Baltic Marine Environment Protection Commission

HELCOM Platform for sufficiency of measures — SOM Platform 3-2020

Helsinki, Finland, 24-26 March 2020

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Code	3-2
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Reference	

Background

Sufficiency of measures analysis supports the BSAP update by assessing the pressure reductions and state improvements that can be achieved with existing measures. Methods to accomplish this task have been developed in the HELCOM ACTION project, with guidance from the SOM platform. Input data to the SOM model on activity-pressure contributions, effectiveness of measures and pressure-state linkages come from online expert surveys, literature reviews and other data sources. Document 2-1 describes the SOM approach and the data used in the SOM model in detail.

This document presents the first interim results of the SOM model using benthic habitats and non-indigenous species as examples. It includes initial proposals on how the results could be presented and visualized, as well as how uncertainty can be addressed in presenting the results. The document will potentially be updated to include additional results before the 3rd meeting of SOM Platform, and sent as a revised document.

It is worth noting some simplifications of the current version of the SOM model that will be addressed at a later stage. In this presentation of the interim model results, only expert survey data for the effectiveness of measures are used. Literature data on effectiveness of measures will be incorporated in the analysis later. Additional considerations of joint effects and spatial restrictions in the measures may still be included. Projections on the development of human activities have not yet been included in the model and will be added later.

Note that the numeric results are not final – they will change as more topics and interactions across topics and the development of human activities will be added to the SOM model. The main aim of this document is to illustrate the potential SOM results and their presentation.

Action requested

The Meeting is invited to:

- consider the preliminary results of the SOM analysis
- agree on how they can be used and presented in the further BSAP update process.

Interim results of sufficiency of measures analysis

Contents

Introduction

This document presents the interim results of the analysis for sufficiency of existing measures. The overall approach and details on the input data as well as the SOM model are presented in Document 2-1.

The document describes a set of results which either corresponds to the input data (i.e. effectiveness of single measure types) or are calculated by the SOM model (e.g. total pressure reduction per pressure type, probability to reach good state).

The results are based on survey responses gathered by 29 February 2020, which was set as the endpoint of the data collection via surveys. Some additional data collection and other adjustments to the responses are still possible, as technical problems may require re-surveying some of the experts, and clarifications on individual inputs to group responses are still being elicited. These issues are described in more detail in the method document (Document 2-1).

In principle, the SOM analysis produces various results, including the following:

1. Relative contribution of activities to pressures
2. Lists of existing measures and their implementation status
3. Relative effectiveness of measures types in reducing pressures from activities
4. Effectiveness of measure types in reducing pressures (%)
5. Pressure reductions from existing measures
6. The most significant pressures affecting state components
7. Pressure reductions required to achieve GES/status improvements
8. Status improvements from existing measures
9. Sufficiency of existing measures to achieve GES/a specific status improvement
10. Information on geographic areas and topics where measures are likely to be insufficient
11. Types of measures still needed and activities/pressures they should target
12. Time lags between measures and environmental state

At this stage, results are presented for two topics: benthic habitats and non-indigenous species, and they cover activity-pressure contributions (1 above), effectiveness of measure types (3, 4), effects of existing measures in reducing pressures (5), the significance of pressures affecting state components (6), and impacts of pressure reductions on environmental state (8,9).

The present SOM model version includes consideration of the joint effects (chain effects, thematic overlaps across measure types) and information on the geographic extent of spatially restricted measures.

Note the difference between measure types and existing actual/individual measures. Measure types have been used in the SOM analysis and expert surveys to make the analysis feasibile. However, existing measures are actual individual measures in current policies, and are considered when assessing reduction in pressure from existing measures. Individual existing measures have been linked with the measure types used in the SOM expert surveys to assess the effects of existing measures. In cases where there are several actual measures linked to a single measure type in a given area, it is assumed that the measure type is implemented once, and the effect of the actual measures under the measure type is represented by the effectiveness of the measure type (see Section 12 in Part III in Document 2-1). In cases where the effectiveness of the measures under the same measure type are not equal, as occurs e.g. when one measure is spatially more restricted than the other, the larger effectiveness value is applied.

Description of results

Significance of activities producing a pressure: These results present the percent (%) contribution of activities to a pressure. The input data for the pressures *potential loss of seabed and disturbance to seabed* (benthic habitats) originate from the HELCOM HOLAS II data call for spatial data of pressures. The input data for the pressure *anthropogenic introduction of non-indigenous species (NIS)* is based on the AquaNIS database. The activity-pressure contributions are used to weight the effectiveness of measures, because some measures target activities which have a minor role in producing a pressure, while other measures may target activities of more significant role in the Baltic Sea.

Effectiveness of measure types: The results show the effectiveness of measure types and can be compared across measure types so assess which are more effective than others. The effectiveness is shown by pressures and activities to provide information which activities could be targeted with the measure types. The input data into these results come from the expert online surveys, which also collected assessments of the certainty of the effectiveness. The survey data were fed into the SOM model. The results are based on 10 000 simulations from the pooled distributions that represent the combined view of all experts on the effectiveness of measure types. In addition to the effectiveness of measure types in reducing a pressure from an activity, the effectiveness information has been combined with the activity-pressure contributions to assess the "impacts" of measures and show where in the Baltic Sea these measure types would have the most impact on pressures. The difference to the effectiveness of measures is that the impact includes the activity-pressure contributions and is area-specific at the level of assessment for the topic in question. This gives a more realistic view to the effectiveness of measure types and may give a better understanding which measure types could be preferred in reducing pressures.

Confidence in the effectiveness of measure types results: The experts evaluated their own confidence in the responses given to the effectiveness of measures survey using a three-point scale (high, medium, low). The results are available for each pressure-activity combination. They can be studied side by side with the previous results to interpret the effectiveness data.

Significance of pressures to the state components: In the online survey, experts were asked to identify from three to six significant pressures affecting the state components and assess their significance on a six-point scale (not very significant – extremely significant). These data are primarily an important component of the SOM model, but secondarily, they also provide information on the pressures that could be targeted to improve the state of the Baltic Sea. The results are available for those geographic areas that were defined for the state component in question.

Projected pressure reductions: One of the two main results of the SOM model are the projected pressure reductions. They provide information on the sufficiency of measures for pressure topics, such as nutrient inputs, introduction of non-indigenous species, input of litter and input of noise. The projected pressure reductions feed, however, also the next step which is run only for those topics with state components (mammals, birds, fish, hazardous substances, benthic habitats). The total pressure reductions take into account the joint effects of measures and measure types, which prevents overestimation of pressure reduction. They are presented as probabilities to reduce a certain amount of pressure, and this is shown per HELCOM sub-basin or per groups of sub-basins.

Probability to reach good state/state improvements: This is the end result of the SOM model where all mid-steps are included, and it can be used to evaluate if the existing measures have the potential to reduce enough pressures to reach the good state of each of the state components. In this step, the projected pressure reductions are compared with the so-called gap to good environmental status (i.e. how much pressures should be reduced to achieve good state or specific state improvements). The total pressure reductions are weighed sums of projected pressure reductions, where significances of pressures to the state components and spatial shares of the state assessment areas are used as weights. Whenever there is an existing GES threshold, the expert survey asked the pressure reductions to achieve good state. When

there was no GES threshold, the survey asked pressure reductions required to achieve a specific improvement. The SOM model estimates probabilities to achieve good state, improve the state by a specific percent (%) or achieve a noticeable improvement in state, depending on the state component. The results are estimated for all HELCOM sub-basins.

Benthic habitats

Activity-pressure contributions

Data on activity-pressure contributions for the potential loss and disturbance to the seabed (benthic habitats) is based on the approach employed in HELCOM HOLAS II, which utilizes the Baltic Sea Pressure Index (BSPI) and Baltic Sea Impact Index (BSII) to integrate data reported to the Secretariat from the Contracting Parties through regular reporting and previous data calls. The format of the below graphs of activity-pressure contributions for potential loss and disturbance to the seabed differs from that used in the corresponding graph for primary introductions of non-indigenous species later in this document. This is due to differences in the data used to generate the activity pressure contributions. For potential loss and disturbance to the seabed, no variability is present in the underlying data (only point estimates available), making the stacked bar charts below a more appropriate visualization of the data.

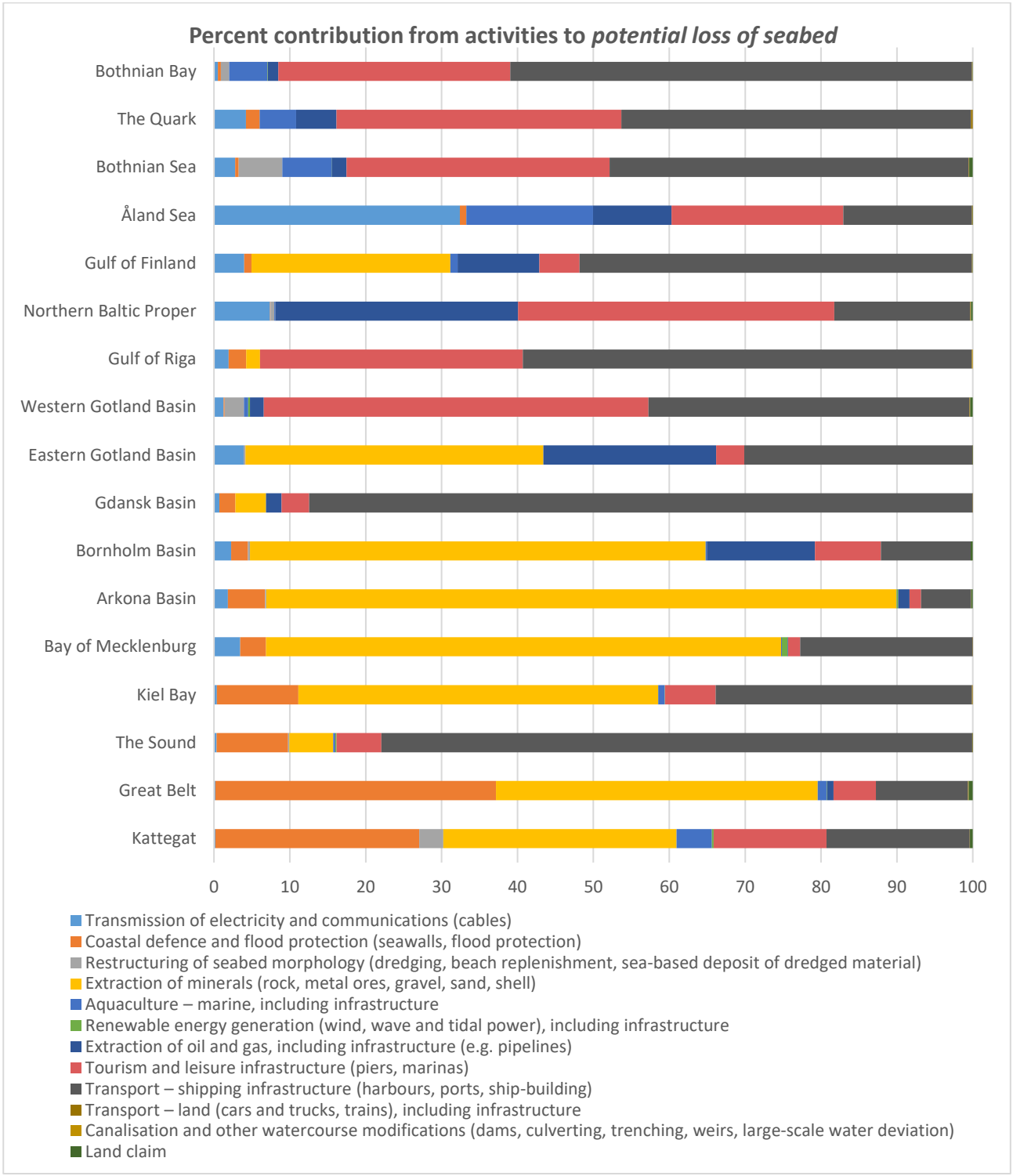


Figure 1. Percent contribution of activities to the *potential loss of seabed* for each of the 17 HELCOM scale 2 sub-basins. Values are derived from data previously submitted to the Secretariat as part of the HOLAS II process.

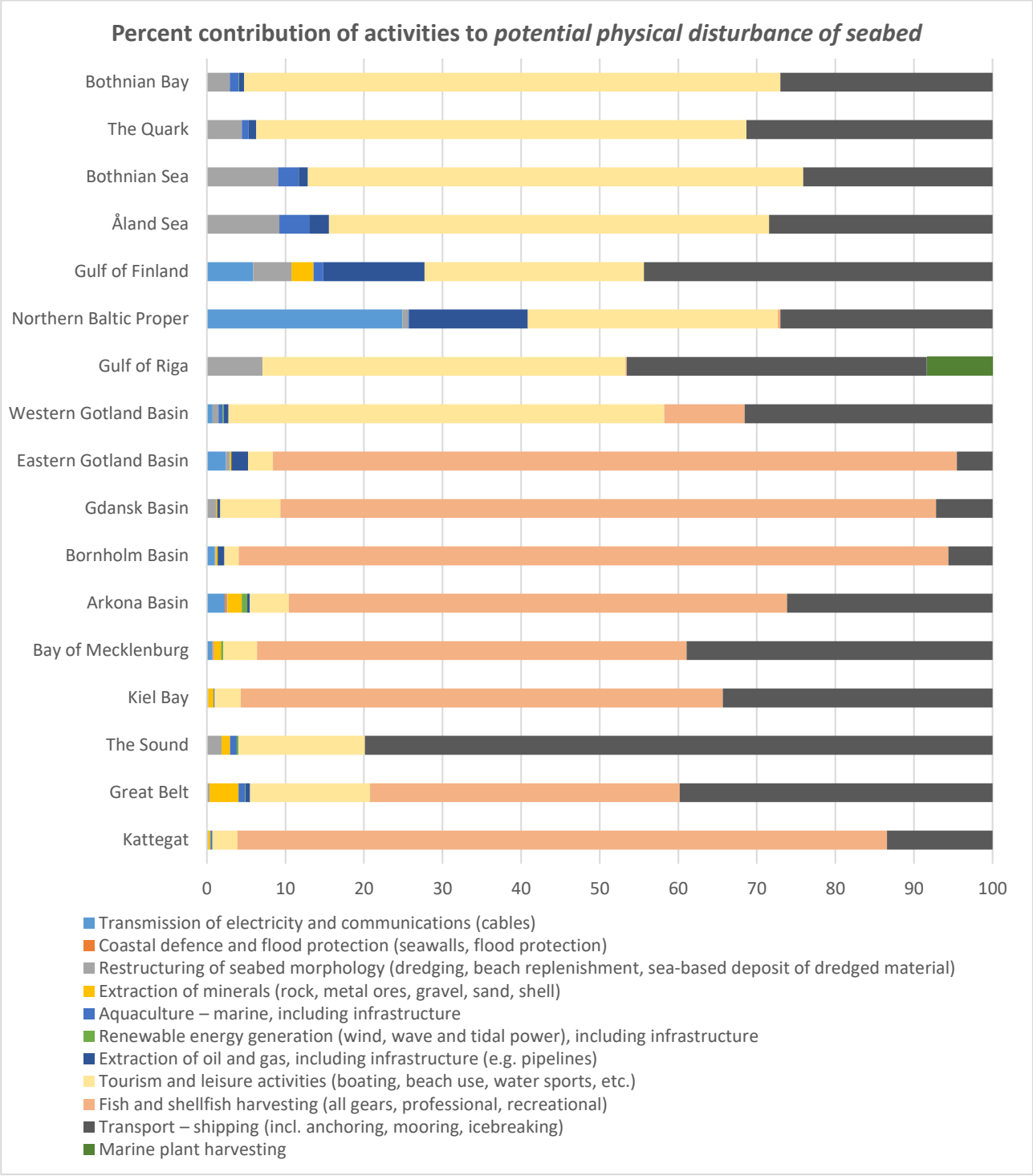


Figure 2. Percent contribution of activities to the *potential disturbance of seabed* for each of the 17 HELCOM scale 2 sub-basins. Values are derived from data previously submitted to the Secretariat as part of the HOLAS II process.

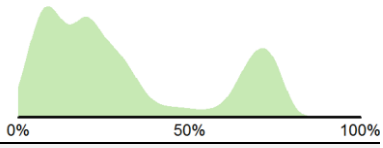
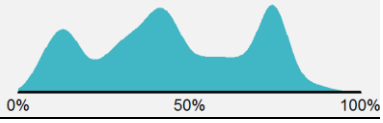
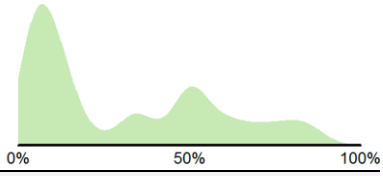
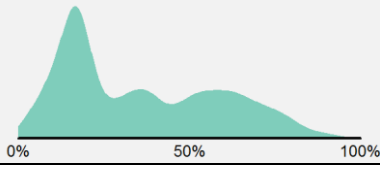
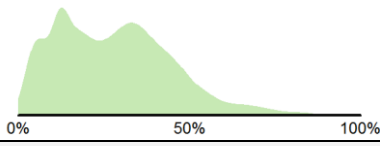
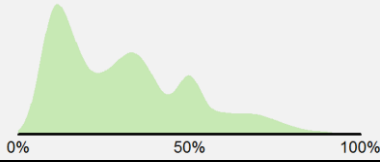
Effectiveness of measure types

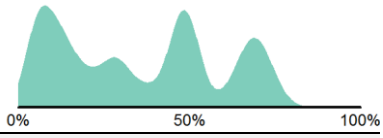
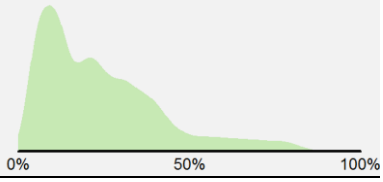
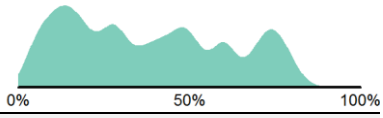
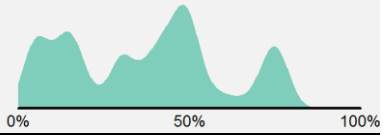
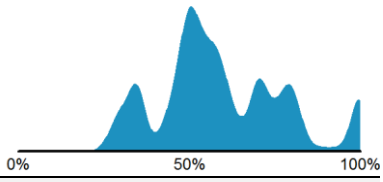
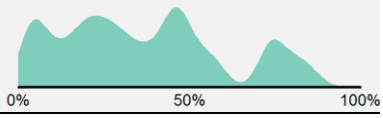
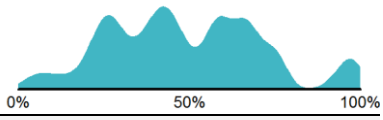
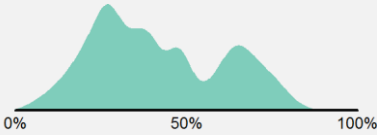
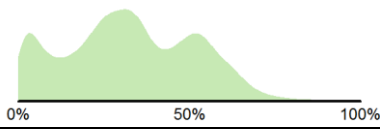
Data on the effectiveness of measures is based on the expert surveys. In general, the data can originate either from online expert surveys or from published sources (peer-reviewed literature, project literature, models). Literature data will be incorporated to the analysis at a later stage.

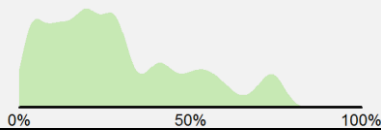
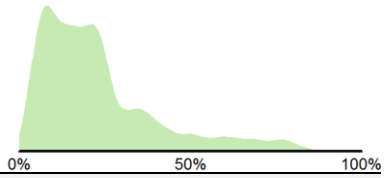
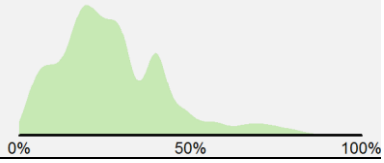
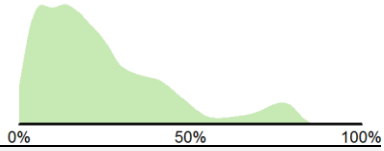
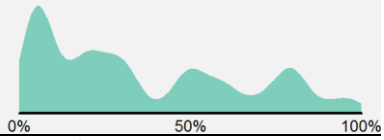
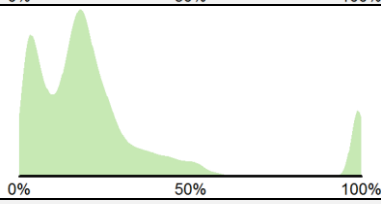
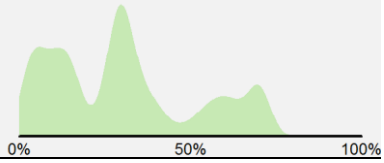
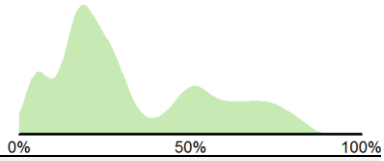
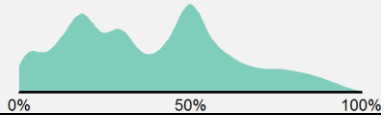
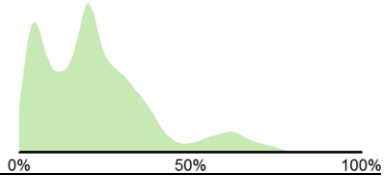
The results are based on two questions: the grid question on the relative effectiveness of the measure types (no effect – highest effect), and the question on the pressure reduction (%) by of the most effective measure type. The relative scale between all the other measure types to the most effective one was used

to define the pressure reductions of those measure types (see Step 4, Section 4 in Part I and Section 15 in Part III in Document 2-1). The certainty of the effectiveness in the grid question was used to form the expert-specific probability distributions of measure type effectiveness. It is assumed that if the lowest certainty was selected, the effectiveness of a measure can have any effectiveness value between 0-100%. However, if the effectiveness calculated from the relative effectiveness values and the effectiveness of the most effective measure is close to either end of the effectiveness scale (0-100%) then the values in the other end would have very low probability. This results from the use of PERT distribution (modified beta distribution). If the highest certainty was selected, the effectiveness is represented by a point value instead of a distribution. in the following, effectiveness is presented per activity, pressure and measure type, and pooled over experts.

Table 1. Distribution of the effectiveness of measure types in controlling the pressure *potential disturbance to the seabed* based on expert responses. The effectiveness of a measure type is the percent reduction in a pressure resulting from a specific activity. Effectiveness values are presented as a probability distribution of effectiveness from 0% to 100% effective. The color of the distribution indicates the average effectiveness of the measure type using the color scale: Low High.

Activity	Measure type	Effectiveness
Extraction of minerals (rock, metal ores, gravel, sand, shell)	Expand EIA reporting requirements e.g. to cover new activities or include new environmental components	
Extraction of minerals (rock, metal ores, gravel, sand, shell)	Enhance legal protection of habitats and species	
Extraction of minerals (rock, metal ores, gravel, sand, shell)	Seasonal restrictions	
Extraction of minerals (rock, metal ores, gravel, sand, shell)	Alternative extraction technologies	
Extraction of minerals (rock, metal ores, gravel, sand, shell)	Full implementation of the EU Maritime Spatial Planning Framework Directive	
Extraction of minerals (rock, metal ores, gravel, sand, shell)	Expand EIA reporting requirements e.g. to cover new activities or include new environmental components	

Aquaculture – marine, including infrastructure	Full implementation of the EU Maritime Spatial Planning Framework Directive	
Aquaculture – marine, including infrastructure	Expand EIA reporting requirements e.g. to cover new activities or include new environmental components	
Aquaculture – marine, including infrastructure	Implement industry best practices	
Aquaculture – marine, including infrastructure	Enhance legal protection of habitats and species	
Fish and shellfish harvesting (all gears; professional, recreational)	Spatial trawling restrictions	
Fish and shellfish harvesting (all gears; professional, recreational)	Seasonal trawling restrictions	
Fish and shellfish harvesting (all gears; professional, recreational)	Enhance legal protection of habitats and species	
Fish and shellfish harvesting (all gears; professional, recreational)	Technical regulations of fishing gear (e.g. type, modifications, etc.)	
Fish and shellfish harvesting (all gears; professional, recreational)	Full implementation of the EU Maritime Spatial Planning Framework Directive	

Transport – shipping (incl. anchoring, mooring)	Enhance legal protection of habitats and species	
Transport – shipping (incl. anchoring, mooring)	Technical modifications to ships	
Transport – shipping (incl. anchoring, mooring)	Speed limits	
Transport – shipping (incl. anchoring, mooring)	Full implementation of the EU Maritime Spatial Planning Framework Directive	
Tourism and leisure activities (boating, beach use, water sports, etc.)	Enhance legal protection of habitats and species	
Tourism and leisure activities (boating, beach use, water sports, etc.)	Full implementation of the EU Maritime Spatial Planning Framework Directive	
Restructuring of seabed morphology (dredging, beach replenishment, sea-based deposit of dredged material)	Limit sediment deposition from e.g. mining to selected "dumping sites"	
Restructuring of seabed morphology (dredging, beach replenishment, sea-based deposit of dredged material)	Application of best practices	
Restructuring of seabed morphology (dredging, beach replenishment, sea-based deposit of dredged material)	Expansion of permitting requirements	
Restructuring of seabed morphology (dredging, beach replenishment, sea-based deposit of dredged material)	Seasonal restrictions	

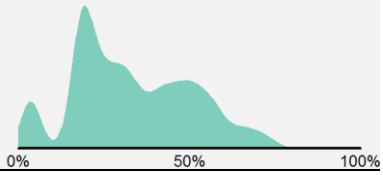
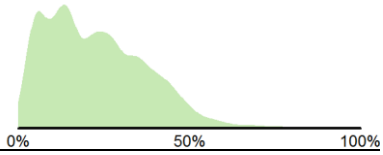
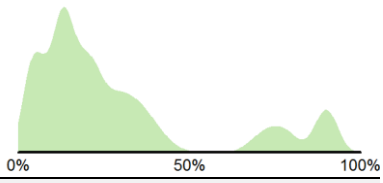
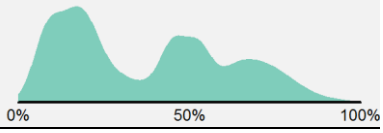
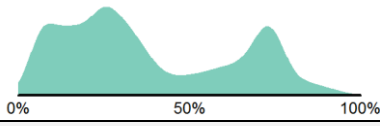
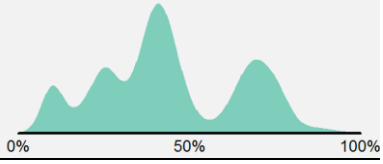
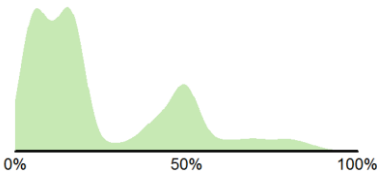
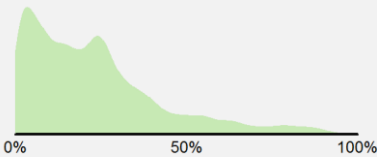
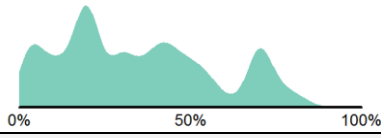
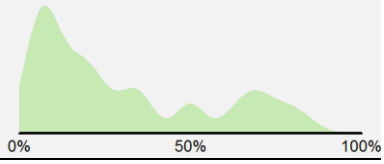
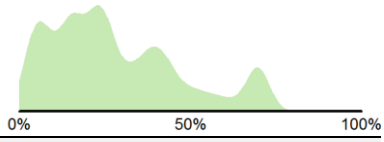
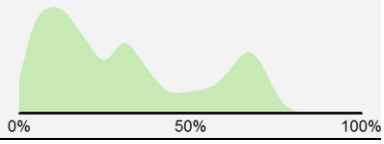
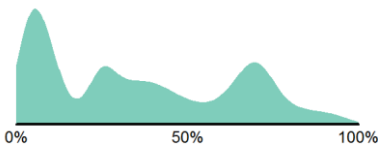
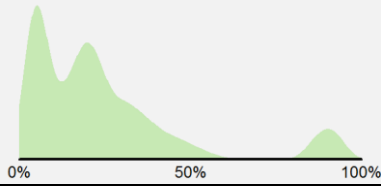
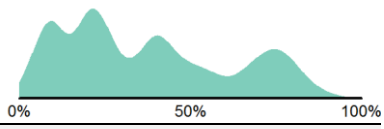
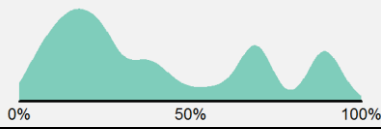
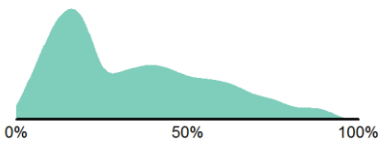
Restructuring of seabed morphology (dredging, beach replenishment, sea-based deposit of dredged material)	Enhance legal protection of habitats and species	
Restructuring of seabed morphology (dredging, beach replenishment, sea-based deposit of dredged material)	Full implementation of the EU Maritime Spatial Planning Framework Directive	

Table 2. Distribution of the effectiveness of measure types in controlling the pressure *potential loss of seabed* based on expert responses. The effectiveness of a measure type is the percent reduction in a pressure resulting from a specific activity. Effectiveness values are presented as a probability distribution of effectiveness from 0% to 100% effective. The color of the distribution indicates the average effectiveness of the measure type using the color scale: Low  **High.**

Activity	Measure type	Effectiveness
Extraction of minerals (rock, metal ores, gravel, sand, shell)	Expand EIA reporting requirements e.g. to cover new activities or include new environmental components	
Extraction of minerals (rock, metal ores, gravel, sand, shell)	Implement national plan for sand and aggregate extraction	
Extraction of minerals (rock, metal ores, gravel, sand, shell)	Full implementation of the EU Maritime Spatial Planning Framework Directive	
Extraction of minerals (rock, metal ores, gravel, sand, shell)	Enhance legal protection of habitats and species	
Transport – shipping infrastructure (harbours, ports, shipbuilding)	Expand EIA reporting requirements e.g. to cover new activities or include new environmental components	
Transport – shipping infrastructure (harbours, ports, shipbuilding)	Full implementation of the EU Maritime Spatial Planning Framework Directive	

Transport – shipping infrastructure (harbours, ports, shipbuilding)	Enhance legal protection of habitats and species	
Coastal defence and flood protection (seawalls, flood protection)	Expand EIA reporting requirements e.g. to cover new activities or include new environmental components	
Coastal defence and flood protection (seawalls, flood protection)	Full implementation of the EU Maritime Spatial Planning Framework Directive	
Coastal defence and flood protection (seawalls, flood protection)	Enhance legal protection of habitats and species	
Tourism and leisure infrastructure (piers, marinas)	Expand EIA reporting requirements e.g. to cover new activities or include new environmental components	
Tourism and leisure infrastructure (piers, marinas)	Full implementation of the EU Maritime Spatial Planning Framework Directive	
Tourism and leisure infrastructure (piers, marinas)	Enhance legal protection of habitats and species	
Restructuring of seabed morphology (dredging, beach replenishment, sea-based deposit of dredged material)	Expand EIA reporting requirements e.g. to cover new activities or include new environmental components	
Restructuring of seabed morphology (dredging, beach replenishment, sea-based deposit of dredged material)	Full implementation of the EU Maritime Spatial Planning Framework Directive	

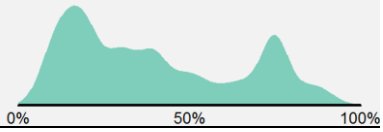
Restructuring of seabed morphology (dredging, beach replenishment, sea-based deposit of dredged material)	Enhance legal protection of habitats and species	

Table 3. Distribution of the effectiveness of measure types directly affecting benthic habitats based on expert responses. The effectiveness of a measure type is the percent improvement in a state component. Effectiveness values are presented as a probability distribution of effectiveness from 0% to 100% effective. The color of the distribution indicates the average effectiveness of the measure type using the color scale: Low  **High.**

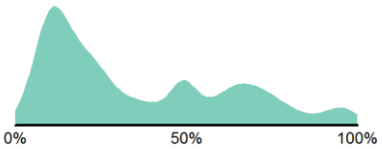
Activity	Measure type	Effectiveness
NA (Direct to state)	Habitat restoration	

Figure 3 shows experts' confidence in the effectiveness of measure types results to reduce physical disturbance and physical loss, which they evaluated using a three-point scale (high, medium, low). The results are presented by pressures and activities and provide supporting information for interpreting the effectiveness of measure types data.

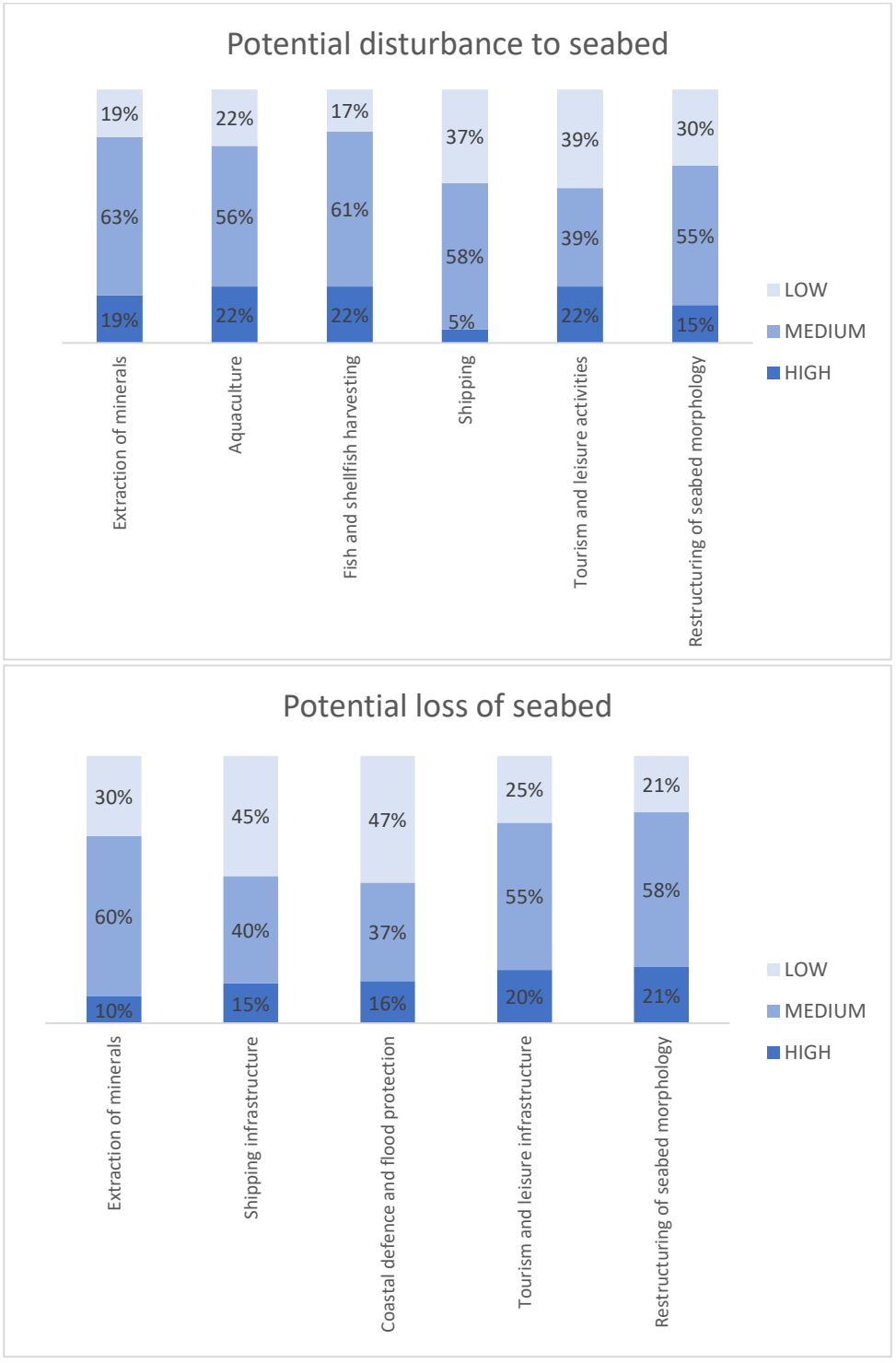


Figure 3. Experts' own confidence in their responses on the effectiveness of measures for potential loss of seabed and potential disturbance to seabed (by activity)

Projected pressure reductions from existing measures

These results show the effects of existing measures in reducing pressures by sub-basin (Figure 4). They are based on the activity-pressure contributions, effectiveness of measure types and links between measures

and measure types. The activity-pressure data are at the sub-basin level, and the effectiveness of measures data at the Baltic Sea level, and thus the total pressure reductions are presented at the sub-basin level. While estimating the effects of existing measures, the SOM model accounts for the joint impacts across measure types (see Sections 12 and 13 in Part III in Document 2-1). It also uses spatial multipliers for spatially limited measures which reflect the actual sea area where the pressures can be reduced (see Section 3 in Part I and Section 14 In Part III in Document 2-1). These are to avoid overestimating the pressure reductions.

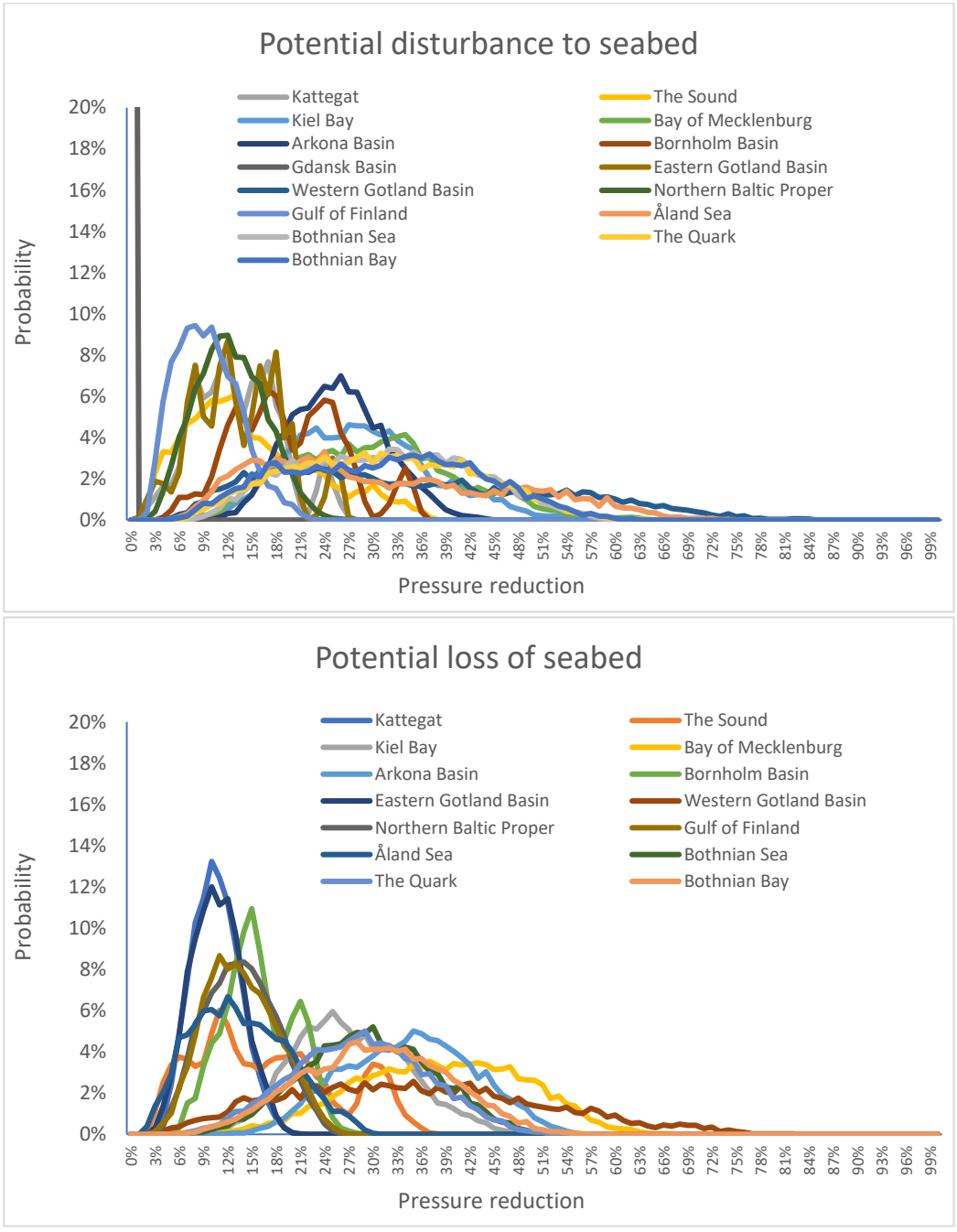
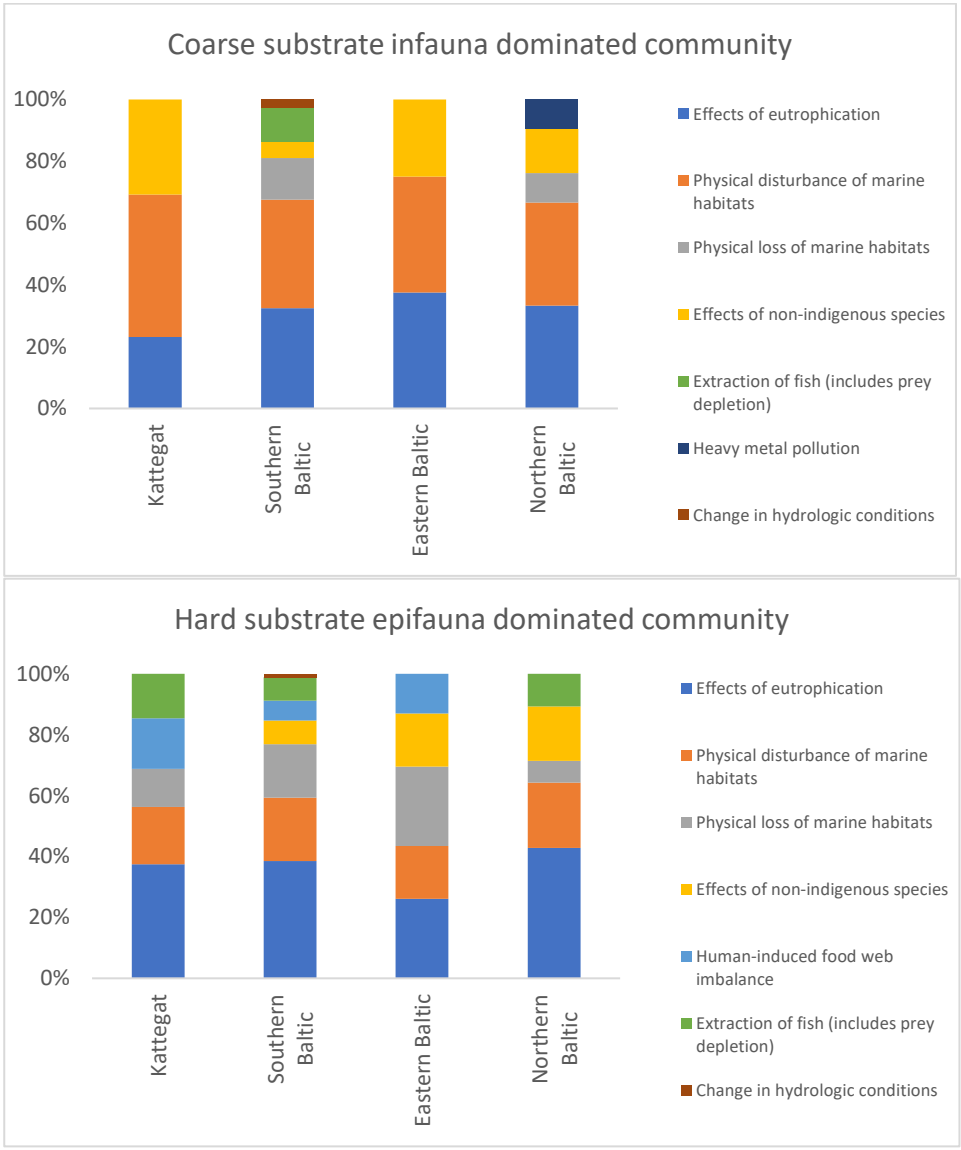


Figure 4. Probability of total pressure reductions with existing measures for potential loss and disturbance to seabed by sub-basin. Note that disturbance and loss of seabed are not reduced in the Great Belt or Gulf of Riga and loss of seabed is not reduced in the Gdansk Basin. The likely reason is that the measures in those areas are already fully implemented (such as trawling bans), and thus there are no measures that are included in the SOM analysis, which considers partially or not yet implemented measures that still have the potential to reduce pressures in the time frame of the analysis. Sub-basins with distributions concentrated on some section of the graph have a relatively narrow range of potential

pressure reduction, while those with flatter distributions extending to the right show more uncertainty and potential for both low and high pressure reductions.

Significance of pressures to state components

Experts identified 3-6 most significant pressures to the five benthic habitat types by area and rated their significance on a scale from 0 = not very significant to 5 = extremely significant. These significance scores were summed across experts, and after that, the score for each individual pressure was divided with the total score for all pressures to calculate the percent shares of pressures to the state component. This calculation was done by habitat types and areas. The results illustrate the significance of different pressures affecting the state component in questions, and in the case of benthic habitats, enables comparison across habitat types and geographic areas. Figure 5 shows the shares of pressures by habitat type and area. It is important to note the high significance of eutrophication as a pressure to benthic habitats, and that the reductions in this pressure are not yet included in the analysis of state improvements for benthic habitats.



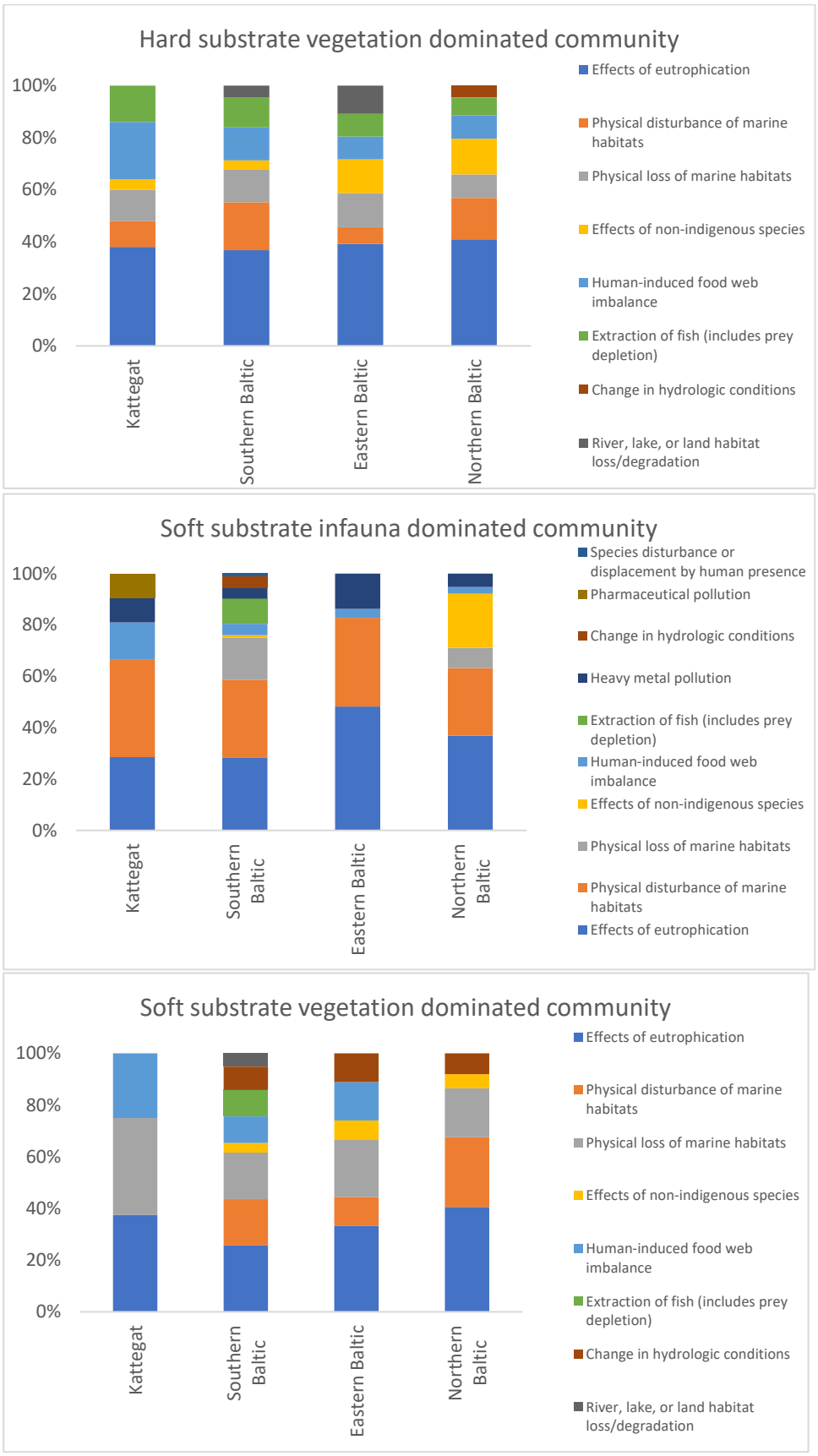
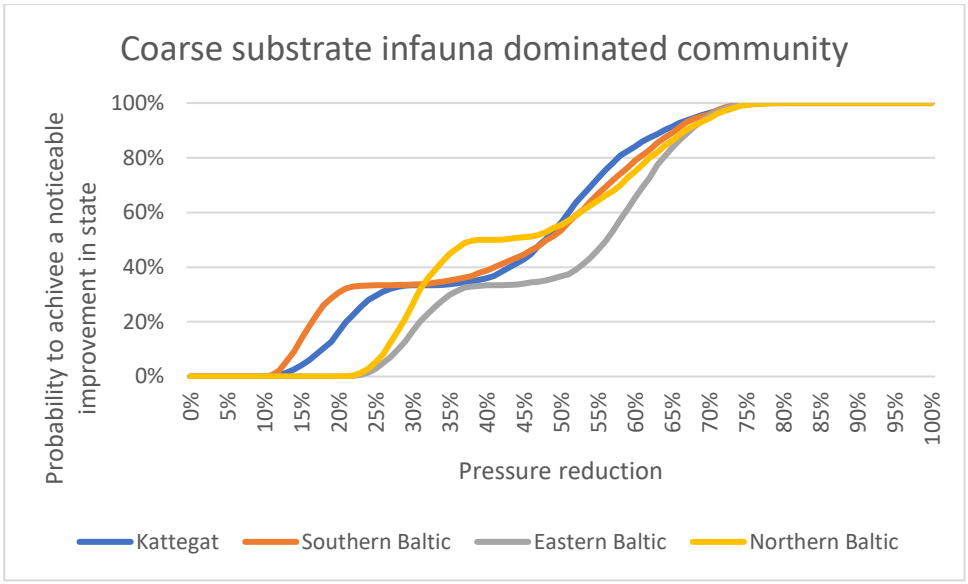


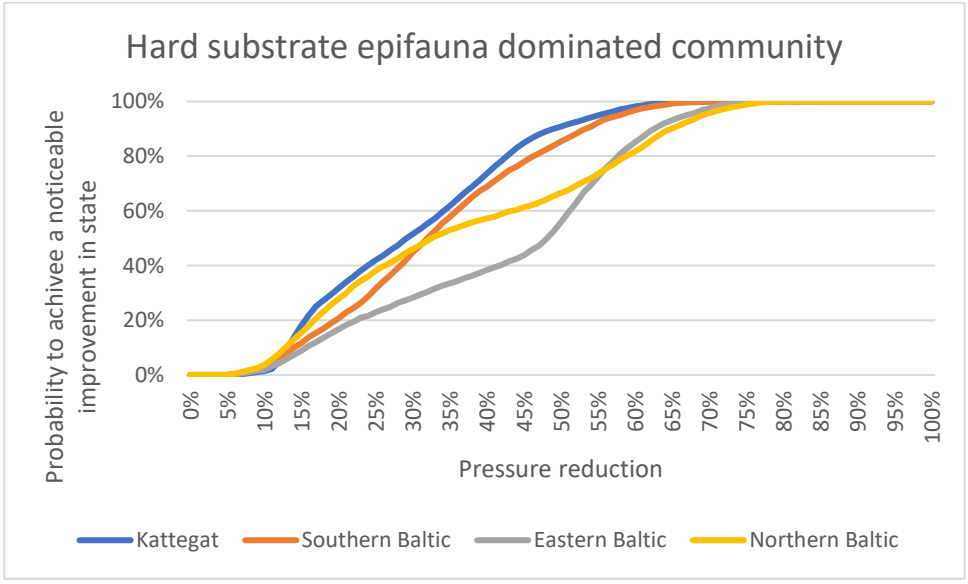
Figure 5. Significance of pressures to benthic habitats (by habitat type and area)

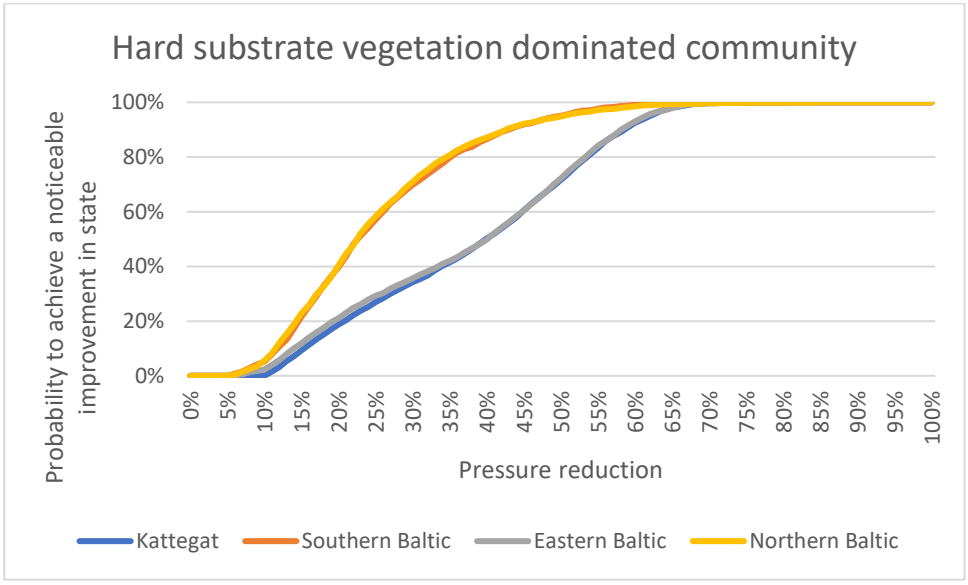
Pressure-state linkages

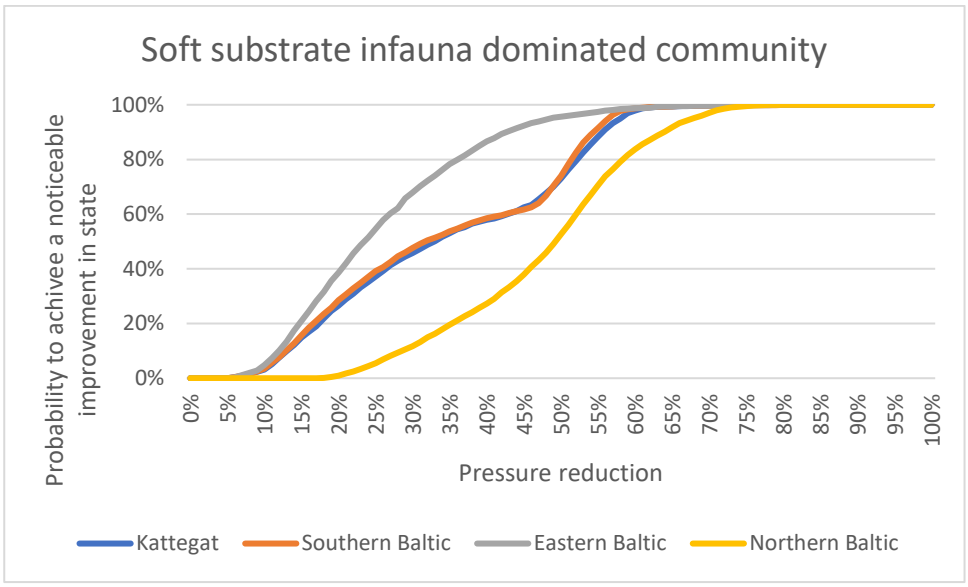
Figure 6 presents the cumulative distributions for required reductions in total pressure, calculated as a weighed sum of projected pressures that are significant for the given state component, for noticeable improvement in state. If total pressure is reduced by certain amount, the probability that this reduction is sufficient to reach good state is the cumulative probability of required pressure reductions to reach good state between 0% reduction in total pressure and the pressure reduction in question. This is based on an assumption that state is improved when total pressure is reduced. It also implies that cumulative probability is equivalent to the probability to reach noticeable improvement in the state of benthic habitats given the reduction in total pressure. These results are shown by habitat type and area. They are based on survey question on the minimum, maximum and most likely pressure reduction required to achieve a noticeable improvement in the state of the habitat type in question.

Combining the results on the reduction in total pressure from existing measures and the pressure reduction required to achieve a noticeable improvement in benthic habitats will indicate the probability to achieve a noticeable improvement in the benthic habitat types with existing measures. However, given the incomplete results for other pressures significant to benthic habitats, e.g. input of nitrogen and phosphorus, this result is not yet considered even preliminary and has been omitted.









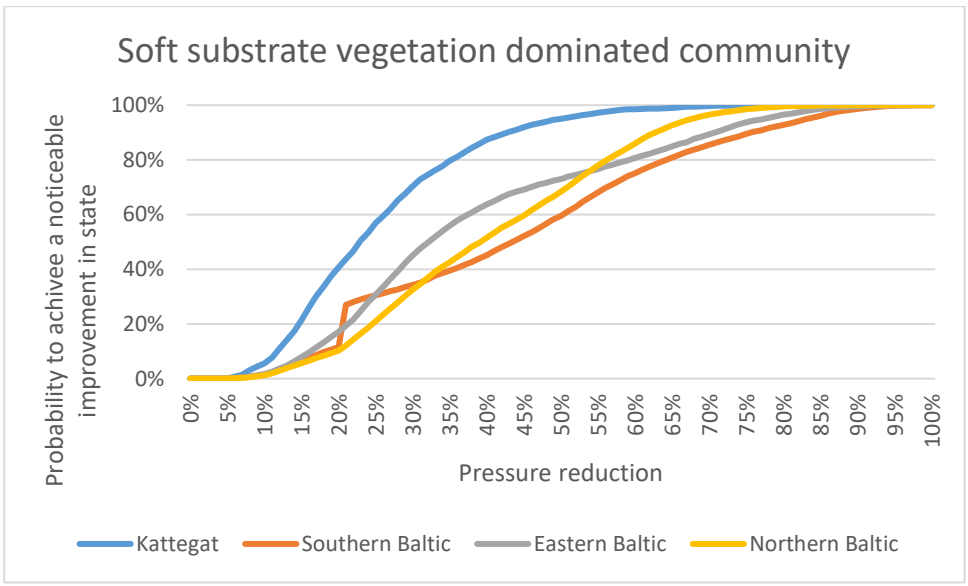


Figure 6. Probability to reach noticeable improvement in state of benthic habitats given the reduction in total pressure by habitat type and area

Background of respondents

Altogether 20 survey responses with 23 experts were received to the effectiveness of measures survey for benthic habitats. Three of the answers were group responses, with two experts contributing to the response. For the pressure-state survey, there were 19 responses with 21 contributing experts. Two group responses were received.

Almost all experts stated marine or benthic ecology/biology as their field. Most experts had over 10 years of experience in their field (Table 2). Experts represented universities, government institutes, state agencies or ministries. Note that response numbers by countries and topics are presented in Document 2-1.

Table 2. Years of experience in the field for benthic surveys

	Effectiveness of measures		Pressure-state	
Years	**Number of experts**	**Share of experts**	**Number of experts**	**Share of experts**
0-2 years	0	0%	0	0%
3-5 years	1	4%	1	5%
5-10 years	3	13%	3	14%
10-20 years	12	52%	9	43%
over 20 years	7	30%	8	38%

Non-indigenous species

Activity-pressure contributions

Data for the activity-pressure contributions on the primary introduction of non-indigenous species have been gathered from the AquaNIS database on reported vectors of introduction for all primary introductions into the Baltic Sea in 2005-2016.

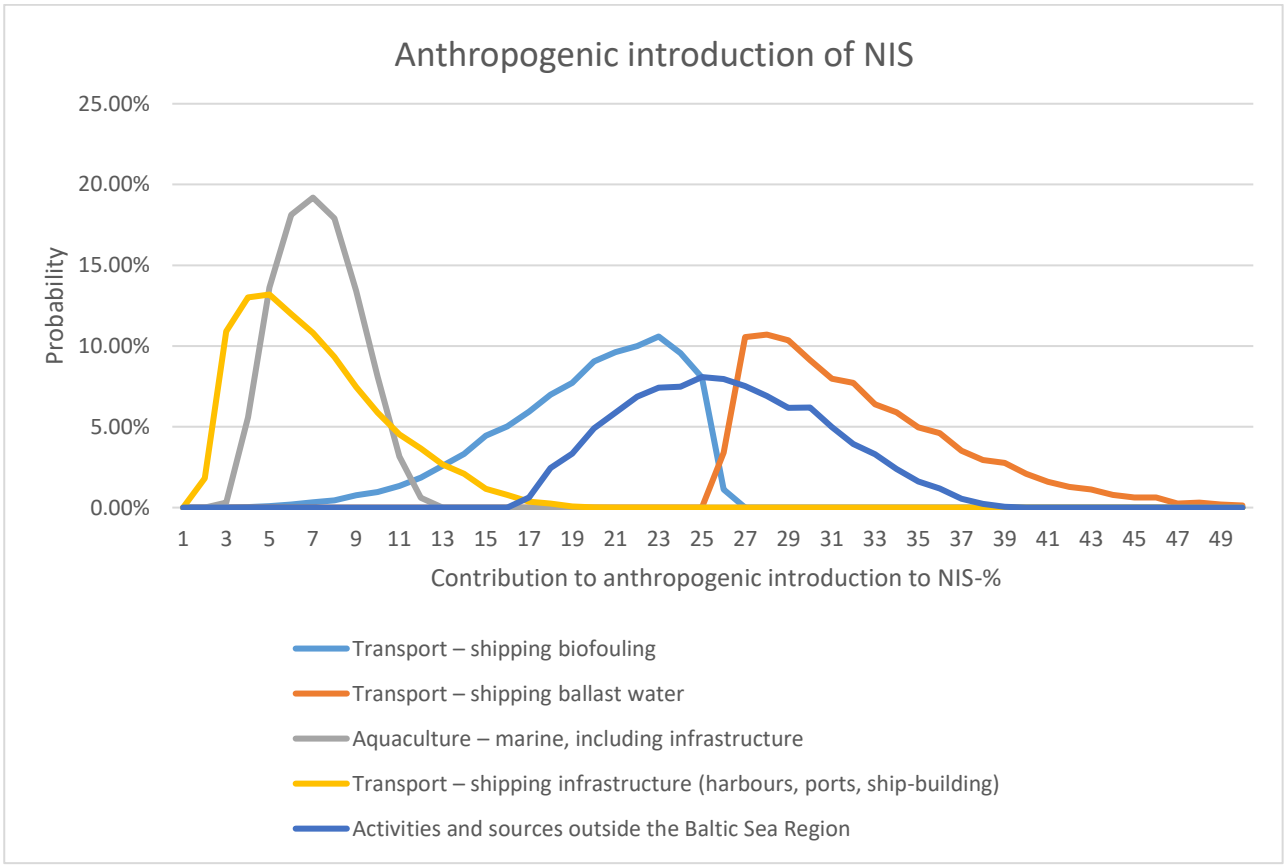


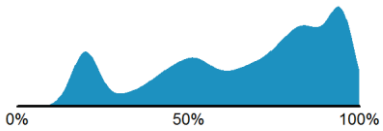
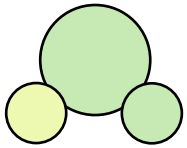
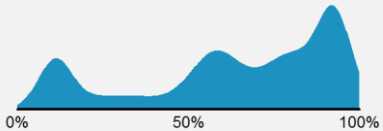
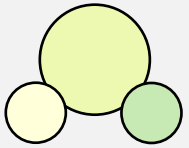
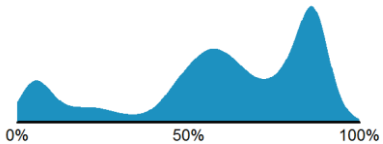
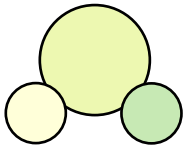
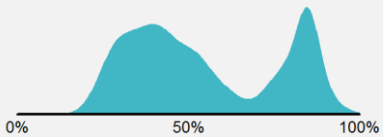
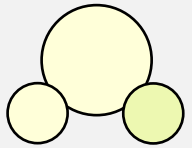
Figure 7. Activity-pressure contributions for introduction of non-indigenous species. Values are derived from data retrieved from the AquaNIS database.

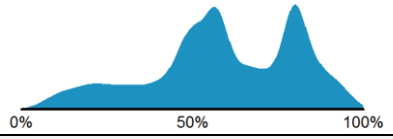
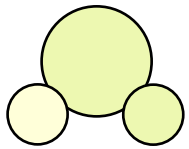
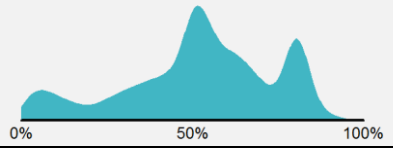
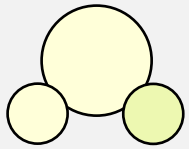
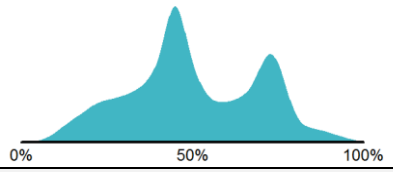
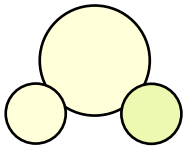
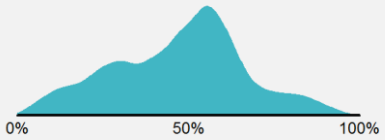
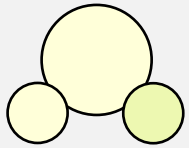
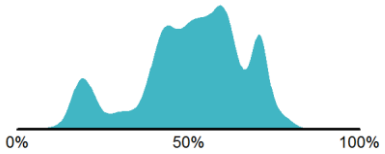
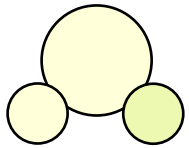
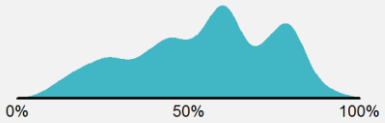
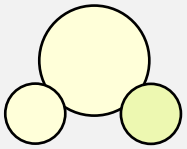
Effectiveness of measure types

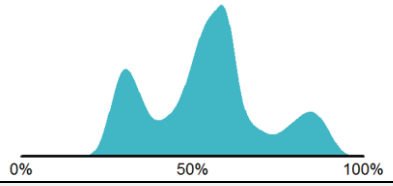
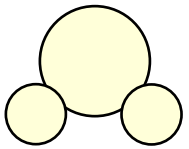
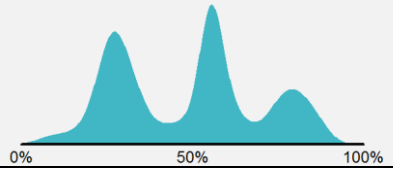
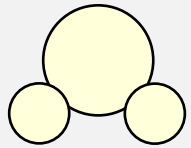
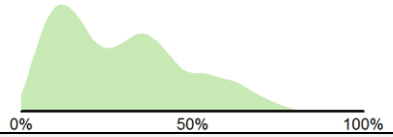
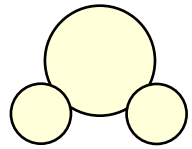
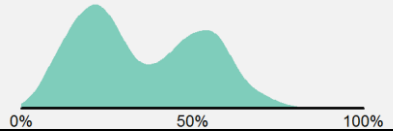
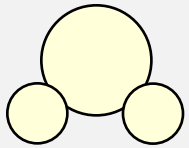
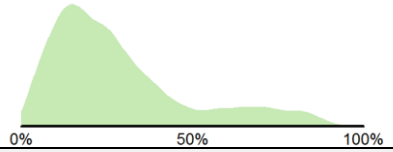
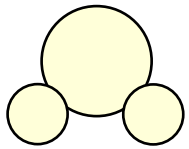
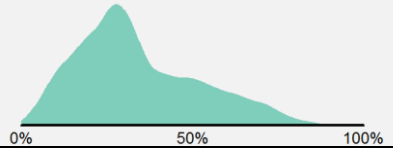
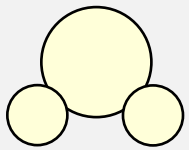
Data on the effectiveness of measures is based on the expert surveys. In general, the data can originate either from online expert surveys or from published sources (peer-reviewed literature, project literature, models). Literature data will be incorporated to the analysis at a later stage.

The results are based on two questions: the grid question on the relative effectiveness of the measure types (no effect – highest effect), and the question on the pressure reduction (%) by of the most effective measure type. The relative scale between all the other measure types to the most effective one was used to define the pressure reductions of those measure types (see Step 4, Section 4 in Part I and Section 15 in Part III in Document 2-1). The certainty of the effectiveness in the grid question was used to form the expert-specific probability distributions of measure type effectiveness. It is assumed that if the lowest certainty was selected, the effectiveness of a measure can have any effectiveness value between 0-100%. However, if the effectiveness calculated from the relative effectiveness values and the effectiveness of the most effective measure is close to either end of the effectiveness scale (0-100%) then the values in the other end would have very low probability. This results from the use of PERT distribution (modified beta distribution). If the highest certainty was selected, the effectiveness is represented by a point value instead of a distribution. in the following, effectiveness is presented per activity, pressure and measure type, and pooled over experts.

Table 3. Distribution of the effectiveness of measure types in controlling the pressure *primary introduction of non-indigenous species* and the expected impact of the measure types on that pressure at the Baltic wide scale based on expert responses. Expected impact is represented by three circles with the larger central circle indicating expected impact and the smaller circles indicating expected impact plus (right) or minus (left) one standard deviation. The effectiveness of a measure type is the percent reduction in a pressure resulting from a specific activity, while the impact of a measure type is the percent reduction in a pressure at a specific geographic scale. In this way, impact values integrate the effectiveness of measures data and percent contribution of activities to the pressure in order to estimate the realized impact of implementing each measure type on the pressure. Both the effectiveness and impact use a shared color scale: Low  **High**

Activity	Measure type	Effectiveness	Impact
Transport – shipping ballast water	Full implementation of the Ballast Water Management Convention		
Transport – shipping ballast water	Strict enforcement of compliance with the Ballast Water Management Convention through increased frequency of sampling and analysis of ballast water as part of port State control inspections		
Transport – shipping ballast water	More stringent technical requirements and standards for ballast water and sediment management on ships		
Transport – shipping biofouling	Enforce installation and maintenance of anti-fouling systems		

Transport – shipping biofouling	Regionally harmonized in-water cleaning regulations		
Transport – shipping biofouling	Adoption and implementation of a HELCOM Roadmap on Biofouling Management		
Transport – shipping biofouling	Perform in-water inspections of ships' hulls for ships arriving from high risk areas prior to entering the Baltic. Take necessary action if NIS are identified (denying port access, requiring in-water cleaning of hull, dry-docking etc.)		
Transport – shipping biofouling	Require hull niche areas to be free of biofouling		
Transport – shipping biofouling	Implementation of biofouling management plan and biofouling management record book for ships		
Transport – shipping biofouling	Risk assessment based in-water cleaning procedures		

Transport – shipping infrastructure (canals)	Mandatory hull cleaning en route		
Transport – shipping infrastructure (canals)	Mandatory ballast water treatment en route		
Transport – shipping infrastructure (canals)	Acoustic deterrents		
Transport – shipping infrastructure (canals)	Salinity barriers		
Transport – shipping infrastructure (canals)	Electrified barriers		
Transport – shipping infrastructure (canals)	Lock and dam operation optimized to minimize upstream-downstream mixing		

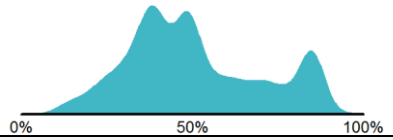
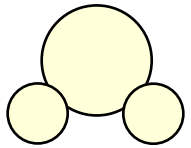
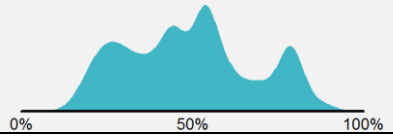
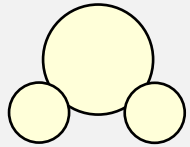
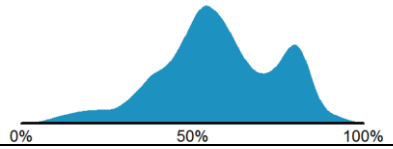
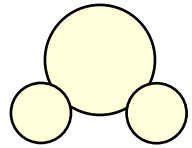
Aquaculture – marine, including infrastructure	Tighten restrictions for aquaculture management (transportation between facilities/prevent escapes etc)		
Aquaculture – marine, including infrastructure	Mandatory and rigorous NIS risk assessments prior to introduction of new fish stock (e.g. stock escape, parasites, etc)		
Aquaculture – marine, including infrastructure	Require rigorous invasion risk assessment before any potential NIS is allowed for importation		

Figure 8 shows experts' confidence in the effectiveness of measure types results for non-indigenous species, which they evaluated using a three-point scale (high, medium, low). The results are presented by activities and provide supporting information for interpreting the effectiveness of measure types data.

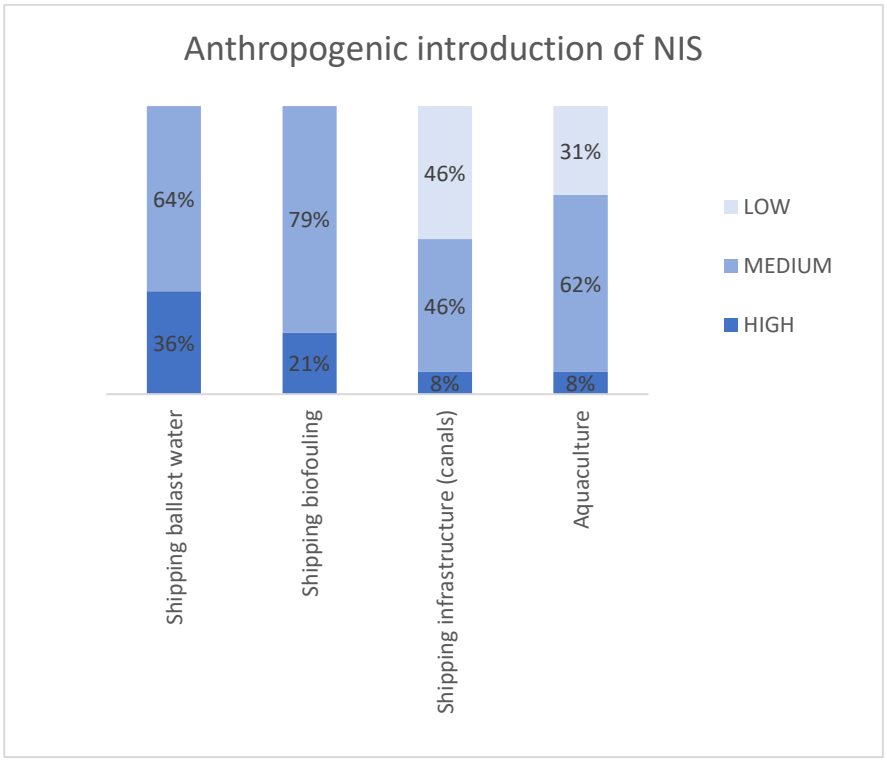


Figure 8. Experts' own confidence in their responses on the effectiveness of measures for the introduction of non-indigenous species (by activity)

Projected pressure reductions from existing measures

These results show the effects of actual measures in reducing pressures (Figure 9). They are based on the activity-pressure contributions, effectiveness of measure types and links between measures and measure types. Both the activity-pressure and the effectiveness of measures data are at the Baltic Sea level, and thus the projected pressure reductions are also presented at the Baltic Sea level. While estimating the effects of existing measures, the SOM model accounts for the overlaps across measures within a measure type and overlaps across measure types. It also uses spatial multipliers for spatially limited measures which reflect the actual sea area where the pressures can be reduced. These are to avoid overestimating the pressure reductions.

To meet the pressure reduction goal of no new introductions, the pressure introduction of NIS should be eliminated. A 100% (or close to 100%) pressure reduction with existing measures is not supported by the data.

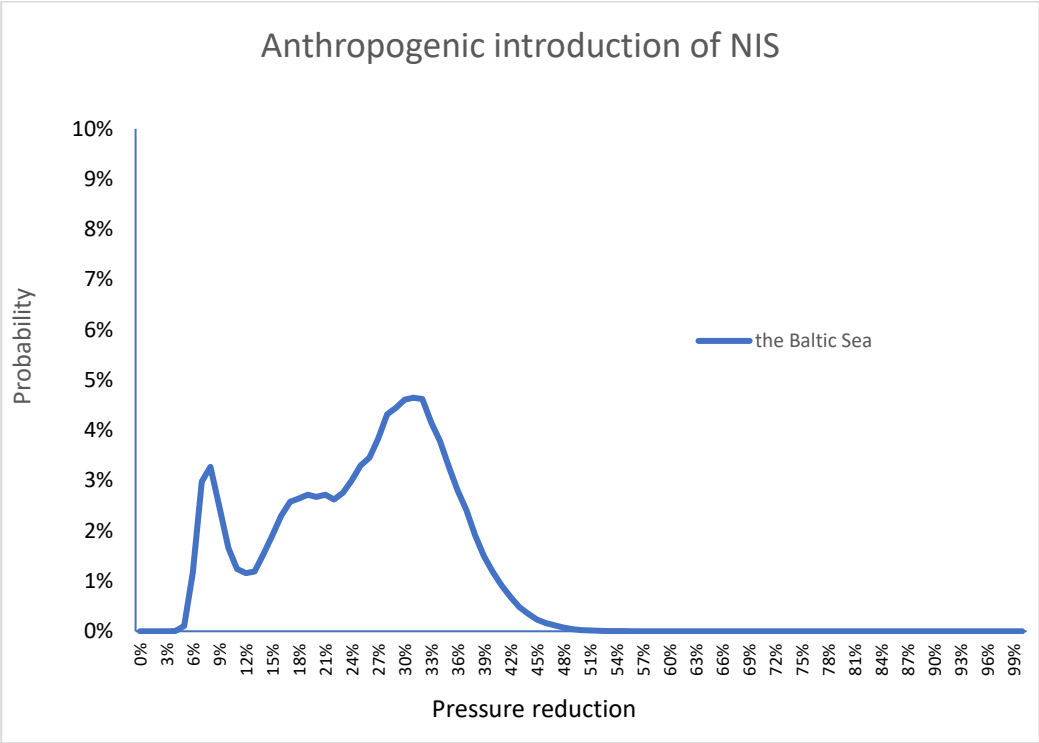


Figure 9. Probability of pressure reductions with existing measures for anthropogenic introduction of non-indigenous species.

Background of respondents

Altogether 14 survey responses with 16 contributing experts were received to the effectiveness of measures survey for non-indigenous species. One of the answers was a group response, with three experts contributing to the response.

Experts represented various fields, including stated marine or benthic ecology/biology as their field. Most experts had over 10 years of experience in their field (Table 2). Experts represented universities, government institutes, state agencies or ministries. Note that response numbers by countries and topics are presented in Document 2-1.

Table 2. Years of experience in the field for non-indigenous species survey

	Effectiveness of measures	
Years	**Number of experts**	**Share of experts**
0-2 years	1	6%
3-5 years	2	13%
5-10 years	5	31%
10-20 years	6	38%
over 20 years	2	13%