SOM topic report: marine mammals

HELCOM ACTION project, HELCOM Secretariat

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Summary of main results

Assessment of sufficiency of measures is not available for mammals due to lacking and inconsistent data.

Overall, low reductions in pressures affecting marine mammals are expected. There is considerable uncertainty about the pressure reductions.

Main pressures affecting grey seal population are:

> Bycatch in fishing gears (excludes ghost nets); Extraction of fish (includes prey depletion); Intentional killing; Organohalogen pollution (e.g. PFOS, PCBs, PBDEs, dioxins)

The results provide only limited support to which measure types have the most impact on the pressures to marine mammals. Marine protected areas appear among the most impactful measures for disturbance and displacement of porpoise and harbour seals by human presence.

Main activities contributing to the disturbance and displacement of harbour porpoise and harbour seal by human presence are fish and shellfish harvesting, tourism and leisure activities and shipping. In addition, hunting and population control is important to the disturbance and displacement of harbour seal.

Further, fish and shellfish harvesting is the single activity that contributes to bycatch of porpoise and seals, and hunting and population control to the intentional killing of seals.

Background

Report background

The sufficiency of measures (SOM) analysis assesses improvements in environmental state and pressures that can be achieved with existing measures in the Baltic Sea, and whether these are sufficient to achieve good environmental status (GES). The analysis involves estimating the state of the marine environment in 2030, given measures in existing policies, their implementation status and projected development of human activities over time, which can be compared to the agreed HELCOM threshold for GES, when 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 pressures on environmental state. The SOM approach, model and data collection are described in detail in the methodology report.

The methodology for the SOM analysis is designed to accommodate the broad array of topics covered and enable a regional-level analysis, and 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 considered as approximate. Due to the pioneering nature and variable data quality and availability of the SOM analysis, the findings do not provide complete or final answers on the need for new measures, and should be reviewed in relation to the results of other assessments.

This topic report describes the analyses and results for marine mammals in the SOM analysis, 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 will be 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[1]

Four marine mammal species are resident in the Baltic Sea: the grey seal (*Halichoerus grypus*), harbour seal (*Phoca vitulina*), ringed seal (*Pusa hispida*) and the harbour porpoise (*Phocoena phocoena*). They have an important role in regulating the food web, but are also sensitive to pressures and changes in the food web. Their exposure to accumulated pressures make marine mammals important indicators of ecosystem health. The overall status of marine mammal species is unfavourable. However, at species level, grey seals and harbour seals show increasing population sizes. Of particular concern are the local population of harbour porpoise in the Baltic Proper, with a population size recently estimated at around 500 animals. Ringed seal is in a critical state in the Gulf of Finland, where it is currently only represented by around 100 animals and has a decreasing abundance.

Out of the four species of marine mammals in the Baltic Sea, grey seal occurs in the whole region, whereas harbour seal is restricted to the southwestern Baltic Sea and the Kattegat, and ringed seal to the eastern and northern Baltic Sea. Harbour porpoise occurs mainly in the Kattegat and the southern parts of the Baltic Sea.

Hunting has been a major pressure on marine mammals in the Baltic Sea historically. The populations were severely reduced due to hunting in the beginning of the 1900s. Environmental contaminants caused further decimation of the populations in the 1960s and 1970s, by severely reducing the fertility of ringed and grey seals (Helle 1980). The harbour seal sub-populations in Kattegat and the Danish Straits have experienced two cases of mass mortality in recent times, caused by the 'Phocine distemper virus', resulting in more than 50% of the sub-population dying in 1988 and about 30% in 2002 (Härkönen et al. 2006). For harbour porpoise, drowning in fishing gear is a main pressure of concern. In all, these events have resulted in severe reduction of the abundance of marine mammals in the Baltic Sea, although today, the situation has improved for several seal populations.

Description of marine mammals in the SOM assessment

Marine mammals are included in the SOM analysis as four state components: *abundance of grey seals*, *abundance of harbour seals*, *abundance of ringed seals*, and *abundance of harbour porpoises* (Figure 1). In the SOM analysis, marine mammals are only evaluated by their abundance. Numerous other factors are important to their populations but are not included in this assessment.

The seal components reflect the structure of MSFD criteria D1C2[2] and portions of the HELCOM indicator "Population trends and abundance of seals". Good status for all species and populations has been defined as abundances above 10,000 individuals and a growth rate above 7% (9% for harbour seals), or less than 10% decrease over 10 years if at carrying capacity. In the latest HOLAS assessment period (2011-2016), only grey seals and the Kattegat population of harbour seals were assessed as being in good status. The grey seal population is estimated to be 37,500 to 50,000 individuals with the population stable and assumed to be at carrying capacity (Ahola, 2018; HELCOM, 2018b). The Kattegat population of harbour seals is estimated at 16,000 individuals with the population stable and assumed to be at carrying capacity (Ahola, 2018; HELCOM, 2018b). The remaining harbour seal populations in Kalmarsund and the Southern Baltic were not in good status with estimated populations of 1,400 individuals each and growth rates of 6.9% and 5.9%, respectively (Ahola, 2018; HELCOM, 2018b). Neither of the ringed seal populations was found to be in good status, with the northern population size estimated at above 20,000 individuals with a 4.6% growth rate and the southern population estimated at 1,350 individuals with a growth rate of 0% (Ahola, 2018; HELCOM, 2018b).

[1] Paraphrased or quoted from HELCOM (2018): State of the Baltic Sea – Second HELCOM holistic assessment 2011-2016. Baltic Sea Environment Proceedings 155.

[2] Marine Strategy Framework Directive D1C2 – The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured.

No HELCOM indicator currently exists for harbour porpoise, but MSFD criteria D1C2 is applicable to the current analysis. As no GES threshold exists for the harbour porpoise abundance, the SOM analysis assesses the probability to achieve noticeable state improvement. In the latest HOLAS assessment period (2011-2016), harbour porpoise populations were only qualitatively assessed. Both recognized populations are categorized as threatened, with the Baltic Proper population listed as critically endangered and the western Baltic population listed as vulnerable (HELCOM 2018a).

Five pressures specific to marine mammals have been included in the SOM analysis: *bycatch of porpoise, bycatch of seals, disturbance or displacement of porpoise by human presence, disturbance or displacement of seals by human presence,* and *intentional killing of seals*. The HELCOM pre-core indicator "Number of drowned mammals and waterbirds in fishing gear" and MSFD criteria D1C1 apply to the bycatch pressures (HELCOM 2018c). However, currently only a descriptive assessment is available through the HELCOM indicator and the pressure is therefore not assessed against the test thresholds available in the indicator. The disturbance or displacement pressures do not have a corresponding HELCOM indicator nor do they reflect a MSFD criterion. Instead they are a component of anthropogenic pressure not otherwise accounted for, and therefore relevant to any of the MSFD D1 criteria. Finally, intentional killing of seals does not have a corresponding HELCOM indicator, but it is a component of MSFD criteria D1C2.

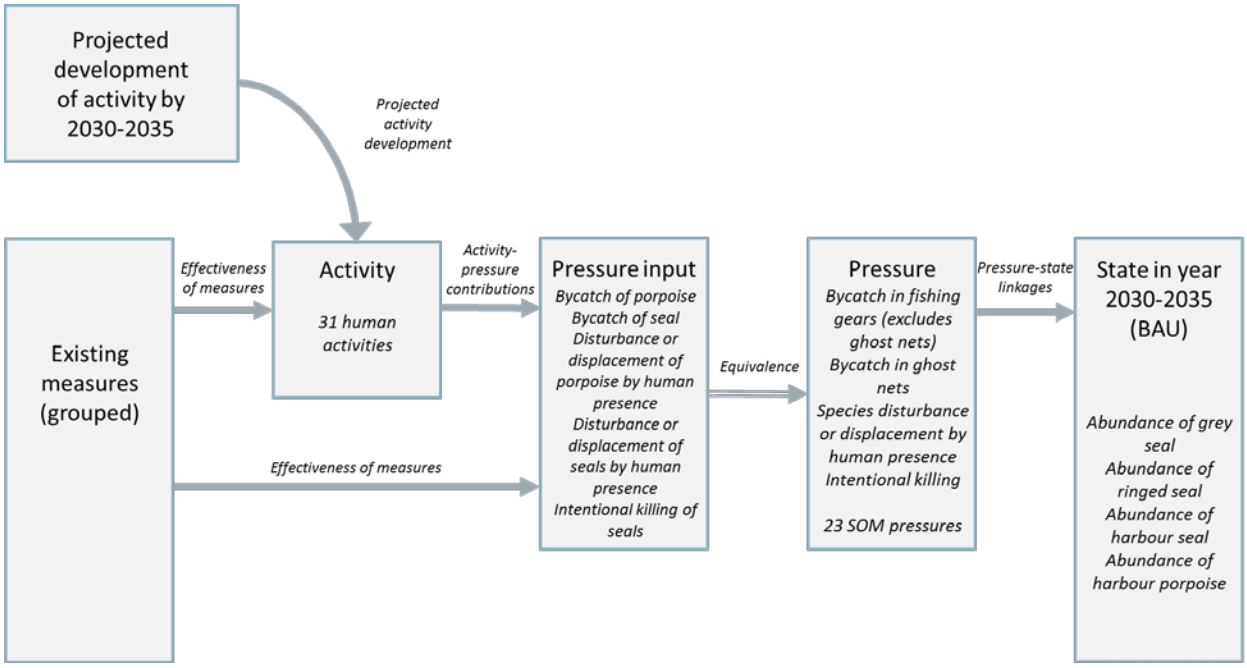

Figure 1. Schematic of the SOM analysis for marine mammals. The main components of the analysis are assessing the contribution of activities to pressures, the effect of existing measures on pressures, the effect of development of human activities on pressures, and the effect of changes in pressures to environmental state. The result is the state (in terms of pressure reductions or improvements in environmental components) in 2030, which can then be compared to the threshold for good environmental status (GES), when available. This allows assessing the probability to achieve GES with existing measures.

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.

Activity-pressure contributions

The contributions of activities to the disturbance or displacement by human presence for each of the four marine mammal species were determined using surveys that were distributed to national topic experts via the HELCOM Expert Group on Marine Mammals (EG MAMA). However, due to the lack of responses to this request, surveys were also distributed alongside the expert surveys on effectiveness of measures and pressure-state linkages. Responses from individual experts were accepted, but because national responses were preferred, all responses were weighted nationally to standardize the data set. Respondents were asked to assess the maximum, minimum, and most likely contribution of any activity contributing more than 5% to the pressures on marine mammals. Responses to activities contributing below that threshold were invited but not required. Respondents were also asked to assess the extent to which data informed their answer using a five-point scale (1 being very low and 5 very high).

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 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 marine mammals, the effectiveness of measures survey structure comprised 18 unique measure types covering 5 activities. The same measure type may be listed under multiple activities and pressures. Altogether this resulted in 43 assessments of measure type effectiveness across the five pressures, *Bycatch of seals, Bycatch of porpoises, Seal disturbance or displacement by human presence, Porpoise disturbance or displacement by human presence, and Intentional killing of seals*. 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 Expert Group on Marine Mammals 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.

Topic specific model structure, assumptions and challenges

The lack of a dedicated Topic Team consisting of topic experts during the design of the SOM analysis on marine mammals was a significant obstacle to achieving an effective analysis. Future work on the topic requires greater expert input to be productively advanced.

Overview of data

Table 1 shows the origin and spatial resolution for the data components in the SOM analysis for marine mammals. Activity-pressure contributions and pressure-state links are based on expert data. 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 marine mammals, 22

effectiveness estimates from 15 studies were compiled. Out of these, 7 estimates from 4 studies could be included in the model. Detailed results are presented using only the expert data, and the implications of using the literature data for the effectiveness of measures are reviewed in the discussion section.

The spatial resolution (level of detail) differs across the data components of the SOM analysis. All assessment areas are based on the 17 HELCOM scale 2 sub-basins and the assessment area ranges from the entire Baltic Sea to individual sub-basins. The spatial scale of the activity-pressure contributions for marine mammals varies with each assessed population from one sub-basin to the whole Baltic Sea (Figures 2-5), while 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 is the same as for activity-pressure contributions, varying with each assessed population (Figures 2-5). Table 1 shows the origin and spatial resolution for the data components in the SOM analysis for marine mammals.

Table 1. Data for marine mammals (more information on data collection is available in the methodology document).

Data component	Origin of data	Spatial resolution
Activity-pressure contributions	Expert evaluation	Varies by assessed population (Figures 2-5)
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	Varies by assessed population (Figures 2-5)

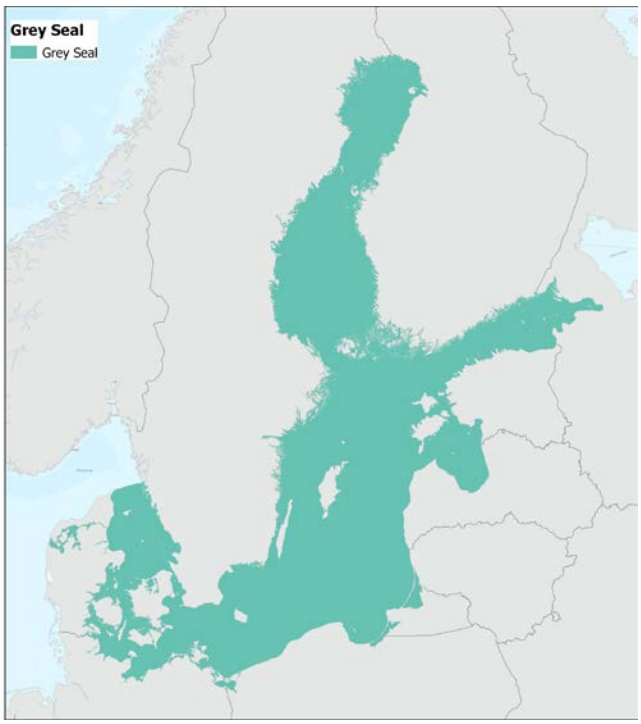

Figure 2. Spatial division of the Baltic Sea used for state assessment for grey seal. Grey seal is assessed as a single Baltic wide population.

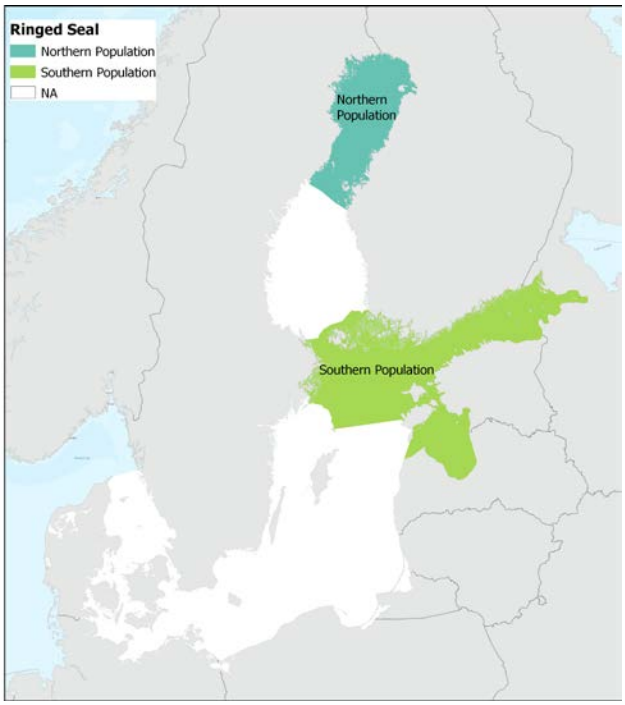

Figure 3. Spatial division of the Baltic Sea used for state assessments for ringed seals. The two populations are primarily present in the following sub-basins: Southern population (Gulf of Riga, Northern Baltic Proper, Gulf of Finland, Åland Sea) and Northern population (The Quark, Bothnian Bay).

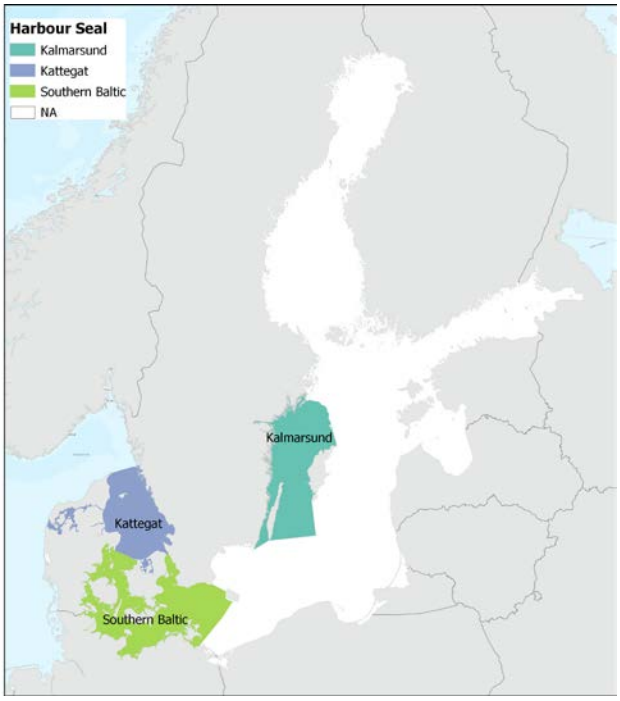

Figure 4. Spatial division of the Baltic Sea used for state assessments for harbour seal. The three populations are primarily present in the following sub-basins: Kattegat; Southern Baltic (The Sound, Great Belt, Kiel Bay, Bay of Mecklenburg, Arkona Basin) and Kalmarsund (Western Gotland Basin).

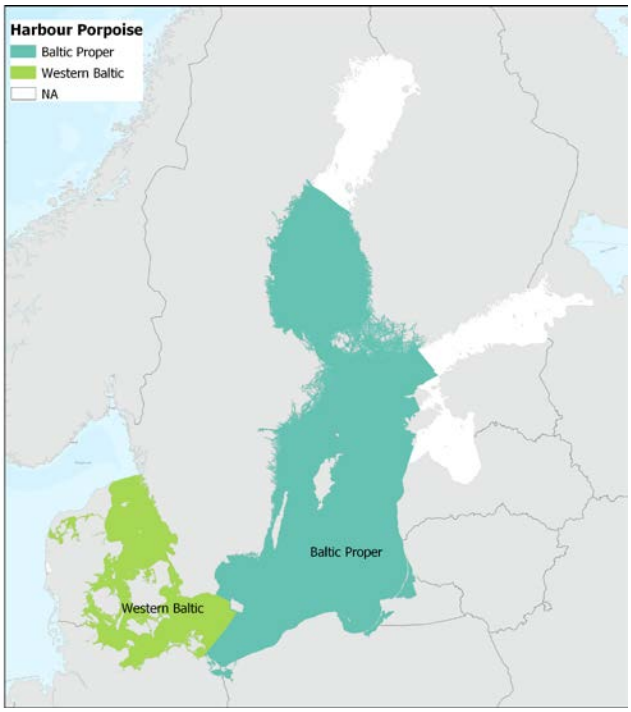

Figure 5. Spatial division of the Baltic Sea used for state assessments for harbour porpoise. The two populations are primarily present in the following sub-basins: Western Baltic (Kattegat, The Sound, Great Belt, Kiel Bay, Bay of Mecklenburg, Arkona Basin) and Baltic Proper (Bornholm Basin, Gdansk Basin, Eastern Gotland Basin, Western Gotland Basin, Northern Baltic Proper, Åland Sea, Bothnian Sea).

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 affects 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. 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.

For marine mammals, most of the main activities contributing to the pressures have development scenarios. Coverage of activities that contribute to the disturbance and displacement of marine mammals by human presence in the change scenarios is overall high (65-75%), as the main activities have development scenarios (fish and shellfish harvesting, tourism and leisure activities, and transport – shipping). For the single-activity pressures, fish and shellfish harvesting that contributes to the bycatch of porpoise and seals has a

development scenario, but no scenarios were made for hunting and population control that affects intentional killing of seals does, so it is assumed to remain constant.

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

The SOM analysis for marine mammals suffers from exceptionally poor response rates to the expert surveys and is being presented here in a modified format to avoid the inclusion of results that rely on very few data points. However, certain results are presented, some in a qualitative and some in a quantitative format. The format of presentation depends on the amount of data as outlined in Section "Format of presentation".

As for all SOM results, it is important to note the reliance on expert opinion for the majority of the analysis and to note the number of experts contributing to each estimate/results.

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 in percent (e.g. how many percent would the measure reduce the pressure). Results are presented mainly in tables, which show the the most likely (expected) values and standard deviations. Standard deviation is a way of showing the variation in the values, and 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 a different way of presentation.

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'; 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 received from topic experts, all results for mammals with fewer than 5 expert responses are shown as 'insufficient data'.

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 expert-based activity-pressure results, expert responses where primarily sought through the HELCOM expert networks in the form of national responses. Individual expert responses were accepted but were consolidated into average responses by country to conform to the format of other responses. Thus, the maximum number of responses is 9. This maximum is rarely reached due to responses typically only applying to areas adjacent to the specific country. Acknowledging this, activity-pressure relationships are reported if there are expert responses from 3 or more countries or if the number of countries providing expert responses is greater than 1/2 the number of countries bordering any given sub-area (see Table 2 below; responses from experts based in any HELCOM country will be counted toward the reporting threshold, i.e. the reporting assessment is not limited to responses from bordering countries).

Table 2. Required number of countries providing expert responses to the activity-pressure survey to meet the minimum data threshold for reporting.

Bordering countries	Required number of countries providing expert responses to meet minimum data threshold	Example areas
1	1	Western Gotland Basin
2	2	Bothnian Sea, Gulf of Riga
3	2	Gulf of Finland
4+	3	Eastern Gotland Basin, Baltic Sea

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 has been excluded due to not being able to quantify the link between the pressures inputs, 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 are 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?

All seal populations have established HELCOM GES thresholds, and thus in principle it would be possible to evaluate whether existing measures are sufficient in achieving/maintaining GES. However, low number of contributing experts and high disagreement among experts have resulted in an incomplete SOM assessment, and the data do not allow for assessing the sufficiency of measures to achieve or maintain GES for mammals (see Table 3). Likewise, results on the required pressure reductions to achieve or maintain GES are not presented due to insufficient data (Table 4).

The calculation of sufficiency of measures would take all the components of the SOM analysis into account: the activity-pressure contributions, 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 (see methodology document). There were deficiencies in the amount of data for all of the underlying elements, and particularly in the pressure-state expert survey. Thus, the amount of data is too low to present the results on sufficiency of measures. Further, there is insufficient data for presenting information on time lags, i.e. how long it would take to achieve/maintain GES assuming sufficient measures were implemented.

Table 3. Sufficiency of measures in achieving or maintaining GES (grey seal, ringed seal, harbour seal) or a noticeable improvement in state (harbour porpoise) for mammals. Results are not presented due to insufficient data.

State	**Assessment area**	**Expected total pressure reduction (%)** (x-axis) [10 percentile – 90 percentile]	**Probability to achieve or maintain GES (%) with expected pressure reduction** (y-axis) [10 percentile – 90 percentile]	**Probability (%) to achieve a noticeable state improvement** (y-axis) [10 percentile – 90 percentile]	**Maximum possible pressure reduction with pressures included in the SOM analysis (%)** (x-axis, dashed line)
Grey seal	Baltic Sea	Insufficient data			
Ringed seal	Northern pop.	Insufficient data			
	Southern pop.	Insufficient data			
Harbour seal	Kattegat	Insufficient data			
	Southern Baltic	Insufficient data			
	Kalmarsund	Insufficient data			
Harbour porpoise	Western Baltic	Insufficient data			
	Baltic Proper	Insufficient data			

Table 4. Most likely percent total pressure reduction required to reach or maintain GES (grey seal, ringed seal, harbour seal) or a noticeable improvement in state (harbour porpoise) for mammals. Results are not presented due to insufficient data.

State	**Grey seal**	**Ringed seal, Northern population**	**Ringed seal, Southern population**	**Harbour seal, Kattegat**
Most likely pressure reduction required (%)	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Confidence	NA	NA	NA	NA
Number of experts	Less than 5	Less than 3	Less than 5	Less than 3
State	**Harbour seal, Southern Baltic**	**Harbour seal, Kalmarsund**	**Harbour porpoise, Western Baltic**	**Harbour porpoise, Baltic proper**
Most likely pressure reduction required (%)	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Confidence	NA	NA	NA	NA
Number of experts	Less than 3	Less than 3	Less than 5	Less than 3

Data used: required pressure reductions to achieve GES
NA: not available

What are the pressures contributing to the state components?

The results in this section illustrate the significance of different pressures affecting marine mammals. Only results for grey seal are presented, as the number of data points is too low for the other species. Experts identified in total 10 pressures significant to the abundance of grey seal population (see Table 5). The most significant pressures are *bycatch in fishing gears (excludes ghost nets)*, *extraction of fish (includes prey depletion)*, *intentional killing* and *organohalogen pollution (e.g. PFOS, PCBs, PBDEs, dioxins)*. The results are based on five expert responses and evaluated to have moderate to high confidence by the experts themselves.

[Potential further discussion and interpretation, input from experts needed]

Table 5. Significance of pressures (%) affecting the state of grey seal in the Baltic Sea. There is insufficient data for ringed seal, harbour seal, and harbour porpoise.

State	**Grey seal**	**Ringed seal**		**Harbour seal**			**Harbour porpoise**	
Pressure	Baltic Sea	Northern population	Southern population	Kattegat	Southern Baltic	Kalmarsund	Western Baltic	Baltic proper
Bycatch in fishing gears (excludes ghost nets)	20	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Bycatch in ghost nets	5							
Impulsive underwater noise	7							
Continuous underwater noise								
Extraction of fish (includes prey depletion)	17							
Species disturbance or displacement by human presence	7							
Intentional killing	16							
Physical disturbance of marine habitats								
Physical loss of marine habitats								
Effects of eutrophication	5							
Hydrocarbon pollution	2							
Organohalogen pollution (e.g. PFOS, PCBs, PBDEs, dioxins)	18							
Heavy metal pollution	2							
Confidence	High - Moderate	NA	NA	NA	NA	NA	NA	NA
Number of experts	5	Less than 5	Less than 5	Less than 5	Less than 5	Less than 5	Less than 5	Less than 5

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 the state of marine mammals.

Data used: expert responses on significance of pressures to state components

What are the reductions in pressures from existing measures?

Tables 6.1-6.3 show the results of the effects of existing measures in reducing pressures on marine mammals by sub-areas in 2016-2030, considering the changes in the extent of human activities. They are calculated using the data on activity-pressure contributions, effectiveness of measure types, links between existing measures and measure types, and projected development of human activities.

The activity-pressure data are at the sub-area level, and the effectiveness of measures data at the Baltic Sea level, and thus the total pressure reductions are presented at the relevant sub-area level (varies depending on the species, see Figures 2-5). They account for the joint impacts across measure types and spatial multipliers to reflect the actual sea area where the pressures can be reduced to avoid overestimating the pressure reductions. Pressure reductions can 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.

There is considerable uncertainty about the projected pressure reductions in pressures affecting mammals, based on the large standard deviations compared to the expected values.

Table 6.1 shows the reduction of *seal bycatch* as well as *intentional killing of seals* on average in the Baltic Sea. Bycatch of seals is expected to be reduced to a moderate extent. This estimate incorporates measures throughout the Baltic Sea and the analysis for individual mammal populations utilizes population specific reductions. Very small reductions in the intentional killing of seals are expected.

Tables 6.2 and 6.3 show the reduction of *seal and porpoise disturbance/displacement by human presence*. There is enough data only for the harbour seal in the Kattegat and Southern Baltic and for porpoise in the Western Baltic, where low pressure reductions are projected.

Overall, the impact of future development in the extent of human activities on marine mammals is relatively important, as the main activities contributing to the pressures to mammals have development scenarios and some of these are expected to increase either by low or moderate extent by 2030 (in particular tourism and leisure activities and transport – shipping). Most of the activities having a minor contribution on mammals are also expected to increase (e.g. renewable energy generation). Thus, the projected pressure reductions are a combination of effects of existing measures and changes in the extent of human activities.

Further details on the effectiveness of different measure types and activity-pressure contributions can be found in Tables 7 and 8.

[Potential further discussion and interpretation, input from experts needed]

Table 6.1 Projected reductions (%) in *mammal bycatch and intentional killing of seals* from existing measures. The table depicts the expected values of pressure reduction, and standard deviation is given in parenthesis.

Pressure	Bycatch		Intentional killing of seals		
Area	Porpoise	Seal	Grey seal	Ringed seal	Harbour seal
Baltic Sea	Insufficient data	25 (8) ○●●	3 (2) ○○●	6 (5) ○○●	5 (4) ○○●

Colour scale for the pressure reductions in percent (based on the expected value):
<0%, 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: activity-pressure contributions, effectiveness of measure types, information on existing measures

Table 6.2 Projected reductions (%) in *seal disturbance/displacement by human presence* from existing measures. The table depicts the expected values of pressure reduction, and standard deviation is given in parenthesis.

Pressure / Sub-area		Seal disturbance/displacement by human presence		
		Grey seal	Harbour seal	Ringed seal
Baltic Sea	Kattegat	Insufficient data	5 (8) ○○●	Not applicable
	Southern Baltic		10 (11) ○○●	Not applicable
	Kalmarsund		Insufficient data	Not applicable
	Gulf of Riga, Northern Baltic Proper, Gulf of Finland, Åland Sea		Not applicable	Insufficient data
	Bothnian Bay & The Quark		Not applicable	Insufficient data
	Other*		Not applicable	Not applicable
*Remaining basins include Bornholm Basin, Gdansk Basin, Eastern Gotland Basin and Bothnian Sea				

Colour scale for the pressure reductions in percent (based on the expected value):
<0%, 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: activity-pressure contributions, effectiveness of measure types, information on existing measures

Table 6.3 Projected reductions (%) in *porpoise disturbance/displacement by human presence* from existing measures. The table depicts the expected values of pressure reduction, and standard deviation is given in parenthesis.

Pressure / Sub-area	Porpoise disturbance/ displacement by human presence
Western Baltic	2 (16) ○○●
Baltic Proper	Insufficient data

Colour scale for the pressure reductions in percent (based on the expected value):
<0%, 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: activity-pressure contributions, 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 bycatch of mammals, mammal disturbance or displacement by human presence, and intentional killing of seals from specific activities. 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. 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.

Data on the effectiveness of measure types originate from expert surveys on the effectiveness of measures. Results for measure types with fewer than 5 experts are not shown.

In the following, percent effectiveness is presented per pressure, activity and measure type, 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.

Confidence depicts the most common rating of expert's confidence in their own responses to the effectiveness of measure types question. Annex 10 presents the distributions of the effectiveness of measure types for additional information.

Tables 7.1 and 7.2 shows the effectiveness of measure types in reducing the *bycatch of porpoise and seals* from the activity *fish and shellfish harvesting (all gears; professional, recreational)*. The effectiveness of measure types to reduce porpoise bycatch are not shown due to low number of expert estimates (Table 7.1). The effectiveness of measure types to reduce seal bycatch is potentially rather high (Table 7.2), with all measure types having roughly the same effectiveness.

Tables 7.3-7.6 show the effectiveness of measure types in reducing *mammal disturbance or displacement by human presence*. Each table presents the results for one species (porpoise, grey seal, harbour seal, ringed seal). The pressure is influenced by the same four activities for all species, but the measure types are slightly different. For porpoise, the effectiveness of all the measure types is moderate. For grey seal, harbour seal and ringed seal, measure types of *new or expanded marine protected areas with implemented management plans covering seals* and *strengthen protections in existing marine protected areas containing seal habitat* seem overall the most effective ones, although all measures types have approximately a similar effectiveness.

Table 7.7 presents the effectiveness of measure types in reducing the *intentional killing of seals* from the activity *hunting and population control*. For all the presented species (grey seal, ringed seal, and harbour seal), *measures against illegal killing of seals* seems to have the highest effectiveness, but differences across measures types are small.

The effectiveness of measure type estimates are based on 5-8 expert responses, and reported confidence of the assessment is most often moderate. The uncertainty of the effectiveness of measure types is rather high, as shown by the standard deviations, and there are no substantial differences in the average effectiveness across the measure types. Thus, the information provided by the results on the relative effectiveness of different measure types is limited.

[Potential further discussion and interpretation, input from experts needed]

Table 7.1 Effectiveness of measure types (%) in reducing *porpoise bycatch*. The effectiveness of a measure type is the percent reduction in the pressure resulting from a specific activity. The table depicts the most likely/expected effectiveness, and standard deviation is given in parenthesis.

Measure type ID	Activity Measure type	Fish and shellfish harvesting	Has corresponding existing measures in the SOM analysis (Yes/No)
65	New Marine Protected Areas with implemented management plans restricting fishing activity	Insufficient data	Yes
66	National management plans for harbour porpoise		Yes
67	Expanded mandatory use of acoustic deterrent devices (pingers)		Yes
68	Reduce bycatch of harbour porpoise by modifications of fishing gears		No
69	Reduce fishing effort with gillnets or other gears causing bycatch of harbour porpoise		Yes
70	Strengthen fishing regulations in existing marine protected areas		Yes
	Confidence	NA	
	Number of experts	Less than 5	

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: ●●●
NA = not applicable
Data used: expert responses on effectiveness of measure types
Full activity names:

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

Table 7.2 Effectiveness of measure types (%) in reducing *seal bycatch*. The effectiveness of a measure type is the percent reduction in the pressure resulting from a specific activity. The table depicts the most likely/expected effectiveness, and standard deviation is given in parenthesis.

Measure type ID	Activity Measure type	Fish and shellfish harvesting	Has corresponding existing measures in the SOM analysis (Yes/No)
65	New Marine Protected Areas with implemented management plans restricting fishing activity	51 (22) ○●●	Yes
70	Strengthen fishing regulations in existing marine protected areas	52 (14) ●●●	Yes
77	Reduce fishing effort with gillnets or other gears causing bycatch of seals	56 (18) ○●●	No
78	Reduce bycatch of seals by modifications of fishing gears	58 (22) ○●●	Yes
	Confidence	High	
	Number of experts	5-7	

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 responses on effectiveness of measure types
Full activity names:

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

Table 7.3 Effectiveness of measure types (%) in reducing the potential *porpoise disturbance or displacement by human presence*. The effectiveness of a measure type is the percent reduction in the pressure resulting from a specific activity. The table depicts the most likely/expected effectiveness, and standard deviation is given in parenthesis.

Measure type ID	Activity Measure type	Renewable energy generation	Fish and shellfish harvesting	Tourism and leisure activities	Transport – shipping	Has corresponding existing measures in the SOM analysis (Yes/No)
39	Full implementation of the EU Maritime Spatial Planning Framework Directive	29 (12) ○●●	28 (16) ○●●	21 (13) ○○●	21 (15) ○○●	Yes
71	New or expanded marine protected areas with implemented management plans covering harbour porpoise	32 (21) ○○●	31 (14) ○●●	33 (15) ○●●	29 (14) ○●●	Yes
72	Measures targeting general protection of threatened habitats and biotopes	33 (14) ○●●	28 (11) ○●●	25 (13) ○●●	Not assessed	Yes
73	Strengthen protections in existing marine protected areas containing harbour porpoise habitat	Not assessed	32 (14) ○●●	31 (17) ○●●	29 (14) ○●●	Yes
	Confidence	High - Moderate	Moderate	Moderate - Low	Moderate	
	Number of experts	5	5	5	6	

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 responses on effectiveness of measure types
Full activity names:

- Renewable energy generation (wind, wave and tidal power), including infrastructure
- Fish and shellfish harvesting (all gears; professional, recreational)
- Tourism and leisure activities (boating, beach use, water sports, etc.)
- Transport – shipping (incl. anchoring, mooring)

Table 7.4 Effectiveness of measure types (%) in reducing the potential *grey seal disturbance or displacement by human presence*. The effectiveness of a measure type is the percent reduction in the pressure resulting from a specific activity. The table depicts the most likely/expected effectiveness, and standard deviation is given in parenthesis.

Measure type ID	Activity Measure type	Renewable energy generation	Fish and shellfish harvesting	Tourism and leisure activities	Transport – shipping	Has corresponding existing measures in the SOM analysis (Yes/No)
39	Full implementation of the EU Maritime Spatial Planning Framework Directive	36 (22) ○○●	27 (22) ○○●	29 (22) ○○●	32 (26) ○○●	Yes
72	Measures targeting general protection of threatened habitats and biotopes	39 (23) ○●●	35 (22) ○○●	38 (25) ○○●	Not assessed	Yes
79	New or expanded marine protected areas with implemented management plans covering seals	45 (25) ○●●	37 (26) ○○●	47 (26) ○●●	34 (27) ○○●	Yes
80	Strengthen protections in existing marine protected areas containing seal habitat	42 (24) ○●●	39 (23) ○●●	45 (29) ○○●	33 (25) ○○●	No
81	Strengthened coastal strip management	26 (16) ○○●	Not assessed	31 (20) ○○●	Not assessed	Yes
	Confidence	Moderate	Moderate	High	High	
	Number of experts	5-7	6-7	6-7	7	

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 responses on effectiveness of measure types

Full activity names:

- Renewable energy generation (wind, wave and tidal power), including infrastructure
- Fish and shellfish harvesting (all gears; professional, recreational)
- Tourism and leisure activities (boating, beach use, water sports, etc.)
- Transport – shipping (incl. anchoring, mooring)

Table 7.5 Effectiveness of measure types (%) in reducing the potential *harbour seal disturbance/displacement by human presence*. The effectiveness of a measure type is the percent reduction in the pressure resulting from a specific activity. The table depicts the most likely/expected effectiveness, and standard deviation is given in parenthesis.

Measure type ID	Activity Measure type	Renewable energy generation	Fish and shellfish harvesting	Tourism and leisure activities	Transport – shipping	Has corresponding existing measures in the SOM analysis (Yes/No)
39	Full implementation of the EU Maritime Spatial Planning Framework Directive	38 (22) ○●●	28 (22) ○○●	29 (23) ○○●	31 (26) ○○●	Yes
72	Measures targeting general protection of threatened habitats and biotopes	40 (23) ○●●	35 (21) ○○●	38 (24) ○○●	Not assessed	Yes
79	New or expanded marine protected areas with implemented management plans covering seals	46 (26) ○●●	36 (25) ○○●	49 (25) ○●●	34 (26) ○○●	Yes
80	Strengthen protections in existing marine protected areas containing seal habitat	41 (24) ○●●	40 (24) ○●●	44 (29) ○○●	32 (24) ○○●	No
81	Strengthened coastal strip management	26 (16) ○○●	Not assessed	31 (20) ○○●	Not assessed	Yes
	Confidence	Moderate	Moderate	High	High	
	Number of experts	5-7	6-7	6-7	7	

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 responses on effectiveness of measure types

Full activity names:

- Renewable energy generation (wind, wave and tidal power), including infrastructure
- Fish and shellfish harvesting (all gears; professional, recreational)
- Tourism and leisure activities (boating, beach use, water sports, etc.)
- Transport – shipping (incl. anchoring, mooring)

Table 7.6 Effectiveness of measure types (%) in reducing the potential *ringed seal disturbance/displacement by human presence*. The effectiveness of a measure type is the percent reduction in the pressure resulting from a specific activity. The table depicts the most likely/expected effectiveness, and standard deviation is given in parenthesis.

Measure type ID	Activity Measure type	Renewable energy generation	Fish and shellfish harvesting	Tourism and leisure activities	Transport – shipping	Has corresponding existing measures in the SOM analysis (Yes/No)
39	Full implementation of the EU Maritime Spatial Planning Framework Directive	37 (22) ○●●	28 (22) ○○●	29 (23) ○○●	32 (26) ○○●	Yes
72	Measures targeting general protection of threatened habitats and biotopes	41 (23) ○●●	36 (22) ○●●	38 (24) ○○●	Not assessed	Yes
79	New or expanded marine protected areas with implemented management plans covering seals	45 (25) ○●●	37 (26)○○●	48 (26) ○●●	33 (25) ○○●	Yes
80	Strengthen protections in existing marine protected areas containing seal habitat	40 (24) ○●●	41 (24) ○●●	44 (29) ○○●	31 (24) ○○●	No
81	Strengthened coastal strip management	26 (16) ○○●	Not assessed	32 (20) ○○●	Not assessed	Yes
	Confidence	Moderate	Moderate	High	High	
	Number of experts	5-7	6-7	6-7	7	

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 responses on effectiveness of measure types

Full activity names:

- Renewable energy generation (wind, wave and tidal power), including infrastructure
- Fish and shellfish harvesting (all gears; professional, recreational)
- Tourism and leisure activities (boating, beach use, water sports, etc.)
- Transport – shipping (incl. anchoring, mooring)

Table 7.7 Effectiveness of measure types (%) in reducing the potential *intentional killing of seals* from *hunting and population control*. The effectiveness of a measure type is the percent reduction in the pressure resulting from a specific activity. The table depicts the most likely/expected effectiveness, and standard deviation is given in parenthesis.

Measure type ID	Species Measure type	Grey seal	Ringed seal	Harbour seal	Has corresponding existing measures in the SOM analysis (Yes/No)
74	National management plans for seals	37 (29) ○○●	36 (28) ○○●	35 (27) ○○●	Yes
75	Killing ban for populations below Limit Reference Level (LRL); above LRL licences are needed	36 (25) ○○●	36 (25) ○○●	36 (25) ○○●	No
76	Measures against illegal killing of seals	42 (24) ○●●	42 (23) ○●●	42 (23) ○●●	No
	Confidence	Moderate	Moderate	Moderate	
	Number of experts	6-8	6-8	6-8	

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 responses on effectiveness of measure types

Which activities contribute to pressures?

Table 8 shows the contribution of activities to the *disturbance and displacement of marine mammals by human presence*. The remainder of the pressures affecting marine mammals do not require detailed activity-pressure linkages, as they are, by definition, single-activity pressures: *bycatch of porpoise and seals* caused by *fish and shellfish harvesting* (for all species) and *intentional killing of seals* caused by *hunting and population control*.

Expert elicitation has been used to estimate the activity-pressure relationships (further differentiated by species). The assessment has been done for the relevant sub-areas of the Baltic Sea (see Figures 2-5). Data are insufficient grey seal, ringed seal, harbour porpoise in the Baltic Proper and harbour seal in Kalmarsund.

Altogether 15 different activities are identified to contribute to the *disturbance and displacement of marine mammals*. The contributions depend on the species in question. The most important contributing activities are *fish and shellfish harvestin*g, *hunting and population control*, *tourism and leisure activities* and *transport – shipping*.

[Potential further discussion and interpretation, input from experts needed]

What are the impacts of measures?

The impacts of measure types show the impact of measure types on reducing the pressures on marine mammals. They include the effectiveness of measure types and 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.

Overall, the results on the impacts of measures for mammals are uncertain, as the standard deviations are high compared to the mean value. They are also lacking for some state components. Thus, the extent to which these results can support the evaluation of the usefulness of measure types in reducing pressures to mammals is limited.

For the disturbance or displacement by human presence, the impacts of marine protected areas appear somewhat higher than for the other measure types for porpoise in the Western Baltic and harbour seal in Kattegat and Southern Baltic.

All measures to reduce seal bycatch or intentional killing of seals are evaluated to have the approximately the same impact, and thus the results are not useful in ranking the measures based on their influence on pressures.

[Potential further discussion on existing measures and their impact, which existing measures are driving pressure reductions, which HELCOM measures are important but not yet implemented]

Detailed information on the impacts of measures are given in Annex 11.

Table 8. Activity-pressure contributions (%). The activity-pressure contributions show the percentage share the activity contributes to *disturbance and displacement of marine mammals by human presence*. The table depicts the most likely/expected contribution (%), and standard deviation is given in parenthesis. Note that activity-pressure contributions for marine mammals were assessed in different sub-areas of the Baltic Sea, depending on the species (see Figures 2-5). The assessed area is given in parenthesis.

Disturbance and displacement of marine mammals	**Agriculture**	**Waste waters**	**Aquaculture – marine**	**Renewable energy generation**	**Fish and shellfish harvesting**	**Hunting and population control**	**Extraction of minerals**	**Restructuring of seabed morphology**	**Tourism and leisure activities**	**Tourism and leisure infrastructure**	**Transport – shipping**	**Transport – shipping infrastructure**	**Military operations**	**Research, survey and educational activities**	**Marine and coastal construction**	**Other/ not determined**
Harbour porpoise (Western Baltic)	3 (5) ○○●	7 (10) ○○●		6 (8) ○○●	32 (12) ○●●		4 (5) ○○●		13 (7) ○●●		14 (5) ○●●	2 (2) ○○●	10 (7) ○○●	4 (5) ○○●	2 (2) ○○●	4 (4) ○○●
Harbour porpoise (Baltic Proper)	Insufficient data															
Harbour seal (Kattegat)	6 (6) ○○●		5 (4) ○○●	4 (4) ○○●	15 (5) ○●●	14 (10) ○○●	2 (2) ○○●	3 (2) ○○●	21 (8) ○●●	2 (2) ○○●	12 (4) ○●●	1 (1) ○○●	6 (4) ○●●		3 (2) ○●●	5 (5) ○○●
Harbour seal (Southern Baltic)	6 (6) ○○●		3 (3) ○○●	7 (7) ○○●	15 (5) ○●●	12 (11) ○○●	3 (3) ○○●	3 (3) ○○●	21 (8) ○●●	2 (2) ○○●	15 (4) ●●●	1 (1) ○○●	6 (4) ○●●		4 (2) ○●●	2 (2) ○○●
Harbour seal (Kalmarsund)	Insufficient data															
Ringed seal (Northern Population)	Insufficient data															
Ringed seal (Southern Population)	Insufficient data															
Grey seal (Whole Baltic)	Insufficient data															

Colour scale for the contribution of the activity to the pressure in percent (based on the expected value): 0-10%, 10-20%, 20-40%, 40-60%, 60-100%

Categories for the certainty of the activity-pressure contribution estimate (based on the relative size of the standard deviation to the expected value): low: ○○●, moderate: ○●●, high: ●●●

Data used: expert responses on activity-pressure contributions

Full activity names:

- Agriculture
- Waste waters (urban, industrial, and industrial animal farms; includes all waste streams entering wastewater systems e.g. microplastics, pharmaceuticals, etc.)
- Aquaculture – marine, including infrastructure
- Renewable energy generation (wind, wave and tidal power), including infrastructure
- Fish and shellfish harvesting (all gears; professional, recreational)

- Hunting and population control
- Extraction of minerals (rock, metal ores, gravel, sand, shell)
- Restructuring of seabed morphology (dredging, beach replenishment, sea-based deposit of dredged material)
- Tourism and leisure activities (boating, beach use, water sports, etc.)
- Tourism and leisure infrastructure (piers, marinas)
- Transport – shipping (incl. anchoring, mooring)
- Transport – shipping infrastructure (harbours, ports, shipbuilding)
- Military operations (infrastructure, munitions disposal)
- Research, survey and educational activities (seismic surveys, fish surveys)
- Marine and coastal construction
- Other/not determined

Background of respondents

Two expert surveys were conducted for marine mammals: one on the effectiveness of measures and another on pressure-state linkages. For the effectiveness of measures survey, altogether 10 survey responses with 12 contributing experts were received. One of the answers was a group response with three contributing experts. For the pressure-state survey, seven responses from seven experts were received. For the activity-pressure survey, three responses were received from three individual contributing experts.

The number of experts contributing to the surveys on mammals by country is shown in Table 9, with the response counts by sub-topic and geographic area presented in Table 10. Response counts to individual questions with each survey will vary.

Table 9. Number of experts contributing to the surveys on marine mammals

Survey	DE	DK	EE	FI	LT	LV	PL	RU	SE	Total
Effectiveness of measures	2	3	2	-	4	-	-	1	-	12
Pressure-state linkages	1	4	1	-	-	-	-	1	-	7
Activity-pressure contributions	1	2	-	-	-	-	-	-	-	3

Table 10. Number of responses to the surveys on marine mammals

Survey	Sub-topic	Geographic area	Response count
Effectiveness of measures	Porpoise	Whole Baltic	8
	Seals	Whole Baltic	10
Pressure-state linkages	Grey seal	Whole Baltic	5
	Ringed seal	Northern population	1
		Southern population	3
	Harbour seal	Kattegat	1
		Southern Baltic	2
		Kalmarsund	0
	Harbour porpoise	Western Baltic	4
		Baltic proper	2

More detailed information about the background is available for the experts participating in the effectiveness of measures and the pressure-state surveys. As their respective field, experts stated the most often marine mammals/biology, followed by conservation and population management. For both surveys, most experts had over 10 years of experience in their field, while only 8-14% had 0-2 years of experience (Table 11). Experts represented research institutions, NGOs, museums, federal institutes, or ministries.

Table 11. Years of experience in the field for the surveys on marine mammals

	Effectiveness of measures		Pressure-state	
Years	Number of experts	Share of experts	Number of experts	Share of experts
0-2 years	1	8 %	1	14 %
3-5 years	0	0 %	0	0 %
5-10 years	1	8 %	0	0 %
10-20 years	5	42 %	3	43 %
over 20 years	5	42 %	3	43 %

Discussion

Impact of alternative scenarios on 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 GES or state improvements. The impact depends on to what extent the activities contributing to the specific pressure are covered in the change scenarios. For marine mammals, the coverage of activities that contribute to pressures in the change scenarios is high.

The reduction in the bycatch of seals is affected by the assumption on the development scenario. In the low scenario, fish and shellfish harvesting is expected to decrease and in the high scenario increase, and thus bycatch is projected to be decreased more the low scenario and less in the high scenario. The most likely scenario corresponds to the no change scenario.

The disturbance/displacement by human presence of harbour seal and porpoise is dependent on tourism and leisure activities, shipping, and fish and shellfish harvesting. If no changes in these activities are assumed, the pressure is expected to decrease more compared to the most likely scenario. With high change scenario, the projected pressure reductions approach zero, as the impact of increase in the extent of activities counteracts the effect of existing measures.

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 morel 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 mammals, 7 estimates from 4 studies could be included in the SOM model. Somewhat smaller pressure reductions are projected for seal bycatch when using the literature data (19% vs. 25%), but this falls within the standard deviation of the estimates. The results for the other pressures affecting mammals are not impacted.

Evaluation of quality and confidence

The SOM analysis for marine mammals suffers from lack of data and inconsistent responses to the expert surveys. Thus, an assessment of the sufficiency of measures to achieve or maintain GES has not been possible, and results that rely on very few data points are not presented.

The overall certainty of the assessment for mammals could generally be characterized as low due to the aforementioned reasons. Quality could be improved with the collection of additional expert responses, but in addition, changes to the topic and survey structures and questions would potentially be required.

The most common confidence levels of experts in their own evaluations are overall moderate or high for the effectiveness of measure types and significance of pressures to state components. This does not indicate serious concerns of the experts' responses.

The geographic distribution of expert responses was moderate to poor, with several countries with significant marine mammals populations not contributing any expert responses.

There is considerable uncertainty about the projected pressure reductions, and in some cases the uncertainty on the effectiveness of measure types is likewise high. This should be kept in mind, in particular when examining the percent pressure reduction and effectiveness estimates.

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. The original responses became often 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 activity-pressure contributions, measure type effectiveness and pressure-state linkages need to be taken into account. When interpreting the results, the assumptions and generalizations that were made when collecting the input data and defining and using the data on activity-pressure contributions, 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 the methodology document.

[Potential further discussion on the credibility of the results and how they should (and should not) be interpreted, input from experts needed]

Reflection on measure types

Poor response rates and lack of expert involvement make assessing the measure type design more difficult. However, generally, the measure types for marine mammals could benefit from some standardization between seal and porpoise measures. This is particularly true for spatial measures (e.g. marine protected areas) where different wordings and structural approaches have been taken within marine mammals and across other biodiversity topics (fish, birds, benthic habitats). Systematic review of such measures would be prudent in future work. For this and other biodiversity topics, national or international management plans are difficult measures frameworks to deal with. They likely contain many distinct measure types but often 1) are in national languages, 2) can be quite large, and 3) include measures that are overly localized for the SOM analysis. A solution using partial overlaps was developed (see methodology document), however, it is imperfect. Further development on this issue is warranted.

[Potential further reflection on the measure types, input from experts needed]

Lessons learned

Overall, the SOM analysis for marine mammals suffers from scarcity of data due to low participation of experts to the expert survey. Thus, not all element of results could be presented, and also the remaining elements are often based on rather few expert evaluations. A major drawback was the lack of a topic team to support the development of the topic-specific methodology and the expert survey structures. With this, it is good to acknowledge the feedback from the HELCOM EG MAMA meeting that contributed to the format

of the data collection for mammals and all topics. Further similar work would benefit from close cooperation and active engagement of topic experts.

Climate change was not included among the pressures to marine mammals or otherwise evaluated as part of the analysis. This is a critical issue for several populations, but the framework used in the SOM analysis is largely based on the EU Marine Strategy Framework Directive, which excludes climate change as a pressure. Under this framework, pressure from climate change would result in a reassessment of GES thresholds rather than requiring the pressure be controlled. This issue is likely to remain outside the scope of any future iterations of the SOM analysis. However, the consequences of including climate change in the SOM pressure list as an aid to expert evaluations could be explored.

Assessing the impact of the SOM pressure *disturbance or displacement by human presence* proved difficult for topic experts, for both the identification of significant pressures and assessing the contribution of activities to the pressure. This was particularly true for fully aquatic species such as the harbour porpoise. It was considered unrealistic to assess the impact of e.g. the presence of ships without the simultaneous consideration of the noise they generate. For semi-aquatic species, this pressure is perhaps more easily conceptualized due to the higher potential for direct human contact. Nevertheless, this remains an important pressure to consider. Its value lies in determining the sensitivity of a particular species to human presence, and thereby the need for strict spatial protections (e.g. no-use protected areas). Improvement with this issue might be best pursued through continued discussion with a variety of topic experts to reach a formulation that is more accessible to a broader range of experts.

Expert responses to survey questions on the required reduction to maintain GES showed high disagreement for populations that were already in GES and disagreement appeared to increase the further above the GES threshold the population was. Thus, it seems the question format was not particularly successful and would benefit from a revision. Future survey design must incorporate clearer instructions and framing concerning such populations.

Use of results, implications and future perspectives

[Potential further information on how and to what purposes the results could be used and on the practical implications of the work, input from experts needed]

[Note the ICES threat matrix for marine mammal species as a future resource for determining significant pressures]

[Potential further information on future perspectives and what are the information gaps to be tackled in the future, input from experts needed]

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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 10–11 contain graphs and tables that provide additional information and perspectives on the results.

Annex 1 Activity-pressure survey template

Excel used as a template for receiving data for the activity-pressure survey.

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 *Marine mammals*. 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

PDF document containing the search terms used during the literature review on effectiveness of measures for *Marine mammals*.

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 *Marine mammals*.

Annex 9 Pressure-state survey

PDF of the Pressure-state survey for *Marine mammals*.

Annex 10 Supplementary results for effectiveness of measures

[updated graphs to be included later]

[improve the outlook of the graphs, include in all figures and graphs the number of experts contributing to the result, include standard deviations or confidence intervals in the graphs, where appropriate]

Annex 11 Impacts of measure types

Table A1. Impacts of measure types (%) in reducing pressures on marine mammals. The impact shows how much the measure type reduces the pressure across all activities contributing to the pressure.

Pressure on marine mammals *(spatial scale)*	**Measure type**	**Mean (Standard deviation)**
Porpoise bycatch *(Baltic Sea)*	Reduce fishing effort with gillnets or other gears causing bycatch of harbour porpoise	insufficient data
	Strengthen fishing regulations in existing marine protected areas	insufficient data
	Reduce bycatch of harbour porpoise by modifications of fishing gears	insufficient data
	New Marine Protected Areas with implemented management plans restricting fishing activity	insufficient data
	Expanded mandatory use of acoustic deterrent devices (pingers)	insufficient data
	National management plans for harbour porpoise	insufficient data
Seal bycatch *(Baltic Sea)*	Reduce bycatch of seals by modifications of fishing gears	58 (22)
	Reduce fishing effort with gillnets or other gears causing bycatch of seals	56 (18)
	Strengthen fishing regulations in existing marine protected areas	52 (14)
	New Marine Protected Areas with implemented management plans restricting fishing activity	51 (22)
Porpoise disturbance or displacement by human presence *(Western Baltic)*	New or expanded marine protected areas with implemented management plans covering harbour porpoise	20 (7)
	Strengthen protections in existing marine protected areas containing harbour porpoise habitat	19 (7)
	Full implementation of the EU Maritime Spatial Planning Framework Directive	16 (7)
	Measures targeting general protection of threatened habitats and biotopes	14 (6)
Porpoise disturbance or displacement by human presence *(Baltic Proper)*	New or expanded marine protected areas with implemented management plans covering harbour porpoise	insufficient data
	Strengthen protections in existing marine protected areas containing harbour porpoise habitat	insufficient data
	Full implementation of the EU Maritime Spatial Planning Framework Directive	insufficient data
	Measures targeting general protection of threatened habitats and biotopes	insufficient data
Grey seal disturbance/displacement by human presence *(Baltic Sea)*	Strengthen protections in existing marine protected areas containing seal habitat	insufficient data
	New or expanded marine protected areas with implemented management plans covering seals	insufficient data
	Full implementation of the EU Maritime Spatial Planning Framework Directive	insufficient data
	Measures targeting general protection of threatened habitats and biotopes	insufficient data
	Strengthened coastal strip management	insufficient data
Harbour seal disturbance/displacement by human presence	New or expanded marine protected areas with implemented management plans covering seals	22 (9)
	Strengthen protections in existing marine protected areas containing seal habitat	21 (9)

Pressure on marine mammals *(spatial scale)*	**Measure type**	**Mean (Standard deviation)**
(Kattegat)	Full implementation of the EU Maritime Spatial Planning Framework Directive	16 (8)
	Measures targeting general protection of threatened habitats and biotopes	15 (7)
	Strengthened coastal strip management	8 (5)
Harbour seal disturbance/displacement by human presence *(Southern Baltic)*	New or expanded marine protected areas with implemented management plans covering seals	24 (9)
	Strengthen protections in existing marine protected areas containing seal habitat	23 (10)
	Full implementation of the EU Maritime Spatial Planning Framework Directive	18 (8)
	Measures targeting general protection of threatened habitats and biotopes	16 (8)
	Strengthened coastal strip management	9 (5)
Harbour seal disturbance/displacement by human presence *(Kalmarsund)*	New or expanded marine protected areas with implemented management plans covering seals	insufficient data
	Strengthen protections in existing marine protected areas containing seal habitat	insufficient data
	Full implementation of the EU Maritime Spatial Planning Framework Directive	insufficient data
	Measures targeting general protection of threatened habitats and biotopes	insufficient data
	Strengthened coastal strip management	insufficient data
Ringed seal disturbance/displacement by human presence *(Northern Population)*	New or expanded marine protected areas with implemented management plans covering seals	insufficient data
	Strengthen protections in existing marine protected areas containing seal habitat	insufficient data
	Full implementation of the EU Maritime Spatial Planning Framework Directive	insufficient data
	Measures targeting general protection of threatened habitats and biotopes	insufficient data
	Strengthened coastal strip management	insufficient data
Ringed seal disturbance/displacement by human presence *(Southern Population)*	New or expanded marine protected areas with implemented management plans covering seals	insufficient data
	Strengthen protections in existing marine protected areas containing seal habitat	insufficient data
	Full implementation of the EU Maritime Spatial Planning Framework Directive	insufficient data
	Measures targeting general protection of threatened habitats and biotopes	insufficient data
	Strengthened coastal strip management	insufficient data
Intentional killing of seals - Grey seal *(Baltic Sea)*	Measures against illegal killing of seals	42 (24)
	National management plans for seals	37 (29)
	Killing ban for populations below Limit Reference Level (LRL); above LRL licences are needed	36 (25)
Intentional killing of seals - Ringed seal *(Baltic Sea)*	Measures against illegal killing of seals	42 (23)
	National management plans for seals	36 (28)
	Killing ban for populations below Limit Reference Level (LRL); above LRL licences are needed	36 (25)
	Measures against illegal killing of seals	42 (23)

Pressure on marine mammals ***(spatial scale)***	**Measure type**	**Mean (Standard deviation)**
Intentional killing of seals - Harbour seal *(Baltic Sea)*	Killing ban for populations below Limit Reference Level (LRL); above LRL licences are needed	36 (25)
	National management plans for seals	35 (27)

Data used: activity-pressure contributions, effectiveness of measure types