause adverse effects for the marine environment. Based on the observations, extents of the geographical distribution will be estimated (i.e. outer boundaries of the distribution). The NIS species will be linked to their characteristic habitats. As the HELCOM habitat (and ecosystem component) maps are well advanced, the intersection of the NIS distribution and habitat maps will produce a more realistic maps of the NIS distributions. The maps can be reviewed by HELCOM experts. The final pressure layer follows the CIMPAL method (Katsanevakis et al., 2016; Teixeira et al. 2019) where each species is given a weight score to indicate its potential impacts on ecosystem components. These weight scores are used when integrating the species spatial layers (by weighted sum) into a pressure layer representing the pressure to marine environment.

Benthic habitats

In HOLAS II, Ecosystem components presenting benthic habitats were based on data submitted by Contracting Parties, that was generalized for 5x5km grid. The data included mainly observation points, but also modelled distribution for some habitats and regions. Observation points are based on national monitoring programs that were carried out within the assessment period of HOLAS II, that was 2011-2016.

Benthic habitats (species) that were included in HOLAS II assessment were Furcellaria lumbricalis, Fucus sp., Charophytes, Mytilus spp. and Zostera Marina. Except for Charophytes all species selected for HOLAS II, have a distribution that is centred around the more southern parts of the Baltic, due to salinity gradient in the Baltic Sea. In order to have a more balanced selection of species and to cover also the northern and less saline parts of the Baltic, the following species were decided to be added to the assessment: Potamogeton, Myriophyllum, Najas marina, Fontinalis, Callitriche and Zanichellia. These species were included in the national data call for HOLAS III, and the layers will be used and edited in a similar manner than described above, as submitted by Contracting Parties.

Similar methodology to produce the benthic habitat layers will be also used for HOLAS III but including some additional data improvements.

Firstly, the national monitoring programs for different species and regions vary between different years and it is possible that within the HOLAS III period (2016-2021), exhausting monitoring is not carried out across all species and regions. The layers for benthic habitats that are comprised of observation points of absence/presence, there is a risk that the distribution would be underestimating the geographical extent of some species. Therefore in HOLAS III the data to produce the benthic habitat layers will be based on the monitoring that has taken place within both HOLAS II and HOLAS III assessment periods. The data that will be included will therefore comprise of the period of 2011-2021.

Secondly the aggregation of data to 5x5km grid is potentially overestimating the geographical extent of some species, as their distribution might be limited within this area, due to e.g. substrate or depth. In HOLAS III the distribution of benthic habitats will be "clipped" to include only areas within this 5x5km grid that is suitable for each species. Different environmental gradient layers will be used for this purpose. The suitability of the environmental gradient layers for each species will be considered separately. The final decision, how to carry out this work and which environmental layers to use, will be made when the HOLAS III data call is completed during spring 2022.

Uncertainty and validation of the assessment

The assessment of uncertainty of the SPIA is important for the transparency of the assessment and to understand the limitations of a such assessment. Uncertainty can be considered to be comprised of the uncertainty of data and the uncertainty of the methodology, including the assumptions and modelling done to create the data layers.

In HOLAS II, the uncertainty of data layers were considered as the regional availability of data and as a description of the quality of data indicated in the metadata description of most of the layers. Same methods are applied in HOLAS III, with small improvements. In HOLAS III there should be better information available regarding the rationale if data for some layer is not submitted by a Contracting Party. This enables better and more accurate maps regarding the regional data availability of human activities and ecosystem components. This information will also be taken into account in the metadata descriptions of the layers. In addition to the qualitative data quality description, a quantitative method will be used to rank the uncertainty of each layer, as far as it's possible.

Uncertainty, or the effect, of the sensitivity scores will be assessed by using a Monte Carlo simulation. The SPIA will be run 100 times with randomly generated sensitivity scores and the different results will be analysed in terms of variability of the result, the visual effect for the impact distribution and change in the contribution of pressures and ecosystem components for the total impact. This analysis will provide information on the magnitude of effect the scores have for the result and how largely is contributes to the uncertainty of the assessment as a whole. The possibilities to implement similar Monte Carlo simulation for the intensity of pressure and ecosystem layers, will be scrutinized during the remaining months of the MetDev project.

Validation of a cumulative impact assessment is challenging due to the complex and overarching nature of the assessment and was not carried out in HOLAS II. In HOLAS III an attempt will be made to validate the assessment by testing the comparison to other cumulative impact, status or environmental assessments.

Annex 1 Pressure and ecosystem component layers to be used in HOLAS III

Table 1The aggregated pressure layers that will be used in the SPIA in HOLAS III.

Layer code	Name of the pressure layer
PL_01	Physical loss
PL_02	Physical disturbance
PL_03	Changes to hydrological conditions
PL_04	Input of continuous anthropogenic sound
PL_05	Input of impulsive anthropogenic sound
PL_06	Input of heat
PL_07	Inputs of hazardous substances
PL_08	Relative distribution of nutrient concentration - Total Nitrogen*
PL_09	Relative distribution of nutrient concentration - Total Phosphorus*
PL_10	Introduction of radionuclides
PL_11	Oil slicks and spills
PL_12	Disturbance of species due to human presence
PL_13	Extraction of fish - Herring extraction (landings)
PL_14	Extraction of fish - Cod extraction (landings)
PL_15	Extraction of fish - Sprat extraction (landings)
PL_16	Extraction of seabirds - Bird hunting
PL_17	Extraction of mammals - Seal hunting
PL_18	Introduction of non-indigenous species and translocations*

**Layer name might change due to possible changes in the methodology*

Layer code	Name of the Ecosystem component layer
EC_01	Productive surface waters (Chl-a)
EC_02	Deep water habitats not influenced by permanent anoxia
EC_03	Infralittoral hard substrate
EC_04	Infralittoral sand
EC_05	Infralittoral mud
EC_06	Infralittoral mixed substrate
EC_07	Circalittoral hard substrate
EC_08	Circalittoral sand
EC_09	Circalittoral mud
EC_10	Circalittoral mixed substrate
EC_11	Furcellaria lumbricalis distribution
EC_12	Zostera marina distribution
EC_13	Charophyte distribution
EC_14	Mytilus distribution
EC_15	Fucus distribution
EC_16	Sandbanks (1110)
EC_17	Estuaries (1130)
EC_18	Mudflats and sandflats (1140)
EC_19	Coastal lagoons (1150)
EC_20	Large shallow inlets and bays (1160)
EC_21	Reefs (1170)
EC_22	Baltic Esker islands (1610)
EC_23	Submarine structures made by leaking gas (1180)
EC_24	Boreal Baltic islets and small islands (1620)
EC_25	Potential nursery areas for flounder (PBS)*
EC_26	Potential recruitment areas for perch (PBS)*
EC_27	Potential recruitment areas for pikeperch (PBS)*
EC_28	Potential spawning areas for cod (PBS)*
EC_29	Potential spawning areas for Baltic flounder (PBS)*
EC_30	Potential spawning areas for European flounder (PBS)*
EC_31	Potential spawning areas for herring (PBS)*
EC_32	Potential spawning areas for Sprat (PBS)*
EC_33	Wintering areas for birds
EC_34	Breeding areas for birds
EC_35	Grey seal distribution
EC_36	Harbour seal distribution
EC_37	Ringed seal distribution
EC_38	Harbour porpoise distribution
EC_39	Potamogeton distribution**
EC_40	Myriophyllum distribution**
EC_41	Najas marina distribution**
EC_42	Fontinalis distribution**
EC_43	Callitriche distribution**
EC_44	Zanichellia distribution**

**Updated fish layer created in Pan Baltic Scope project*
***New layer for HOLAS III*

Annex 2 Renewed methodology for the pressure layer Introduction of NIS

Pressure layer for established marine non-indigenous species in the Baltic Sea

Background

HELCOM HOLAS III will include spatial assessments of anthropogenic pressures and their potential effects on the Baltic marine environment. This will require spatial data or models of pressure distributions. Already HOLAS II included spatial layers of anthropogenic pressures which were used separately in pressure assessments and together in the cumulative effect assessment (CEA) called Baltic Sea Impact Index (BSII).

Spatial representation of the distribution of non-indigenous species (NIS) is not a simple task for at least three reasons: (i) many NIS do not establish stable populations but are found occasionally in marine surveys, (ii) marine monitoring programmes do not focus to assess distributions of NIS, and (iii) it is not obvious which NIS should be included in maps. The HOLAS II approach to indicate this pressure was based on the number of observed NIS per assessment unit. In HOLAS III, this pressure layer could be improved to indicate the threat more realistically in marine environment.

Method summary

The suggested approach will use the most up-to-date input data from the available NIS portals agreed in HELCOM level and reviewed by HELCOM experts. The list of NIS will be filtered to include only established species which are suspected (or known) to cause adverse effects for the marine environment. Based on the observations, extents of the geographical distribution will be estimated (i.e. outer boundaries of the distribution). The NIS species will be linked to their characteristic habitats. As the HELCOM habitat (and ecosystem component) maps are well advanced, the intersection of the NIS distribution and habitat maps will produce a more realistic maps of the NIS distributions. The maps can be reviewed by HELCOM experts. The final pressure layer follows the CIMPAL method (Katsanevakis et al., 2016; Teixeira et al. 2019) where each species is given a weight score to indicate its potential impacts on ecosystem components. These weight scores are used when integrating the species spatial layers (by weighted sum) into a pressure layer representing the pressure to marine environment.

Method details

The method addresses the consequences of pressures arising from non-indigenous species (i.e. alien species), through measurements of their impacts on the natural systems by the Cumulative IMPact of ALien species (CIMPAL) index (Katsanevakis et al., 2016; Teixeira et al. 2019).

CIMPAL is a semi-quantitative expert judgement-based approach to rate alien species impacts, providing a unit-less cumulative impact index. The vulnerability of marine ecosystems to the additive negative impact of marine alien species was assessed with the **CIMPAL** index (Equation 1), after Katsanevakis et al. (2016). The index (I_c) was calculated for the 10x10km EEA grid (Teixeira et al. 2019) and will be calculated to a finer grid in HOLAS III.

Equation 1 $$I_c = \sum_{i=1}^{n} \sum_{j=1}^{m} A_i H_j w_{i,j}$$

where, A_i = status of alien species *i*, H_j = index of the extent of habitat *j*, $w_{i,j}$ = impact weight for alien species *i* and habitat *j* , n = number of alien species, and m = number of marine habitats. The index is calculated in its simplified binomial version, using 0 for absence and 1 for presence of habitat (H_j) and species (A_i).

Impact weights ($w_{i,j}$) of alien species in biodiversity were defined by following the **uncertainty-averse strategy**, which accounts for the magnitude of the impacts (Table 1; Figure 1) and the strength of evidence of the information on impacts (Table 2). The classification of the magnitude of the impacts is based on the Blackburn et al. (2014) proposal adapted for the marine environment by Katsanevakis et al. (2016) (Table 1). This assessment considers only negative impacts of alien species specifically affecting biodiversity at different levels (Katsanevakis et al., 2014).

Table 1. Categories for characterizing the magnitude of the impact and respective score, adapted from Blackburn et al. 2014 and Katsanevakis et al. 2016.

Impact categories: score and definition	
Minimal (0)	No effect on fitness of native species; negligible impact on native species due to competition or predation or parasitism or toxicity or bio-fouling or grazing/herbivory; negligible impact on ecosystem processes and ecosystem functioning; negligible impact on keystone species or species of high conservation value; no chemical, physical or structural impact on the ecosystem (not an ecosystem engineer).
Minor (1)	Reduction in individual fitness due to competition or predation or parasitism or toxicity or bio-fouling or herbivory, but no substantial population declines; minor impact on ecosystem processes and ecosystem functioning with no related population declines; negligible impact on keystone species or species of high conservation value; or causes changes in chemical, physical or structural habitat characteristics without decline of native populations.
Moderate (2)	Declines in population densities because of competition or predation or parasitism or toxicity or bio-fouling or herbivory, but no changes in community composition; or displacement of no more than one species of similar niche; or impact on ecosystem processes and ecosystem functioning resulting to population declines but no substantial change in species composition; or reduction in individual fitness of at least one keystone species or species of high conservation value, but no substantial population declines; or ecological engineering, resulting to population declines but no substantial change in community composition.
Major (4)	Changes in community composition and local or population extinction of at least one native species, because of competition or predation or parasitism or toxicity or bio-fouling or herbivory; impact on ecosystem processes and ecosystem functioning resulting to change in species composition; or population decline of at least one keystone species or species of high conservation value; or ecological engineering, resulting to change in community composition. Induced changes are reversible in the short term (<1 decade) with proper management measures or if the alien species population declines naturally.
Massive (8)	The same as in 'major' but changes are irreversible in the short term (<1 decade) or currently there is no known effective management action for the control of the invasive alien species and a natural decline of its population seems highly unlikely.

Table 2. Strength of evidence of the impact information adapted from Katsanevakis et al. 2016.

Strength of Evidence categories	
High	Impact is documented based on **Manipulative Experiments** (field or laboratory experiments that include treatments/control and random selection of experimental units) or **Natural Experiments** (one of the elements of manipulative experiments is missing and the experimental units are selected by nature, i.e. not randomly)
Medium	Impact is documented based on **Modelling** (i.e. as derived from ecosystem models), **Direct Observations** (an observation or direct measurement of the impact about which there is no doubt, e.g. large-scale mortality events because of harmful algal blooms), or **non-experimental-based Correlations** (inference based on an observed correlation between the species' presence/abundance and the impact, but not based on an experimental design for data collection)
Low	Impact is based on **Expert Judgement**, usually on the basis of empirical knowledge or the species' traits or the documented impact of similar species

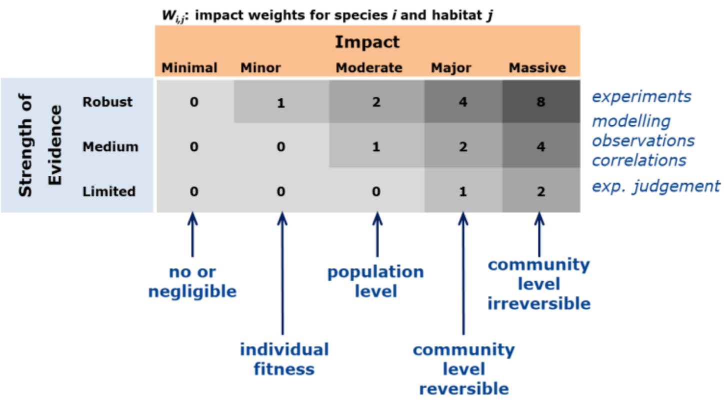

Figure 1. Impact weights defined on the basis of the magnitude of impact and the related strength of evidence following an uncertainty-averse strategy (adapted from Katsanevakis et al. 2016).

Criteria for alien species selection

The list of alien species should consider established species observed within the geographical area of interest and which have been selected on the basis of the following criteria:

1. All alien species considered to have an impact on biodiversity of coastal and marine ecosystems in the Baltic Sea will be included. The selection will follow the NIS portals agreed on HELCOM level and national experts can review and revise the selections.
2. All alien species included in the assessment need to have established populations in the area.
3. Cryptogenic (CR) species have been excluded from this assessment.
4. Alien fresh-water species can be included if they cause adverse effects in any parts of the Baltic Sea.

Alien species' distributions

The data covers all observations since the first observation but changes in the distribution area (e.g. disappearances) are taken into account in the review process.

Alien species habitats

This assessment focuses on the negative cumulative impacts of alien species on coastal and marine habitats, for which the main habitat types were considered. In addition to coastal and marine waters, also coastal littoral zones, estuaries and coastal lagoons can be included in the assessment, whenever spatial data is available. Teixeira et al. (2019) used a simplified reduced list of 16 habitat categories as the basis for assigning the negative impacts of alien species in biodiversity (Table 4). This can be changed to the HELCOM HOLAS III ecosystem component list.

Adverse effects of alien species are reported to different habitats, communities and species in the several NIS portals. Emphasis should be in the Baltic Sea relevant information. These reported habitats will be aligned with the HELCOM HOLAS III ecosystem components.

Table 4. Reduced list of 16 habitats used in this assessment for assigning species negative impacts.

Reduced list of habitats	source	Equivalence to habitats in source
Estuaries & coastal lagoons infralittoral	Derived from Copernicus Water & Wetness 2015	Coastal water surfaces: lagoons, estuaries (WWPI ≥ 95%)
Estuaries & coastal lagoons littoral	Derived from Copernicus Water & Wetness 2015	Intertidal areas (WWPI ≥ 60%)
Coastal wetlands (incl. salt marshes)	Derived from Copernicus Water & Wetness 2015	Coastal wetlands (incl. salt marshes) (WWPI ≥ 20%)
Coastal intertidal softbottoms	This work	Coastal littoral zones (beaches and/or rocky shores)
Coastal intertidal rocky shores	This work	Coastal littoral zones (beaches and/or rocky shores)
***Posidonia* beds**	Emodnet euseamap2016	A5.535 and dependencies
Seagrass-seaweed beds	Emodnet euseamap2016; and derived from Copernicus Water & Wetness 2015	A5.531: Cymodocea beds; Coastal water surfaces: lagoons, estuaries (WWPI ≥ 95%); Intertidal areas (WWPI ≥ 60%)
Coralligenous	Emodnet euseamap2016	A4.26 or A4.32: Mediterranean coralligenous communities moderately exposed to or sheltered from hydrodynamic action
Shallow sediment (<60)	Emodnet euseamap2016	See correspondence in Sup. Mat. 3
Shallow rock (<60)	Emodnet euseamap2016	See correspondence in Sup. Mat. 3
Circalittoral sediment (60-200)	Emodnet euseamap2016	See correspondence in Sup. Mat. 3
Circalittoral rock (60-200)	Emodnet euseamap2016	See correspondence in Sup. Mat. 3
Bathyal-abyssal sediment (>200)	Emodnet euseamap2016	See correspondence in Sup. Mat. 3
Bathyal-abyssal rock (>200)	Emodnet euseamap2016	See correspondence in Sup. Mat. 3
Pelagic (<200)	Emodnet bathymetry portal	derived from bathymetric data: 0 to 200m depth
Mesopelagic (200-1000)	Emodnet bathymetry portal	derived from bathymetric data: 200 to 1000m depth

References

Katsanevakis, S., Tempera, F., & Teixeira H. 2016. Mapping the impact of alien species on marine ecosystems: the Mediterranean Sea case study. Diversity and Distributions, 22: 694-707.

Teixeira H, Zenetos A, Katsanevakis S & Korpinen S (2019) Cumulative Impact of Marine Alien Species (CIMPAL) in European Seas. In: Korpinen et al., Multiple pressures and their combined effects in Europe's seas. ETC/ICM Technical Report 4/2019: European Topic Centre on Inland Coastal and Marine waters 164 pp,