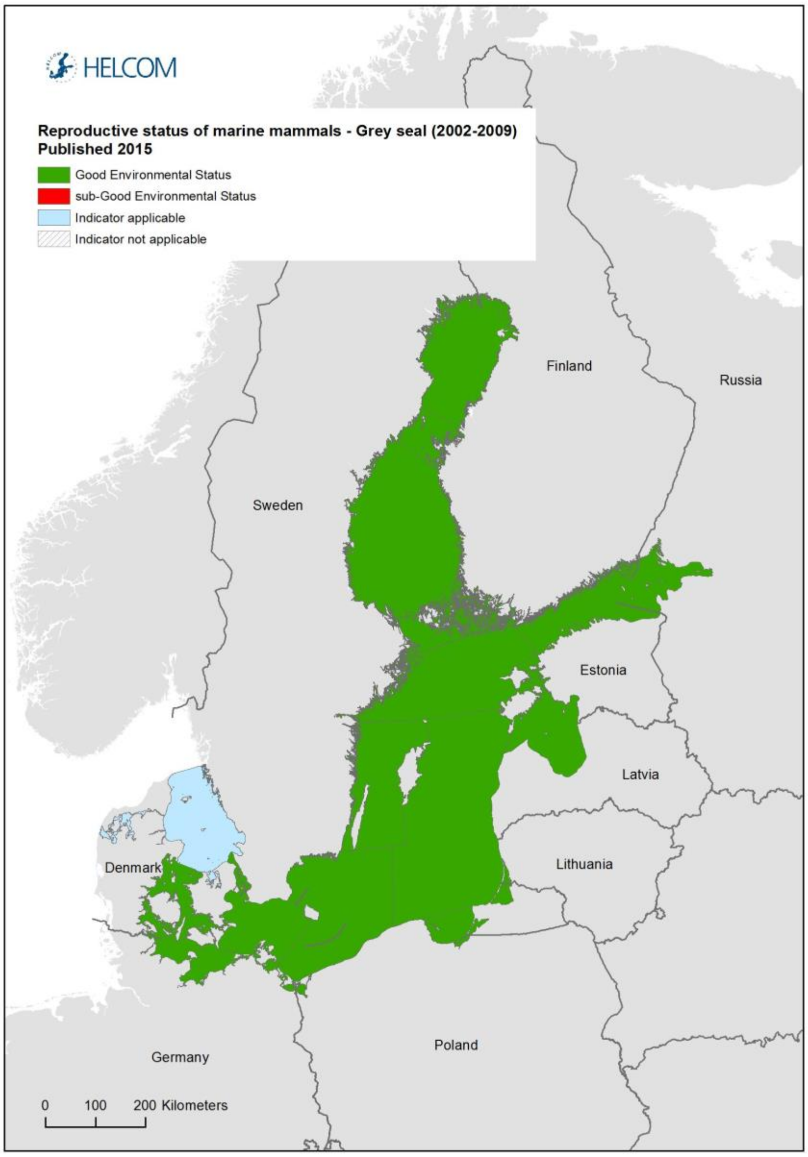
Reproductive status of marine mammals

Key message



The pregnancy rate signals female health with regard to disease, food availability and hazardous substances. Currently a status evaluation for the Baltic Sea has only been done using the grey seal. In order to be applicable in the whole HELCOM area, the indicator includes all species of seals and marine mammals that occur in the Baltic Sea, however data has so far been insufficient for an evaluation using the other seal species or other marine mammals. Good Environmental Status (GES) boundaries are set at annual pregnancy rate 90% for all species for age classes 5 years and older in harbour seals and 6 years and older for grey seals and ringed seals.

Grey seals occurs in the entire Baltic Sea except for the Kattegat where the species has not been breeding since the 1930s except for a few observations from recent years. The grey seal in the Baltic proper is evaluated as a single unit, whereas the Kattegat grey seals are evaluated separately. Grey seals achieve GES with regard to pregnancy rate in the entire Baltic when evaluated as one single population. The confidence of evaluation is high.

Ringed seals occur in the Bothnian Bay, which is one management unit, and the Gulf of Finland, the Archipelago Sea, the Gulf of Riga and the Estonian coastal waters, which is a second management unit. The status of ringed seals is evaluated for two management units and harbour seals for four units. A tentative GES boundary is set at 90%. Data are insufficient for evaluation of GES.

Harbour seals are confined to the Kalmarsund, Southern Baltic, the Kattegat and the Limfjord, which all are separate management units. GES is set at 90%, but observed data not analyzed.

Relevance of the core indicator

Marine mammals are top predators of the marine ecosystem and good indicators for the state of the food webs. Marine mammals accumulate fat solvable hazardous substances such as heavy metals, PCB and PFOS in their tissues and thus reflect the level of pollution in the environment. Seals are also affected by human disturbance such as hunting, by-catches disturbance and noise pollution.

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

Pregnancy rate is documented to be affected by xenobiotic compounds i.e. alien and not naturally occurring compounds as well as disturbance.

Policy relevance of the core indicator

	BSAP **Segment and Objectives**	**MSFD Descriptors and Criteria**
Primary link	Biodiversity - Viable populations of species	D1. Biodiversity 1.3. Population condition
Secondary link	Biodiversity: Thriving and balanced communities of plants and animals Hazardous Substances: Healthy wildlife	D1. Biodiversity 1.1 Species distribution (range, pattern, covered area) 1.2 Population size (abundance, biomass) D4. Food webs 4.1. Productivity of key species or trophic groups 4.3 Abundance/distribution of key trophic groups/ species D8. Contaminants 8.2. Effects of contaminants D10. Marine litter 10.2 Impacts of litter on marine life D11. Introduction of energy (including underwater noise)
Other relevant legislation: WFD – Chemical quality, Habitat directive		

Cite this indicator

HELCOM [2015] [Indicator name] HELCOM core indicator report. Online. [Date Viewed], [Web link].

Indicator concept

Good Environmental Status

The status of the environment is evaluated using the reproductive status of marine mammals, as any changes in pregnancy rates are belied to be caused by pollutants and other anthropogenic pressures and will affect the population structure of these marine top predators. The concept for defining GES-boundaries for pregnancy 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. Pregnancy rate is an important aspect of population status, affecting population growth.

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

Table 1. Species specific GES-boundary for the marine mammals in the Baltic Sea.

	GES-boundary	
Species	age class [year]	pregnancy rate
Grey seal	6	90%
Ringed seal (tentative)	6	90%
Harbour seal	5	90%
Harbour porpoise	?	?

Pregnancy 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.

Anthropogenic pressures linked to the indicator

	General	MSFD Annex III, Table 2
Strong link	Contamination by hazardous substance. Fisheries and food availability Ecosystem changes (food web, introduction of pathogens and non-indigenous species) Noise pollution Diseases	Biological disturbance -selective extraction of species, including incidental non-target catches (e.g. by commercial and recreational fishing) Contamination by hazardous substance: -introduction of synthetic compounds -introduction of non-synthetic substances and compounds Ecosystem changes
Weak link	Hunting	

Historically, hunting of seals has been a major anthropogenic 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 to 1912, and the very detailed bounty statistics provide detailed information on the hunting pressure. The original population sizes in the beginning of the 20th century was about 180,000 for ringed seals, 80,000 for Baltic grey seals and 5,000 for the Kalmarsund population of harbour seals (Harding and Härkönen 1999, Härkönen and 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 and 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), 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 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.

Assessment protocol

- Seals in each assessment unit are evaluated against set GES boundaries
- 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 will be regarded as three independent data sets and tested if they deviate from set GES boundaries using non-parametric tests
- HELCOM assessment units used; Level 2 for all species of seals.

Parameter calculation

Pregnancy rate is measured as the presence or absence of an embryo or foetus during the pregnancy period in mature females (mature = presence of an ovarian Corpus luteum).

It is expressed as:
Percent pregnant females of the number of all mature females (age 4-20 years in seals) investigated during the seasons when *Corpus Luteum* or foetus is present

Grey seals

Pregnancy rate is measured as presence or absence of a foetus in the pregnancy period in 6-20 year-old seals. GES compliance based on data is proposed to be evaluated every third year (pooling the data for each 3-year period) for 6-20 years old females.

Current data suggest that pregnancy rates exceed 90% in 6-20 year-old females referring to the period 2001-2009. The GES-boundary at 90% is believed to be representative of a healthy population (Figure **1**). Data should also be tested for trends in a time series.

Ringed seals

Life history data is similar to grey seals (Harding et al 2007), which would imply that the GES for ringed seals should be similar to that of grey seals. The GES-boundary of 90% is tentatively suggested, also in this species until proven false. Age classes to be included in the analysis should encompass 6 years and older.

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 GES-boundary at 90%, the age classes to be included are females 5 years and older.

Harbour porpoise

To be included.

Management units and assessment units

The existing management plans for seals operate based on management units that are derived based on the distribution of seal populations. The management units typically encompass a handful HELCOM Level 2 assessment units, i.e. sub-basins. Evaluations of assessment units is therefore done by grouping HELCOM assessment units to align with the management units defined for each seal population.

- The Baltic grey seal is a single management unit, although genetic data show spatial structuring (Graves 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 represent two different management units. This subdivision 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).
- 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 as compared with other harbour seal populations.
- Southwestern Baltic (Danish Straits, Danish, German, Polish Baltic and the Öresund region including Skåne county in Sweden) harbour seals. This stock is genetically distinct from adjacent populations of harbour seals (Olsen et al. 2014) and should be managed separately.
- 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

Policy Relevance

The Baltic Sea Action Plan has the ecological objective 'Viable populations of species' with the 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 the indicators GES-boundary 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 EU Marine Strategy Framework Directive requires, inter alia, assessments for the state of biodiversity (Descriptor 1), food webs (Descriptor 4) and effects of hazardous substances (Descriptor 8), with specific criteria for population status and productivity (EC Decision 477/2010). Marine mammals were recognized by the MSFD Task Group 1 as a group to be assessed.

The EU Water Framework Directive (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. In line with both the OSPAR Convention and the Marine Strategy Framework Directive, the Helsinki Commission (HELCOM) in its HELCOM CORESET project is developing a framework using indicators for the Baltic ecosystem. 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 seals 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 anthropogenic impacts. These impacts can affect fish stocks, levels of harmful substances as well as direct mortality in form of hunting or by-catches. The vulnerability of seals to these pressures makes them good candidates for measuring the environmental status of ecosystems.

Ecological background to the indicator approach

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 fertilisation or early abortions reduce annual pregnancy rates. Mean pregnancy rates rarely reach 0.96 in samples of reasonable sizes in American (Boulva and 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 our seal species (e.g. Heide-Jørgensen et al. 1992) and another factor that will decrease mean pregnancy rates is senescence (Heide-Jorgensen et al 1992), however due to annual mortality rates, a only a small fraction of the population becomes older than about 20 years old. Further, extrinsic factors will reduce pregnancy rates. In evaluating changes in mean pregnancy rate among years in the 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. The HELCOM core indicator 'Trends in Abundance of Marine Mammals' 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 decline, 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 (Kjellqwist et al. 1995, Harding and Härkönen 1999). 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 (Kjellqwist 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 characters in the PCB scandal. The mean level of PCB in seals from the northern Baltic proper was about 450 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 and 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 mink (*Mustela 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 industrialisation 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 parts per million (PPM) lipid, while the heavily industrialised and enclosed St Lawrence Estuary show concentrations 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 polychlorinated biphenyls (PCB) (Helle 1979, Bredhult et al., 2008).

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 the examined Baltic ringed seals still suffer 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). There are no observations or reports of uterine obstructions in Baltic harbour seals or harbour porpoises.

It is important to distinguish between pregnancy rate, pup production, and the role of pregnancy 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 and Harding 2001, Harding et al. 2005). Winter survival in the young of the year was highly dependent on the autumn weight. Consequently, pregnancy rate is an important indicator of status, but in evaluations for population consequences also other information is needed.

Grey seals

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 (Figure **1**). Thus, a pregnancy rate of 88% pregnancy seems to be normal in 4-20-year old Baltic grey seals (Figure **1** and Figure **2**). This rate is also close to the pregnancy rate of Northwest Atlantic grey seals older than five years.

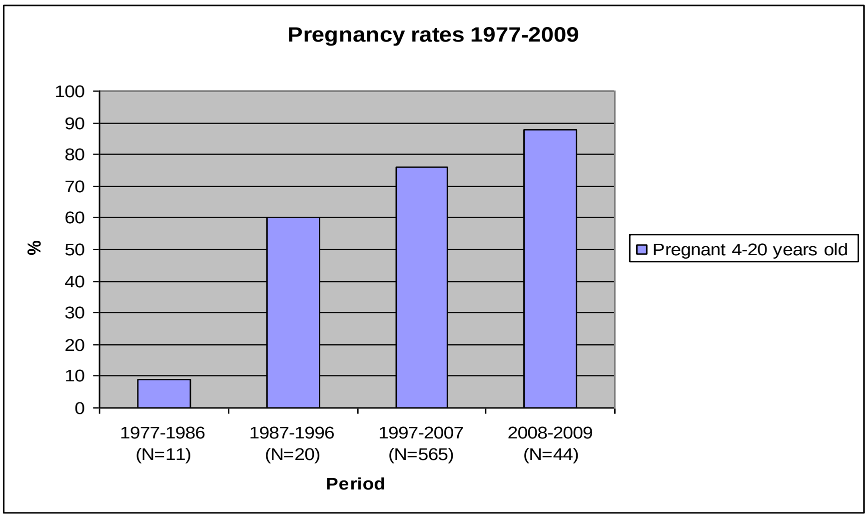


Figure 1. Pregnancy rate in 4-20-year old female Baltic grey seals (August to March). Finnish data is included in the period 1997-2007.

The pregnancy rate for the 4-5-year old individuals is 65% and for the 6-20-year old individuals is 95.5% among hunted and by-caught grey seals in 2002-2009 in Sweden (Fig. 3).

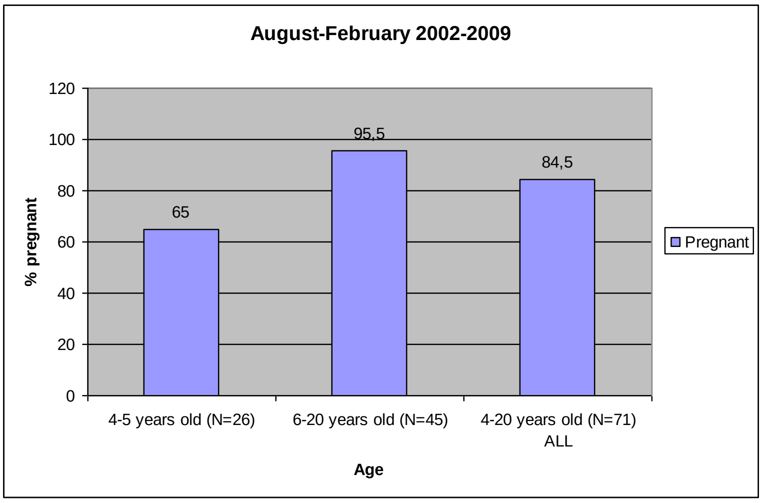


Figure 2. Pregnancy rate in 4-6 year-old females (first column), 6-20 year-olds (second column), and all age classes 2-20. Based on by-caught and hunted seals during 2002-2009. .

About 4-13 dead grey seal females at the ages between 4 - 20 years are collected annually in Sweden during the pregnancy period. If the females are divided into younger and older, the annual Swedish contribution will be further reduced. However, the GES should be based on females older than 6 to avoid effects from young females with late sexual maturity. Consequently, GES boundaries should be based on material sampled from age classes 6-20.

Ringed seals

The annual number of investigated 4-20-year old Baltic female ringed seals and Baltic harbour seals during the pregnancy period is very small. In Figure **3**, pregnancy rate of a total number of 19 ringed seals examined 1981-2009 is shown. 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 single ringed seals are still suffering from uterine occlusions.

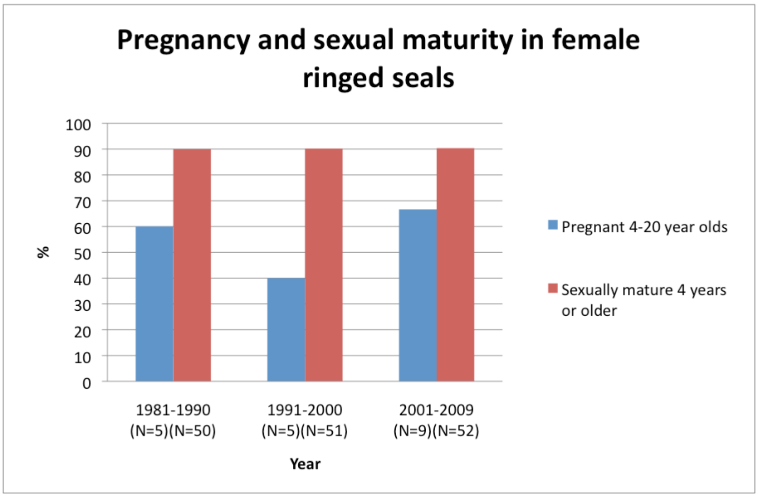


Figure 3. The prevalence of pregnant (females blue columns) sampled in the implantation period August to February (Kunnasranta 2010). Proportion sexually mature (red columns) encompass females with presence of *Corpus luteum* (4 years or older) sampled year round in Finland and Sweden.

Harbour seals

Large data sets were collected during the 1988 and 2002 PDV-epidemics that killed thousands of harbour seals. Pregnancy rates were determined either by signs of late abortions or the presence of a CL (Heide-Jorgensen and Härkönen 1992). The pregnancy rate was found to be 94% in the 59 females older than 5 year that were sampled, and three of the four females older than 25 years and senescent. This data set can be used to establish a GES-boundary, and there are many samples available from the 2002 PDV epidemic as well as from later years in Sweden. This material and data 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 and the Kalmarsund.

Results and confidence

Grey seal

The observed pregnancy rate is exceeding the GES boundary of 90% (Figure **2**), and does not deviate from GES regardless of which statistical tool is used. Consequently, the Baltic grey seal will attain GES with regard to pregnancy rate (Figure **4**).

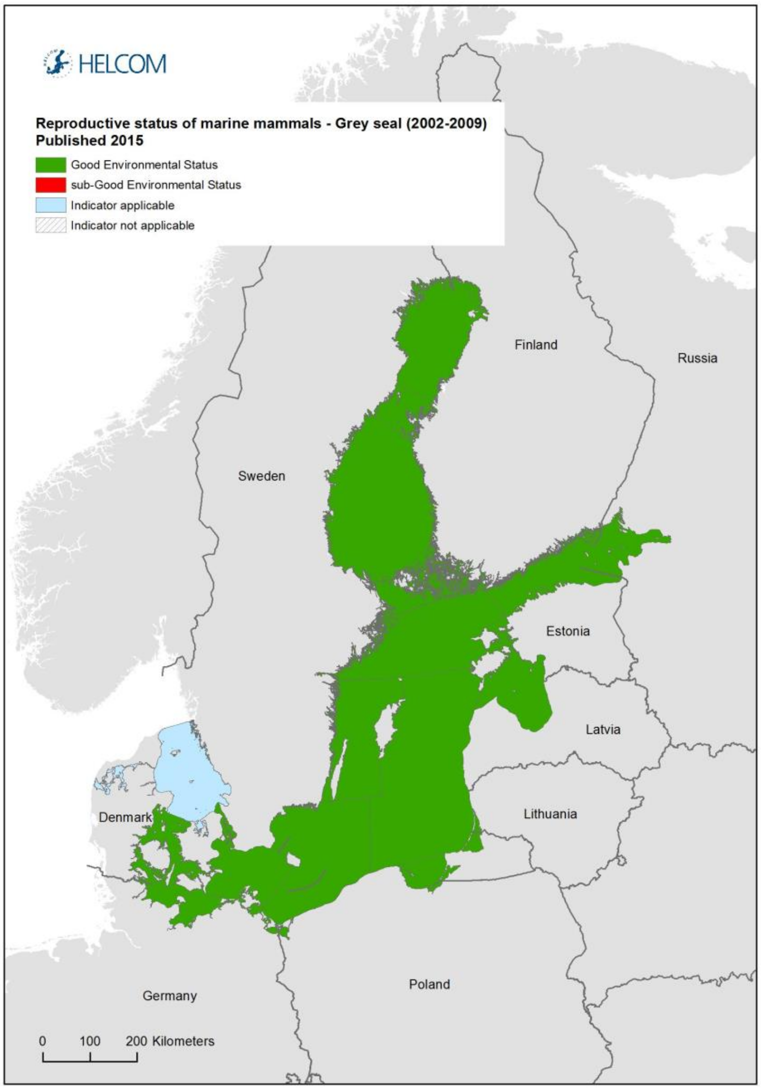


Figure 4. Baltic grey seals attain GES with regard to pregnancy rate.

Ringed seal

The GES boundary at 90% is not met, but data is confined to 9 females of which 6 were pregnant. Such a low number is insufficient for evaluating this indicator for ringed seals.

Harbour seal

The GES boundary is set at 90% also for harbour seals, as data from 1988 show that the pregnancy rate was very high at the time. Current data is available and will be tested for GES in the near future.

Confidence of the indicator status evaluation

Considerable and sufficient material is collected annually for grey seals in Finland and Sweden, so confidence is high for this species in the central and northern part of the Baltic. The samples also include Swedish material from the southern Baltic, but it would be desirable to include samples from Denmark, Germany and Poland.

Confidence is low for ringed seals since data is insufficient. Data on post reproductive signs might be one way to determine “birth rate” but not “pregnancy rate” in ringed seals in the future, since more date are available from the pre implantation period.

High confidence will be achieved for harbour seals in the Kattegat. Material is collected annually, but need to be compiled and analyzed.

Monitoring requirements

Monitoring methodology

HELCOM common monitoring of relevance to the indicator is described on a general level in the HELCOM Monitoring Manual in the sub-programme: Seal health status.

The monitoring methodology is described in detail in Bäcklin et al 2013:

Description of optimal monitoring

The optimal monitoring should encompass sufficient numbers of samples from all species of seals in all areas where they occur. Sufficient material is collected for grey seals in the central and northern Baltic, but it would be important to include more material from the southern Baltic for analyses of regional differences.

Current monitoring

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.

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

Description of data and up-dating

Metadata

Initiatives have been taken to compile national data is compiled 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 data bases. The health team of the HELCOM seal expert group is currently given the responsibility to compile, store current national data, and investigate future arrangements for establishing a HELCOM database.

Publications and archive

Contributors

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Archive

2013 Indicator report (pdf)

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