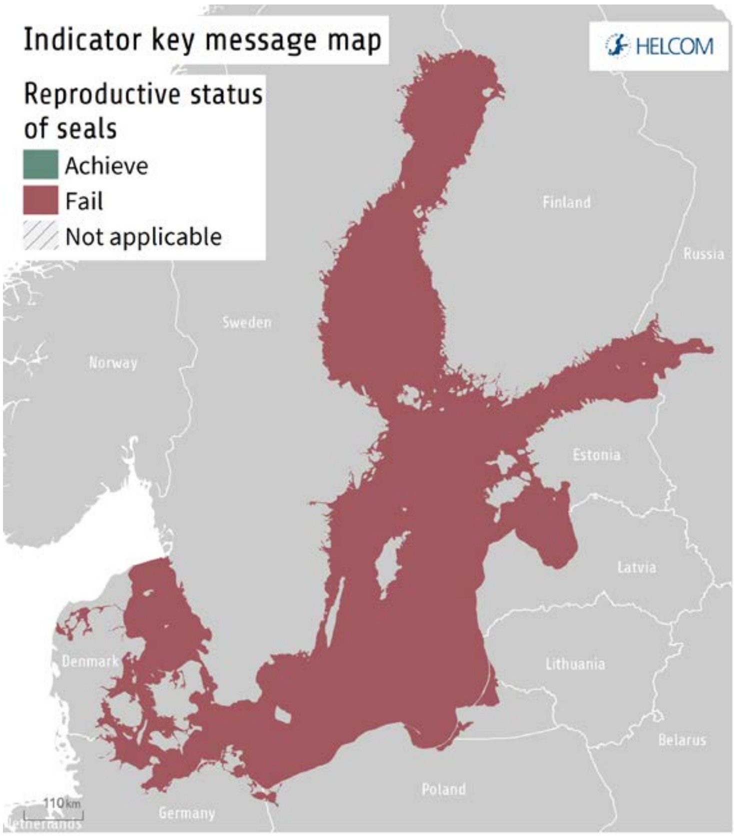
HELCOM core indicator report

July 2018

# Reproductive status of seals

## Key Message

This core indicator evaluates the status of the marine environment based on the reproductive status of seals in the Baltic Sea. Good status is achieved when the annual reproductive rate (i.e. the proportion of females pregnant/showing postpartum pregnancy signs per year) is at least 90% for harbour seals of five years and older, and grey and ringed seals of six years and older. A reproductive rate of 90% is defined as the threshold for each of these parameters as this is indicative of increasing populations. The overall status assessment is evaluated based on the average ratio (pregnancy rate or inferred birth rate % divided by the threshold) for the two parameters, where a value below 1 is deemed to fail the threshold for the combined parameters. However, it should be noted that should a population be defined as at carrying capacity, it may exhibit a lower reproductive rate due to the prevailing conditions and population stability or equilibrium.




**Key message figure 1**. Status assessment results based on evaluation of the indicator 'reproductive status of seals'. The assessment is carried out using Scale 2 HELCOM assessment units (defined in the HELCOM Monitoring and Assessment Strategy Annex 4). **Click here to access interactive maps at the HELCOM Map and Data Service: reproductive status of seals.**

Currently, a full status evaluation has only been carried out for the grey seal based on Finish and Swedish data. The indicator is applicable for all species of seals and marine mammals that occur in the Baltic Sea, however the amount of data have so far been insufficient for an evaluation of other marine mammal species. The evaluation of grey seal reproductive status is based on data from 2011-2016 and for the established threshold in failed for this period.

The confidence in the assessment is **low** for this period due to the small and spatially restricted data sample used to calculate the current status evaluation.

Further ongoing work is being carried out in association with this reproductive status indicator to develop a new Seal Health Indicator that will provide details about the reproductive health and thus link causes and effects of population level trends in reproductive status.

**Grey seals** occur in the entire Baltic Sea except for the Kattegat where the species has not been breeding since the 1930s, except for a few observations inrecent years. The grey seal in the Baltic Proper is evaluated as a single unit since they perform long migrations across the sea region, whereas the Kattegat grey seals are evaluated separately. Grey seal reproduction is not in good status with regard to reproductive rate in the entire Baltic when evaluated as one single population.

**Ringed seals** are evaluated for two management units: 1) the Bothnian Bay and 2) the Gulf of Finland, Archipelago Sea, Gulf of Riga and Estonian coastal waters. A tentative threshold value is set at 90% reproductive rate for six years and older seals but there are insufficient data to carry out an evaluation of status at present.

**Harbour seals** are confined to the Kalmarsund, Southern Baltic Sea, the Kattegat and the Limfjord, which are all separate management units. Harbour seals are evaluated for four management units. A threshold value is set at 90% reproductive rate for five years and older seals but data have not been analysed yet and hence no evaluation of status has been carried out.

The indicator is applicable in the waters of all the countries bordering the Baltic Sea as the indicator includes all seal species that occur in the Baltic Sea and at least one of the species occurs in all HELCOM assessment units. The indicator is currently only fully operational for some species and in some assessment units due to data availability, resources and additional proposals to develop alternative approaches.

## Relevance of the core indicator

Marine mammals are top predators in the marine ecosystem and good indicators of the state of food webs. They have a disposition for the accumulation of fat soluable hazardous substances such as heavy metals and PCBs in their tissues and thus reflect the level of pollution in the environment. Marine mammals are also affected in their reproductive functions by human influences that cause stress and disturbance such as hunting, by-catches, disturbance and noise pollution. The effect of algal toxins on seal reproductive health is so far unknown.

Distributions of different seal species during feeding and annual migrations encompass the entire Baltic Sea although no land-based haul-out sites occur in Germany, Latvia and Lithuania. Monitoring of relevant reproductive rate parameters occurs in all countries where stranded, by-caught or hunted seals are collected.

The reproductive rate provides important information at the average population level and on female health. It will be important to also develop an additional Seal Health Indicator that links trends in reproductive rate to the causes behind its variation, such as disease, food availability or hazardous substances.

## Policy relevance of the core indicator

| | BSAP segment and objectives | MSFD Descriptor and criteria |
|---|---|---|
| **Primary link** | Biodiversity<br>• Viable populations of species | D1 Biodiversity<br>D1C3 Population demographic characteristics of the species are indicative of a healthy population which is not adversely affected due to anthropogenic pressures. |
| **Secondary link** | Biodiversity:<br>• Thriving and balanced communities of plants and animals<br>Hazardous Substances<br>• Healthy wildlife | D1 Biodiversity<br>D1C2: The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured.<br><br>D1C4: The species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions.<br><br>D4 Food-web<br>D4C4: Productivity of the trophic guild is not adversely affected due to anthropogenic pressures.<br><br>D8 Contaminants<br>D8C2: The health of species and the condition of habitats are not adversely affected due to contaminants including cumulative and synergetic effects. |
| **Other relevant legislation:** In some Contracting Parties also EU Water Framework Directive – Chemical quality, Habitats Directive | | |

## Cite this indicator

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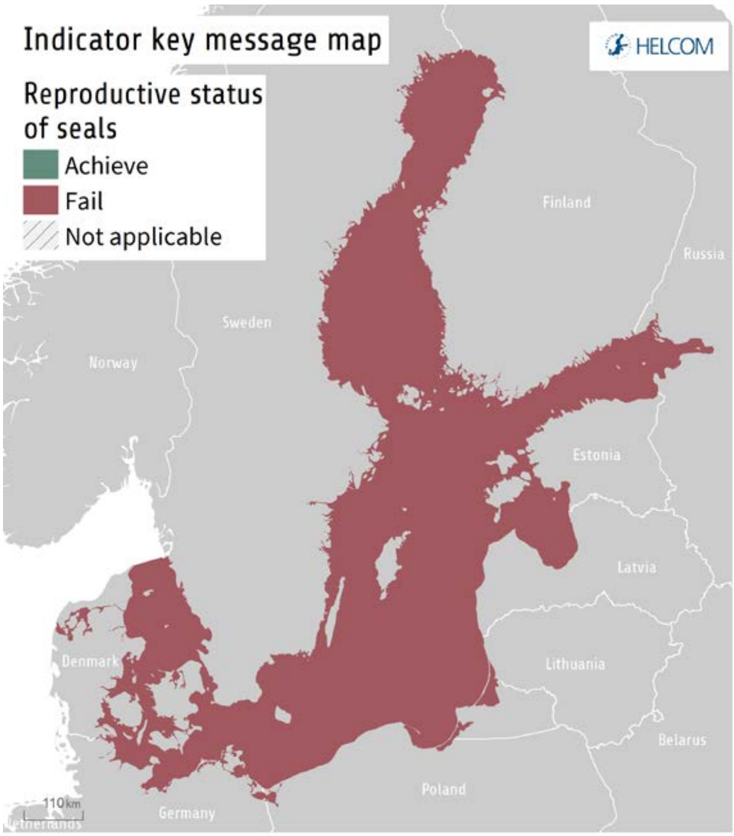
**Reproductive status of seals HELCOM core indicator 2018 (pdf)**

# Results and Confidence

## Grey seal

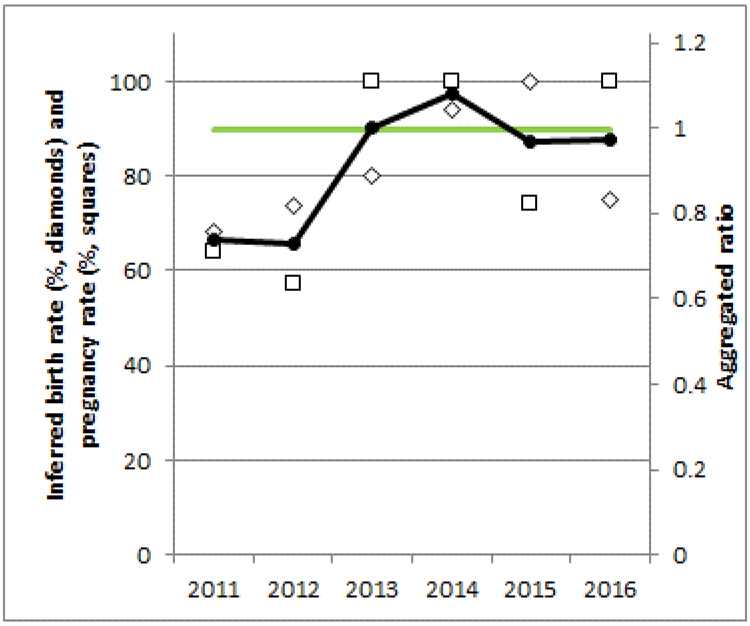
The grey seal did not achieve good status in the Baltic Sea with regard to reproductive status during 2011-2016 (Results figure 1). The reproductive rate (the proportion of pregnant females and females having postpartum pregnancy signs) reached the threshold value in the 2013, 2014 and in 2016 but on average across the current assessment period the threshold value of 90%, which is representative of a healthy increasing population, was not achieved. The inferred birth rate parameter achieved the threshold in 2014 and 2015, though failed the threshold value on average for the current assessment period (Results table 1 and Results figure 2). Combining these two parameters into a single status assessment indicated that the aggregated threshold value (see assessment protocol below) was achieved in 2013 and 2014, however the overall average for the assessment period 2011-2016 field the threshold (Results table 1). These assessment results must be treated with caution since the sample size (165 for whole assessment period) is small in relation to the population size, and this factor is reflected in the confidence assigned to the indicator assessment. Current pooled data from Finland and Sweden show that pregnancy rate is 82% (SD = 13%) in 6–24 year-old females referring to the period 2011–2016. It is however important to note that there do appear to be improvements with pooled values for the period 2014-2016 indicating the threshold would be achieved (91 %) and the aggregated assessment value for this shorter more recent period being 1 which would also indicate that the indicator may be on the borders of achieving the threshold values in recent years.




**Results figure 1.** Baltic grey seals is not in good status with regard to reproductive rate.

**Results table 1.** Data and aggregated results for the reproductive status of the grey seal. The numbers in parentheses indicate the number of samples in the parameter. In the three last columns, 1.0 represents the threshold value for which and ratio values is compared, with values at or above 1 indicating good status.

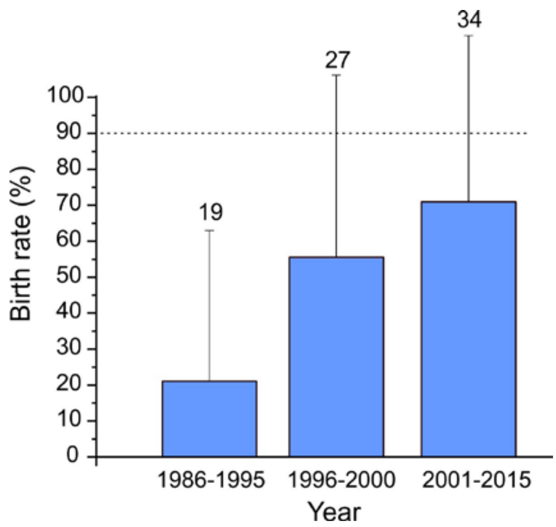
| Year | Pregnancy rate (SE) | Inferred birth rate (FI) | GES threshold | Pregnancy rate ratio | Birth rate ratio | Aggregated ratio |
|---|---|---|---|---|---|---|
| **2011** | 64 % (11) | 68 % (19) | 90 % | 0.71 | 0.76 | 0.74 |
| **2012** | 57 % (7) | 74 % (23) | 90 % | 0.63 | 0.82 | 0.73 |
| **2013** | 100 % (10) | 80 % (5) | 90 % | 1.11 | 0.89 | 1 |
| **2014** | 100 % (6) | 94 % (51) | 90 % | 1.11 | 1.05 | 1.08 |
| **2015** | 74 % (19) | 100 % (6) | 90 % | 0.82 | 1.11 | 0.97 |
| **2016** | 100 % (4) | 75 % (4) | 90 % | 1.11 | 0.83 | 0.97 |
| **Average 2011-2016** | **83 % (10)** | **83 % (18)** | **90 %** | **0.92** | **0.91** | **0.91** |




**Results Figure 2.** Temporal change in the parameters used to evaluate the reproductive status of seals. The squares represent the reproductive rate (pregnancy rate) based on Swedish data. The diamonds represent reproductive rate (inferred birth rate) based on Finnish data. These two parameters are shown on the % scale (left vertical axis). The filled black circles and trend line represent the combined indicator value (aggregated ratio, see Results table 1) which is used to assess the overall status against the threshold value (1, green line), as shown on the right vertical axis.

## Ringed seal

The provisional assessment indicates that the threshold value of 90% is not met for ringed seals. The pregnancy rate of >5-year-old females was 71% (SD = 46.2, n = 34, 95% CI = 54.5–86.7) in 2001–2015. The corresponding figure before 2001 was 41% (SD = 49.7, n = 46), suggesting that the reproductive rate has improved during the 2000s (Results figure 3). Pregnancy rates of females > 4 years of age was 70% (SD = 48.3, 95% CI = 35.4–1.05) during the 2000s but the sample size is very small (n = 10). Combined it is not possible to assess the reproductive status of ringed seals because the sample size is too small.




**Results Figure 3.** Reproductive rate of ringed seals 1986–2015 from Finnish and Swedish data.

## Harbour seal

The threshold value is set at 90% also for harbour seals, but no assessment could be conducted at this time due to data constraints, and an assessment will be developed in the future.

## Confidence of the indicator status evaluation

Overall, the confidence for the assessment is **low** due to small sample size in relation to the population sizes, and due to the current limited spatial sampling. Furthermore, in future assessments of reproductive status it will be important to review if the seal populations have reached carrying capacity or not, as this can markedly influence the threshold values applied.

In addition to wider data coverage additional data should be gathered where possible for grey seals in Finland and Sweden so the confidence of the indicator status evaluation for this species in the central and northern part of the Baltic Sea can be improved. Currently the samples used in this assessment are dominantly from the northern Baltic Sea regions, though they also include Swedish data from the southern Baltic Sea. However, it would be desirable to include samples from Denmark, Germany and Poland. An improved reporting and data collating system for this indicator would facilitate progress, for example annual reporting of relevant data from all countries.

The confidence of the evaluation for ringed seals is low due to insufficient data for evaluating the reproductive rate against the threshold. The difference between birth rate and pregnancy rate would give us valuable data of fetal mortality, if the data for pregnancy rate were larger.

High confidence will be achieved for harbour seals in the Kattegat for the phase of exponential growth. Material is collected annually, but remains to be compiled and analysed. However, threshold values remain to be elaborated for the carrying capacity scenario as well.

# Thresholds and Status evaluation

Good status is achieved when the aggregated ratio for annual pregnancy rate and inferred birth rate achieve the threshold value (of 1). The initial assessment addressed the annual pregnancy rate and the inferred birth rate to determine if each parameter meets the level of at least 90% in an increasing population - for five years and older harbour seals and six years and older grey and ringed seals (see assessment protocol, below).

The concept for defining threshold values for reproductive rates of seals is derived from the general management principle in the HELCOM Recommendation 27/28-2, which states that the population size is to be managed with the long-term objective of allowing seal populations to recover towards carrying capacity levels. The Recommendation further states that the long-term goal is to reach a health status that ensures the future persistence of marine mammals in the Baltic. Reproductive rate is an important aspect of population status, affecting population growth rate.

A modern baseline approach is applied for establishing the threshold value for all species of seals, since pristine conditions are unknown. The modern baseline is based on the first available data, and data on reproductive rates from populations with minimal impacts from human activities are used in this indicator.

**Thresholds table 1**. Species specific threshold values for seal species showing increasing populations (i.e. not currently at carrying capacity) in the Baltic Sea, as agreed by HELCOM HOD 48-2015 (outcome para 3.63, Annex 4).

| Species | Threshold value<br>Age class [year] | Threshold value<br>Pregnancy rate |
|---|---|---|
| **Grey seal** | ≥6 | 90% |
| **Ringed seal (tentative)** | ≥6 | 90% |
| **Harbour seal** | ≥5 | 90% |

The modern baseline approach (using 1992 data as a baseline) is also applied in OSPAR (Commission for the Protection of the Marine Environment of the North-East Atlantic). The reproductive rate would appear to be similar as the OSPAR common indicator M5: 'Grey seal pup production', but pup production is only used for estimating total population size by multiplying numbers of counted pups with a factor between 4 and 5 in HELCOM. For these indicators there is no comparability between HELCOM and OSPAR.

# Assessment Protocol

This core indicator assesses the reproductive status of seals in the Baltic Sea.

Seals in each assessment unit are evaluated against the set threshold values. Samples from opportunistically collected, hunted, by-caught and diseased seals can be used in the analysis. Observed data for 3-year intervals for each species are regarded as three independent datasets and tested if they deviate from the set threshold values using non-parametric tests. Also 3-year-moving averages can be used to be able to test the trends in the reproductive rate (at least for birth rate of grey seals).

The indicator evaluation is assessed in the following stages. Firstly the annual pregnancy rate (Swedish data) and inferred birth rate (Finnish data) are calculated as a percentage of the sampled individuals. Secondly the value is assessed against the threshold value (of 90%). The ratio for each parameter for each year in the assessment period is calculated as the percentage of pregnant animals or animals inferred to have given birth divided by the threshold value or 90%. The ratios for each parameter are then aggregated by calculating a mean value and assessed against the threshold value of 1. If the value of the aggregated ratios is above 1 the indicator achieves the threshold value (i.e. good status) and if below 1 the threshold is failed (not good status). The mean values for the overall assessment period are then calculated and this value gives the status evaluation for the assessment period.

## Parameter calculation

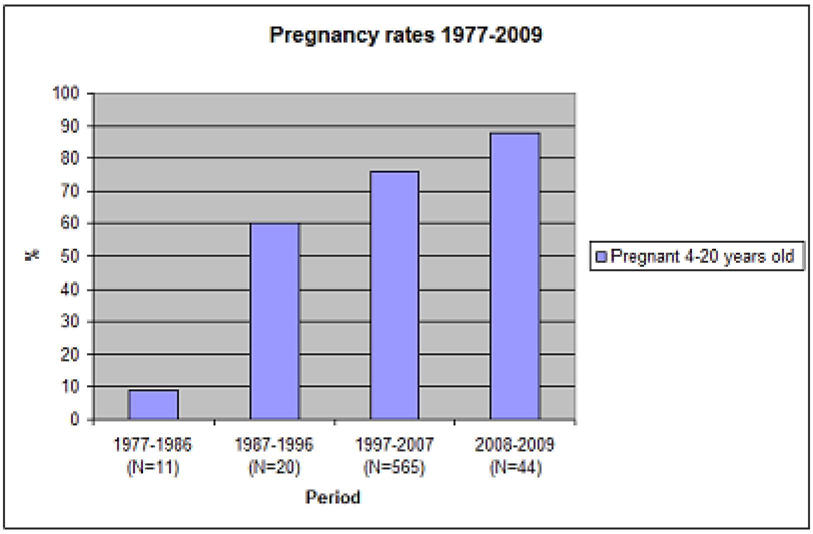
Pregnancy rate is measured as the proportion of 5/6–24-year-old females, depending on the seal species, with an embryo or foetus during the pregnancy period (post-implantation period). Postpartum pregnancy rate is calculated from the pre-implantation sample as the proportion of 6/7–25-year-old females with post-partum signs, i.e. a *corpus albicans*/placental scar.

## Grey seals

Pregnancy rate is measured as the presence of an embryo/foetus in the pregnancy period in 6–24 year-old (or ≥ 6 yr) seals. Birth rate is calculated from the pre-implantation sample as the proportion of 7–25-year-old (or ≥ 7 yr) females with a *corpus albicans*/placental scar. From Finland about 30 females (7-25-year-old) are analyzed in spring each year for inferring birth rate.

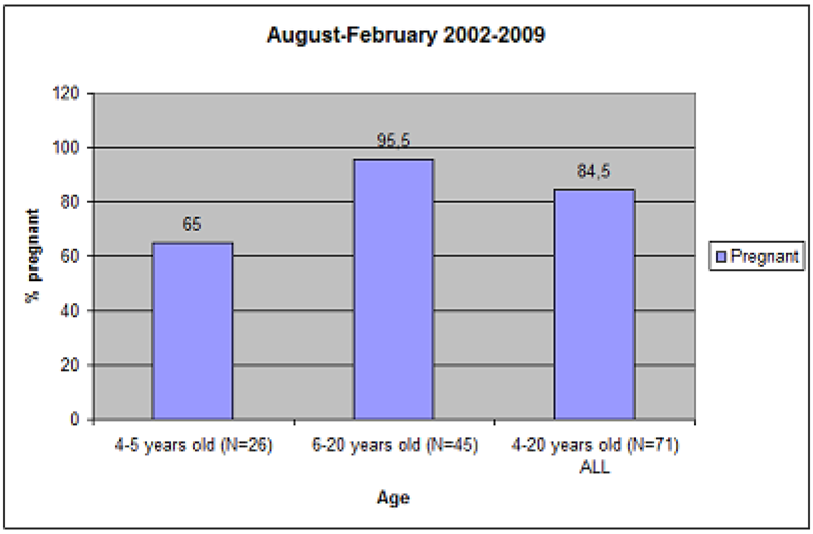
The reason for using the age interval 6-24 years is that estimated age-specific birth rates increase steeply from the age of four to six (Hamill & Gosselin 1995). The birth rates for six-year old females in the Northwest Atlantic, British, Norwegian and Baltic populations ranged between 60-91%. In a sample of 526 female grey seals from the Northwest Atlantic, pregnancy rates were estimated from the presence/absence of a foetus. The pregnancy rate for the Northwest Atlantic population was relatively stable at about 90% after the age of six (Hamill & Gosselin 1995; Harding et al. 2007).

In the Baltic grey seal population, the pregnancy rate was 88% in 4–20-year old females in 2008–2009 (Assessment protocol figure 1). Thus, a pregnancy rate of 88% pregnancy seems to be normal in 4–20-year old Baltic grey seals in an increasing population (Assessment protocol figure 1 and Assessment protocol figure 2). This rate is also close to the pregnancy rate of Northwest Atlantic grey seals older than five years.




**Assessment protocol figure 1**. Pregnancy rate in 4–20-year old female Baltic grey seals (August to March). Finnish data for inferred birth rates is included in the period 1997–2007, in addition to Swedish pregnancy rate data.

The pregnancy rate for the 4–5-year old individuals was 65% and for the 6–20-year old individuals it was 95.5% among hunted and by-caught grey seals in 2002–2009 in Sweden (Assessment protocol figure 2).



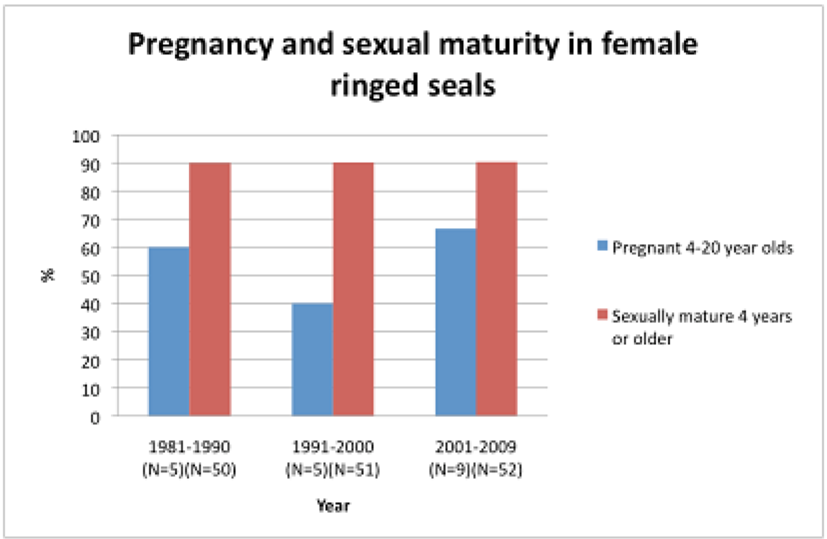

**Assessment protocol figure 2.** Pregnancy rate in 4-6 year-old females (first column), 6–20 year-olds (second column), and all age classes 4-20. Based on by-caught and hunted seals during 2002–2009.

About 4–19 dead grey seal females of ages between 4–20 years are collected annually in Sweden during the pregnancy period. From Finland about 5-51 females (7–25-year-old) wereanalysed in spring for calculating inferred birth rates between 2011 and 2016. If the females are divided into younger and older, the annual Swedish contribution will be further reduced. However, the status assessment should be based on females six years or older (for pregnancy rate) to avoid effects from young females with late sexual maturity. Consequently, threshold values should be based on material sampled from age classes 6–24 for pregnancy rate and 7–25-year-old females for birth rate.

## Ringed seals

Life history data of ringed seals is similar to grey seals (Harding et al. 2007), which would imply that the threshold value for ringed seals should be similar to that of grey seals. The threshold value of 90% is tentatively suggested also for this species until proven false. Age classes to be included in the analysis should encompass six years and older.

The annual number of investigated 6-20-year old Baltic female ringed seals and Baltic harbour seals during the pregnancy period is very small. Assessment protocol figure 3 shows the pregnancy rate of a total number of 19 ringed seals examined during 1981-2009. The pregnancy rate in ringed seals was 68% in 2001-2009, but the sample size is confined to 9 animals. Although later material is limited, some individual ringed seals sampled are still suffering from uterine occlusions.




**Assessment protocol figure 3.** The prevalence of pregnant females (blue columns) sampled in the implantation period August to February (Kunnasranta 2010). Proportion of sexually mature (red columns) encompass females with presence of Corpus luteum (4 years or older) sampled year round in Finland and Sweden. Sample sizes must be increased before assessments of status can be performed.

## Harbour seals

The harbour seal historical pregnancy rates are based on samples from Danish and Swedish sampling programs in the Kattegat in 1988. When evaluating the threshold value at 90%, the age classes to be included are females of five years and older.

Large data sets were collected during the 1988 and 2002 phocine distemper virus (PDV) epidemics and 2014 influenza die-off that killed thousands of harbour seals. Pregnancy rates were determined either by signs of late abortions or the presence of pregnancy indicators (Heide-Jorgensen & Härkönen 1992). The pregnancy rate was found to be 94% in the 59 females older than 5 years that were sampled, and three of four females that were older than 25 years and senescent. This dataset can be used to establish a threshold value, and there are many samples available from the 2002 PDV epidemic as well as from later years in Sweden which is stored at the Swedish Museum of Natural History. However, most of is the samples are from the Kattegat, and only few are available from the Southern Baltic Sea and the Kalmarsund.

## Assessment units and management units

This core indicator evaluates the reproductive status of seals using HELCOM assessment unit scale 2 (division of the Baltic Sea into 17 sub-basins). The assessment units are defined in the HELCOM Monitoring and Assessment Strategy Annex 4.

Existing management plans for seals operate according to management units that are based on the distribution of seal populations. The management units typically encompass a handful of HELCOM scale 2 assessment units. Evaluations are therefore done by grouping HELCOM assessment units to align with the management units defined for each seal population.

- The Baltic grey seal (excluding Kattegat) is a single management unit, although genetic data show spatial structuring (Fietz et al. 2013). Also behavioural data suggest some large scale structuring. However, grey seals show extensive migration patterns.
- The Baltic Ringed seal is distributed in the Gulf of Bothnia on the one hand and Southwestern Archipelago Sea, Gulf of Finland and Gulf of Riga on the other, and is represented by two different management units. This sub-division is justified by ecological data that indicate separate dynamics of these stocks. Since ringed seals from both areas show a high degree of site fidelity, as seen in satellite telemetry data (Härkönen et al. 2008), it is unlikely that extensive migrations occur at current low population numbers, although some individuals can show more extensive movements (Kunnasranta 2010). See Oksanen et al. 2015 for ringed seal movements.
- Harbour seals in the Kalmarsund, Sweden constitute a separate management unit and is the genetically most divergent of all harbour seal populations in Europe (Goodman 1998). It was founded about 8,000 years ago, and was close to extinction in the 1970s as a consequence of intensive hunting, and possibly also impaired reproduction (Härkönen et al. 2005). The genetic diversity is substantially reduced compared with other harbour seal populations.
- Harbour seals in the southwestern Baltic (Danish Straits, Danish, German, Polish Baltic and the Öresund region including Skåne county in Sweden) should be managed separately as this stock is genetically distinct from adjacent populations of harbour seals (Olsen et al. 2014).
- Harbour seals in the Kattegat are also genetically distinct from adjacent populations (Olsen et al. 2014). This population has experienced dramatic declines in 1988 and 2002 caused by phocine distemper epidemics. A third epidemic caused by an unknown virus caused substantial mortality in 2007 (Härkönen et al. 2008).
- Harbour seals in the Limfjord form the fourth management unit and is genetically distinct from the Kattegat harbour seals (Olsen et al. 2014).

# Relevance of the Indicator

## Biodiversity assessment

The status of biodiversity is assessed using several core indicators. Each indicator focuses on one important aspect of the complex issue. In addition to providing an indicator-based evaluation of the reproductive status of seals, this indicator will also contribute to the next overall biodiversity assessment to be completed in 2018 along with the other biodiversity core indicators.

## Policy relevance

The core indicator on reproductive status of seals addresses the Baltic Sea Action Plan's (BSAP) Biodiversity and nature conservation segment's ecological objective 'Viable populations of species'.

The core indicator is relevant to the following specific BSAP target:

- 'By 2015, improved conservation status of species included in the HELCOM lists of threatened and/or declining species and habitats of the Baltic Sea area, with the final target to reach and ensure favourable conservation status of all species'.

The HELCOM Recommendation 27/28-2 'Conservation of seals in the Baltic Sea area' outlines the conservation goals which the indicator's threshold value is based on. The explicit long-term objectives of management plans to be elaborated are: Natural Abundance, Natural Distribution, and a health status that ensures the persistence of marine mammals in the Baltic.

The core indicator also addresses the following qualitative descriptors of the MSFD for determining good environmental status (European Commission 2008):

Descriptor 1: 'Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions'

Descriptor 4: 'All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity'

Descriptor 8: 'Concentrations of contaminants are at levels not giving rise to pollution effects'

Descriptor 10: 'Properties and quantities of marine litter do not cause harm to the coastal and marine environment' and

Descriptor 11: 'Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment'

and the following criteria of the draft Commission Decision on GES criteria (2016):

- D1C3 Population demographic characteristics of the species
- D1C2: The population abundance of the species
- D1C4: The species distributional range
- D4C4: Productivity of the trophic guild

- D8C2: The health of species and the condition of habitats are not adversely affected due to contaminants

Marine mammals were recognized by the MSFD Task Group 1 as a group to be assessed.

In some Contracting Parties the indicator also has potential relevance for implementation of the EU Water Framework Directive (WFD, Chemical quality) and Habitats Directive. The WFD includes status categories for coastal waters as well as environmental and ecological objectives, whereas the EU Habitats Directive (European Commission 1992) specifically states that long-term management objectives should not be influenced by socio-economic considerations, although they may be considered during the implementation of management programmes provided the long-term objectives are not compromised. All seals in Europe are also listed under the EU Habitats Directive Annex II (European Commission 1992), and member countries are obliged to monitor the status of seal populations.

## Role of marine mammals in the ecosystem

Being top predators in the Baltic ecosystem, seals are exposed to ecosystem changes in lower trophic levels, but also to variations in climate (length of seasons and ice conditions) and impacts of human activities. These pressures can affect fish stocks, levels of harmful substances, boat traffic, noise pollution, as well as direct mortality caused by hunting or by-catch. The vulnerability of seals to these pressures makes them good indicators for measuring the environmental status of ecosystems.

## Ecological background to the indicator concept

An adult female seal bears at most one pup annually in healthy growing seal populations. The mean values of fecundity for entire populations will always be lower than the theoretical maximum for an individual, also for populations which live under favourable conditions. Chance events such as failed fertilization or early abortions reduce annual pregnancy rates. Mean pregnancy rates rarely reach 0.96 in samples of reasonable sizes in American (Boulva & McLaren 1979; Bigg 1969), and European harbour seals (Heide-Jørgensen et al. 1992) in age classes >4 years of age. Maximum life span is about 35-45 years in Baltic seal species (e.g. Heide-Jørgensen et al. 1992). Another factor that will decrease mean pregnancy rates is senescence (Heide-Jorgensen et al. 1992), however due to annual mortality rates, only a small fraction of the population becomes older than about 24 years old. Further, extrinsic factors will reduce pregnancy rates. In evaluating changes in mean pregnancy rate among years in this core indicator, it is important to separate the causes into (1) natural decline due to density dependent effects and (2) anthropogenic effects from environmental pollution, this will be linked in the new Seal Health Indicator. The HELCOM core indicator 'Population trends and abundance of seals' will signal when the populations reach carrying capacity. But at population abundances below carrying capacity, a change in pregnancy rate can be an early warning of unwanted changes in the ecosystem.

# Natural decline in fertility due to limited food supply

As seal populations approach carrying capacity and food limitation becomes an issue, body growth rate in sub-adult seals declines and the age at sexual maturation is delayed. In poor nutritive conditions, age at sexual maturity in phocid seals can be delayed up to three or four years (Kjellqvist et al. 1995; Harding &

Härkönen 1999). Other stressors such as infectious disease and stress can also delay sexual maturity. Another response to poor nutritive conditions is so called 'year skipping', i.e. the female does not become pregnant when her fat stores are too low (Kjellqvist et al. 1995). Seals have delayed implantation and the fertilized egg does not attach to the uterine wall unless the female is well fed. Decreased pregnancy rate due to food shortage at carrying capacity is thus a natural phenomenon and shall not be confused with reproductive failure caused by disease or xenobiotics.

## Reproductive failure caused by disease or xenobiotics

The Baltic ringed and grey seal populations became the main subjects in the PCB scandal. The mean level of PCB in seals from the northern Baltic Proper was about 450 parts per million (PPM) lipid in the early 1970s, which eventually declined to considerably lower values in accordance with lower concentrations in their prey (Jensen et al. 1969; Olsson 1977; Bignert et al. 1998). A sample of 225 adult ringed seal females revealed an alarmingly low pregnancy rate of 30% which dropped further to 20% during the period 1973-1979 (Helle 1980). The low reproductive rates were largely explained by occlusions in the uterine horns. The prevalence of this pathological change increased from 35% to 59% during the same time period (Helle 1980). The occlusions caused permanent sterility in ringed seals and the frequency of occlusions also increased with the age of the animals (Helle 1979; 1980). Also in grey seals, severe reproductive disturbances were documented (Bergman & Olsson 1986; Bergman 1999). An underlying cause of some of the toxic effects of PCBs may be alterations in hormonal levels (Bäcklin et al. 2003). Experiments carried out on the American mink (*Neovison vison*) showed that the early formation of the placenta is disrupted in animals exposed to PCBs, which leads to the death of the foetus (Bäcklin et al. 2003).

In populations of harbour seals, concentrations of PCBs vary with the level of industrialization and the extent of water exchange of different sea regions. This is demonstrated by mean values of concentrations of different PCB fractions in harbour seals in the Atlantic, where Icelandic harbour seals have the lowest concentrations of about 1.5-5.0 PPM lipid, while seals in the heavily industrialized and enclosed St. Lawrence Estuary show concentrations of about 17.1 PPM (Safe 1984). The harbour seals in the Baltic Sea and Wadden Sea had mean concentrations of 85 PPM lipid (Bernt et al. 1999) in the late 1970s. The effects of high levels of PCBs are generally very difficult to quantify. One reason is that levels of PCBs vary substantially depending on which part of the season, which age groups, individuals and which parts of the body are sampled (Safe 1984; Bignert et al. 1993). However, a controlled feeding experiment revealed lowered pregnancy rates in captive seals fed with Baltic herring compared to the control group that got North Sea herring (Reijnders 1986). The most likely candidate responsible for the former low gynaecological health among Baltic seals was high concentrations of PCB (Helle 1979; Bredhult et al. 2008; ). Levels in the Wadden Sea harbour seal populations are still quiet high (Siebert et al. 2012), nevertheless the populations have recovered very quickly after each die-off.

In 2008-2009, the pregnancy rate was 88% in 4-20 years old grey seal females hunted in the Bothnian Sea and the Baltic Proper. The last case of uterine obstruction in grey seals investigated in Sweden was seen in 1993 (Bergman 1999). And in 2009, one unilateral occlusion was seen in a 13-year old female grey seal in Finland. In the 2000s, about 20% of examined Baltic ringed seals still suffered from uterine obstructions, which likely explain the 68% pregnancy rate in ringed seals in 2001-2009, which is lower than "normal" (Helle et al. 2005; Kunnasranta 2010). After the year 2000 there are 62 females which are at least four years old (data from Finland and Sweden), and 8.1% of these had occusions. The last observed case is from 2011. There are no observations or reports of uterine obstructions in Baltic harbour seals or harbour porpoises.

It is important to distinguish between pregnancy rate, birth rate, pup production (= pups that survive until weaning), and the role of pregnancy/birth rate rate for the population growth rate. Even if a female weans her pup successfully, a study on individually branded harbour seals showed a delayed response to poor nutritive conditions (Härkönen & Harding 2001; Harding et al. 2005). Winter survival in the young of the year was highly dependent on the autumn weight. Consequently, pregnancy/birth rate is an important indicator of status of the population, but in evaluations for population consequences also other information is needed, the new Seal Health Indicator aims to assess the causes behind shifting trends in pregnancy rates.

## Human pressures linked to the indicator

| | General | MSFD Annex III, Table 2 |
|---|---|---|
| **Strong link** | Contamination by hazardous substance<br>Fisheries and food availability<br>Ecosystem changes (food web, introduction of pathogens and non-indigenous species)<br>Noise pollution<br>Diseases | Theme: Biological<br>- Disturbance of species (e.g. where they breed, rest and feed) due to human presence<br>- Extraction of, or mortality/injury to, wild species (by commercial and recreational fishing and other activities)<br>Theme: Substances, litter and energy<br>- Input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides) |
| **Weak link** | Hunting | Theme: Substances, litter and energy<br>- Input of litter (solid waste matter, including micro-sized litter)<br>- Input of anthropogenic sound (impulsive, continuous) |

Historically, hunting of seals has been a major human pressure on all the seal species in the Baltic Sea. A coordinated international campaign was initiated in the beginning of the 20th century with the aim of exterminating the seals (Anon. 1895). Bounty systems were introduced in Denmark, Finland and Sweden over the period 1889-1912, and very detailed bounty statistics provide detailed information on the hunting pressure. The original population sizes were about 180,000 for ringed seals, 80,000 for Baltic grey seals and 5,000 for the Kalmarsund population of harbour seals (Harding & Härkönen 1999; Härkönen & Isakson 2011). Similar data from the Kattegat and Skagerrak suggest that populations of harbour seals amounted to more than 17,000 seals in this area (Heide-Jørgensen & Härkönen 1988). Changes in population density will affect pregnancy rates.

By-caught grey seals are significantly leaner as compared with hunted seals (Bäcklin et al. 2011, Kauhala et al. 2015), which may suggest that food is a limiting factor for by-caught grey seals. It is possible that food limitation is becoming an important factor also for the entire population since data on blubber thickness in Baltic grey seals show a significant decline during the last decade (Bäcklin et al. 2011). Food limitation is expected to lead to declining pregnancy rates in all species.

# Monitoring Requirements

## Monitoring methodology

HELCOM common monitoring relevant for the seal population trends is documented on a general level in the **HELCOM Monitoring Manual** under the sub-programme: Seal abundance.

HELCOM monitoring guidelines for seals were adopted in 2014 and currently all monitoring guidelines are being reviewed for inclusion in the **HELCOM Monitoring Manual**.

The monitoring methodology is described in detail in the core indicator report from 2013.

## Current monitoring

The monitoring activities relevant to the indicator, which are currently carried out by HELCOM Contracting Parties are described in the **HELCOM Monitoring Manual** in the Monitoring Concept Table.

**Sub-programme: Seal Abundance**

**Monitoring Concept Table**

Current monitoring is carried out on a national basis, but initiatives of coordinating methodology have been taken by the Health tem of the HELCOM Seal expert group.

## Description of optimal monitoring

The optimal monitoring should encompass sufficient numbers of samples from all species of seals in all areas where they occur. Monitoring occur opportunistically when dead seals are recovered by stranding, by catches or hunting. Hunting is not motivated by environmental monitoring but is decided upon by national authorities for other reasons (mainly to protect fishing gear).

For grey seals, sufficient material is available in the central and northern Baltic Sea, but it would be important to include more material from the southern Baltic Sea for analyses of regional differences.

Monitoring of harbour seals is sufficient in the Kattegat, but more data is needed from the Kalmarsund and the Southern Baltic from Danish waters could prove to be important in the future.

For ringed seals more samples are required from the entire area of distribution.

# Data and updating

## Access and use

The data and resulting data products (tables, figures and maps) available on the indicator web page can be used freely given that the source is cited. The indicator should be cited as following:

HELCOM (2018) Reproductive status of seals. HELCOM core indicator report. Online. [Date Viewed], [Web link].

## Metadata

Result: Reproductive status of seals

Data: Reproductive status of seals

Initiatives have been taken to compile national data annually by the HELCOM Seal Expert Group. Much of Swedish and Finnish data have been merged. German and Polish data remain to be included.

The data collected and used in the indicator are based on national databases. The health team of the HELCOM seal expert group is given the responsibility to compile, store current national data, and investigate future arrangements for establishing a HELCOM database.

# Contributors and references

## Contributors

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## Archive

This version of the HELCOM core indicator report was published in July 2018:

**Reproductive status of seals HELCOM core indicator 2018 (pdf)**

Older versions of the core indicator report are available:

Core indicator report – web-based version December 2015 (pdf)

Extended core indicator report – outcome of CORESET II project (pdf)

2013 Indicator report (pdf)

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