Guidelines for monitoring Seal abundance and distribution in the HELCOM area

1. Background

HELCOM Recommendation 27-28/2 tasks the HELCOM SEAL Expert Group to develop and coordinate monitoring programmes to, among other things, assess the abundance and distribution, and the trends of these parameters of the Baltic seal management units. The HELCOM Core Indicators 'Distribution of Baltic seals' and 'Population trends and abundance of seals' are used to assess the progress of achieving Good Environmental Status in the Baltic Sea based on parameters of seal abundance and distribution. To obtain the objectives of Recommendation 27-28/2 and these core indicators, standardized data from internationally coordinated efforts are necessary. This document describes guidelines for data collection for these needs as recommended by the HELCOM SEAL Expert Group. Annex 1 describes regional applications and modified practises of these recommendations.

1.1 Introduction

As top predators of the Baltic Sea, seals are important sentinels for the state of the ecosystem. The three regularly occurring seal species, namely harbour seal (*Phoca vitulina),* grey seal (*Halichoerus grypus),* and ringed seal (*Pusa hispida botnica*) were severely depleted in the 20th century and still face anthropogenic pressures such as hunting (and other deliberate killing), bycatch, pollution, climate change, disturbance and prey competition.

Ultimately, abundance trends reflect the combined effects of anthropogenic and natural pressures on the populations. The distribution of seals reflects combined effects of such pressures on the populations as well as more local effects such as local disturbance and habitat degradation.

For most of the year, seals spend the majority of time in water where observation and counting are severely impeded. They use land or ice for resting, breeding and moulting. The highest percentage of the population can be seen hauling out on land or ice during their species-specific moulting period when seals haul out in high numbers representing proportions of the total populations that enable monitoring of temporal trends. Due to these restrictions in temporal coverage of monitoring the data only describes haulout distribution while other methods would be needed for monitoring offshore distribution and possible changes in it. The current knowledge of offshore distribution, which is used in indicator work, is based on a limitied number of telemetry studies conducted outside of national monitoring programs.

Moulting grey seals and harbour seals gather at their established haulout sites on land where they are counted. Ringed seals moult scattered over ice where they are surveyed using line transect methods to estimate their abundance. Alternative methods are under development to adjust to the poor ice-conditions in the southern parts of Baltic ringed seal distribution.

Even if the largest proportion of seals are hauled out during peak moulting time, the survey methods do not generate total population estimates since the exact haulout fraction has not been estimated for most management units. To produce total population estimates, haulout fraction estimates need to be generated for all management units. However, on average the hauled out fraction can be assumed to be constant between years, permitting analyses of abundance trends. Seals tend to have a higher haulout rate in dry weather with moderate wind and waves. Therefore, surveys are conducted during such weather.

Another requirement for achieving useful monitoring data for following the population development and detecting signals of changes in the ecosystem at their early stage is the frequency of surveys. It has been shown, that with the unavoidable variation between abundance estimate data-points that is caused by weather conditions, disturbance and stochasticity, a 5 % of change in growth rate can only be determined after nearly a decade, even with annual surveys (Harding et al. 2007). Decreasing the frequency of the surveys severely reduces the power to detect changes in trends. In practice, only a drastic population decline would be differentiated from stochastic variation, while detecting moderate changes in trends would take one to two decades. Decreasing frequency of monitoring also severily impedes aims to explain annual variation in abundance estimates, producing correction factors for weather variables and total population estimates.

1.2 Purpose and aims

All three seal species in the Baltic Sea are to be annually monitored at their haulouts on land or ice during their moulting and pupping seasons, in order to produce estimates of abundance and abundance trends (moulting counts) and pup production (pupping counts) as well as the distributions and distribution trends of these species during their moulting and pupping seasons. These monitoring data are used to assess the status of the populations under the HELCOM core indicators 'Population trends and abundance of seals' and 'Distribution of Baltic seals'.

2. Monitoring methods

2.1 Monitoring features

Aerial surveys are used in population monitoring of seals. The method is chosen because accurate counting of the number of individuals in dense herds on rugged terrain is only possible from above, and large areas can be covered by aircrafts in a relatively short time and with minimized disturbance in areas out of reach with other methods.

The established monitoring methods vary to some extent between species, countries and regions due to differences in haulout behaviour, haulout geography and cost-efficiency of different methods in different regions.

2.2 Time and area

All monitoring is to be carried out annually. This is especially important for moulting counts in core areas which form the basis for monitoring population trends.

The timing of moulting surveys is targeted to species-specific peak moulting times when the highest proportion of the animals can be observed in the surveys. The surveys should cover the whole moulting distribution of the species in the Baltic Sea. Pup counts are carried out during species-specific breeding seasons at regionally important breeding locations.

Survey days with wind velocities below 10 m/s and no rain at a haulout within 6 hours prior to the survey and during the survey are selected.

2.2.1 Harbour seals

a. Harbour seal moult: Three aerial surveys of moulting harbour seals at all known haulouts during the peak moulting season in the latter half of August (Teilmann et al. 2010). In the Kattegat, these surveys are coordinated and synchronized between Denmark and Sweden. Potential new haulouts are investigated during the survey.
b. Harbour seal pups: Two aerial surveys of breeding harbour seals in June .

2.2.2 Grey seals

a. Grey seal moult: Three aerial surveys of moulting grey seals at all known haulouts. Potential new haulouts are investigated during the surveys. All moult counts are carried out during a two-week period in late May – early June, which is agreed among the international partners.

b. Grey seal pups: two aerial or land surveys in late February / early March and in mid to late March.

2.2.3 Ringed seals

a. Ringed seal moult: Ringed seals are moulting primarily on ice and are surveyed by line-transect methodology during mid-April to beginning of May. With the aerial transect flights, a sample of minimum 13 % of the ice-cover is surveyed, the number of days required for the survey varies depending on ice-cover. Other methods for poor ice-conditions are under development.

b. Ringed seal pups: No pupping surveys are conducted due to impossibility of locating and counting pups in their covered birth-lairs.

2.3 Monitoring procedure

2.3.1 Monitoring strategy

Seals are counted during key stages of their life cycle, namely breeding and moulting. During these key stages, seals are in particular need of land sites throughout their distribution. During the moult, the highest proportion of the population haul out, which makes it the optimal time for surveys to get the best comparable abundance estimate. During breeding, pups are counted to get estimates of pup production and mortality.

2.3.2 Sampling method(s) and equipment

2.3.2.1 Harbour seal and grey seal

Aerial moult and pup surveys follow a standard protocol. To ensure photographic quality and maximum haulout rate, surveys are only carried out at wind velocities below 10 m/s and if there has been no rain at haulouts within 6 hours prior to the survey. The haulouts are photographed from an altitude of 150-400 m depending on the disturbance effect of the aircraft. A pilot and one or two observers are required for each survey depending on density of haulout sites in each area. With help of GPS, maps and local experience, the pilot and the observers ensure that the flight route allows the photographing observer to photograph all targets. The observer(s) at the opening window takes a series of overlapping photographs of seal groups at each haulout while both the pilot and the other observer, if present, scan for other hauled out groups or swimming seals. Occurrence of seals outside of photographs is noted.

2.3.2.2 Ringed seals

Line transect methodology (Härkönen & Lunneryd 1992, Härkönen et al. 1998) is used as ringed seals haul out scattered on ice to moult and not all the ice can be covered in a survey.

In Bothnian Bay, surveys are flown at an altitude of 90 m and the surveyed strips are 800m wide. Survey strips are measured with inclinometer and marked on the aircraft prior to the flights. The two observers photograph all the seals on the strips (one 400 m strip on each side of the plane). The transects are evenly spaced over the ice area in a manner so that a minimum of 13% of the entire ice covered sea area is surveyed.

Modifications of these methods are used in southern areas of ringed seal distribution due to poor ice-coverage in most years, see Annex.

2.3.2.3 Equipment:

- High-wing fixed wing aircraft or helicopter with opening windows
- Digital cameras with zoom lenses including 200 mm in their range and image stabiliser. The cameras should have a sufficient resolution and lenses of high optical quality to facilitate species recognition.
- GPS-device
- Binoculars
- Intercom headsets
- Inclinometer to mark transect strips for ringed seal surveys

2.3.3 Sample handling and analysis

2.3.3.1 Harbour seal

Numbers of seals are counted from the pictures by experienced counters. In pup counts, the number of adults and pups are counted separately. Numbers of observed seals are summed up by sea area according to established area units. A 'trimmed mean' (the average of abundance of the two surveys with the highest counts) is used as the index of 'haulout abundance' for each year (Teilmann et al. 2010).

2.3.3.2 Grey seals

Numbers of grey seals are counted from the pictures by experienced counters. Numbers of observed seals are summed up by sea area according to established sea area units and the highest number obtained over the survey days in each area is used as the index of haulout abundance for each year. In pup counts the number of adults and pups are counted separately.

2.3.3.3 Ringed seals

All seals within survey strips are photographed and their numbers are counted from the pictures. The location data of observations are retrieved from EXIF of aerial photographs. The hauled out population is calculated by multiplying the number of seals on the observed strips to the whole survey area (Härkönen and Lunneryd 1992).

Ice-conditions can significantly affect the survey results, see Annex.

2.4 Additional information on region-specific modifications of the methods are gathered in Annex 1 (Additional information on regional applications and modified practices for the HELCOM Monitoring guidelines for seal abundance and distribution)

3. Data reporting and storage

All national data are secured in databases of the Department of Bioscience, Aarhus University (DCE), the Danish Nature Agency, the Swedish Meteorological and Hydrological Institute (SMHI), Natural

Resources Institute Finland, the Estonian Environment Agency and Hel Marine Station, University of Gdansk (HMS; online camera monitoring) and Chief Inspectorate of Environmental Protection Poland - State Environmental Monitoring (aerial surveys). Raw data are partially processed before being entered into the databases, after which they are publicly available. Data are also reported to the HELCOM Seal Abundance Database.

4. Quality control

4.1 Quality control of methods

The development of the monitoring methods was done in cooperation among the participating institutions and international partners and represents state of the art in seal monitoring. Standardized monitoring minimize the method-derived variation in abundance estimates.

4.2 Quality control of data and reporting

For harbour and grey seals, two persons perform individual counts of each locality. In cases of discrepancies exceeding 5% of the two counts, a third independent count is performed. With help of GPS-logs, archived raw-material and computer programs, such as iTag and ImageJ, the results can be easily revisited and corrected.

5.Contacts and references

5.1 Contacts

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5.2 References

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Teilmann, J., Riget, F. & Härkönen, T. (2010). Optimising survey design for Scandinavian harbour seals: Population trend as an ecological quality element. ICES Journal of Marine Science, 67: 952-958.

Annex 1. Describing additional information on regional applications and modified practices for the HELCOM Monitoring guidelines for seal abundance and distribution

1. Background

This document is a complement to the HELCOM Monitoring Guidelines for seal abundance and describes regional or temporal exceptions, improvements, or other modifications that may change the quality or comparability of the collected monitoring data. These exceptions occur due to logistical constraints, local variation in habitat and technological advancements.

This document is intended as a record of methods used over-time to aide interpretation of monitoring results. It is to be to be reviewed and updated on annual basis.

2. Monitoring methods

2.1 Monitoring features

N/A

2.2 Time and area

2.2.1 Harbour seals

a. Harbour seal moult

Note: From 2017, the southwestern Baltic, the Limfjord and the Danish part of Kattegat are only surveyed twice during the moult.

Note: In 2018 only 2 surveys of harbour seals along the Swedish West coast was carried out due to poor weather conditions.

b. Harbour seal pups

Only carried out in the Danish part of the Kattegat area and the Limfjord.

2.2.2 Grey seals

a. Grey seal moult

- Finland: 3 aerial surveys of moulting grey seals at all known haul-outs in SW Archipelago (the core area of moulting distribution) and 2 aerial counts in the Gulf of Bothnia and the Gulf of Finland.

  Note: In 2018 no annual surveys for moulting grey seals were conducted in Finland.

- Denmark: 1 survey covering the Danish HELCOM area is performed.

- Sweden: 3 aerial surveys are carried out at haul-outs in the key areas from archipelago of Central Sweden to Qvarken, in other areas 3 surveys are carried out from land or boat.

- Estonia: Gulf of Finland (2 surveys) and Estonian W archipelago including Gulf of Riga (3 surveys) are carried out.

- Russia: Eastern part of the Gulf of Finland is surveyed from ships or boats for 1-2 times depending on weather.

Note: During 2013-2017 no annual surveys for moulting grey seals were conducted in Russia.

- Poland: two independent monitoring programs

1. Regular monitoring since 2010 using both on-line camera and direct observation at a newly established haul-out
2. Pilot monitoring project: two aerial surveys following the standardized methods in 2016 and 2017. Regular state monitoring scheme covering all possible haul-outs? planned for the coming years.

- Germany: In the German Baltic Sea there are presently no permanent haul out sites, neither for breeding nor for moulting seals, therefore a standardized monitoring is not possible. However, seals can be observed along the coast, in particular grey seals in Greifswald Lagoon and harbour seals in Wismar Bay.

b. Grey seal pups

- Denmark: 2 aerial surveys at all grey seal breeding localities in the Danish HELCOM area.

- Estonia: Land surveys on major breeding islands (2-4) in Estonian western Archipelago and the Gulf of Riga.

- Finland: 2 aerial surveys at land breeding islands in core breeding area in the Finnish southwestern Archipelago. These surveys were conducted during 2006-2017.

- Sweden: No grey-seal pup surveys have been conducted.

2.2.3 Ringed seals

a. Ringed seal moult

- Bay of Bothnia: Annual line transect surveys covering minimum of 13 % of the sea ice between mid-April and beginning of May

- Archipelago Sea: 2 aerial line transect surveys in mid-April in years with sufficient ice-cover. In addition, boat- and land-based surveys under ice-free circumstances have been tested in known land haul-out areas.

- Gulf of Finland in years with noticeable ice-coverage: on the Finnish side two aerial line-transect surveys East of Helsinki (the main series of transect lines located east of the Kotka longitude); on the Russian side 1-2 aerial line transect surveys; on the Estonian side of the Gulf of Finland, one line-transect survey East of Tallinn (the main series of transect lines located east of the Kunda longitude). Timing of these surveys are coordinated between the three countries.

- Gulf of Riga: One aerial line transect survey between the 15th of April and 1st of May in years with sufficient ice coverage. In addition, surveys at known haul-out localities on land in circumstances of no ice and open-water conditions have been tested.

Note: Due to warming winters sufficient ice-conditions are rare in the southern areas and poor ice conditions prior to the survey period are expected to become more frequent in the Bothnian Bay. Therefore alternative survey methods or earlier survey time and calibration of the results will be needed in all areas.

2.2 Monitoring procedure

2.3.1 Monitoring strategy

N/A

2.3.2 Sampling method(s) and equipment

2.3.2.1 Harbour seal and grey seal

Note: At a few harbour seal localities in Denmark, seals haul-out on individual rocks covering a large area. At these sites, overlapping photographs are not possible and the seals are directly counted from the aircraft. The counting is done independently by each observer and the mean of these counts is used.

Note: in Russia, the main grey seal haul-outs are located in a no-fly zone, and photographs are taken from boats at a distance of 100-400 meters.

Note: In parts of southern and northern Sweden, a few grey seal haul-out sites are scattered far from main survey routes. For time- and cost-efficiency reasons these locations are surveyed from boats or nearby land vantage points. Aerial survey methods using drones are under development.

Note: in Poland an on-line camera together with land based visual surveys are used at the newly established grey seal island haul-out. – In the pilot project (2016 and 2017), aerial surveys using drones were conducted following the standard protocol.

Note: grey seal haul-out sites surveyed with other than the standardized aerial methods together form only a marginal proportion of all counted individuals.

Grey seal pups are surveyed with aerial survey methodology similar to moult survey methods (Denmark, Poland), during land visits to breeding sites (Estonia, Poland) and with on-line camera (Poland). In Estonia, grey seal pups in different age classes as well as remains of dead pups are counted separately.

a. Poland: two independent monitoring programs

    1. Regular monitoring since 2010 using both on-line camera and direct observation at a newly established land breeding site?
    2. Pilot monitoring project: one aerial survey in March in 2017 and 2018 covering *which area?*. Regular state monitoring scheme planned for the coming years.

2.3.2.2 Ringed seal

Line transect methodology (Härkönen & Lunneryd 1992, Härkönen et al. 1998) has been carried out since 1988 in Bothnian Bay and the method is also used in Estonia and Russia. The methodology is employed since ringed seals haul out scattered on ice to moult and not all the ice-covered area can be observed. Surveys are flown at an altitude of 90m and the surveyed strips are 800m wide. Survey strips are measured with inclinometer and marked on the aircraft before the survey. The two observers photograph all the seals on the strips (one 400 m strip on each side of the plane). The transects are evenly spaced over the ice area in a manner so that a minimum of 13% of the entire ice covered sea area is surveyed. A greater survey fraction only marginally reduces variances of survey results (Härkönen & Lunneryd 1992).

In the Archipelago Sea and Finnish side of the Gulf of Finland transect lines are set ca. 4 km from each other over the ice area. The flight altitude is 170-180m and the whole area between the

transect lines is observed. In the Archipelago Sea, ringed seals in area without ice-cover may haul out on land instead of moving to the ice-covered area.

In the Gulf of Riga, Gulf of Finland and the Archipelago Sea, poor ice conditions in most years have suggested that seal distribution on ice has not resembled that of a “normal” winter, the observation results can then only be used to describe distribution rather than comparable abundance estimates. With sufficient coverage of surveys the result can be used as a minimum population estimate for a particular sea area.

One presumption is that survey conditions are not systematically changing during the time series, permitting trend analyses. Surveys during 1988-2012 were carried out under “normal” ice conditions with mostly intact fast ice, where the ringed seals haul out scattered on ice. However, during most of the recent mild winters the intact fast ice area has begun to break up before and during the survey period, leading to large groups of up to 100 ringed seals or more congregating on the ice. Due to these behavioural changes of the ringed seals under reduced ice-cover, approximately twice as many seals were observed on ice as in earlier years under ’normal conditions. As such, results from surveys during extremely mild winters stand out as statistical outliers in the long-term data and represent a larger proportion of the total population compared to results from “normal” winters. Therefore, surveys under these different conditions are not comparable and cannot be used in the same *trend* analysis. The results from exceptionally mild winters, however, show that total population size is larger than previously thought. During ice break-up a variety of ice types occur. Not all of them are favourable for the ringed seals to haul out. However, more census data are needed to better understand how the amount and quality of the ice affects the haul-out rate of the ringed seals. For be able to continue producing a time series of abundance estimate and using results following mild winters together with counts from meteorologically “normal” winters, a model using appropriate quantitative measures on ice-quality as correction factor, needs to be built and used. Climate warming may, however, impose the need to develop new methods for monitoring ringed seal populations in years with even poorer ice conditions.

2.3.2.3 Equipment

- Fixed-wing aircraft is used in Finland, Estonia, Russia and Denmark as well as for harbour seal and ringed seal surveys in Sweden, helicopter is used for grey seal surveys in Sweden
- GPS-log not used in Denmark
- on-line video camera is used in Poland

2.3.3 Sample handling and analysis

N/A

3. Data reporting and storage

N/A

4. Quality control

4.1 Quality control of methods

Note: In some year,s only one experienced person is counting the number of individuals in Sweden, Finland and Estonia.

Annual monitoring is important for enabling enough power to detect changes in abundance trends which are the early signs of changing in the populations. Where possible, the monitoring is performed using aerial surveys, where the seal haul-outs are photographed during the relevant periods in areas where there is a significant occurrence of seals.

4.2 Quality control of data and reporting

N/A

5.Contacts and references

5.1 Contacts

N/A