Sufficiency of existing measures for coastal fish in the Baltic Sea

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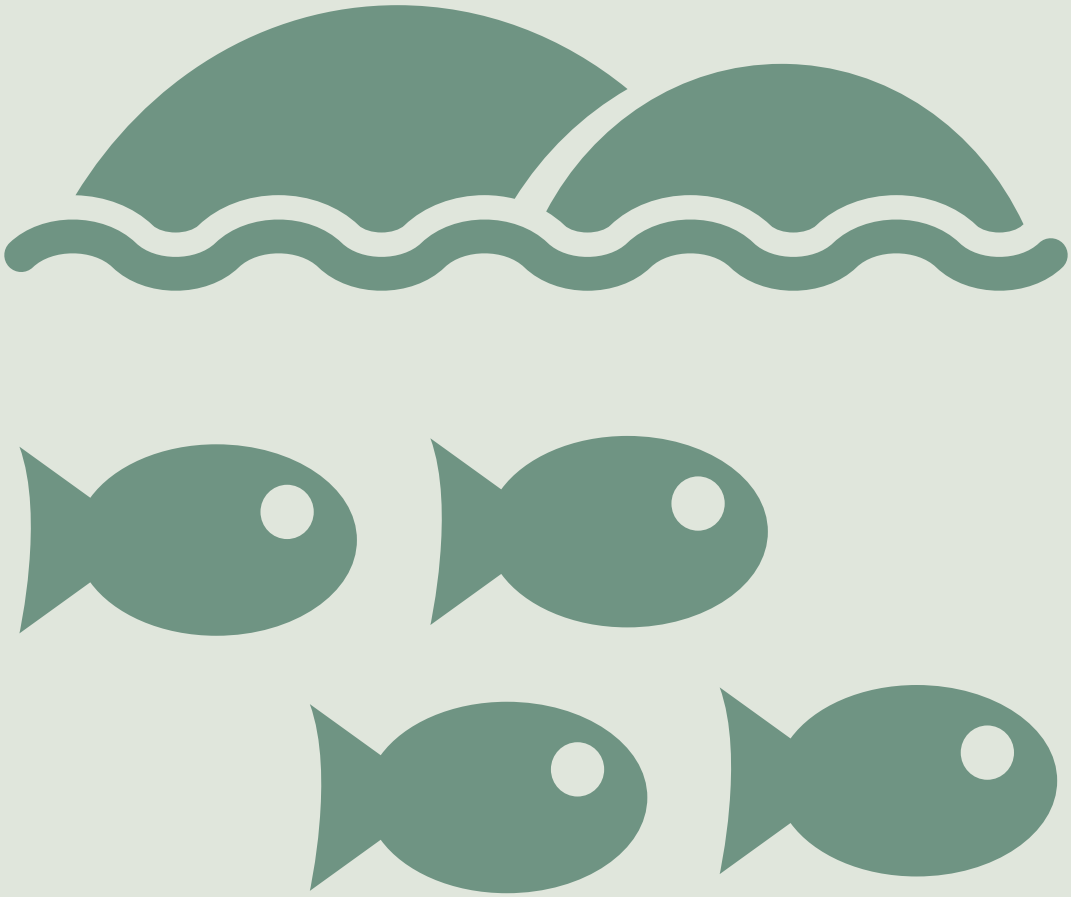
Species and biotopes

2021



HELCOM

ACTION

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Contibutor(s): Heini Ahtiainen, Lena Bergström, Luke Dodd, Samuli Korpinen, Liisa Saikkonen, Sara Estlander, Laura Hoikkala, Leena Laamanen, Tin-Yu Lai, Kaius Oljemark, Jyri Tirroniemi, Jana Wolf

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Official address
Katajanokanlaituri 6B, 00160 Helsinki, Finland

Name and title of the Project Coordinator
Owen Rowe, Project Manager

Name of partners in the project and abbreviations used
Finnish Environment Institute (SYKE)
Technical University of Denmark (DTU)
Aarhus University (AU)
Tallinn University of Technology (TTU)
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Sufficiency of existing measures for coastal fish in the Baltic Sea

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Summary of main results

SOM analysis for coastal fish has evaluated the sufficiency of measures to achieve GES or specific state improvements for perch and other coastal piscivores, cyprinids and other mesopredators and flounder by comparing projected pressure reductions from existing measures to required pressure reductions.

The results suggest that existing measures would not be sufficient in achieving GES or significant state improvements for most of the coastal fish species/species groups.

Based on the assessment, the main pressure affecting coastal fish is the extraction of fish (includes prey depletion). Other important pressures are eutrophication and human-induced food web imbalance, followed by several other pressures having a low or moderate effect.

Spatial and seasonal closures appear among the most effective measure types to reduce targeted extraction and bycatch of coastal fish from fish and shellfish harvesting. There is considerable uncertainty about the effectiveness of measure types.

Contribution of activities to pressures was not assessed, as all pressures are created by a single activity or are not dependent on activities but affect pressures or state directly.

The overall certainty of the assessment for coastal fish could be characterized as low to moderate. Experts from seven coastal countries contributed to some part of the assessment. The total number of experts contributing to the surveys is high for both the effectiveness of measures and pressure-state part, but some individual elements suffer from a low amount of data and have not been presented. As the effects of some important pressures to the state of coastal fish have not been quantified in the analysis, the pressure reductions and probability to achieve GES/state improvements are likely underestimated.

Introduction

Report background

The sufficiency of measures (SOM) analysis assesses improvements in environmental state and reduction of pressures that can be achieved with existing measures in the Baltic Sea region, and whether these are sufficient to achieve good environmental status (GES). The analysis involves estimating the state of the marine environment in 2030, based on a starting point of 2016 (i.e. the latest HELCOM status assessment), and given measures in existing policies, their implementation status, and the projected development of human activities over time. The evaluation can be carried out compared to relevant and agreed HELCOM threshold values for GES, where available.

The main aim of the SOM analysis is to support the update of the HELCOM Baltic Sea Action Plan (BSAP) by identifying potential gaps in achieving environmental objectives with existing measures for the Baltic Sea. In addition, the analysis can indicate both thematically and spatially where new measures are likely needed.

The same overall approach has been applied across all topics included in the SOM analysis to ensure comparability and coherence of the results, while considering topic-specific aspects and making necessary adjustments. The main components of the analysis include assessing the contribution of activities to pressures, the effect of existing measures on pressures, the effect of development of human activities on pressures, and the effect of changes in pressure on environmental state. The SOM approach, model and data collection are described in detail in methodology report.

The methodology for the SOM analysis is designed to accommodate the broad array of topics relevant in the HELCOM region and to enable a region-level analysis. It balances between state-of-the-art knowledge, availability of data, and advice taken onboard from various HELCOM meetings and bodies.

The data used in the SOM analysis have been collected using expert elicitation and by reviewing existing literature, model outputs and other data sources. Data availability varies substantially across topics and data components, which is reflected in the presentation of the methods and results in this report.

The SOM analysis presents the first attempt to quantify the effects of existing measures and policies on the environment and achieving policy objectives for various environmental topics in HELCOM and the Baltic Sea area. It is aimed at assessing the overall sufficiency of existing measures at the Baltic Sea level. The results are based mainly on expert elicitation, and thus they should be utilized appropriately. Due to the pioneering nature of the approach and variable data quality and availability in the SOM analysis, the findings do not provide conclusive answers on the need for new measures, but indicate likely gaps, and should thus also be reviewed in relation to the results of other assessments.

This topic report describes the analyses carried out and the results for the SOM analysis on coastal fish, providing detailed topic-specific information. First, it presents background information and describes the data and methods for addressing the topic in the SOM assessment, including relevant assumptions and challenges. Second, it presents and

discusses the findings for each result component. Third, it provides discussion on the impacts of alternative assumptions and data, evaluates the quality and confidence of the analysis, and provides implications and future perspectives. The annexes contain detailed information on the data components, topic structure and expert surveys for the analysis, as well as supplementary results.

Similar topic reports have been prepared for all nine topics covered in the SOM analysis. In addition, the results are summarized in the main report and the full methodology is described in the methodology report.

Topic background

Coastal fish are here defined as fish assemblages in near-shore areas of less than 20 meters depth. In the Baltic Sea, they are represented by species of both marine and freshwater origins. Typical freshwater species are perch, pikeperch, pike, roach and breams, and typical marine species are flounder, cod and herring. The freshwater species reside in coastal areas, while the marine species mainly appear during certain seasons. In some areas, fish of freshwater and marine origin may occur in the same location. Coastal fish contribute directly to human livelihood and many coastal fish species are targeted by small-scaled coastal commercial fishery. In addition, they have high importance for the recreational fisheries in all Baltic countries. Due to their central role in the food web, coastal fish also contribute to several ecosystem functions. For example, they are important for food web productivity, and key functional groups, such as piscivores, contribute to maintaining natural ecosystem structure and functioning via food web regulation. A multitude of natural and human-induced pressures can affect coastal fish communities simultaneously (HELCOM 2018a). Examples of key pressures are fishing, physical habitat loss, climate change and eutrophication. Coastal fish are also highly influenced by species interactions in the food-web. Many of the pressures and driving forces may manifest as clearly local effects.

Description of coastal fish in the SOM assessment

Coastal fish are included in the SOM analysis as three state components: *Abundance of perch and other coastal piscivores*, *Abundance of cyprinids and other mesopredators*, and *Abundance of flounder* (Figure 1). These components reflect the structure of the MSFD criteria D1C2[1] and D4C1[2], as well as the following two HELCOM core indicators, which represent characteristic species and functional groups for the coastal Baltic Sea:

- **Abundance of key coastal fish species** focuses on a predominating species and is represented by either perch (*Perca fluviatilis*) or flounder (*Platichtys* spp.). The choice of species depends on natural distributions, with flounder assessed in southern areas and perch in the central and northern Baltic Sea (HELCOM 2018b).
- **Abundance of coastal fish key functional groups** focuses on selected functional groups and has two components. The 'piscivores' component reflects the total abundance of piscivorous fish species, and a lower trophic level component represents either the total abundance of Cyprinidae ('cyprinids') or lower trophic levels species ('mesopredators') (HELCOM 2018c).

Indicator status is assessed using site-specific threshold values and focuses on relative changes in the indicators (or their components) over time (HELCOM 2018a). Good status is achieved when the abundance of perch, flounder and piscivores is above a site-specific threshold value, and when the abundance of cyprinids or mesopredators is within an acceptable range. Status is assessed at scale 3 (17 HELCOM sub-basins with 40 coastal sub-divisions). The coastal fish indicators are only applicable in the coastal divisions.

In the latest HOLAS II assessment period (2011-2016), the status of the coastal fish communities was assessed in less than half of the 42 coastal areas and when assessed varied among areas and indicators. The core indicator 'Abundance of key coastal fish species' showed good status in 13 out of 21 assessed areas (HELCOM 2018a-b). Areas where perch was assessed as the key species were more often assessed to be in good status than areas where flounder was assessed. For the core indicator 'Abundance of key coastal fish functional groups', the piscivore component achieved the threshold value in 13 out of 16 assessed coastal areas, and the group cyprinids/mesopredators in 7 out of 16 (HELCOM 2018a, c). The status of piscivores was relatively better in northern areas, while the status of cyprinids was increasingly inadequate in north-eastern areas.

The HELCOM scale 3 areas used in the indicators were aggregated to conform to the scale 2 sub-basins used by the SOM analysis (Figures 2-4). As these areas contain more than one coastal fish assessment area, a one-out-all-out approach was adopted, meaning that for each SOM assessment area, the assessment result for the scale 3 unit furthest away from the good status is used to represent the status of the whole area (HELCOM 2018a).

For coastal fish, when an agreed HELCOM GES threshold value is available, the SOM analysis is based on comparing the state improvement from existing measures to the improvement required to achieve this threshold with existing measures (proper gap assessment).

[1] Marine Strategy Framework Directive criteria D1C2 – The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured.
[2] Marine Strategy Framework Directive criteria D4C1 – Primary: The diversity (species composition and their relative abundance) of the trophic guild is not adversely affected due to anthropogenic pressures. Member States shall establish threshold values through regional or subregional cooperation.

Alternatively, when a GES threshold value has not been set for all aggregated assessment areas, the probability of achieving specific state improvements with the pressure reductions from existing measures is assessed. Given the use of site-specific threshold values in the assessment of coastal fish, results for different areas were made comparable by adopting transformations similar to those applied in the BEAT tool for integrated assessment. This also allows for data indicators to be combined, as was done here for indicators perch and piscivores. The transformed range between 0 and 1, where values above 0.5 represent good status (details available in HELCOM 2018d). Table 1 presents the structure and base states of the SOM coastal fish assessments.

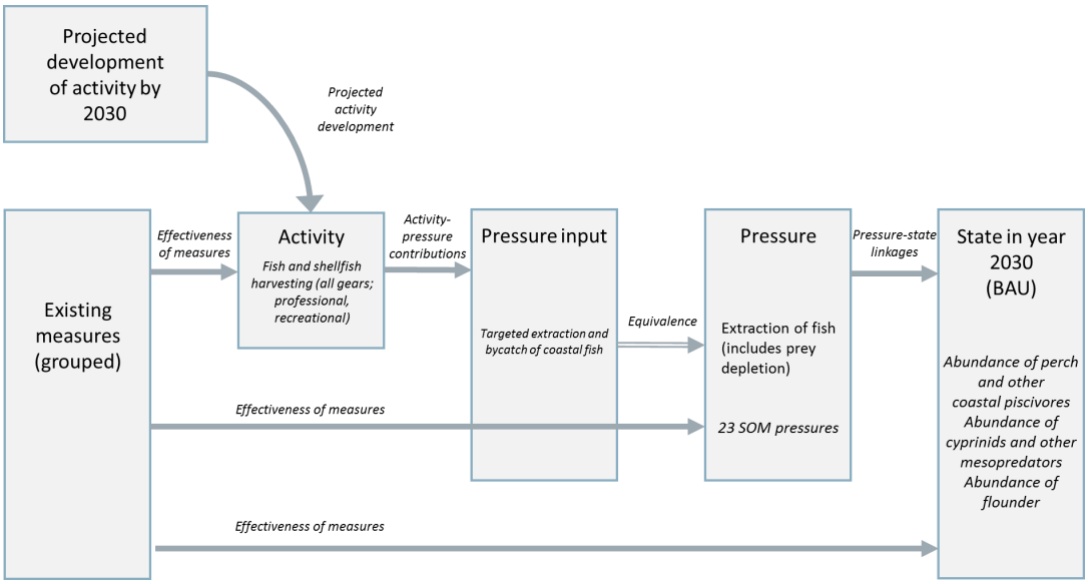

Figure 1. Schematic of the SOM model for coastal fish. While coastal fish can be influenced by any pressure in the model, they are only present in the model as a state component and therefore do not influence any other model component.

Table 1. Structure and base states of the SOM coastal fish assessments. The table presents each coastal fish assessment and the type of assessment made. For GES-based assessments, the base state and HELCOM scale 3 area furthest from GES are presented (the area determining the base state under a one-out-all-out methodology). The threshold for good status for the GES-based assessments corresponds to the value 0.5. Improvement-based assessments do not have a base state and show not applicable (NA) in the relevant columns. Note that only coastal areas are assessed.

Species/functional group	Assessment area	Assessment type	Base state	HELCOM scale 3 area(s) determining base state
Perch and other coastal piscivores	Gulf of Bothnia	GES	0.375	The Quark Swedish Coastal waters
Perch and other coastal piscivores	Gulf of Finland	% improvement	NA	NA
Perch and other coastal piscivores	Gulf of Riga	GES	0.375	Gulf of Riga Estonian Coastal waters
Perch and other coastal piscivores	Central (Swedish coastal areas only)	GES	0.375	Western Gotland Basin Swedish Coastal waters
Perch and other coastal piscivores	South (Polish coastal areas only)	% improvement	NA	NA
Perch and other coastal piscivores	Eastern Gotland Basin (Latvian & Lithuanian coastal areas only)	GES	0.625	Eastern Gotland Basin Lithuanian Coastal waters
Cyprinids and other mesopredators	Gulf of Bothnia	GES	0.125	Åland Sea Swedish Coastal waters Åland Sea - Archipelago Sea Finnish Coastal waters
Cyprinids and other mesopredators	Gulf of Finland	% improvement	NA	NA
Cyprinids and other mesopredators	Gulf of Riga	GES	0.125	Gulf of Riga Estonian Coastal waters
Cyprinids and other mesopredators	Central (Swedish coastal areas only)	GES	0.625	Northern Baltic Proper Swedish Coastal waters Western Gotland Basin Swedish Coastal waters Bornholm Basin Swedish Coastal waters
Cyprinids and other mesopredators	South (Polish coastal areas only)	% improvement	NA	NA
Cyprinids and other mesopredators	Eastern Gotland Basin (Latvian & Lithuanian coastal areas only)	GES	0.375	Eastern Gotland Basin Latvian Coastal waters
Flounder	Central (Swedish coastal areas only)	GES	0.375	Western Gotland Basin Swedish Coastal waters
Flounder	Eastern Gotland Basin (Latvian & Lithuanian coastal areas only)	GES	0.625	Eastern Gotland Basin Lithuanian Coastal waters
Flounder	South (Polish coastal areas only)	% improvement	NA	NA
Flounder	Southwest (Danish coastal areas only)	GES	0.375	Arkona Basin Danish Coastal waters Mecklenburg Bight Danish Coastal waters Belts Danish Coastal waters The Sound Danish Coastal waters Kattegat Danish Coastal waters, including Limfjorden

Fish specific pressures

For the fish specific pressures, pressure input and pressure are equivalent and only the term pressure is used further in the report (see Figure 1). Several assessed pressures are exclusive to fish, including *targeted extraction and bycatch of fish* for coastal fish, cod, flatfish, pelagic fish, salmon, seatrout and eel, as well as *disturbance of species: obstructions (dams)* The targeted extraction pressures do not correspond to a HELCOM indicator but are assessed by ICES for many commercial species (ICES 2019a-j). Additionally, MSFD criteria D3C1[3] and to a limited extent D1C1[4] apply in combination to these pressures. The pressure *disturbance of species: obstructions (dams)* does not correspond to a HELCOM indicator but is a quality element of ecological status for rivers under the Water Framework Directive (River continuity). These pressures all originate from a either a single activity (*targeted extraction and bycatch* is only caused by fishing) or are not connected to a SOM activity (*disturbance of species: obstructions (dams))*. None of these pressures is assessed against a threshold in the SOM analysis.

[3] Marine Strategy Framework Directive D3C1 – Primary: The Fishing mortality rate of populations of commercially-exploited species is at or below levels which can produce the maximum sustainable yield (MSY). Appropriate scientific bodies shall be consulted in accordance with Article 26 of Regulation (EU) No 1380/2013.
[4] Marine Strategy Framework Directive D1C1 – The mortality rate per species from incidental by-catch is below levels which threaten the species, such that its longterm viability is ensured.

Methods and data

The section below includes an overview of any topic-specific methodologies. A full description of the general approach, methods and data collection for the SOM analysis is available in this document. Note that the detailed results are presented for the most likely development of human activities and using the expert data on effectiveness of measures.

Effectiveness of measures and pressure-state linkages

Measure types (Annex 3) and structural relationships between the measure types and activities and pressures (Annex 7) were designed by the HELCOM Workshop on the analyses of Sufficiency of Measures (SOM) for Fish (SOM-FISH_WS_1-2019) in collaboration with HELCOM ACTION WP6. The measure types were informed by the existing measures list (Annex 4) but were also designed to acknowledge the full breadth of potential measures.

For coastal fish, the effectiveness of measures survey structure comprised 17 unique measure types covering one activity and two direct to pressure or state relationships. The exact list of measure types, and their grouping by activities and pressures is shown in Annex 7. The effectiveness of measures survey itself is included as Annex 8.

Effectiveness of the measure types and links between the pressures and state components were determined using online expert surveys implemented in December 2019 – February 2020 with follow-up surveys conducted in the spring 2020. The expert pool consisted of the HELCOM Group on Ecosystem-based Sustainable Fisheries, HELCOM Task Force on Migratory Fish Species, HELCOM Project for Baltic-wide assessment of coastal fish communities in support of an ecosystem-based management, participants of the HELCOM Workshop on the analysis of sufficiency of measures for fish and nationally nominated experts. Additionally, the project received survey responses from experts not on the original invitation list; these responses were also included in the analysis. The full description of the methodology and data collection is available as part of the SOM methodology report.

Pressure reductions and state improvements

The projected reductions in pressures are calculated using the data on effectiveness of measure types, links between existing measures and measure types, and projected development of human activities. They account for the joint impacts across the measure types, as well as the spatial area where the pressures can be reduced to avoid overestimating the pressure reductions. Pressure reductions can in principle be positive, negative or zero, depending on the combined effect of existing measures and changes in the extent of human activities. When the reduction in pressures from existing measures is larger than the increase from changes in human activities, pressures are reduced.

The calculation of sufficiency of measures takes into account all the components of the SOM analysis for fish: the effectiveness of measure types in reducing pressures, links between existing measures and measure types, projected pressure reductions from existing measures, development of human activities, significance of pressures to state components

and pressure reductions required to achieve GES/state improvements. The analysis assumes that all existing measures are fully implemented and that there are no time lags between the input of pressures and environmental state.

Topic specific model structure, assumptions and challenges

The aggregation of HELCOM scale 3 areas into HELCOM scale 2 areas used in the SOM assessment was a clear methodological challenge for coastal fish. The SOM assessment benefited greatly from a very knowledgeable topic team with expertise in the BEAT tool which was used to make this integration. Further reflection can be found in the section Lessons learned.

Overview of data

The SOM analysis for fish evaluates the sufficiency of measures in achieving GES or state improvements, considering the effects of existing measures and future development of human activities.

Table 2 shows the origin and spatial resolution for the data components in the SOM analysis for coastal fish. Activity-pressure contributions have not been assessed, as all fish-specific pressures are created by a single activity (fishing) or are not dependent on activities but affect pressures or state directly (longitudinal connectivity of rivers). Information on existing measures comes from literature reviews and Contracting Parties, and development of human activities is based on existing literature, data and projections.

Estimates of the effectiveness of measures were collected both via expert surveys and a literature review for all topics included in the SOM analysis. The aim of the literature review was to compile information from scientific articles and reports providing estimates on the effects of measures in reducing pressures that could be used in the SOM analysis, either by including the estimates in the SOM model or by providing comparison points. The literature review was conducted by topic, with the information collected into structured excel files (see the methodology document, Annex 5 and Annex 6 for more information). For all fish topics, 248 effectiveness estimates from 76 studies were compiled. Out of these, 1 estimate could be included in the model for coastal fish. Reflection on this low rate of data use can be found in the section Lessons learned. Scenarios for the development of human activities were based on existing information and projections for the Baltic Sea region, and pressure-state links were evaluated with expert elicitation.

The spatial resolution (level of detail) differs across the data components of the SOM analysis (Table 2). All areas are based on the 17 HELCOM scale 2 sub-basins and the assessment area ranges from the single Baltic Sea to individual sub-basins. The effectiveness of measure types in reducing pressures and the effect of development of human activities are assessed at the scale of the entire Baltic Sea. The spatial resolution for the pressure-state linkages varies across fish species/species groups. The definition of the state component may already include a geographic element, for example, the population of the species in a specific part of the Baltic Sea. Maps of the spatial coverage of each coastal fish group are presented in Figures 2-4.

Table 2. Data for fish (more information on data collection is available in the methodology document)

Data component	Origin of data	Spatial resolution
Activity-pressure contributions	NA	NA
Existing measures	Literature review, Contracting Parties	17 sub-basins
Effectiveness of measures	Expert evaluation	Whole Baltic Sea
Development of human activities	Literature review, existing data and projections	Whole Baltic Sea
Pressure-state links	Expert evaluation	Various (Figures 2-4)

NA = not applicable. The activity-pressure contributions were not necessary as all fish specific pressures are created by a single activity or are not activity dependent.

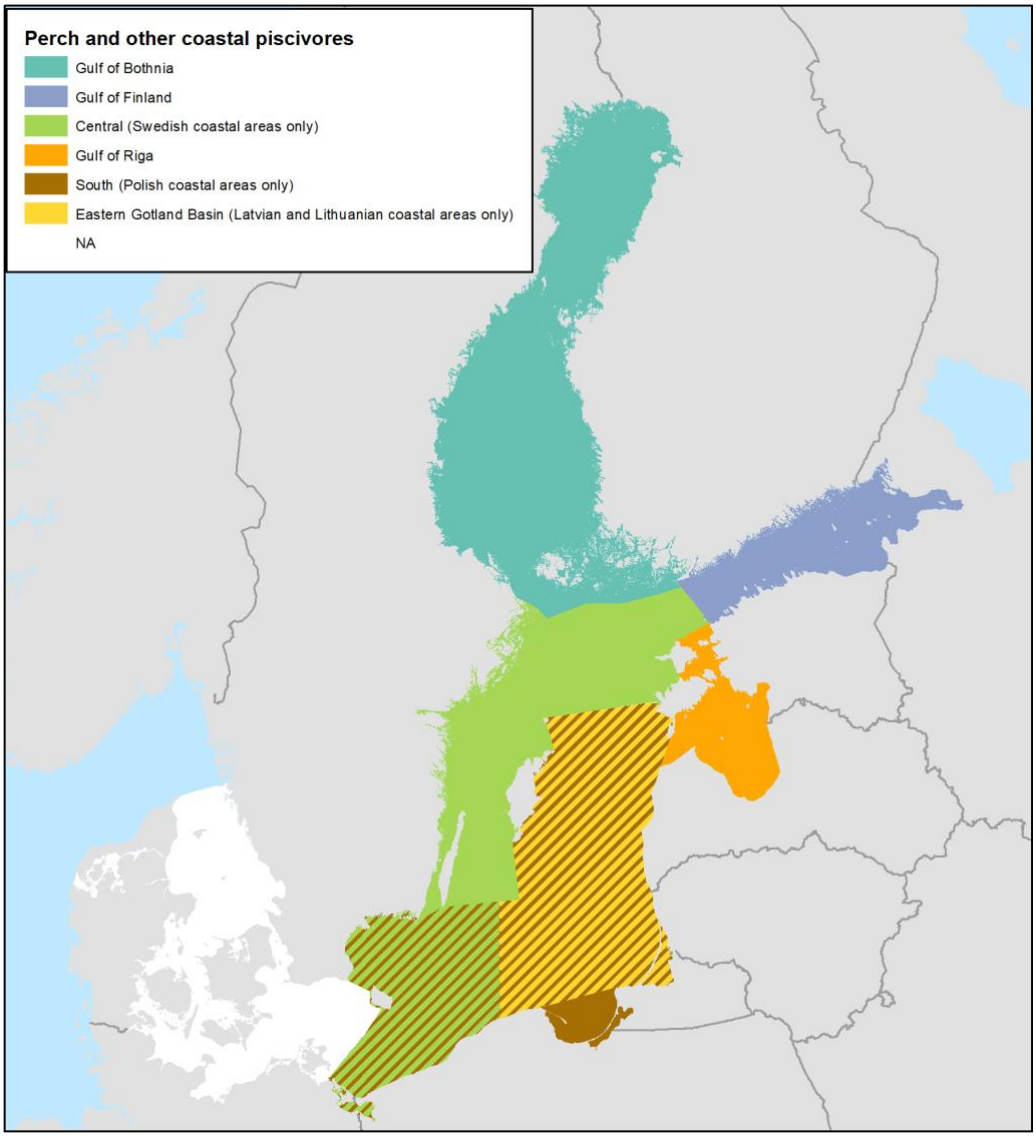

Figure 2. Spatial division of the Baltic Sea used in the state assessment of *Perch and other coastal piscivores*. Note that only coastal areas are assessed; colour in the map extends beyond those areas only for improved readability.

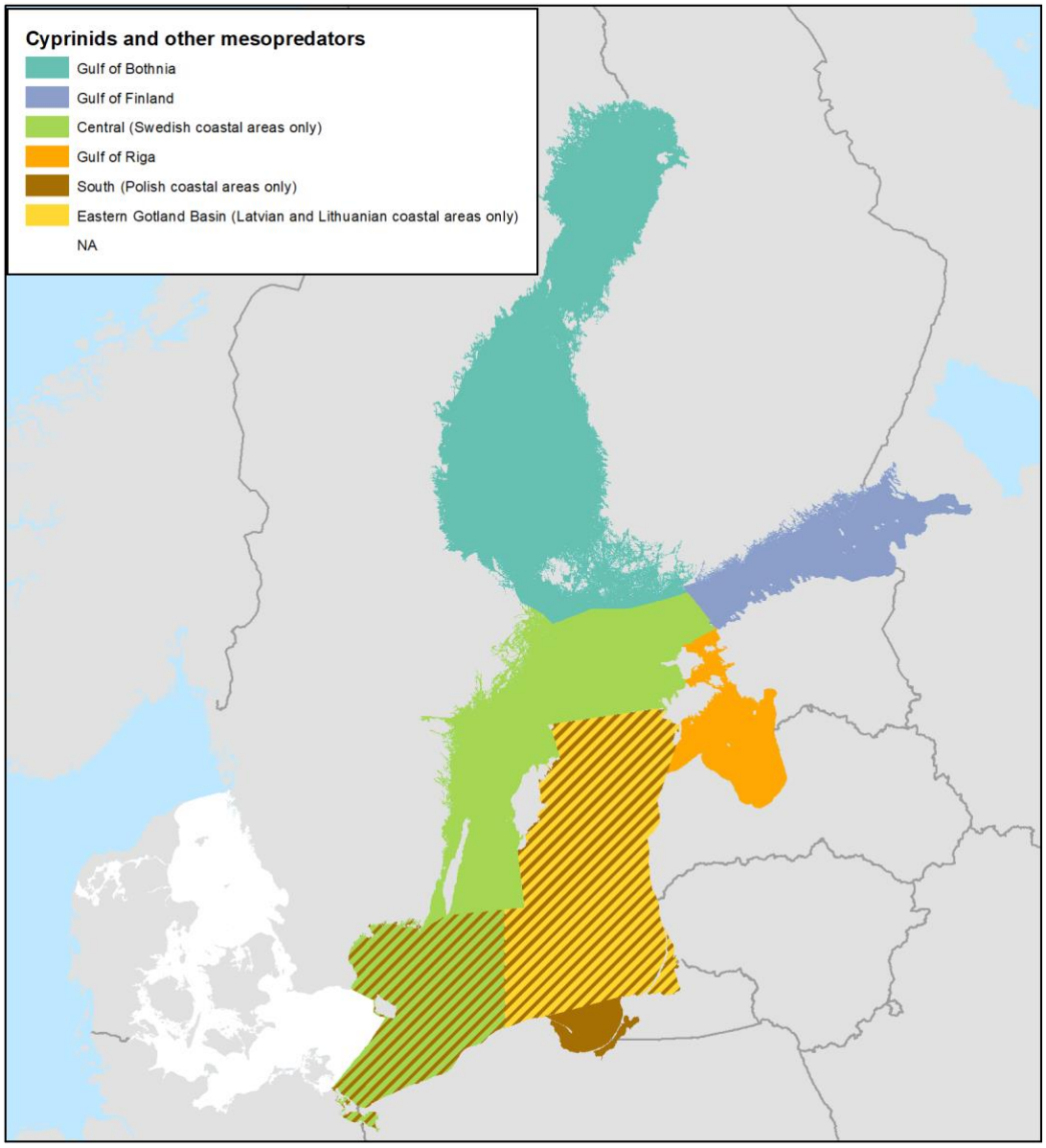

Figure 3. Spatial division of the Baltic Sea used in the state assessment of *Cyprinids and other mesopredators*. Note that only coastal areas are assessed; colour in the map extends beyond those areas only for improved readability.

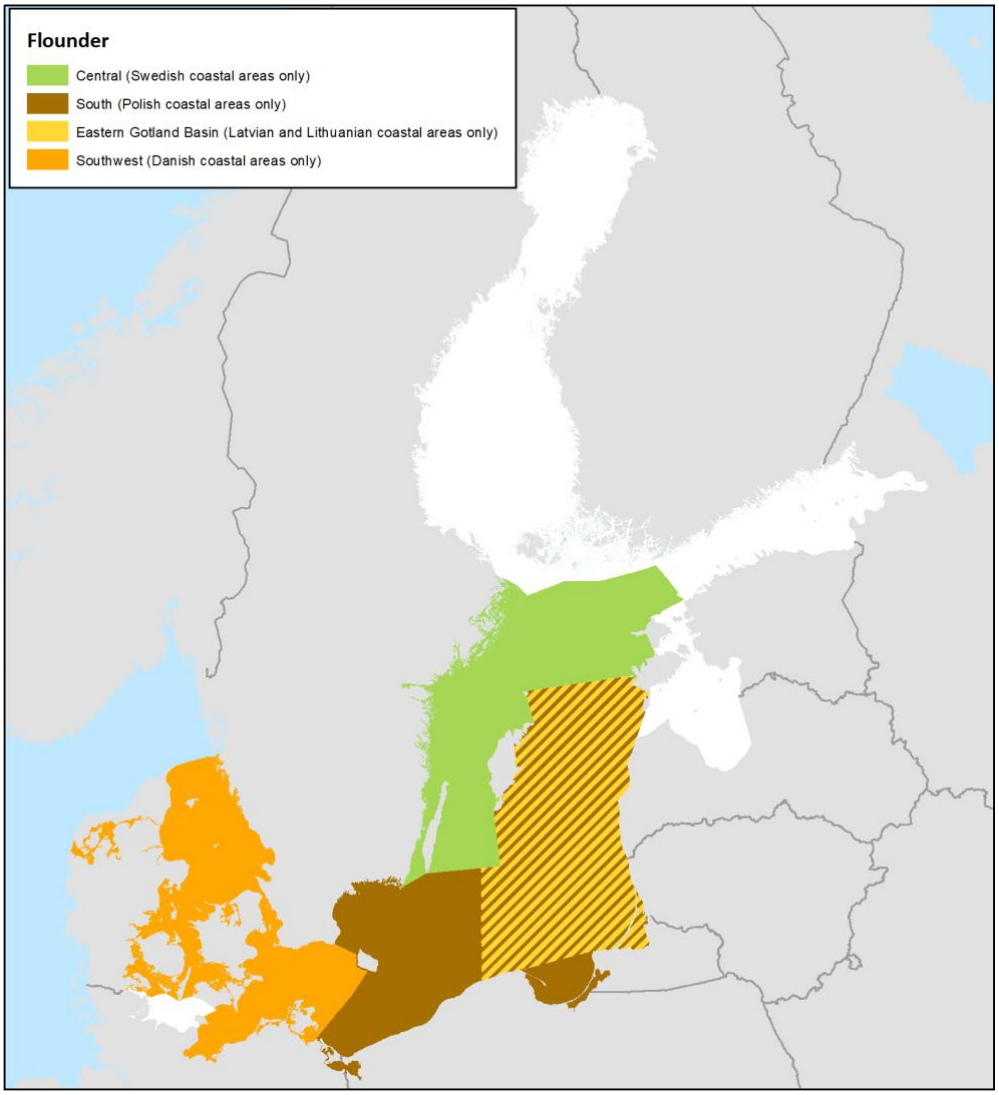

Figure 4. Spatial division of the Baltic Sea used in the state assessment of *Flounder*. Note that only coastal areas are assessed; colour in the map extends beyond those areas only for improved readability.

Development of human activities

In addition to existing measures, changes in the extent of human activities may affect pressures over time. Four scenarios for future changes in human activities were developed: 1) no change, 2) low change, 3) moderate (most likely) change, and 4) high change. These alternative scenarios aim to capture uncertainties and variation in the future development of human activities. The results of the SOM analysis were estimated for each of the four scenarios to assess how the alternative assumptions on the development of human activities affect the findings. Detailed results are presented for the most likely development scenario, and implications of using the other scenarios on the results are reviewed in the discussion section.

The scenarios specify a percent change in each activity in 2016-2030 based on existing information and projections from the Baltic Sea region (see details and references in the

methodology report). Change scenarios were made only for predominant activities in the Baltic Sea region, including agriculture, forestry, waste waters, (commercial) fish and shellfish harvesting, aquaculture, renewable energy production, tourism and leisure activities, transport shipping and transport infrastructure. Other activities are assumed to stay unchanged. This means that only 9 of the 31 standard SOM activities have change scenarios in the SOM analysis. This results in varying influence of these scenarios on the results across topics, pressures and state components, depending on the significance of the activities to the pressures relevant to the topic.

Development scenarios have been made for fish (and shellfish) harvesting, which is the only activity in the assessment that contributes to the targeted extraction and bycatch of coastal fish. In the most likely scenario, fishing is assumed to stay constant until 2030. The alternative low and high scenarios project a decrease and increase of 10% by 2030, respectively. Note that these development scenarios do not cover changes in the direct pressure to fish habitats or disturbance of species by obstructions (dams). More information on the development scenarios and source materials is given in section 9 of the methodology report.

The current situation with COVID-19 and its possible implications to the development of human activities is not reflected in the scenarios, as there is no information on the long-term effects it may have on the economy or activities. The current situation poses a challenge for choosing the most likely scenarios for the development of human activities, which has been done based on currently available information.

Results and interpretation

Background

The SOM results are presented in the format of percent shares or probabilities. The main finding of the analysis is the probability to achieve GES or specific state improvements/pressure reductions, taking into consideration the effects of existing measures and changes in the activities on pressures. The contribution of activities to pressures, the effect of measures on pressures, and the significance of pressures to state components are presented as percent values (e.g. how many percent would the measure reduce the pressure). Results are presented mainly in tables, which show the most likely (expected) values and standard deviations. Standard deviation is a way of showing the variation in the values. When it is high, values are spread over a wider range, and when it is low, values are closer to the most likely value. Figures and graphs presenting distributions are included in the annexes. They show the same results as the tables but allow either more detailed information or alternative visualization of the results.

For the data that are based on expert surveys, the confidence rating gives the most common answer to experts' assessment of the confidence in their own survey responses on a low-moderate-high scale. More detailed information on how each result has been calculated is presented in a separate document.

This document presents the detailed results based on the expert-based data (survey responses). Literature data on the effectiveness of measures has been collected and included in an alternative model estimation. The impacts of using the literature data are evaluated in the discussion section. In the detailed results, the projected development of human activities is based on the most likely future development until 2030 (for details, see the methodology document), and the impacts of alternative scenarios on human activities are examined in the discussion section.

Format of presentation

The format the results are reported in (not presented, qualitative/semi-quantitative, quantitative) depends on the type of result and the number of participating experts. Further, for all results utilizing other SOM results as input data, reporting is done at the most conservative standard used in the input data. In practice this means that if one input data point is reported as 'insufficient data', all results using that data point will also be reported as 'insufficient data'; and similarly for qualitative/semi-quantitative data points. However, note that this standard is only applied in the case of data points actively used to calculate another result. For example, many measure types are hypothetical or otherwise not implemented in the Baltic Sea and therefore do not factor into results on projected pressure reductions from existing measures. Insufficient data for such measure types does not affect reporting other results that rely on data for effectiveness of measure types. Results that do not meet the data standards described here and in greater detail below are marked with 'insufficient data' in the report.

For results concerning required pressure reductions and significance of pressures to state components, results with 2 or fewer respondents are not reported; results with 3 to 4 respondents will be either not reported, or qualitatively/semi-quantitatively reported based on feedback from the SOM topic teams or other HELCOM expert body; results with 5 or more respondents are reported quantitatively. This standard allows flexibility for reporting on assessments that are of spatially limited areas and therefore have fewer experts available to survey, while also being somewhat conservative in reporting fully quantitative results. Based on input from the coastal fish topic team, results with 3 to 4 respondents will appear as ranges rather than fully quantified results.

For expert-based effectiveness of measures results, measure types with 5 or more respondents are reported quantitatively and those with 4 or fewer respondents are listed as having insufficient data.

For coastal fish, pressure-state results for some geographic areas for perch and other coastal piscivores, cyprinids and other mesopredators, and flounder have been excluded as they are based on less than 3 expert responses. This affects the results on sufficiency of measures in achieving GES/state improvements, required pressure reductions to achieve GES/state improvements, time lags between pressure and state, and pressures contributing to state components. All effectiveness of measures data are presented, as they are based on the evaluations of 5-14 experts. No activity-pressure expert data for coastal fish have been collected, because all fish-specific pressures are created by a single activity or are not dependent on activities but affect pressures or state directly.

Coverage of pressures in the SOM analysis

The SOM analysis has only been able to account for a portion of all pressures that affect the state components, and the effect of several significant pressures have not been included due to not being able to quantify the link between the pressures, pressures and state components in the analysis. This means that the effect of reductions in these excluded pressures on the state components is not included in the total pressure reductions, and the projected total pressure reductions and probability to achieve GES may be underestimated. The share of pressures covered in the analysis has been calculated based on the significance of pressures to the state component in question. The share varies across topics and state components from low (around 20%) to high (more than 80%).

Are existing measures sufficient for achieving good status and state improvements?

For the coastal fish state components that have established HELCOM GES thresholds, the SOM analysis evaluates whether existing measures are sufficient in achieving GES by comparing the state improvement from existing measures to the state improvement required to achieve or maintain GES. For the state components that do not have a GES threshold, the analysis assesses the sufficiency of measures in achieving specific state improvements (10, 25 and 50% improvement in the abundance of fish). In the latest HOLAS II assessment period (2011-2016), only three of the assessed areas were in a good status for

one of the coastal fish groups for all included basins: perch and other coastal piscivores in Eastern Gotland Basin (Latvian & Lithuanian coastal areas only), flounder in Eastern Gotland Basin (Latvian & Lithuanian coastal areas only), and cyprinids and other mesopredators in Central (Swedish coastal areas only).

Overall, the results indicate that the probability to achieve GES for coastal fish with existing measures is often very low or low. Reductions in total pressures are around 5-35% for perch and other coastal piscivores, 5-20% for cyprinids and other mesopredators, and 5-30% for flounder. The only exception is flounder in the Danish coastal areas (Southwest), where the probability to achieve GES is assessed as high. For the state components without GES thresholds, 10% state improvements have a high probability, except for perch and other coastal piscivores in the Gulf of Finland. For flounder in the Polish coastal areas (South), probability to achieve a 50% state improvement is considered to be rather high.

In the case of coastal fish, the SOM analysis was able to account for 40-100% of the pressures linked to the state components (pressures highlighted in white in Table 6). This percent reflects the share of pressures that have: 1) a quantifiable link to the fish state components and 2) measure types that affect them in the SOM analysis. The share of quantified pressures has been calculated based on the significance of pressures affecting coastal fish (Table 6), and represents the maximum pressure reduction that could be achieved if the pressures linked to coastal fish species (groups) in the SOM analysis were eliminated. Notably, the effects of several important pressures are not included in this total, such as effects of eutrophication and human-induced food web imbalance (pressures highlighted in grey in Table 6). Although some of these pressures are expected to decrease, based on the results of the SOM analysis, the analysis is not able to estimate how this would affect the state of coastal fish. Thus, the total pressure reductions and maximum probability to achieve GES are probably underestimated.

The results are presented as the probability of achieving or maintaining GES/state improvements with the projected total pressure reduction by fish species (group) and sub-area. Table 3 shows the expected total pressure reductions from existing measures, the probability to achieve GES or a specific state improvement with such a pressure reduction, and the maximum pressure reduction that could be achieved with the fully quantified pressures in the SOM analysis. Total pressure reductions are calculated based on the reduction in the pressures affecting coastal fish (Table 8), significance of different pressures to coastal fish (Table 6), and spatial weighting to account for the target area of existing measures. The format of the results depends on whether an agreed HELCOM GES threshold exists for the state component (species/species group and geographic area) in question. Results with 2 or fewer responding experts are not shown due to insufficient data.

For *perch and other coastal piscivores*, the expected pressure reduction ranges from 3 to 35%. In the Gulf of Bothnia, the findings suggest that the probability to achieve GES with existing measures is low, and in the Central area (Swedish coastal areas) close to zero. In the Gulf of Finland, the probability to achieve any state improvements with existing measures seems low. In Polish coastal areas, the results indicate a high probability to achieve a 10% state improvement, but not larger. There is insufficient data for the Gulf of Riga and Eastern Gotland Basin (Latvian and Lithuanian coastal areas).

The findings for *cyprinids and other mesopredators* suggest that the expected pressure reductions range from 5 to 20%, which results in a very low probability to achieve GES. This

is despite the fact that the Central area was already assessed as being in good state. In the South (Polish coastal areas), there is a high probability to achieve a 10% state improvement. Results for the Gulf of Finland, Gulf of Riga and Eastern Gotland Basin are not given due to lack of data.

For *flounder*, the findings indicate that pressure reductions from existing measures are 5-30%. According to the obtained expert responses (three) for the Southwest (Danish coastal areas), the probability to achieve GES is very high, which may need to be examined against the fact that the status assessment shows these coastal areas to be far below GES. In the South (Polish coastal areas), the results indicate a moderate to high probability to achieve a 50% state improvement. While in the Central area (Swedish coastal areas), probability to achieve GES is very low. Data is insufficient for the Eastern Gotland Basin.

Table 4 presents the mostly likely total pressure reduction required to reach GES or a specific state improvement for each fish species/species group by sub-area, based on the expert responses. Most of the estimates are based on group responses, and thus there is very little variation (small or even zero standard deviations). The required pressure reduction to achieve GES for perch and other coastal piscivores ranges between 30 and 60%, depending on the sub-area. For cyprinids and other mesopredators, the required pressure reduction is 50-70%, and for flounder 0-70%. Expert's confidence in their own responses to the question on total pressure reduction required is moderate or high for perch and other coastal piscivores, low or moderate for cyprinids and other mesopredators, and low for flounder.

Distributions of expert responses on the required pressure reductions to achieve GES/state improvements are included in Annex 10. The figures indicate that experts have differing opinions about the pressure reductions required and that there is substantial uncertainty about the required pressure reductions (multiple peaks, wide distributions). Thus, these graphs provide further evidence that there is considerable uncertainty about the link between pressure reductions and achieving improvements in state.

Table 3. Sufficiency of measures in achieving GES or specific state improvements for coastal fish. The table presents the expected values and the 10-90 percentile in brackets, which shows the range in which 80% of the observations fall in. When an agreed HELCOM GES threshold exists, the result shows the probability to achieve GES with expected pressure reduction. When there is no GES threshold, the table shows the probability to achieve a specific state improvement (10%, 25% and 50%) with expected pressure reduction. Results with less than 3 contributing experts have been marked to have insufficient data.

State component	**Assessment area**	**Total pressure reduction (%)** [10 percentile – 90 percentile]	**Probability to achieve GES (%) with expected pressure reduction** [10 percentile – 90 percentile]	**Probability (%) to achieve specific state improvement with expected pressure reduction** [10 percentile – 90 percentile]			**Maximum possible pressure reduction due to model coverage (%)**
				10% state improvement	**25% state improvement**	**50% state improvement**	
Perch and other coastal piscivores	Gulf of Bothnia	22 [10-33]	13 [10-48]				59
	Gulf of Finland	14 [6-21]		5 [0-44]	Insufficient data		57
	Gulf of Riga	Insufficient data					
	Central (Swedish coastal areas only)	20 [9-30]	0 [0-0]				59
	Eastern Gotland Basin (Latvian & Lithuanian coastal areas only)	Insufficient data					
	South (Polish coastal areas only)	12 [8-17]		74 [18-92]	0 [0-26]	0 [0-0]	41
Cyprinids and other mesopredators	Gulf of Bothnia	13 [6-21]	0 [0-0]				41
	Gulf of Finland	Insufficient data					
	Gulf of Riga	Insufficient data					
	Central (Swedish coastal areas only)	14 [7-22]	0 [0-0]				48
	South (Polish coastal areas only)	15 [9-20]		67 [31-75]	7 [0-49]	0 [0-0]	48
	Eastern Gotland Basin (Latvian & Lithuanian coastal areas only)	Insufficient data					
Flounder	Central (Swedish coastal areas only)	16 [5-26]	0 [0-0]				46
	Eastern Gotland Basin (Latvian & Lithuanian coastal areas only)	Insufficient data					

State component	Assessment area	Total pressure reduction (%) [10 percentile – 90 percentile]	Probability to achieve GES (%) with expected pressure reduction [10 percentile – 90 percentile]	Probability (%) to achieve specific state improvement with expected pressure reduction [10 percentile – 90 percentile]			Maximum possible pressure reduction due to model coverage (%)
				10% state improvement	25% state improvement	50% state improvement	
	Southwest (Danish coastal areas only)	18 [7-28]	100 [100-100]				100
	South (Polish coastal areas only)	19 [12-26]		85 [72-89]	50 [43-82]	43 [43-43]	63

Data used: expert estimates of effectiveness of measure types, information on existing measures, expert estimates of significance of pressures to state components, expert estimates of required pressure reductions to achieve GES/state improvements, literature and projections of development of human activities

Table 4. Total pressure reduction required to reach GES/specific state improvements for coastal fish (perch and other coastal piscivores, cyprinids and other mesopredators, flounder). Standard deviation is given in parentheses. Confidence depicts the most common rating of expert's confidence in their own responses to the question on total pressure reduction required to reach GES/specific state improvements. Zero standard deviation results from lack of variation in underlying data, e.g. due to a group response. Results with 3 to 4 responding experts are presented without explicit values but with the colour scale representing the percent reduction in pressures required to reach the respective state level.

State	**Perch and other coastal piscivores**			
Area	**Gulf of Bothnia**	**Gulf of Riga**	**Central (Swedish coastal areas only)**	**Eastern Gotland Basin (Latvian and Lithuanian coastal areas only)**
Most likely pressure reduction required (%)	30 (0) ●●●	Insufficient data	60 (0) ●●●	Insufficient data
Confidence	High	NA	High	NA
Number of experts	9	Less than 3	8	Less than 3
State	**Perch and other coastal piscivores**			
Area	**Gulf of Finland, 10% state improvement**	**Gulf of Finland, 25% state improvement**	**Gulf of Finland, 50% state improvement**	
Most likely pressure reduction required (%)		Insufficient data	Insufficient data	
Confidence	Moderate	NA	NA	
Number of experts	3	Less than 3	Less than 3	
State	**Perch and other coastal piscivores**			
Area	**South (Polish coastal areas only), 10% state improvement**	**South (Polish coastal areas only), 25% state improvement**	**South (Polish coastal areas only), 50% state improvement**	
Most likely pressure reduction required (%)		22 (7) ●●●	38 (2) ●●●	
Confidence	Moderate	Moderate	Moderate	
Number of experts	3	3	3	
State	**Cyprinids and other mesopredators**			
Area	**Gulf of Bothnia**	**Gulf of Riga**	**Central (Swedish coastal areas only)**	**Eastern Gotland Basin (Latvian and Lithuanian coastal areas only)**
Most likely pressure reduction required (%)	47 (0) ●●●	Insufficient data	68 (0) ●●●	Insufficient data
Confidence	Moderate	NA	Moderate	NA
Number of experts	5	Less than 3	5	Less than 3
State	**Cyprinids and other mesopredators**			
Area	**Gulf of Finland, 10% state improvement**	**Gulf of Finland, 25% state improvement**	**Gulf of Finland, 50% state improvement**	

Most likely pressure reduction required (%)	Insufficient data	Insufficient data	Insufficient data	
Confidence	NA	NA	NA	
Number of experts	Less than 3	Less than 3	Less than 3	
State	**Cyprinids and other mesopredators**			
Area	**South (Polish coastal areas only), 10% state improvement**	**South (Polish coastal areas only), 25% state improvement**	**South (Polish coastal areas only), 50% state improvement**	
Most likely pressure reduction required (%)				
Confidence	Low	Low	Low	
Number of experts	3	3	3	
State	**Flounder**			
Area	**Central (Swedish coastal areas only)**	**Eastern Gotland Basin (Latvian & Lithuanian coastal areas only)**	**Southwest (Danish coastal areas only)**	
Most likely pressure reduction required (%)	70 (0) ●●●	Insufficient data		
Confidence	Low	NA	High	
Number of experts	5	Less than 3	4	
State	**Flounder**			
Area	**South (Polish coastal areas only), 10% state improvement**	**South (Polish coastal areas only), 25% state improvement**	**South (Polish coastal areas only), 50% state improvement**	
Most likely pressure reduction required (%)	9 (8) ○○●	15 (14) ○○●	25 (22) ○○●	
Confidence	Low	Low	Low	
Number of experts	7	7	7	

Colour scale for the percent reduction in pressures required to reach GES in percent (based on the expected value):
0-10%, 10-20%, 20-40%, 40-60%, 60-100%
Categories for the certainty of the reduction required estimate (based on the relative size of the standard deviation to the expected value): low: ○○●, moderate: ○●●, high: ●●●
NA = not applicable
Data used: expert responses on required pressure reductions to achieve GES/state improvements

What are the time lags between pressure and state?

Information on time lags between pressures and state of coastal fish was collected from experts, who evaluated how long it would take to achieve GES assuming sufficient measures were implemented. Table 5 shows the distribution and average of the answers for the coastal fish species (groups).

Relatively short time lags are estimated for coastal fish, with the averages ranging from 0 to 10 years. The shortest time lags are anticipated for flounder. These expert evaluations indicate that with sufficient measures, state improvements could be achieved relatively quickly.

The main factor contributing to the time lags for all coastal fish was generation time, with additional factors mentioned included eutrophication, poor oxygen conditions and habitat recovery times.

These estimations may be indicating that even populations in poor status are not so depressed as to experience critically reduced recruitment success and that generally, given sufficiently viable habitat and management regimes, populations could recover quickly.

Table 5. Time lags in achieving GES provided sufficient measures for coastal fish. Responses with clear reference to time lags due to lags in the implementation of measures have been excluded. The values in the row **'**Number of experts' includes experts with excluded responses (row 'Excluded').

Time lag	**Perch and other coastal piscivores**						**Cyprinids and other mesopredators**						**Flounder**			
	Gulf of Bothnia	**Gulf of Finland**	**Gulf of Riga**	**Central** ***(SE coastal areas only)***	**Eastern Gotland** ***(LT and LV coastal areas only)***	**South** ***(PL coastal areas only)***	**Gulf of Bothnia**	**Gulf of Finland**	**Gulf of Riga**	**Central** ***(SE coastal areas only)***	**Eastern Gotland** ***(LT and LV coastal areas only)***	**South** ***(PL coastal areas only)***	**Southwest** ***(DK coastal areas only)***	**Central** ***(SE coastal areas only)***	**Eastern Gotland** ***(LT and LV coastal areas only)***	**South** ***(PL coastal areas only)***
0 years (no time lag)	0	0	Insufficient data (less than 3 experts)	0	Insufficient data (less than 3 experts)	Insufficient data (less than 3 experts)	0	Insufficient data (less than 3 experts)	Insufficient data (less than 3 experts)	0	Insufficient data (less than 3 experts)	Insufficient data (less than 3 experts)	4	Insufficient data (less than 3 experts)	Insufficient data (less than 3 experts)	4
0-5 years	8	0		8			0			0			0			0
6-10 years	1	3		0			6			6			0			2
11-25 years	1	0		1			0			0			0			0
26-50 years	0	0		0			0			0			0			0
51-100 years	0	0		0			0			0			0			0
More than 100 years	0	0		0			0			0			0			0
Average	4.5	7.5		4.2			7.5			7.5			0.0			2.5
SD	4.6	0.0		4.7			0.0			0.0			0.0			3.5
Confidence acc. experts	High	Moderate		High			Moderate			Moderate			High			Moderate
Excluded	0	0		0			0			0			0			1
Number of experts	10	3		9			6			6			4			6

Data used expert estimates of time lags

What are the pressures contributing to the state components?

Tables 6.1-6.3 show the significance of pressures affecting coastal fish (perch and other coastal piscivores, cyprinids and other mesopredators, flounder). They enable comparison across species/species groups and geographic areas. Overall, 12 different pressures were identified as significant to coastal fish, the most significant pressure being *extraction of fish,* followed by the *effects of eutrophication*. Several other pressures had a low or moderate contribution to the coastal fish species (groups). The extraction of fish was the only pressure attributed to affecting flounder in the Southwest (Danish coastal areas). This is somewhat surprising and differs from the results for the other sub-areas and species groups. Experts' confidence in their own responses to the significance of pressures question was moderate or high. Results with 2 or fewer contributing experts are excluded due to insufficient data.

Table 6.1. Significance of pressures (%) affecting perch and other coastal piscivores. Results with 3 to 4 responding experts are presented without explicit values but with the colour scale representing the significance of the pressure to the state variable.

State / **Pressure**	**Perch and other coastal piscivores**					
	Gulf of Bothnia	**Gulf of Finland**	**Gulf of Riga**	**Central (Swedish coastal areas only)**	**Eastern Gotland Basin (Latvian & Lithuanian coastal areas only)**	**South (Polish coastal areas only)**
Extraction of fish (includes prey depletion)	30		Insufficient data		Insufficient data	
Species disturbance or displacement by human presence						
Effects of non-indigenous species				6		
Physical disturbance of marine habitats	11			18		
Physical loss of marine habitats	19			18		
Effects of eutrophication	19			12		
River, lake, or land habitat loss/degradation	8					
Change in hydrologic conditions						
Human-induced food web imbalance	14			24		
Confidence	High	Moderate	NA	High	NA	High
Number of experts	10	3	Less than 3	9	Less than 3	3

Colour scale for the significance of the pressure to the state variable (based on the expected value):
0-10%, 10-20%, 20-40%, 40-60%, 60-100%
Pressures for which we cannot quantify the link between the pressure input, pressure and state in the SOM analysis are highlighted in grey, e.g. we cannot link reductions in nutrient inputs to reductions in the effects of eutrophication and further to abundance of fish.
NA = not applicable
Data used: expert estimates of significance of pressures to state components

Table 6.2. Significance of pressures (%) affecting cyprinids and other mesopredators. Results with 3 to 4 responding experts are presented without explicit values but with the colour scale representing the significance of the pressure to the state variable.

State / Pressure	Cyprinids and other mesopredators					
	Gulf of Bothnia	Gulf of Finland	Gulf of Riga	Central (Swedish coastal areas only)	South (Polish coastal areas only)	Eastern Gotland Basin (Latvian & Lithuanian coastal areas only)
Extraction of fish (includes prey depletion)	10		Insufficient data	7		Insufficient data
Effects of non-indigenous species	3			7		
Physical disturbance of marine habitats	14			21		
Physical loss of marine habitats	17			21		
Effects of eutrophication	38			28		
Change in hydrologic conditions						
Human-induced food web imbalance	17			17		
Confidence	High	Moderate	NA	High	Moderate	NA
Number of experts	7	3	Less than 3	6	3	Less than 3

Colour scale for the significance of the pressure to the state variable (based on the expected value):
0-10%, 10-20%, 20-40%, 40-60%, 60-100%
Pressures for which we cannot quantify the link between the pressure input, pressure and state in the SOM analysis are highlighted in grey, e.g.in the analysis we cannot link reductions in nutrient inputs to reductions in the effects of eutrophication and further to abundance of fish.
NA = not applicable
Data used: expert estimates of significance of pressures to state components

Table 6.3. Significance of pressures (%) affecting flounder. Results with 3 to 4 responding experts are presented without explicit values but with the colour scale representing the significance of the pressure to the state variable.

State / Pressure	Flounder			
	Central (Swedish coastal areas only)	**Eastern Gotland Basin (Latvian & Lithuanian coastal areas only)**	**Southwest (Danish coastal areas only)**	**South (Polish coastal areas only)**
Extraction of fish (includes prey depletion)	23	Insufficient data		35
Effects of non-indigenous species	19			
Physical disturbance of marine habitats	15			13
Physical loss of marine habitats	8			15
Effects of eutrophication	19			13
Heavy metal pollution				4
Change in hydrologic conditions				10
Human-induced food web imbalance	15			10
Confidence	High	NA	High	High
Number of experts	6	Less than 3	3	7

Colour scale for the significance of the pressure to the state variable (based on the expected value):
0-10%, 10-20%, 20-40%, 40-60%, 60-100%
Pressures for which we cannot quantify the link between the pressure input, pressure and state in the SOM analysis are highlighted in grey, e.g.in the analysis we cannot link reductions in nutrient inputs to reductions in the effects of eutrophication and further to abundance of fish.
NA = not applicable
Data used: expert estimates of significance of pressures to state components

What are the state components most affected by fishing?

The data from the pressure-state expert surveys for hazardous substances, benthic habitats, birds, fish and mammals allow the state components most affected by pressures related to fishing to be identified. These five expert surveys provide expert views on the significance of various pressures to the state components in the SOM analysis. The most affected state components are identified based on the percent contribution of different pressures to the state component. First, the average percent significance of pressures has been calculated by state component, and then the pressures having the highest averages have been identified. This approach will overemphasize pressures important to geographically smaller assessment areas and may impact the rankings, as no corrections to account for the sizes of the assessment areas have been applied.

Table 7 shows the state components most affected by the extraction of fish and bycatch in fishing gears. State components most affected by bycatch in fishing gears are bird species and harbour porpoise. The extraction of fish most impacts some species of commercial and coastal fish.

Table 7. Top five state components most affected by pressures related to fishing. Listing is based on Baltic-wide averages of the significance of pressures to state components presented in each respective topic report. Average number of expert responses for the state component is given in parenthesis (total response count for the state component divided by the number of geographic areas for the state component).

Pressure	**1st most affected state component**	**2nd most affected state component**	**3rd most affected state component**	**4th most affected state component**	**5th most affected state component**
Extraction of fish (includes prey depletion)	Plaice (6.0)	Flounder (4.3)	Herring (7.8)	Sprat (16.0)	Perch and other coastal piscivores (4.8)
Bycatch in fishing gears (for birds and mammals only; excludes ghost nets)	Red-throated diver (6.0)	Long-tailed duck (7.0)	Harbour porpoise (3.0)	Great cormorant (9.0)	

Less than state components are presented in cases where there is insufficient data for some state component(s) affected by the pressure, i.e. there are not enough expert responses to the significance of pressures to the state component in the survey (e.g. some mammals species). This corresponds to the criteria for the format of presentation.
Data used: expert estimates of significance of pressures to state components for all topics

What are the reductions in pressures from existing measures?

Table 8 shows the effects of existing measures in reducing the pressures on coastal fish (40%) at the scale of the Baltic Sea in 2016-2030, considering the changes in the extent of human activities. They are calculated using the data on effectiveness of measure types, links between existing measures and measure types, and projected development of human activities.

As the effectiveness of measures data are at the Baltic Sea level, the total pressure reductions are presented as an average for the entire Baltic Sea.

The *targeted extraction and bycatch of coastal fish* is projected to be reduced to a moderate-high extent at the Baltic Sea scale, as a result of existing measures. There is rather high uncertainty about the projected reduction, as shown by the large standard deviation. This stems from the uncertainty on the effectiveness of measure types. The certainty of the estimate is evaluated as moderate.

The estimated projected pressure reduction is based only on the estimated effects of existing measures, as fish and shellfish harvesting is projected to stay constant until 2030 in the most likely development scenario for human activities.

Further details on the effectiveness of different measure types can be found in Table 9.

Table 8. Projected total pressure reductions (%) from existing measures on coastal fish in 2016-2030. The table depicts the most likely/expected values of total pressure reductions and gives standard deviation in parenthesis. Projected reductions are presented as the weighted average of each assessment unit.

Pressure Area	Targeted extraction and bycatch
Baltic Sea	39 (15) ○●●

Colour scale for the pressure reductions in percent (based on the expected value):
0-10%, 10-20%, 20-40%, 40-60%, 60-100%
Categories for the certainty of the pressure reductions (based on the relative size of the standard deviation to the expected value): low: ○○●, moderate: ○●●, high: ●●●
Data used: expert estimates of effectiveness of measure types, information on existing measures

How effective are measure types in reducing pressures?

This section presents the percent effectiveness of measure types in reducing the pressures *targeted extraction and bycatch of fish*, *direct pressure to fish habitats*, and *direct to fish abundance*. The estimates are presented per activity, i.e. they portray the percent reduction in the pressure from the activity in question, and not in the total pressure across all activities. Information on the reductions over all activities contributing to the pressure is given in the section on the impacts of measure types. Data on the effectiveness of measure types originate from expert surveys and are at the Baltic Sea scale.

Effectiveness estimates are presented in percent per pressure, activity, measure type and species/species group, and pooled over experts. The effectiveness estimates can be compared across measure types to assess, on average, how effective they are in relation to each other in reducing the pressure from the specific activities, or across activities to assess which measure type could be the most effective for each activity. Results with 4 or fewer responding experts are not shown due to insufficient data.

Spatial and seasonal closures appear among the most effective measure types to reduce *targeted extraction and bycatch of coastal fish* from *fish and shellfish harvesting* (Table 9.1).

Some measure types affect pressures or state directly rather than through activities. The effectiveness of measure types that reduce *direct pressure to coastal fish habitats* are presented in Table 9.2. All of these are assessed to have moderate effectiveness. Effectiveness estimates for *direct pressure to fish habitats* are provided as a separate piece of additional information, and not included further in the SOM analysis (of pressure reductions and sufficiency of measures).

The effectiveness of *fish stocking programs to support existing populations* is presented in Table 9.3. These affect directly the state of coastal fish and are assessed to have moderate effectiveness, but it is worth noting that it affects state directly and thus a lower effectiveness estimate could have a larger overall impact compared to measure types affecting through activities and pressures.

Overall, there is considerable uncertainty about the effectiveness of most measure types based on the standard deviations. The certainty of the estimates varies from low to moderate. Confidence of the estimates is moderate or high.

Estimates of the effectiveness of measure types are used to assess the effects of existing measures in reducing the pressures to coastal fish and to calculate pressure reductions from existing measures by 2030.

Table 9.1. Effectiveness of measure types (%) in reducing the *targeted extraction and bycatch of coastal fish* from fish and shellfish harvesting (all gears, professional and recreational). The effectiveness of a measure type is the percent reduction in the pressure resulting from a specific activity. The table depicts the expected values of effectiveness, and standard deviation is given in parenthesis.

Measure type ID	Activity Measure type	Fish and shellfish harvesting (all gears, professional and recreational)	Are there corresponding existing measures in the SOM analysis (Yes/No)
101	Seasonal closures	64 (33) ○●●	No
102	Spatial closures	70 (33) ○●●	No
103	Technical measures to reduce catches of unwanted species	18 (14) ○○●	No
104	Technical measures to reduce catches of unwanted sizes of fish	31 (19) ○○●	No
105	Coastal species management plans	52 (30) ○●●	Yes
106	Measures to reduce recreational fishing (e.g. licenses)	54 (25) ○●●	No
107	Measures to reduce commercial fishing capacity	45 (22) ○●●	No
108	Catches of commercial fish in line with targets for MSY	22 (20) ○○●	No
109	Bag limits (e.g. daily/seasonal) in recreational fisheries	39 (21) ○●●	No
110	Ensure compliance with existing regulations (commercial and/or recreational)	45 (24) ○●●	No
111	Promotion of sustainable fisheries (commercial and/or recreational)	35 (22) ○○●	Yes
141	Unspecified MPA fisheries restrictions	31 (20) ○○●	Yes
	Average confidence	High - Moderate	
	Number of experts	5-12	

Colour scale for the effectiveness of a measure type in percent (based on the expected value):
0-10%, 10-20%, 20-40%, 40-60%, 60-100%
Categories for the certainty of the effectiveness estimate (based on the relative size of the standard deviation to the expected value): low: ○○●, moderate: ○●●, high: ●●●
Data used: expert estimates of effectiveness of measure types

Table 9.2. Effectiveness of measure types (%) in reducing *direct pressure to fish habitats*. These measure types are included as additional information only and are not included in the calculation of pressure reductions and sufficiency of measures to reach GES/state improvements. They estimate the direct pressure reduction to loss of fish habitat rather than a reduction in pressure from any specific activity. The effectiveness of a measure type is the percent reduction in the pressure. The table depicts the expected values of effectiveness, and standard deviation is given in parenthesis.

Measure type ID	Direct pressure to fish habitats Measure type	Coastal fish habitat	Are there corresponding existing measures in the SOM analysis (Yes/No)
39	Full implementation of the EU Maritime Spatial Planning Directive	18 (18) ○○●	Effectiveness estimates are advisory only and have not been used in the SOM analysis
130	Shallow coastal habitat restoration	34 (17) ○●●	
131	Marine protected areas to protect habitat (fishing allowed)	38 (17) ○●●	
132	Food web management to regulate trophic interactions	32 (22) ○○●	
	Confidence	Moderate	
	Number of experts	12-13	

Colour scale for the effectiveness of a measure type in percent (based on the expected value):
0-10%, 10-20%, 20-40%, 40-60%, 60-100%
Categories for the certainty of the effectiveness estimate (based on the relative size of the standard deviation to the expected value): low: ○○●, moderate: ○●●, high: ●●●
Data used: expert estimates of effectiveness of measure types

Table 9.3. Effectiveness of measure types (%) directly affecting fish abundance. The measure types improve the state directly and not through activities or pressures. The effectiveness of a measure type is the percent improvements in state. The table depicts the expected values of effectiveness, and standard deviation is given in parenthesis.

Measure type ID	Direct to fish abundance Measure type	Coastal fish	Has corresponding existing measures in the SOM analysis (Yes/No)
138	Fish stocking programs to support existing populations	20 (24) ○○●	No
	Confidence	High	
	Number of experts	14	

Colour scale for the effectiveness of a measure type in percent (based on the expected value):
0-10%, 10-20%, 20-40%, 40-60%, 60-100%
Categories for the certainty of the effectiveness estimate (based on the relative size of the standard deviation to the expected value): low: ○○●, moderate: ○●●, high: ●●●
Data used: expert estimates of effectiveness of measure types

Which activities contribute to pressures?

The activity-pressure contributions were not estimated for fish, as all fish specific pressures are created by a single activity (fishing) or are not dependent on activities but affect pressures or state directly (longitudinal connectivity of rivers).

What are the impacts of measure types?

The impacts of measure types estimate the impact of measure types on reducing the targeted extraction and bycatch of coastal fish and direct pressure to coastal fish habitats. They include the effectiveness of measure types and (when relevant) the contribution of activities to pressure. Thus, the impact shows how much the measure type reduces the pressure across all activities contributing to the pressure and give indications on which measures could be the most relevant in addressing specific pressures.

In the case of coastal fish, the effectiveness and impacts of measure types are the same, as the pressures originate from a single activity, or measure types affect pressures directly. The most impactful measures are identified as those related to spatial and seasonal closures.

What are the impacts of existing measures?

This section presents information about existing measures affecting coastal fish. In the SOM analysis, existing measures are those measures in current policy frameworks (e.g. BSAP, EU MSFD, EU WFD, EU Biodiversity Strategy 2020) that affect pressures and environmental state within the time frame of the analysis (2016-2030). This includes measures that have been implemented, are partially implemented or are planned to be implemented by 2030. Measures which have already been fully implemented and have fully affected pressures and environmental state by 2016 are not included, as no further improvement of status due to these is expected during 2016-2030. Information about existing measures was compiled through a literature review and based on information from Contracting Parties.

The impact is the percent reduction in a specific pressure from implementing the measure in the relevant spatial area. It has been calculated based on the effectiveness of the measure, proxied by the effectiveness of the measure type it corresponds to, and the contribution of activities to the pressure in question. Similar to the impact of a measure type, the impact of an existing measure indicates how much the measure reduces the pressure across all activities contributing to the pressure.

Table 10 presents the impacts of existing measures in reducing targeted extraction and bycatch of coastal fish. The impacts are presented both for the Baltic Sea scale and for the area affected by the existing measure. In addition, information on the share of the Baltic Sea area affected by the existing measure is included. Both the effectiveness of the measure and the spatial area affected are relevant for the impact at the Baltic Sea scale. Some existing measures may have high impact in the affected area, but their impact at the Baltic Sea scale is low because they only affect a small area, while some measures may have a relatively low impact in the affected area but affect a large share of the Baltic Sea.

There are altogether six existing measures reducing targeted extraction and bycatch of coastal fish in the SOM analysis. All of these affect a very limited area of the Baltic Sea, except for *HELCOM coastal fish management plans,* which is by far the most impactful measure at the Baltic Sea scale. Other existing measures may have significant impacts in the area affected, but only apply to a small share of the Baltic Sea and thus are not particularly impactful at the scale of the Baltic Sea.

Table 10. Impacts of existing measures in reducing targeted extraction and bycatch of coastal fish. Impact is the percent reduction in a specific pressure from implementing the measure. Measure name and description correspond to those used in Annex 4 for referencing purposes. In rare cases, the name and description may not be representative of the existing measure due to the free text reporting format used during existing measures data collection. Standard deviations are given in parenthesis. Note that values less than 0.5 have been rounded to zero.

Measure name	Description	Activities	Countries	Measure type	Impact at the Baltic Sea scale (%)	Impact in the area affected (%)	Affected area of the total Baltic Sea (%)
Coastal fish management plans - HELCOM	Develop long-term management plans by 2012 for protecting, monitoring and sustainably managing coastal fish species, including the most threatened and/or declining, including anadromous ones, according to BSEP109	Fishing	EE, FI, DE, LT, LV, PL, SE	Coastal species management plans	44 (18)	52 (22)	83
Continue to raise public awareness of sustainable, ecosystem-compatible fisheries (UZ4-01, M411)	Further anchoring of the topic "sustainable eco-system-appropriate fishing" in public awareness	Fishing	DE	Promotion of sustainable fisheries (commercial and/or recreational)	1 (1)	34 (23)	4
BALDE-M919-other	Fisheries management measures in Natura 2000 sites in the EEZ	Fishing	DE	Unspecified MPA fisheries restrictions	0 (0)	30 (20)	0
BALDE-M412-UZ4-02	Fisheries measures	Fishing	DE	Promotion of sustainable fisheries (commercial and/or recreational)	0 (0)	36 (23)	0
BALDE-M412-UZ4-02	Fisheries measures	Fishing	DE	Unspecified MPA fisheries restrictions	0 (0)	30 (19)	0
Fisheries measures (M412-UZ4-02)	o Fisheries management measures in Natura 2000 sites. Germany will develop 'common advices' for necessary fisheries restrictions in these areas, which will be developed with the federal states, stakeholders from the fisheries industry and NGOs involved in fisheries management o MSFD targets considered when developing the federal fisheries policies	Fishing	DE	Unspecified MPA fisheries restrictions	0 (0)	30 (20)	0

Data used: information about existing measures and their spatial scale, expert estimates of effectiveness of measures types

Full activity names:

- Fish and shellfish harvesting (all gears; professional, recreational)

Background of respondents

For the effectiveness of measures survey for fish (common for coastal, commercial and migratory fish), altogether 24 survey responses with 37 contributing experts were received. Six of the answers were group responses with two to eight contributing experts. The coastal fish portion of the effectiveness of measure survey had altogether 14 survey responses and 22 contributing experts (with three group responses from two to eight experts each). For the pressure-state surveys for coastal fish, 13 responses from 22 experts were received. Four group responses were received for the pressure-state survey for coastal fish, with two to eight contributing experts, depending on the sub-topic.

The number of experts contributing to the coastal fish surveys is shown in Table 11, with the division by fish species (groups) and geographic areas presented in Table 12.

More detailed information about the background of experts participating in the effectiveness of measures and the pressure-state surveys is available. Experts stated most often fish research and fisheries as their respective field, followed by aquatic sciences, marine ecology and MSFD. For both surveys, more than 60% of the experts had 10-20 or over 20 years of experience (Table 13). Almost a third of the experts had 5-10 years of experience, and about 10% of them less than that. Experts represented research institutions, NGOs, or ministries.

Table 11. Number of experts contributing to the fish surveys for coastal fish

Survey	DE	DK	EE	FI	LT	LV	PL	RU	SE	Total
Effectiveness of measures (all fish groups)	5	5	3	6	2	-	3	-	13	37
Effectiveness of measures (coastal fish)	3	-	2	4	2	-	2	-	9	22
Pressure-state linkages (coastal fish)	-*	4	2	2	2	-	3	-	9	22

* No German coastal fish stocks were included in the SOM analysis. As a result, contributions from German experts were welcomed but their absence was anticipated.

Table 12. Number of responses to the fish surveys

Survey	Sub-topic	Geographic area	Response count
Effectiveness of measures		Whole Baltic	36
Pressure-state (coastal fish)	Perch and other coastal piscivores	Gulf of Bothnia	10
		Gulf of Finland	3
		Gulf of Riga	2
		Central (Swedish coastal areas only)	9
		Eastern Gotland Basin (Latvian and Lithuanian coastal areas only)	2
		South (Polish coastal areas only)	3
	Cyprinids and other mesopredators	Gulf of Bothnia	7
		Gulf of Finland	3
		Gulf of Riga	1
		Central (Swedish coastal areas only)	6
		Eastern Gotland Basin (Latvian and Lithuanian coastal areas only)	2
		South (Polish coastal areas only)	3
	Flounder	Central (Swedish coastal areas only)	6
		Eastern Gotland Basin (Latvian & Lithuanian coastal areas only)	1
		Southwest (Danish coastal areas only)	4
		South (Polish coastal areas only)	8

Table 13. Years of experience in the field for the coastal fish surveys

	Effectiveness of measures		Pressure-state (coastal fish)	
Years of experience	**Number of experts**	**Share of experts**	**Number of experts**	**Share of experts**
0-2 years	1	3 %	1	5 %
3-5 years	3	8 %	1	5 %
5-10 years	10	27 %	6	29 %
10-20 years	10	27 %	7	33 %
over 20 years	13	35 %	7	33 %

Discussion

Impact of alternative scenarios for development of human activities

The detailed results are presented for the most likely development scenario for the extent of human activities in 2016-2030. In addition, three other development scenarios were estimated: no change, low change and high change scenarios. These scenarios cover 9 out of the 31 activities in the SOM analysis. The extent of other activities is assumed to remain constant in all scenarios.

As activities contribute to pressures, their assumed change over time affects the pressure reductions and probability to achieve state improvements. The impact depends on to what extent the activities contributing to the specific pressure are covered in the change scenarios. For coastal fish, the main activity that contributes to the targeted extraction and bycatch of coastal fish pressure, fish and shellfish harvesting, is covered in the change scenarios. In the most likely scenario, no changes in the extent of fishing are projected until 2030. The alternative low and high scenarios project a decrease and increase of 10% by 2030, respectively.

Overall, the impact of alternative development scenarios on projected pressure reductions is not very significant for coastal fish, as the projected changes in fish and shellfish harvesting by 2030 are relatively small in both the low and high scenarios. Decrease in fish and shellfish harvesting results in somewhat larger pressure reductions, while increase leads to smaller pressure reductions (±6%). This results in somewhat higher total pressure reductions and probability to achieve GES/state improvements in the decrease scenario, and somewhat lower in the increase scenario for perch and other coastal piscivores, but the differences are relatively minor. Effects on the probability to achieve GES/state improvements for cyprinids and other mesopredators and flounder are negligible.

Impact of using literature data on effectiveness of measures

In addition to survey data from experts, literature data on the effectiveness of measures has been compiled. The literature data points have been used in a similar way as the expert survey responses, and when it has been available, it has been used to replace the expert estimates of the effectiveness of the measure type. However, literature estimates are not available for all measure types. Thus, it is not possible to implement the model estimation and provide the results relying entirely on the literature data on effectiveness of measure types. Thus, the model including the literature estimates is a combination of literature and expert data on effectiveness of measure types. The origin of other data components is not affected.

For coastal fish, 1 estimate could be included in the SOM model (Annex 6). The projected pressure reductions from existing measures are not affected by the inclusion of literature data as none of the measure types with literature data are implemented in the SOM analysis. Thus, the results on total pressure reductions or sufficiency of measures to achieve GES or specific state improvements do not change.

Evaluation of quality and confidence

The SOM analysis for coastal fish has been able to assess the sufficiency of existing measures to achieve GES for some species/species groups and sub-areas, but not for all of them as HELCOM agreed GES thresholds were not always available. Additionally, some results have been left out due to too few data points. This has

been the case for results on sufficiency of measures in achieving GES/state improvement, required pressure reductions, pressures contributing to the state components and time lags between pressures and state. Particularly Eastern Gotland Basin (Latvian and Lithuanian coastal areas), Gulf of Riga and Gulf of Finland have been affected by lack of data.

The overall certainty of the assessment for coastal fish could be characterized as low to moderate. Experts from seven coastal countries have contributed to some part of the assessment. The total number of experts contributing to the surveys is high for both the effectiveness of measures and pressure-state part, but some individual elements suffer from a low amount of data and, and some results have also been excluded from the presentation for this reason. Further, the results on the effectiveness of measure types are uncertain. As the effects of some important pressures to the state of coastal fish have not been estimated within the analysis, the pressure reductions and probability to achieve GES/state improvements are likely underestimated.

Quality and precision could potentially be improved with the collection of additional expert responses, particularly for the species and combinations currently lacking data, but changes to the assessment structure and the definition of the state improvement might be required.

One factor to note, present in all the SOM topics but of particular importance to coastal fish, is the balance in choosing a scale of analysis for specific state components. With lower spatial resolution, environmental variation increases and the personal expertise and confidence of experts may be reduced when trying to assess areas far from their national territory. Together this can increase the uncertainty in results. With higher spatial resolution, fewer experts are available for a given area and the more the results will be driven by individual responses. This balance will shift with changing levels of knowledge and available expert resources.

For the individual results, average certainty is low or moderate for the effectiveness of measures types, and moderate for the projected reductions in pressures. Group responses to the pressure-state expert survey have resulted in lack of variation in the data for the required pressure reductions to achieve state improvements, and thus its certainty is difficult to evaluate. These uncertainties should be kept in mind, in particular when examining the numeric estimates. Additionally, there is a general lack of knowledge of pressures other than fishing on fish stocks. Hence, conclusions on the relationship between different pressures are uncertain.

The confidence level experts reported by experts for their own evaluations is moderate or high for the effectiveness of measures and significance of pressures to state components, and moderate to high for required pressure reductions for perch and other coastal piscivores, low to moderate for cyprinids and other mesopredators, and low for flounder in most sub-areas.

There were some technical challenges that affected the survey implementation. Firstly, there was a problem in the survey software for the effectiveness of measure types survey that resulted in losing some responses. Much of the original responses became unusable, as it was not possible to identify which items had been skipped on purpose and which were lost data. This issue was addressed by sending follow-up invitations for experts to review and, when needed, complement their original saved response. Not all experts participated in the review, and thus their response had to be deleted from the final sample. Secondly, the simultaneous assessment of effectiveness of a measure type and certainty of that effectiveness proved in some cases difficult, as it required placing non-quantitative dots in a coordinate system to generate quantitative estimates. The dots were translated into effectiveness and certainty values between 0 and 100. Some experts would have preferred that the quantitative estimates would have been visible and could have been transparently influenced.

When interpreting the results, the assumptions and generalizations that were made when collecting the input data and defining and using the data on measure type effectiveness and pressure-state linkages need to be taken into account. The input data are based mainly on expert elicitations rather than existing models and data, and reflect substantial uncertainty. For more information on the SOM methodology, data collection and assumptions, see this document.

Reflection on measure types

Much credit should go to the participants of the HELCOM Workshop on the analyses of Sufficiency of Measures (SOM) for Fish (SOM-FISH WS 1-2019) for their contributions to the formation of the measure types for fish. The fishing measures types generally and coastal fishing measure types specifically are a model for intra-topic consistency and overall clarity. However, like all topics, review of these measure types should be conducted before they are applied in any future analysis.

The measure types on direct pressure to fish habitats and fish stocking are a separate issue that suffers from poor structural relationships between state components and the focused view of the SOM assessment on a single metric, abundance in the case of coastal fish. The effectiveness of measures directed to fish habitats have no effect on the outcome of the SOM analysis. Instead, they are an alternative perspective on the issue of habitat loss otherwise covered by the pressures *loss and disturbance to the seabed*. Further development of the spatial resolution and/or benthic habitat types in the SOM approach is required before these two perspectives are likely to be merged. Until that point, these measure types will only be advisory. The evaluation of the measure type on fish stocking is perhaps hampered by the focus on abundance of a species or functional group rather than population health. Stocking is not a purely positive activity, but the abundance of the stocked species often increases. The amount of increase is related to the size of the stocking effort and may be better represented through a purely mathematical assessment of the size of the stocking effort compared to the size of the existing population. Further development of measure types that are highly dependent on the magnitude of the action undertaken is required.

Lessons learned

Coastal fish is the only topic in the SOM analysis which used the BEAT tool to integrate data from multiple HOLAS II assessments into a single SOM assessment. The assessment does not appear to have been negatively impacted in any way and the methodology allowed for inclusion of multiple data points when determining a species' current environmental state. Further use of the BEAT tool should be investigated. The ideal outcome would be combining metrics covering different aspects of a state component's overall health into a single SOM assessment (e.g. combining the indicators for seal abundance and distribution into a more complete assessment of seal health). However, such a combination may result in too much lost information and thereby undermine its value in a future SOM analysis. In the case of coastal fish, the combined metrics utilize the same units (abundance) which avoids this issue. Alternatively, the principles of the BEAT tool might be used to combine separate SOM assessments of different indicators covering the same state component after the analysis has run.

Numerous effectiveness of measures data from the literature were originally generated for the fish topics (coastal, commercial, migratory fish). However, structural conflicts with the existing measure types did not allow for their inclusion in the model. In the future, the structural relationships of several of the fish measure types, particularly those related to MPAs and other spatial/temporal closures, will need to be changed from the standard measure type affecting state via activities and pressures to a measure type affecting state

directly. It is also possible that enough literature data exists to comfortably rely solely on those data points and in this case the creation of a new measure type would be sufficient. In either case, the change will significantly increase the utilization of literature data on effectiveness of measures. More broadly, a similar assessment should be undertaken for all of the SOM topics.

Importantly, the SOM analysis on coastal fish had to balance the regional perspective of the SOM analysis with the often-local dynamics of coastal fish populations. A combined approach of analysing multiple sub-areas of the Baltic Sea and using a one-out-all-out approach to integrate the different assessment areas within each Baltic sub-area was implemented to achieve this balance. However, this has resulted in a dynamic where each assessment is partially a sub-national assessment of a single coastal area and partially a sub-regional assessment of a number of coastal areas. The utility of this approach is unclear and further reflection by topic experts is needed before further topic progress can be made. Ideally, assessment results at more detailed resolution should be used, although this was not a possibility in the current case.

Use of results, implications and future perspectives

HELCOM (2018a) concluded that measures to restore and protect coastal fish communities should be developed with a local perspective, and that different measures might be relevant in different geographic areas. The experts found that scientific evidence on the effectiveness of different measures was often poor, and that only few thorough evaluations of implemented measures have been undertaken in the Baltic Sea so far. Among the few measures that have been scientifically evaluated, proven effects were noted for measures removing fishing mortality (such as no take areas). The group also found partial support for measures that reduce fishing mortality, such as temporary fishing closures, as well as gear and catch restrictions. Among measures to improve the production of fish, again, habitat protection and restoration were concluded as effective. Cases generally lacking scientific support were identified, and included biomanipulation, nutrient and substance abatement, as well as stocking of hatchery-reared fish.

The information provided by the SOM analyses provides an additional perspective to these conclusions, taking in national information in relation to measures from the contributing countries. The SOM analysis additionally provides a way to assess aspects of relevance for coastal fish along with other ecosystem elements, by using a coherent assessment structure across different elements. Achieving this aim by necessity involves compromise solutions for some assessment aspects. For example, in the case of coastal fish, the applied spatial scales were not ideal. The SOM analyses nevertheless provide an overarching screening, also for coastal fish, when it comes to identifying which measures and management options would be most important to investigate further. The results suggest a need to improve the spatial management of coastal areas in the Baltic Sea and ensure protection of deteriorated fish populations from too high mortality levels.

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ICES (2019f). Herring (Clupea harengus) in Subdivision 28.1 (Gulf of Riga). ICES Advice on fishing opportunities, catch, and effort. Baltic Sea Ecoregion: 29 May 2018. https://doi.org/10.17895/ices.advice.4749

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ICES (2019h). Plaice (Pleuronectes platessa) in subdivisions 21–23 (Kattegat, Belt Seas, and the Sound). ICES Advice on fishing opportunities, catch, and effort. Baltic Sea Ecoregion: 29 May 2019. https://doi.org/10.17895/ices.advice.4751

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Annexes

Annexes 1–9 contain the expert surveys as well as information on the measure types and the literature review. They are available on the SOM Platform workspace.

Annexes 10–12 contain graphs and tables that provide additional information and perspectives on the results.

Annex 1 Activity-pressure survey

All topic specific pressures are single activity pressures, so no activity-pressure survey is available.

Annex 2 Modified activity list (if modified)

The topic uses the standard activity list, so no modified activity list is available.

Annex 3 Measure types list

PDF containing the measure types used in the assessment of the effectiveness of measures for *Coastal fish*. Document includes examples of existing measures that if implemented would be included in the corresponding measure type.

Annex 4 Linking existing measures to measure types

Excel containing the identified existing measures and their relationship to the measure types used in the SOM analysis.

Annex 5 Literature review search terms

Excel containing the search terms used during the literature review on effectiveness of measures for *Coastal fish*.

Annex 6 Literature review summary

Excel document containing the effectiveness of measures data retrieved from the literature review.

Annex 7 Topic structure

Excel containing the relationships between measure types, activities, pressures, state components, and sub-basins. Also contains information on GES thresholds.

Annex 8 Effectiveness of measures survey

PDF of the Effectiveness of measures survey for *Coastal fish*.

Annex 9 Pressure-state survey

PDF of the Pressure-state survey for *Coastal fish*.

Annex 10 Supplementary results for required pressure reductions

This annex presents the probability density functions of required pressure reductions to achieve a noticeable state improvement based on responses to the expert survey. The graphs show the probability distribution of the pooled expert responses on how much pressures should be reduced to achieve a noticeable state improvement. Pressure reduction is presented on the x-axis (0-100%) and probability density on the y-axis. The probability density function presents the probability of the pressure reduction falling within a particular range of values. This probability is given by the integral of the probability density over that range—that is, it is given by the area under the density function but above the horizontal axis and between the lowest and greatest values of the range.

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 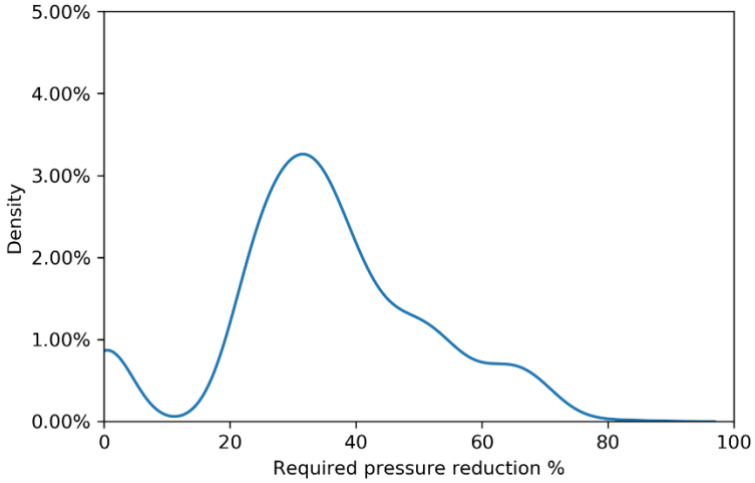
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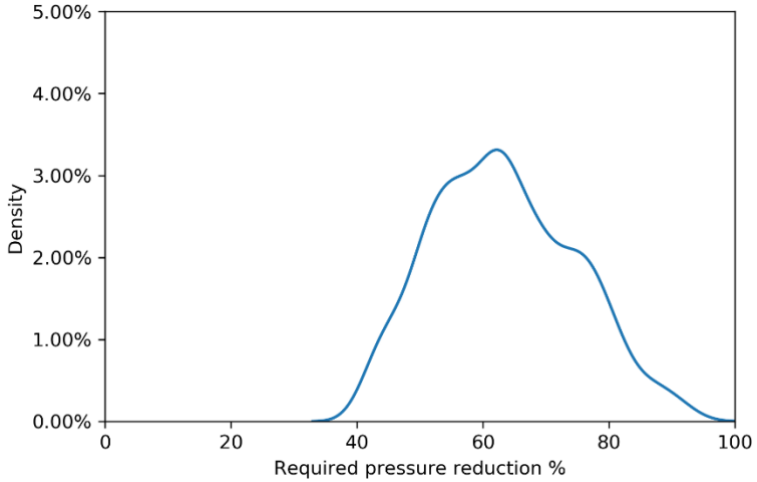
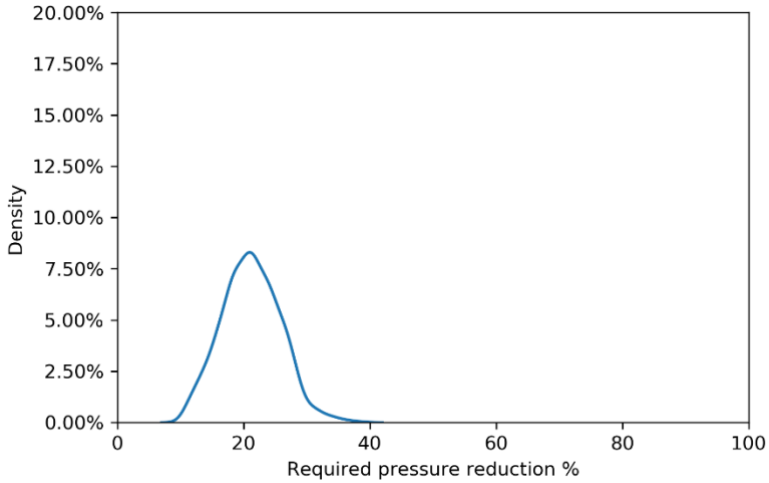
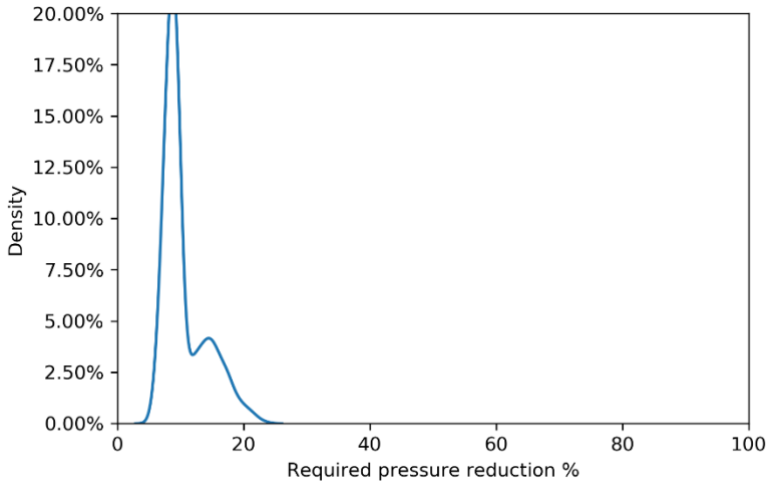
Central (SE coastal areas only) (No of experts = 8, Confidence = high) 	**Eastern Gotland Basin (LV &LT coastal areas only)** Insufficient data
Gulf of Finland, 10% state improvement (No of experts = 3, Confidence = moderate) 	**Gulf of Finland, 25% state improvement** Insufficient data

Gulf of Finland, 50% state improvement

Insufficient data

South (PL coastal areas only), 10% state improvement
(No of experts = 3, Confidence = moderate)



South (PL coastal areas only), 25% state improvement
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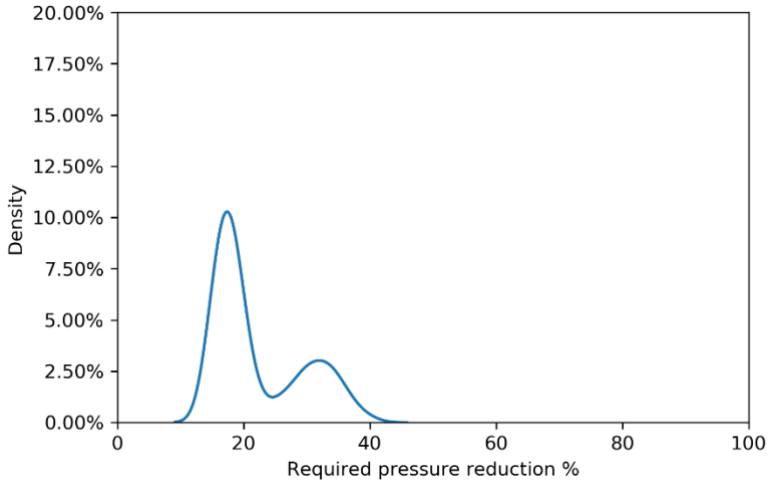

South (PL coastal areas only), 50% state improvement
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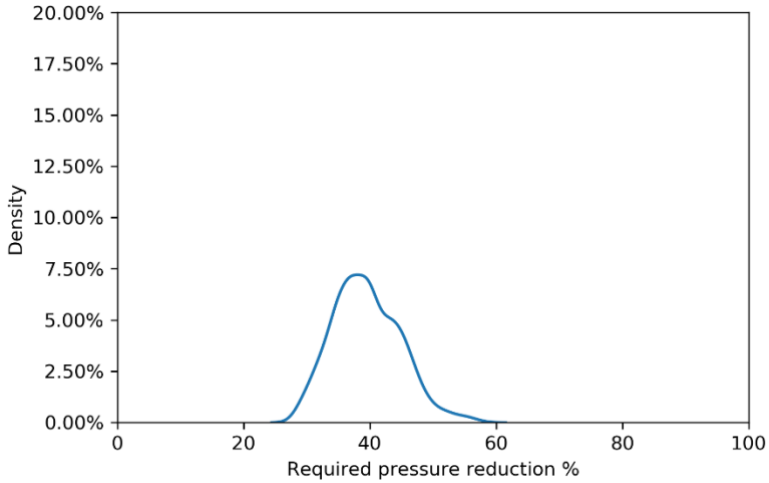

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 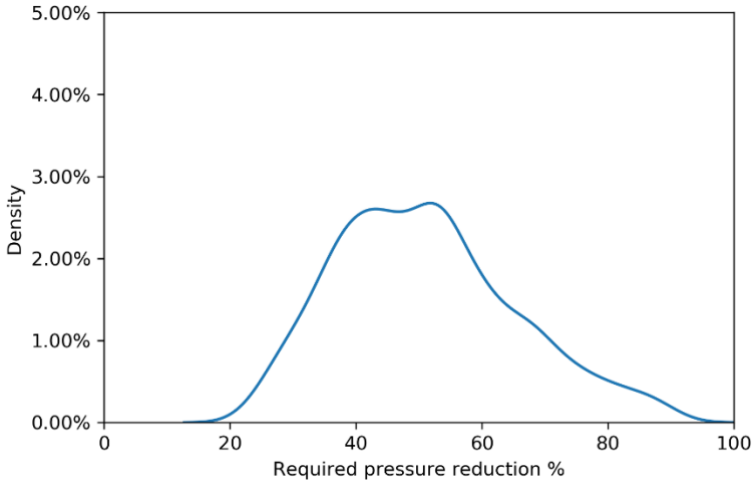
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Insufficient data</td></tr>
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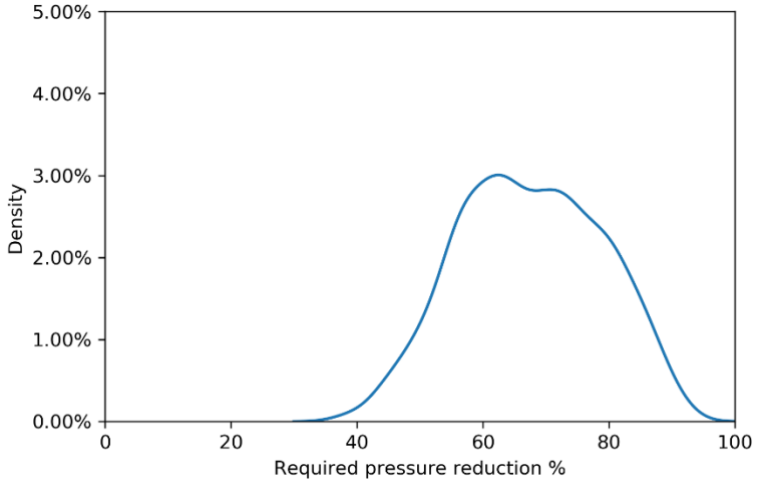
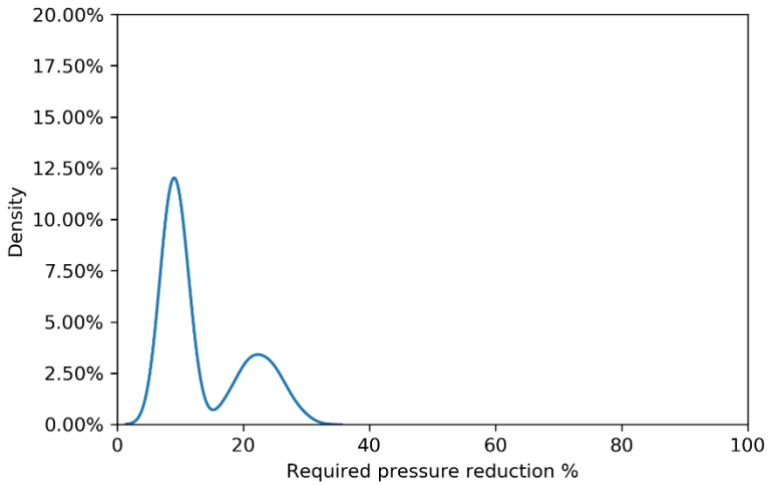
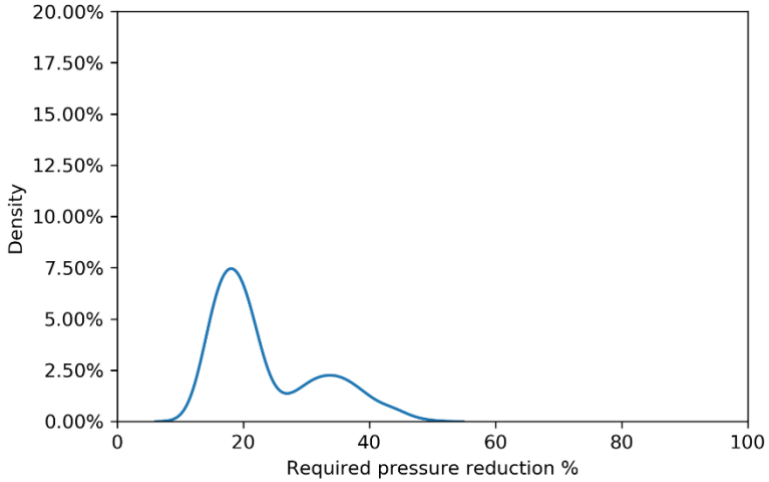
 
</td><td>Eastern Gotland Basin (LV &LT coastal areas only)

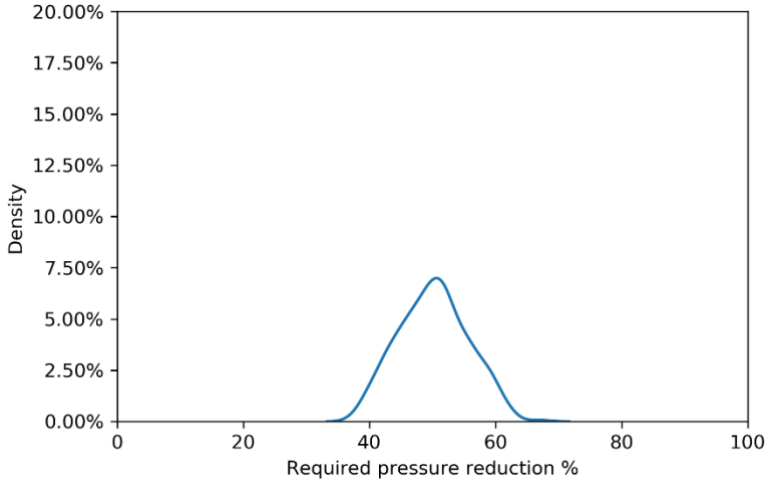
Insufficient data</td></tr>
</table>

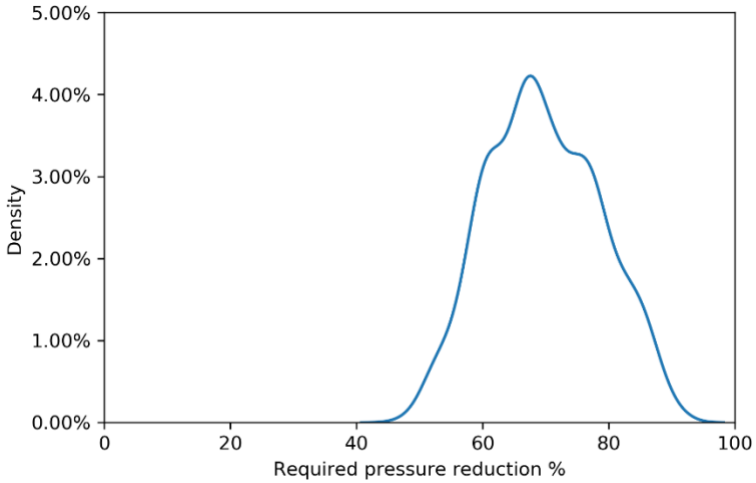
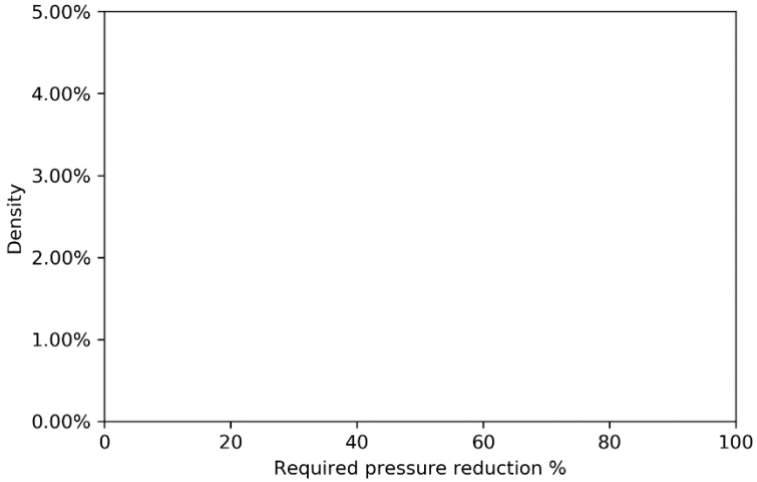
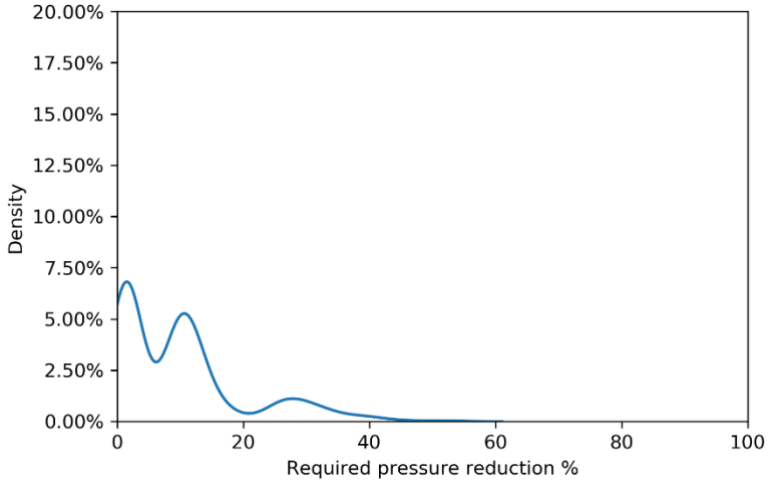
Gulf of Finland, 10% state improvement	Gulf of Finland, 25% state improvement
Insufficient data	Insufficient data
Gulf of Finland, 50% state improvement	**South (PL coastal areas only), 10% state improvement** (No of experts = 3, Confidence = low)
Insufficient data	

South (PL coastal areas only), 25% state improvement
(No of experts = 3, Confidence = low)

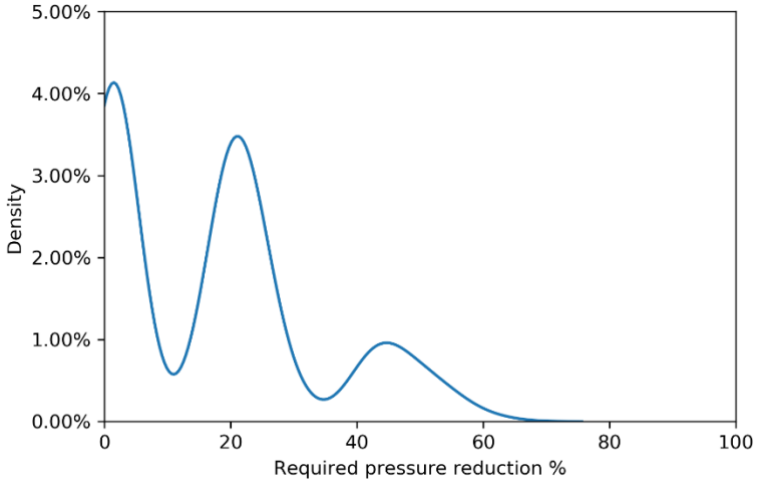


South (PL coastal areas only), 50% state improvement
(No of experts = 3, Confidence = low)

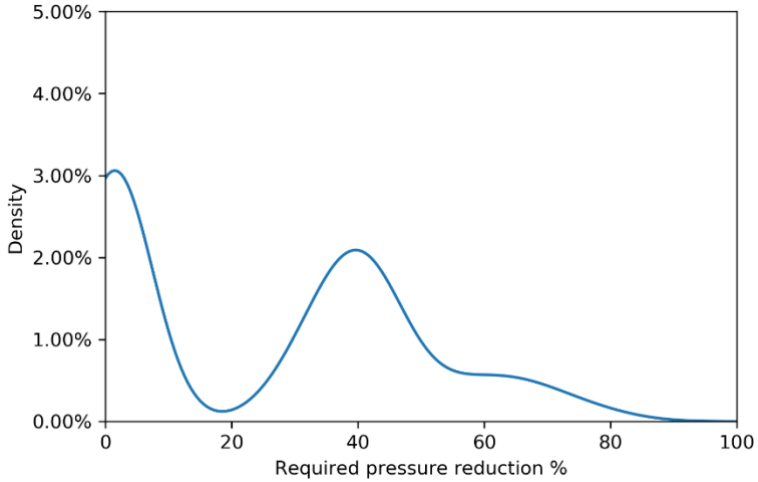


Flounder	
Central (SE coastal areas only) (No of experts = 5, Confidence = low) 	**Eastern Gotland Basin (LV &LT coastal areas only)** Insufficient data
Southwest (DK coastal areas only) (No of experts = 4, Confidence = high) 	**South (PL coastal areas only), 10% state improvement** (No of experts = 7, Confidence = low) 

South (PL coastal areas only), 25% state improvement
(No of experts = 7, Confidence = low)



South (PL coastal areas only), 50% state improvement
(No of experts = 7, Confidence = low)



Annex 11 Supplementary results for effectiveness of measures

Table A1. Distribution of the effectiveness of measure types in controlling the pressure *of targeted extraction and bycatch of coastal fish.* The effectiveness of a measure type is the percent reduction in a pressure resulting from a specific activity. The graphs present the probability distribution of effectiveness, based on expert responses or literature estimates. The dashed line represents the expected value. Figures showing only a dashed line and no apparent probability distribution are point estimates without variation.

Pressure:	Targeted extraction and bycatch of coastal fish
Activity:	Fish and shellfish harvesting (all gears; professional, recreational)
Measure type:	102: Spatial closures
	101: Seasonal closures
	106: Measures to reduce recreational fishing (e.g. licenses)
	105: Coastal species management plans
	107: Measures to reduce commercial fishing capacity
	110: Ensure compliance with existing regulations (commercial and/or recreational)
	109: Bag limits (e.g. daily/seasonal) in recreational fisheries
	111: Promotion of sustainable fisheries (commercial and/or recreational)
	104: Technical measures to reduce catches of unwanted sizes of fish
	141: Unspecified MPA fisheries restrictions
	108: Catches of commercial fish in line with targets for MSY
	103: Technical measures to reduce catches of unwanted species
Expert assessment:	5-12 experts, confidence = high-moderate

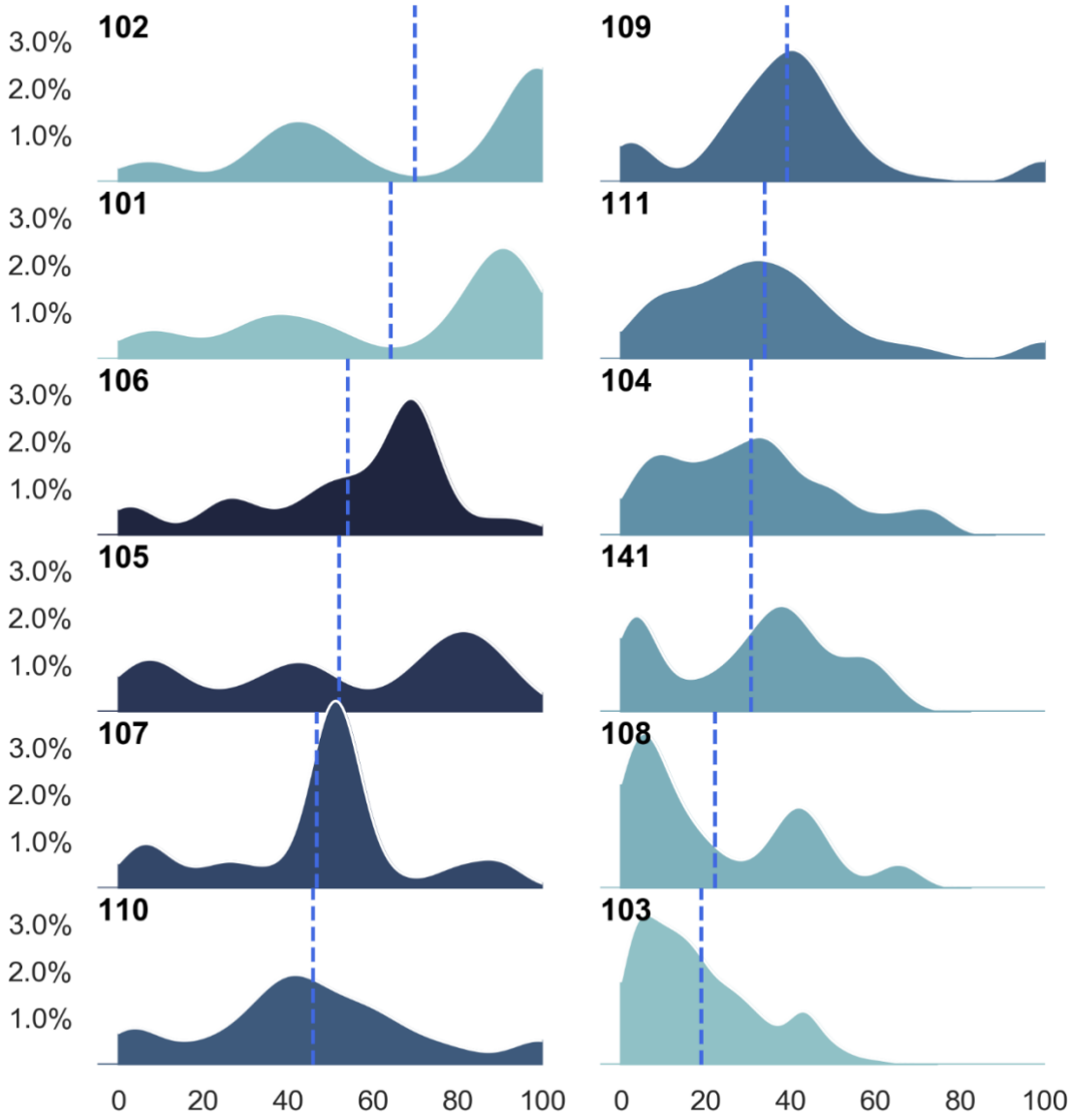
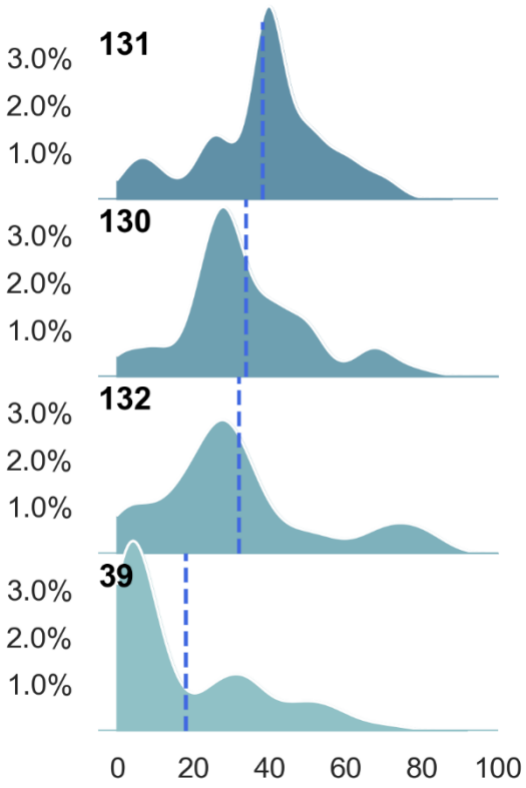

102
109
101
111
106
104
105
141
107
108
110
103
3.0%
2.0%
1.0%
0
20
40
60
80
100

Table A2. Distribution of the effectiveness of measure types in controlling *direct pressure to coastal fish habitat.* The effectiveness of a measure type is the percent reduction in a pressure resulting from a specific activity. The graphs present the probability distribution of effectiveness, based on expert responses or literature estimates. The dashed line represents the expected value. Figures showing only a dashed line and no apparent probability distribution are point estimates without variation.

Pressure:	Direct to pressure - coastal fish habitat
Activity:	Direct to pressure
Measure type:	131: Marine protected areas to protect habitat (fishing allowed)
	130: Shallow coastal habitat restoration
	132: Food web management to regulate trophic interactions
	39: Full implementation of the EU Maritime Spatial Planning Framework Directive
Expert assessment:	12-13 experts, confidence = moderate



Annex 12 Impacts of measure types

Table A3. Impacts of measure types (%) in reducing the targeted extraction and bycatch of coastal fish and direct pressure to coastal fish habitats. The impact shows how much the measure type reduces the pressure across all activities contributing to the pressure.

Pressure on coastal fish in the Baltic Sea	Measure type	Mean (Standard deviation)
Targeted extraction and bycatch of coastal fish	Spatial closures	70 (33)
	Seasonal closures	64 (33)
	Measures to reduce recreational fishing (e.g. licenses)	54 (25)
	Coastal species management plans	52 (30)
	Measures to reduce commercial fishing capacity	45 (22)
	Ensure compliance with existing regulations (commercial and/or recreational)	45 (24)
	Bag limits (e.g. daily/seasonal) in recreational fisheries	39 (21)
	Promotion of sustainable fisheries (commercial and/or recreational)	35 (22)
	Technical measures to reduce catches of unwanted sizes of fish	31 (19)
	Unspecified MPA fisheries restrictions	31 (20)
	Catches of commercial fish in line with targets for MSY	22 (20)
	Technical measures to reduce catches of unwanted species	18 (14)
Direct pressure to coastal fish habitats	Marine protected areas to protect habitat (fishing allowed)	38 (17)
	Shallow coastal habitat restoration	34 (17)
	Food web management to regulate trophic interactions	32 (22)
	Full implementation of the EU Maritime Spatial Planning Framework Directive	18 (18)