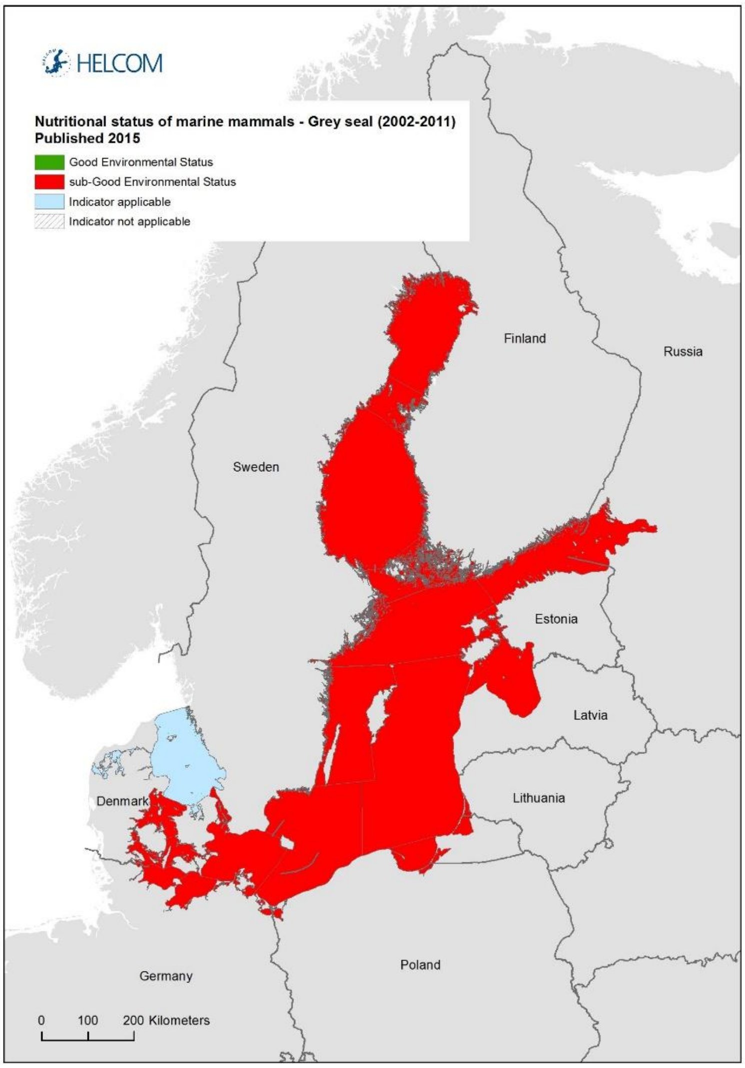
HELCOM core indicator report
December 2015

Nutritional status of marine mammals

Key Message

This core indicator evaluates the status of the marine environment in terms of nutritional status of marine mammals as it signals short term changes in food supply for the seals. Good Environmental Status (GES) is achieved when the blubber thickness is above the defined GES boundary which reflects good conditions. The current evaluation is based on data on grey seals from 2002-2011. In order to be applicable in the whole Baltic Sea area, the indicator includes all species of seals that occur in the Baltic Sea, however data have so far been insufficient for evaluations using the other species.



Key message figure 1: Status assessment results based on evaluation of the indicator 'nutritional status of marine mammals'. The assessment is carried out using Scale 2 HELCOM assessment units (defined in the HELCOM Monitoring and Assessment Strategy Annex 4). Click to enlarge.

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 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 do not achieve GES with regard to nutritional status when evaluated as one single population in the entire Baltic Sea.

Ringed seals occur in the Bothnian Bay (which is one management unit), and the Gulf of Finland, Archipelago Sea, Gulf of Riga and Estonian coastal waters (which is a second management unit). The status of ringed seals is evaluated for two management units. The ringed seal nutritional status is suggested to be declining. GES boundaries are not established yet.

Harbour seals are confined to the Kalmarsund, Southern Baltic Sea, the Kattegat and the Limfjord, all of which are separate management units. The Kattegat and Limfjord subpopulations may be approaching carrying capacity since the annual growth rates are levelling off. GES boundaries with regard to blubber thickness are not finally determined.

Harbour porpoises are evaluated in two management units; the Baltic proper and the Kattegat including the Danish Straits.

Confidence of the indicator evaluation for grey seals is considered to be high.

The indicator is applicable in the waters of all the countries bordering the Baltic Sea as the indicator includes all marine mammal species that occur in the Baltic Sea and since at least one of the species occurs in all HELCOM assessment units.

Relevance of the core indicator

Marine mammals are top predators of the marine ecosystem and good indicators for the state of food webs. Marine mammals accumulate fat soluble 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, incidental catches and disturbance.

Distributions of different 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 the nutritional status of marine mammals occurs in all countries where stranded, incidentally caught or hunted seals are collected.

Blubber is the energy storage of seals and a reduction in blubber affects reproduction and survival of individual seals and thus gives an early warning of declines in population trends. Blubber thickness responds to short-term variations in the environment and is a versatile indicator that complements the population trend and pregnancy rate indicators.

Policy relevance of the core indicator

	BSAP segment and objectives	MSFD Descriptor 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-web 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
Other relevant legislation: In some Contracting Parties also EU Water Framework Directive – Chemical quality, Habitats Directive		

Cite this indicator

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

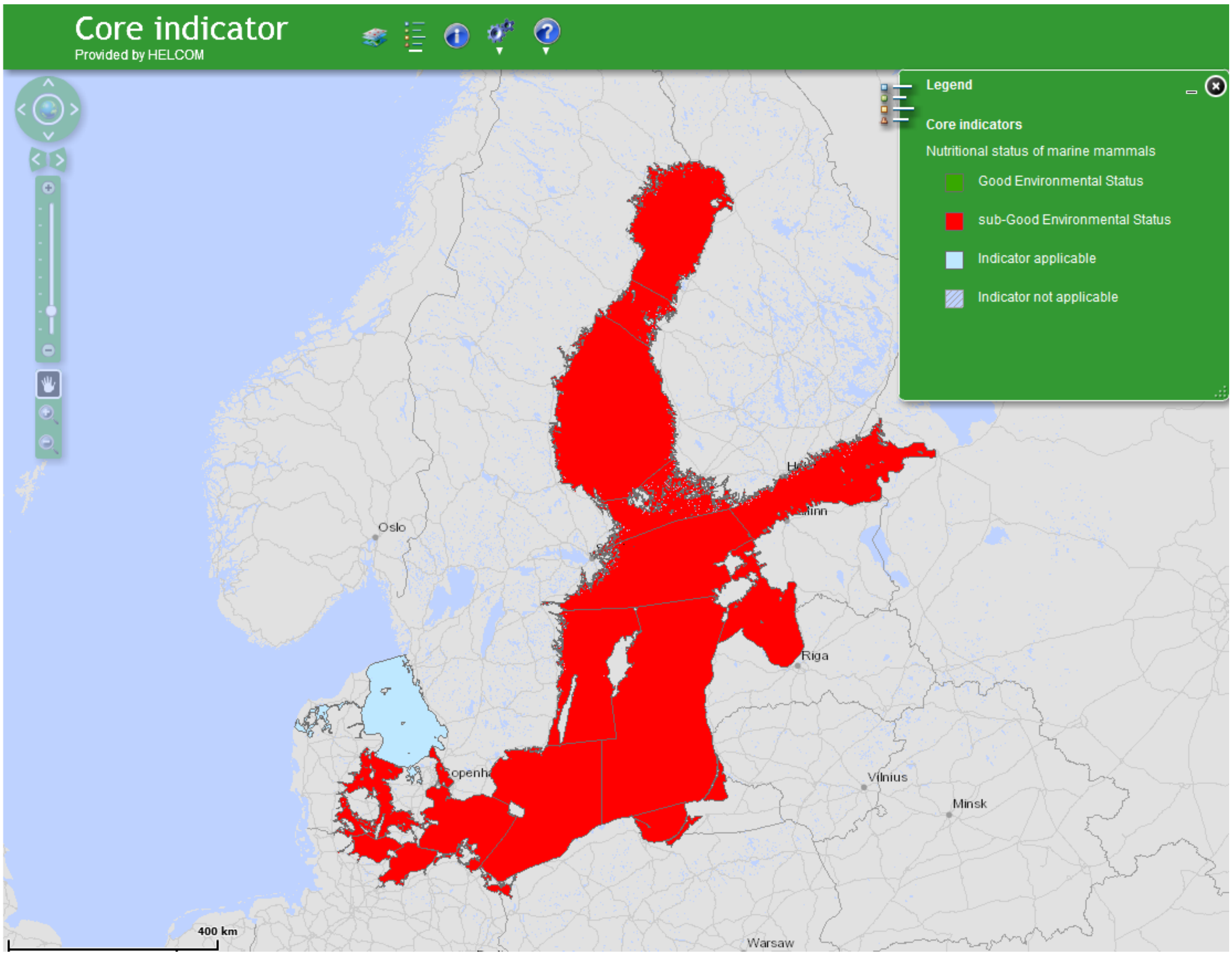
Extended core indicator report – outcome of CORESET II project (pdf)

Results and Confidence

Processed data on blubber thickness is only available for grey seals, hence the present indicator evaluation only covers this species. Currently, the results are based on combined Swedish and Finnish data but in future evaluations will include also German, Estonian and Polish data.

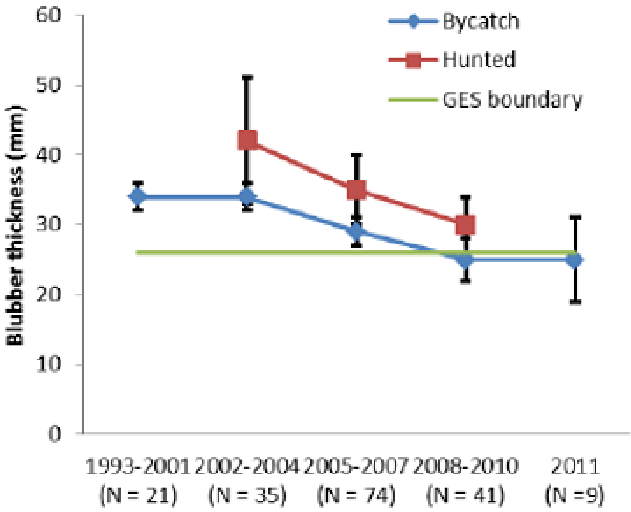
Grey seal

The current evaluation of the nutritional status of grey seals, which treats grey seals as a single population in the entire Baltic Sea, indicates that Good Environmental Status (GES) is not achieved (Results figure 1).



Results figure 1. Baltic grey seals do not attain GES with regard to nutritional status, since observed data fails the blubber thickness GES limits of 40mm for hunted seals and 35mm for by-caught seals. However, current data suggest that grey seals are approaching the carrying capacity of the system, where the GES boundary of 25 mm is applicable.

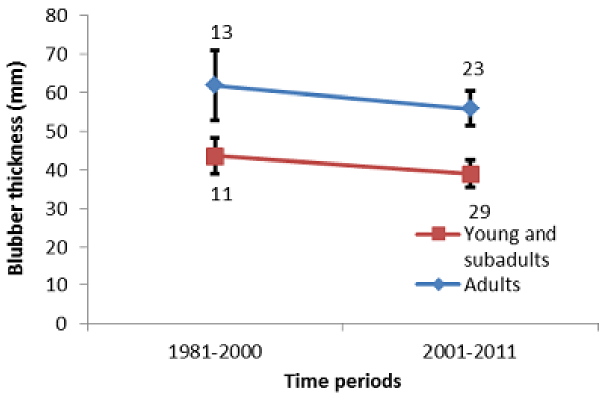
A strict Bayesian analysis has not been carried out yet, but it is evident that such an analysis would support that GES has been achieved for the time periods 1993-2001 and 2002-2004, whereas the status would be sub-GES for data from 2008 and later for both hunted and by-caught grey seals (Results figure 2), when tested against the GES boundaries (40 and 35 mm for hunted and by-caught seals respectively) for populations experiencing exponential growth. However, it is suggested that GES would be attained in both cases when testing against a GES boundary of 25mm (which is applicable in populations close to carrying capacity). Decreasing blubber thickness in both hunted and by-caught grey seals are statistically significant.



Result figure 2. Grey seals. The mean fall/winter blubber thickness ± SD in examined 1–3 years old non-pregnant by-caught (1993–2011) and hunted (2002–2010) grey seals in Sweden. All were by-caught or shot between August and February. The decrease is significant ($p<0.002$). N is the number of investigated animals. Green denotes the GES boundary for populations at carrying capacity.

Ringed seal

Although data are still too scarce to establish a GES boundary for ringed seals, data indicate that also the nutritive condition of ringed seals is deteriorating (Results figure 3). Decreasing blubber thickness is seen both in juveniles and adults.



Result figure 3. Ringed seals. The mean fall/winter blubber thickness ± 95% CI in examined 1–3 and 4–20 years-old animals (bycaught or shot). GES boundary has not been agreed but suggested as 35.6 mm and 51.4 mm for young and adult, respectively. Number of samples is given beside the means.

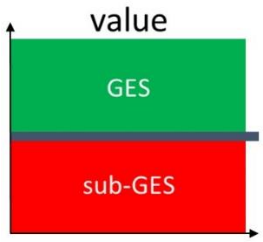
Confidence of the indicator status evaluation

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

High confidence for grey seals is supported by earlier studies which have shown that the autumn/winter blubber thickness has decreased significantly in Baltic grey seals since the beginning of 2000s, especially in 1-4 year-old seals from by-catch and hunt (Bäcklin et al. 2011). This decreasing trend has also been observed in young Baltic ringed seals (Kunnasranta 2010). There could be several reasons for a thin blubber layer in the autumn/winter season, e.g. disease, contaminants, decreased fish stocks and change in diet, or a change in the quality of the diet. The reason for the decreasing trend in blubber thickness in seals is unknown but so far no correlations to disease have been found. Data is still scarce for ringed seals in both management units, resulting in low confidence in the evaluation results for this species. For harbour seals material is collected annually, but needs to be compiled and analyzed further.

Good Environmental Status

For grey seal, Good environmental status (GES) is achieved when blubber thickness is at least 40 mm (for hunted seals), 35 mm (for incidentally caught seals) or 25 mm (if the population is assessed to be at carrying capacity).



Good environmental status figure 1. GES is achieved when blubber thickness is at least 40 mm (for hunted seals), 35 mm (for incidentally caught seals) or 25 mm (if the population is assessed to be at carrying capacity).

The concept for defining a Good Environmental Status (GES) boundary for nutritional status 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 Sea.

The GES boundary for nutritional status is defined based on what is considered to be a good condition in the current environment. As historical data on the nutritional status of marine mammals that could be used to set a baseline in pristine conditions are not available, a modern baseline approach to set the GES boundary is used instead. This is aligned with the approach used in OSPAR (Commission for the Protection of the Marine Environment of the North-East Atlantic), where baseline levels are set at pristine conditions 'where influence of human impact is minimal', or alternatively, a 'modern baseline when the former isn't applicable'.

Good environmental status table 1. GES boundary values set for grey seals applicable in the entire Baltic Sea.

	GES boundary value	
Samples from	**Populations undergoing exponential growth**	**Populations at carrying capacity**
Hunted seals	40 mm blubber	25 mm blubber
Incidentally caught seals	35 mm blubber	25 mm blubber

To set the GES boundary for grey seals, data on blubber thickness during the period 2001-2004 represents the first available data and is used to form a modern baseline for the GES-boundary concept for populations undergoing exponential growth. Indicator evaluations can be based on animals of ages 1-4 to increase sample size. The GES boundary value is set at 40 mm blubber for samples from hunted seals and 35 mm blubber for incidentally caught seals. The GES boundary is applicable in the entire Baltic Sea. At least initially, data from 1-3 year old grey seals of both sexes are used in this indicator (for more information, see the section 'Selection of appropriate data' in the Assessment Protocol). GES boundaries are defined for two scenarios: for populations under exponential growth and for populations at carrying capacity.

Since all growing populations eventually approach the carrying capacity of the ecosystem, vital population parameters will change (see Relevance of the indicator). Nutritional status of seals will deteriorate as a natural consequence of limited food supply and pups of the year and sub-adults (1-3) are the first segments to be affected. This is a natural process, and GES boundary values set for populations under exponential growth are not applicable. To set GES boundary values for populations at carrying capacity thermoregulatory constraints are helpful, since lean seals will have severe problems compensating for heat loss during the winter (Harding et al. 2005). The GES boundary for seal populations at carrying capacity in the whole Baltic Sea is set at 25 mm blubber for both hunted and incidentally caught seals, since leaner seals in both categories will have increased risk for not surviving the winter.

Nutritional status is an important aspect of health, affecting somatic growth, age at sexual maturity, fecundity, age specific mortality as well as vulnerability to parasites and diseases. Although approaches such as body mass index (BMI) have been developed for humans, no GES boundaries are available for nutritional status of animal populations, although several studies have shown that seals are in poor condition (Kjellqwist et al. 1995), or that lean seals show increased mortality (Harding et al. 2005).

The aim is to assess GES by evaluating the nutritional status of all marine mammals present in the Baltic Sea, including the harbour porpoise. However, at this stage insufficient data have been available to derive appropriate GES boundaries for species other than grey seal.

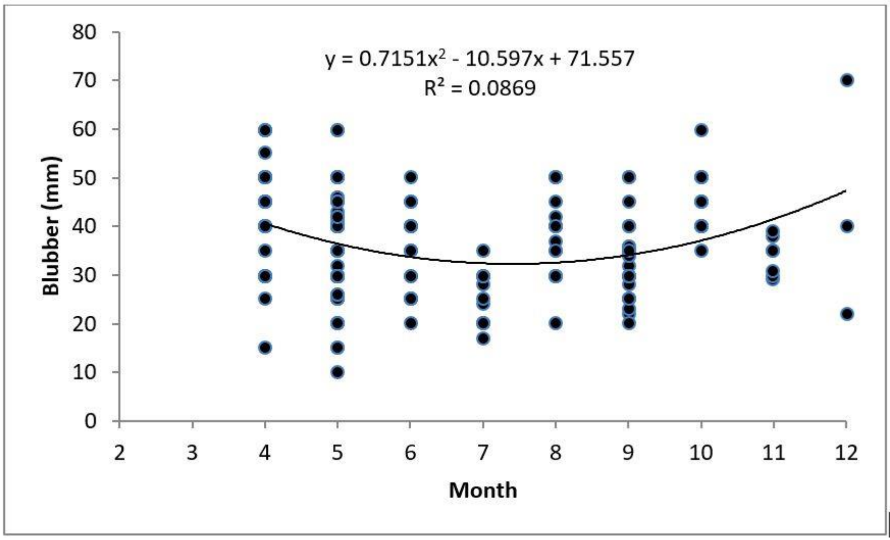
Assessment Protocol

Each management unit is evaluated against two sets of GES boundaries, the GES boundary for exponentially growing populations and the GES boundary for populations at carrying capacity of the system (see Good environmental status table 1).

Treatment of data

Currently, this core indicator assesses the nutritional status of only grey seals due to limited data for other marine mammal species. The Baltic grey seal population has been growing exponentially since the mid 1980's at about 8% per year, and are thus considered not to have reached carrying capacity. The analysis is made using samples from sub-adult grey seals (1-3 years old).

The blubber thickness of 1-3 year old grey seals shows a seasonal flux as illustrated in Assessment Protocol figure 1. A polynome fitted to data can be used to merge data from all months, by recalculating each data point to the month of October (Assessment protocol figure 1). This month was chosen because the fit of the polynome is less affected by outliers here compared with end points (April and December), and that there is a reasonably amount of data in October. The mean of all data in Assessment protocol figure 1 recalculated to October is 39.1 mm (SD 9.9mm). Using this approach, data can be used in this analysis regardless of which month the sample is taken.



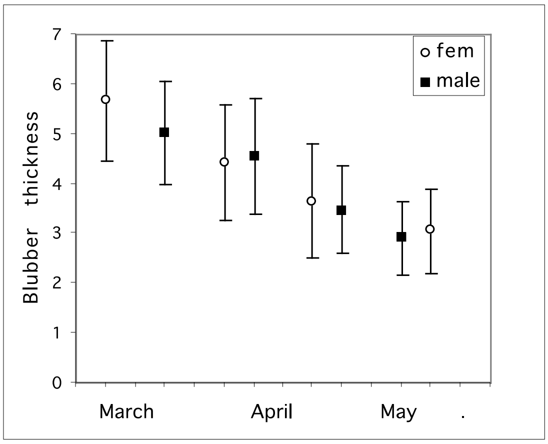
Assessment protocol figure 1. Seasonal changes in blubber thickness of 1-3 year-old hunted grey seals, and the fitted polynome where x is the month of the year that is used to transform blubber samples to be comparable to the situation in October. (Combined Swedish and Finnish data, n=210).

Observed data is merged for 3-5 year intervals, depending on sample size, to be used as input values in Bayesian analyses with uninformative priors, where it is evaluated if observed data from an assessment unit achieve the GES boundary value. In this process, 80% support for a growth rate ≥ GES is required. If the unit fails GES, the probability distribution is used to evaluate the confidence of the evaluation. The package Bayesian in the program R is used in the analysis.

Selection of appropriate data

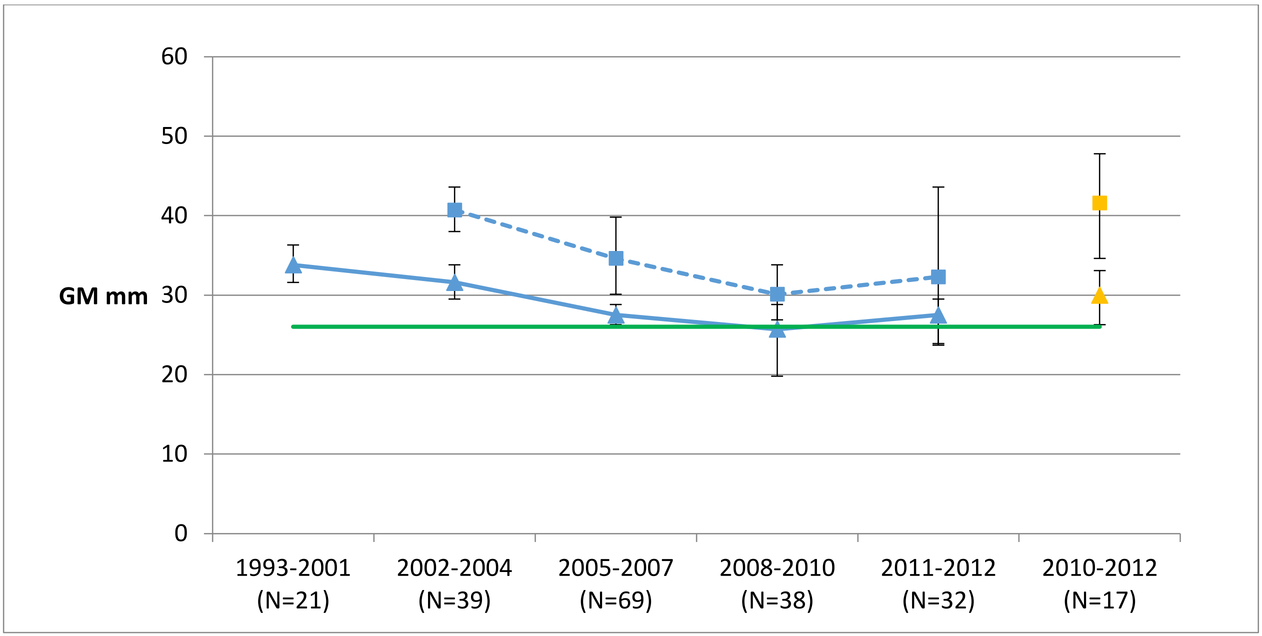
The selection of appropriate data has been developed for grey seals, for which the data availability is sufficient. Other species can be included in the future. The data used is collected opportunistically from seals hunted for other purposes as well as incidentally caught seals in the fisheries.

The flux in blubber thickness is dependent on age and sex of the seal, where adult females are expected to show the greatest seasonal variation since they spend all their energy during lactation. However, also adult males spend much energy during reproduction, with substantial individual variation depending on size and rank of the male (Assessment protocol figure 2). In this approach, a population segment that is least affected by reproductive activities is to be used, i.e. sub-adult seals of ages 1-3. In this segment energy intake is only used for metabolism, locomotion, somatic growth and storage of energy. There is a seasonal flux in blubber thickness also in this segment (Assessment protocol figure 1) but much less pronounced than in adult seals. The age at sexual maturity is not a fixed parameter, and changes over time depending on fluctuations in e.g. food availability. An example of this is the Antarctic crabeater seals where a change from 3.7 to 6.3 years occurred within a couple of decades (Hårding and Härkönen 1995). However, the 1-3 year segment will still be comparable among years.



Assessment protocol figure 2. Decline in blubber thickness in Baltic ringed seals during spring. Data from the hunt (n=723) Olofsson 1930.

To be functional, an indicator must be sensitive enough to detect inter-annual variations, and be applicable in the entire area of distribution. A significant decrease in blubber thickness from 45 mm to 35 mm in seals hunted in the autumn in a 9-year long time series (2002-2009) of sub-adult grey seal (Assessment protocol figure 3). Incidentally caught seals are leaner, but also display a similar trend, here blubber thickness decreased from 35 mm to 25 mm in this category of seals. Thus, both hunted and incidentally caught seals provide useful information on changes in nutritive condition.



Assessment protocol figure 3. The mean annual blubber thickness ± SD in examined 1-3 years old non pregnant grey seals incidentally caught (triangle) and hunted (square) from Sweden (blue) and Finland (yellow). All were incidentally caught or shot between August and February (Bäcklin et al. 2013). The green line shows GES at carrying capacity.

Assessment units

This core indicator evaluates the nutritional status of marine mammals 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.

For the current indicator evaluation, grey seals spatial units in the Baltic Sea have been merged and are treated separately from the Kattegat and Limfjord unit.

- The Baltic grey seal is a single management unit, although genetic data show some spatial structuring (Fietz et al. 2013). Data is available both from land-based surveys starting in the mid-1970s and later aerial surveys.
- 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 the 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 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).
- 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 nutritional status of marine mammals, 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 nutritional status of marine mammals 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 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 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' and

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'

and the following criteria of the Commission Decision (European Commission 2010):

- Criterion 1.1 (species distribution)
- Criterion 1.2 (population size)
- Criterion 1.3 (population condition)
- Criterion 4.1 (Productivity of key species or trophic groups)
- Criterion 4.3 (abundance/distribution of key trophic species)
- Criterion 8.2 (Effects of contaminants)

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

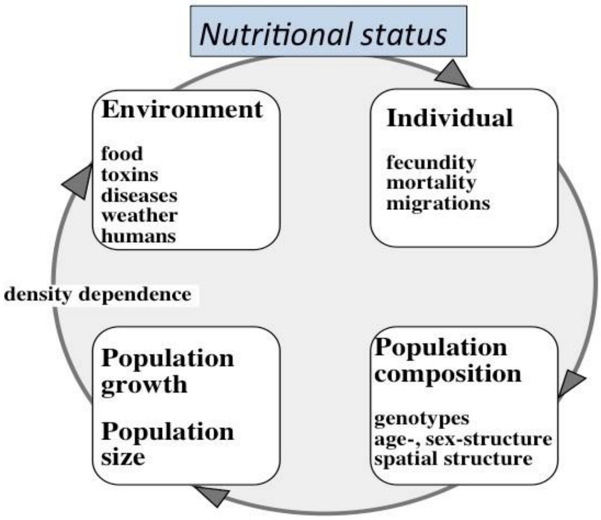
In some Contracting Parties the indicator also has potential relevance for implementation of the EU Water Framework Directive (WFD, Chemical quality) and Habitats Directive. The WFD includes status categories for coastal waters as well as environmental and ecological objectives, whereas the EU Habitats 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 as well as direct mortality caused by hunting or incidental catch. The vulnerability of seals to these pressures makes them good indicators for measuring the environmental status of ecosystems.

The nutritional status of seals can be regarded as a direct link between the environment, individual fitness and population growth rate (Relevance figure 1). Seals fight a constant struggle to reach a critical limit of fat storage each autumn (Relevance figure 2). Failure to reach this level will result in failed reproduction in adults and high mortality in juveniles. Ecosystem effects (e.g. reduced food supply) are readily visible in the blubber layer in a few weeks or months. If poor nutritive conditions persist for a prolonged time period also total body growth rate during the sub-adult ages declines and eventually the asymptotic adult body lengths of the entire population decline. This results in later age at sexual maturity, smaller females that can transfer less energy to their pups, which will have reduced chances of survival. All this will have dramatic effects on the population growth rate and health of the population. The latter because leaner seals are more exposed to parasites, but also to diseases.

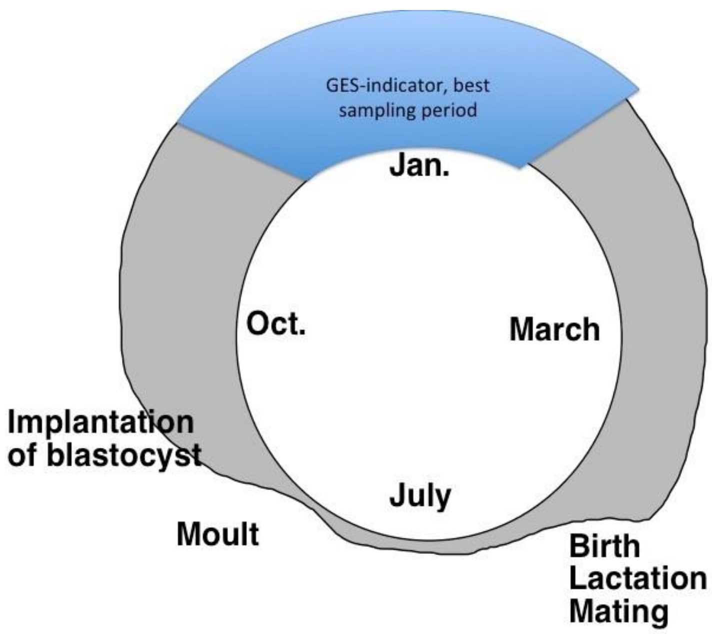


Relevance figure 1. Seal population dynamics is linked to the rest of the ecosystem through individual fitness which in turn is determined by the nutritional status of individuals.

The nutritional status of seals reflects many processes in the Baltic Sea ecosystem, especially abundance of different fish stocks. It also reflects levels of pollutants and other stressors, since diseased animals also lose in body condition. Baltic seals' nutritional status acts as an early warning when new hazardous substances begin to accumulate in the food chain since they are at the top of the food chain and are likely to first show symptoms, as was the case with PCBs in the 1970s (Bergman & Olsson 1986).

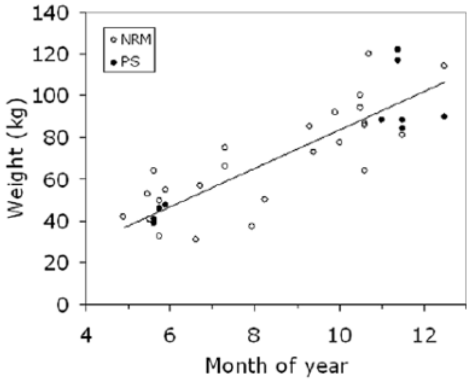
Ecological background to the indicator concept

The three seals included in this indicator description are all *phocid* seals that have a life history where they rely on stored fat reserves for over-winter survival and for reproduction. Their pups are lactated during a few weeks in the spring (grey and ringed seals) or summer (harbour seals) and female weight loss during this short period is massive, up to 30-50% of total body weight (Kovacs & Lavigne 1986; McCann et al. 1989; Haller et al. 1996). During summer and autumn, seals intensively search for prey to build up their fat reserves (Relevance figure 2; Nilssen et al. 1997; Hauksson 2007). Failure to reach a critical fat reserve in late autumn results in decreased survival and failed reproduction. Thus food abundance and other factors that influence feeding success during the autumn are important. Blubber thickness is one vital component of most measures of nutritional status and is most informative during late autumn and winter at its annual maximum. Also body length and weight at age are important parameters to monitor year round for evaluation of nutritional status (examples below).



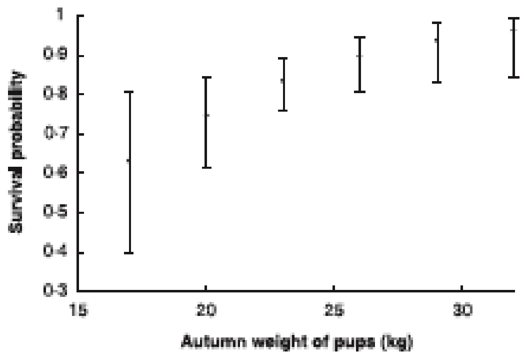
Relevance figure 2. Schematic figure of the blubber thickness during the life cycle of an adult harbour seal in the Baltic Sea and Kattegat. The grey circle illustrates the strong flux in blubber thickness that is connected to the indicated major 'life cycle events'. The figure would be similar if drawn for any true seal (*Phocidae*), if the months are rotated to fit the cycle for each population. The true size of the weight loss is exemplified in Relevance table 1. Modified from Harding 2000.

Grey seal females spend on average 85% of their energy reserves during lactation (Fedak & Anderson 1987). In harbour seal females the associated mean weight loss is about 40% (Härkönen & Heide-Jørgensen 1990), but females need to forage during the last weeks of lactation to successfully wean their pups. Loss in blubber thickness and weight in ringed seals during the breeding season is also dramatic (Figure 6).



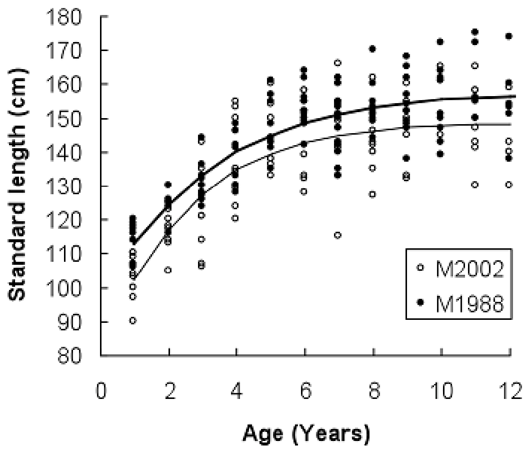
Relevance figure 3. Weight of ringed seal females caught in the open water season. Filled circles refer to data from a ringed seal satellite tag study, and open circles are data compiled from the seal database at the Swedish Museum of Natural History (NRM). A linear regression of pooled data (y = 9.16x27.97, R2 = 0.83) suggest that ringed seal females gain 9.2 kg per month from May up to December. Härkönen et al 2006.

A study on individually branded harbour seals also shows that winter survival in the young of the year was highly dependent on the autumn weight (Härkönen & Harding 2001, Harding et al. 2005). The range in survival was large, from 96% in well fed pups to only 65% in lean pups (Relevance figure 4). Similar fluctuations in life history parameters have also been observed in e.g. harp seals, Canadian harbour seals and ringed seals (Harwood & Prime 1978; Fowler 1981; Kjellqwist et al. 1995; Bowen et al. 2003; Kraft et al. 2006).



Relevance figure 4. Body weight in pups reflects nutritive conditions. First year winter survival of Harbour Seal pups in the northern Skagerrak is significantly related to their body mass in the autumn. Error bars denote 95% confidence limits for each given weight. From Harding et al (2005).

Nutritional status also affects body length, and just as in other mammals the nutritive condition during childhood affects the final adult body size after sexual maturation. Large decline in body length has been documented in harbour seals and harp seals during periods of limited food supply (Kjellqwist et al. 1995). There is, for example, a statistically significant difference at almost 10 cm in average adult mean lengths in the Kattegat-Skagerrak harbour seals collected during the last decades (Relevance figure 6).



Relevance figure 6. Overall body growth curves and final adult body length respond to food availability and stress and reflect the nutritive condition of seals over longer time periods (decades). In the graph above is an example from harbour seals at different population densities. In 2002 adults are 10 cm shorter on average due to higher population density.

For long-term trends, total body length can provide very important information. The benefit of length as a parameter is that available sample size is increased since all animals collected can be incorporated (all seasons, all sampling methods). An additional feasible parameter is pup weaning weight in grey seals, where reference data is available from repeated studies. For harbour seals pup autumn weight is a sensitive parameter (Harding et al. 2005) that could be elaborated in the future.

Human pressures linked to the indicator

	General	MSFD Annex III, Table 2
Strong link	Hunting Incidental catches Disturbance causing stress Ecosystem changes (food web, introduction of pathogens and non-indigenous species) Fishery and food availability	Biological disturbance: -selective extraction of species, including incidental non-target catches (e.g. by commercial and recreational fishing)
Weak link	Diseases Effects of climate change is a threat to the ringed seal that breeds on sea ice Boat traffic, hunting, under water noise, ice breaking	Contamination by hazardous substance: - introduction of synthetic compounds - introduction of non-synthetic substances and compounds

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).

Incidental catches are known to have substantial effects on the population growth rate in species like the Saimaa and Ladoga ringed seals (Sipilä 2003). The current knowledge on the level of incidental catches of Baltic seal species is limited to a few dedicated studies which suggest that this factor can be substantial. An analysis of reported incidentally caught grey seals showed that approximately 2,000 grey seals are caught annually in the Baltic fisheries (Vanhatalo et al. 2014), but numbers of incidentally caught ringed seals and harbour seals are not known. Both hunting and incidental catches will affect population density and thereby the nutritional status of seals via mechanisms described in the above section 'Ecological background of the indicator concept'.

Incidentally aught 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 incidentally 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 (also hunted) show a significant decline during the last decade (Bäcklin et al. 2011).

In the beginning of the 1970s grey seals were observed aborting near full term foetuses, and only 17% of ringed seal females were fertile (Helle 1980). Later investigations showed a linkage to a disease syndrome including reproductive disorder, caused by organochlorine pollution, in both grey seals and ringed seals (Bergman & Olsson 1986). This disease syndrome also included adrenocortical hyperplasia, reduced bone mineral density, loss of teeth, claw deformation (Bergman & Olsson 1986). These manifestations should have had severe effects on the general nutritive condition of seals.

Climate change poses a pressure on species breeding on ice because shorter and warmer winters lead to more restricted areas of suitable ice fields (Meier et al. 2004). This feature alone will severely affect the Baltic ringed seals and the predicted rate of climate warming is likely to cause extirpation of the southern subpopulations (Sundqvist et al. 2012). Grey seals are facultative ice breeders and their breeding success is considerably greater when they breed on ice as compared with land (Jüssi et al. 2008). Furthermore, the weaning weight of grey seal pups was substantially greater when born on ice as compared with land. When a larger proportion of the grey seal pups are born on land in the future, they will be leaner and experience greater juvenile mortality. Consequently, both ringed seals and grey seals are predicted to be negatively affected by a warmer climate.

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 the core indicator report from 2013.

Current monitoring

The monitoring activities relevant to the indicator that are currently carried out by HELCOM Contracting Parties are described in the HELCOM Monitoring Manual in the Monitoring Concepts 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.

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

Monitoring of harbour seals is sufficient, but more data 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 (2015) Nutritional status of marine mammals**.** HELCOM core indicator report. Online. [Date Viewed], [Web link].

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Metadata

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 indicator report was published in December 2015

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

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

Older versions of the indicator report are available:

2013 Indicator Report

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