Status of harbour seals *(Phoca vitulina)* in the Baltic proper

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ABSTRACT

The small population of harbour seals in the Baltic proper descend from seals that entered into the Baltic some 8,000 years ago. They form a genetically separate population with private alleles not present elsewhere. They were hunted close to extinction in the beginning of the 20th century and experienced a severe bottle-neck with perhaps only ten reproductive females in the 1970s. Protective measures and reduction of xenobiotic substances have improved the situation, and the hauled-out moulting population size was 588 in 2008, and about 100 pups have been born annually during the past few years. The protective measures in the form of banned hunting and establishment of protected areas will suffice to allow the population to grow, but the population will not reach favourable conservation status within foreseeable future.

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INTRODUCTION

The harbour seals in the Baltic proper, currently confined to a handful of sites in the Kalmarsund region in Sweden (Fig. 1), form a discrete population that is genetically distinct from adjacent populations in the southern Baltic and the Kattegat. It shows substantially lower genetic diversity in microsatellite loci (F_{ST} = 0.37) than other populations of harbour seals worldwide (F_{ST} = 0.48-0.60) (Goodman 1998), and is fixed for 3 unique mitochondrial haplotypes that are most closely related to a common haplotype in the central North Sea and Iceland, rather than the most common haplotypes in adjacent waters (Stanley *et al.* 1996).

Since harbour seals entered into the Baltic system in connection with the formation of the Littorina Sea 8,000 years ago (Härkönen *et al.* 2005), the genetic uniqueness of the population can only be explained by its being founded by harbour seals that later went extinct elsewhere. Kattegat and Skagerrak must have been re-colonised by harbour seals at a later stage from a different source population (Härkönen *et al.* 2005). The low genetic diversity is a consequence of stochastic loss caused by low population size and near complete isolation through much of its history (Härkönen *et al.* 2005).

As with other Scandinavian seals, this population was severely depleted by an extermination campaign in the beginning of the 20th century. Modelling based on hunting statistics shows that the minimum population size that could withstand the hunt must have exceeded 5,000 seals in the beginning of the 20th century (Fig. 2). Hunting caused a rapid decline in the 1920s and 1930s, and only some 200 seals remained at the end of the 1960s. Sporadic surveys of the population in the beginning of the 1970s showed that only 10-20 pups were born, indicating a severe bottle-neck caused by

Fig. 1. *Distribution of harbour seals in the Baltic proper.*

the hunt, and possibly also by impaired fertility that was prevalent among other species of Baltic seals (Bergman and Olsson 1986, Härkönen *et al.* 2005).

Here we account for the development of the population after regular surveys were initiated in the late 1970s, and discuss protective measures taken to ensure the future persistence of the population.

MATERIALS AND METHODS

Surveys from ground/boat started in 1973 in the Kalmarsund, but all main haulout sites (Värnanäs, Abramsäng and Eckelsudde) were first surveyed in 1977. Those surveys occurred predominantly during the pupping season in June and the moult in August. Surveys between 1977 and 1985 were mainly carried out by volunteers, whereas employed field assistants were responsible for the data collection from 1986 and onwards. Such ground surveys were conducted almost annually in June up to 2008. The data were evaluated such that the day with highest count during a season was used as an index of abundance. Surveys from the air have been carried out after 1999 in the period 13 to 20 August. A single engine Cessna Skyhawk was flown at about 150 m altitude over all sites where seals had been reported in the past. Photographs were taken of seals hauled out, and the photos were analysed afterwards. All sites were surveyed a minimum of 4 times, and the maximum number of counted seals during day was used as the index of abundance for each year.

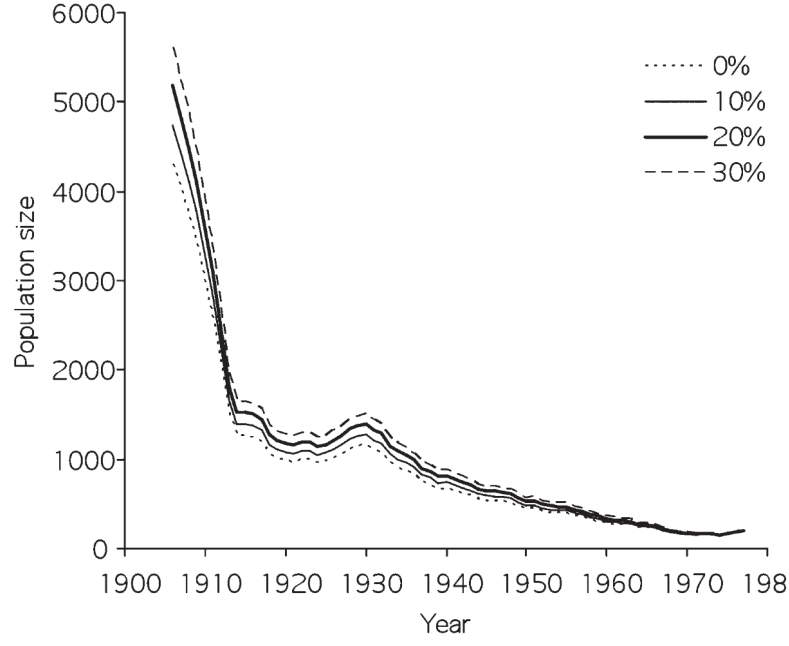

Fig. 2. *Model of the development of the harbour seal in the Baltic Proper as based on hunting statistics. The different lines show values at hunting losses ranging from 0%-30%. From Härkönen et al. (2005).*

RESULTS AND DISCUSSION

Current abundance

A rather constant number of close to 50 harbour seals was counted in the land-based moulting surveys in 1977-1985, after which numbers started to increase (Fig. 3). A basically steady increase at 8.9% per year is seen up to 2008, when 588 harbour seals were counted. The seals have been distributed at the 3 main sites Värnanäs, Abramsäng, and Eckelsudde, and evidently the proportion of seals at Värnanäs is in decline compared with the two other areas. New sites appear to have been re-colonised after 2004, mainly along the coasts of Öland (Össby and Ottenby), but also at mainland Sweden (S. Majör) (Fig. 1). Separating the periods 1986-1998, when seals were counted from land/boat, airborne surveys from 1999-2008 give basically the same annual trend - namely 9.3% and 9.2%, respectively.

Only about 10 pups were observed in the area in the 1970s, but numbers started to increase in the 1980s, and amounted to 100 in 2007 (Fig. 4). The mean annual rate of increase was 9%, which is similar to that of the hauled out population during the moult.

Adjacent depleted populations of harbour seals in the Kattegat and Skagerrak have grown by 12% per year after they were protected in the 1970s (Heide-Jørgensen and Härkönen 1988, Härkönen and Harding 2001). The mean rate of increase in the Kalmarsund population was 9% across the entire period, which is significantly less than in the western populations. However, basically no data is available for evaluations of possible causes for this reduction in growth rate, which can be caused by by-catches in fisheries, infertility, impaired nutritive status, etc.

Distribution in relation to pristine condition

Archaeological data show that the Baltic harbour seal has been confined to the southern Baltic ever since they entered into the Baltic some 8,000 years ago. There are no records of harbour seal remains north of a line Oskarshamn (Sweden) to Hiiumaa in Estonia (Harkonen *et al.* 2005). However, the species was distributed along the southern Estonian coast, Gotland, and southern Baltic including the current Polish, German, Danish and Swedish coasts. Harbour seals have subsequently disappeared from most of these areas and currently only remain in the Kalmarsund region.

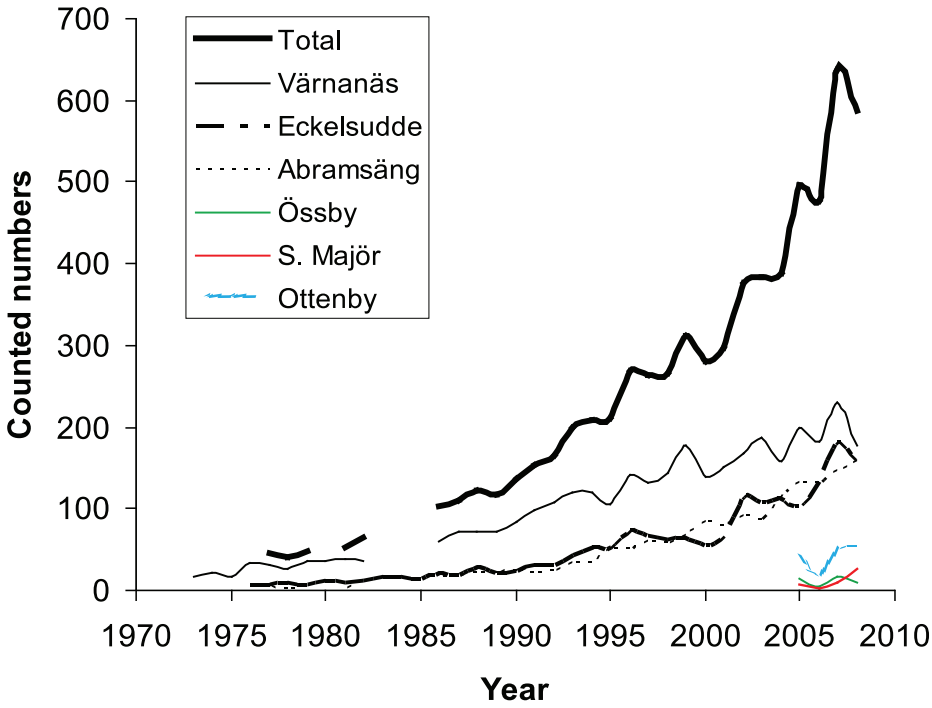

Fig. 3. *Numbers of counted harbour seals in the Kalmarsund region in Sweden. Mean annual growth rate over the period 1977-2008 was 8.9%. New sites such as Össby, S. Majör and Ottenby have been re-colonised in recent years.*

Population discreteness

Harbour seals show a high degree of spatial structuring and form 6 genetically distinct populations along the European coast lines: Iceland, Scotland-Ireland, East Anglia, the Wadden Sea, the Scandinavian west coast (including Norway, the Skagerrak, the Kattegat and the southern Baltic), and the Kalmarsund population in the Baltic proper (Goodman 1998, Andersen and Olsen 2010). The low genetic variation in microsatellite loci and the occurrence of private alleles in mitochondrial DNA indicate that the Kalmarsund population has been effectively isolated ever since it was founded. The lower degree of variation in microsatellite loci compared with mitochondrial DNA in combination with unique mitochondrial alleles also indicates a slight male-biased gene flow into the population (Goodman 1998, Härkönen *et al.* 2005). A male biased gene-flow in harbour seals is also consistent with behavioural data since adult females show a high degree of site fidelity and give birth to their pups at sites where they once were born (Härkönen and Harding 2001).

A high degree of isolation is also suggested by the fact that this population escaped the two pan-European phocine distemper epizootics in 1988 and 2002 that killed up to half of affected populations (Härkönen *et al.* 2006).

Anthropogenic interactions

The Baltic harbour seal has been hunted ever since the Stone Age, and remains at human settlements suggest that harbour seals constituted about 10% of all seals hunted in the southern part of the Baltic (Härkönen *et al.* 2005). Hunting caused the population crash in the beginning of the 20th century (Fig. 2), but infertility caused by organohalogen pollution could have contributed to the consistently low numbers in the end of the 1970s, since both ringed seals and grey seals showed severe impairment of their reproductive functions (Bergman and Olsson 1986). Harbour seals were likely affected in a similar manner, since experimental studies have shown that harbour seals feeding on fish from the Baltic become infertile (Reijnders 1986).

Since hunting of Baltic seals was prohibited in the 1970s, and protected areas were established, by-catches in fishing gear are currently the main factor affecting the harbour seals. However, no systematic information is available on by-catches of marine mammals in the Baltic, which is why the effect of this interaction is difficult to evaluate. Nevertheless, sporadic data suggest that in the 1990s some 20 pups were caught annually in fyke nets set for eel, but modified gear and changed structure of the

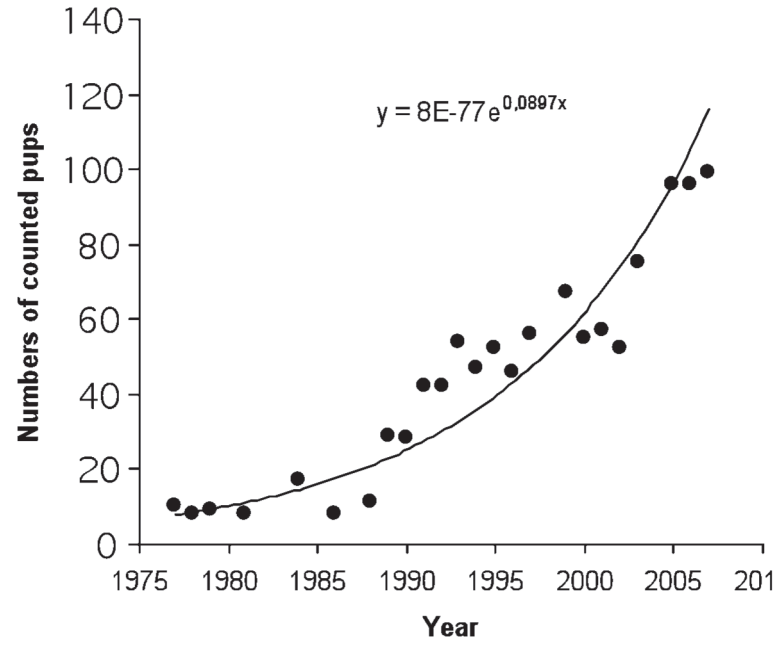

Fig. 4. *Pup production in the Kalmarsund harbour seal population 1977- 2007. The annual rate of increase was 9% per year, which is similar to that of numbers of seals hauled out during moult.*

coastal fisheries are suggested to have reduced by-catches.

The observed annual rate of increase at 9% per year also provides important information on the status of the population. Since the intrinsic rate of increase in harbour seal populations is 12-13% (Härkönen *et al.* 2002), and severely depleted populations have increased at rates close to those values (Härkönen and Heide-Jørgensen 1990), there is no obvious reason why harbour seals in the Baltic shouldn't follow a similar pattern. Consequently, the 3-4% reduction from the intrinsic rate of increase could be a result from by-catches, impaired fertility or a combination of the two. There is currently no information on the health status of the Baltic harbour seal population.

Future ambitions

The 2006 HELCOM seal recommendation states the following general management principles for Baltic seals: The long-term objectives for the management of Baltic seals are to achieve natural abundance and distribution and a health status that ensures their future persistence. And the Baltic Sea Action Plan further specifies "… 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 Baltic harbour seal is included in this list, but it is not likely to achieve favourable conservation status by 2015, since the low abundance will lead to continuing loss of genetic diversity, and the population is not likely to expand to its former area of distribution within the next decades.

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